Appendix D

Biological Technical Report Wildlife Damage Management Project

DRAFT

Biological Technical Report

Wildlife Damage Management Project

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Acronyms and Abbreviations

Acronym	Definition
AB	California Assembly Bill
APHIS	U.S. Department of Agriculture's Animal and Plant Health Inspection Service
amsl	above mean sea level
BBS	Breeding Bird Survey
BTR	Biological Technical Report
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game (currently CDFW)
CDFW	California Department of Fish and Wildlife (previously CDFG)
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
CSA	Cooperative Service Agreement
CWHR	California Wildlife Habitat Relationships
CY	calendar year
DPS	Distinct Population Segment
EIR/EIS	Environmental Impact Report/ Environmental Impact Statement
FAA	Federal Aviation Administration
FESA	federal Endangered Species Act
FP	Fully Protected
IUCN	International Union for the Conservation of Nature
MBTA	Migratory Bird Treaty Act
MIS	Management Information System
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRA	National Recreation Area
Proposed Project	Overall Wildlife Damage Management Project (includes state [CDFA] and federal [WS-California] activities)
SSC	Species of Special Concern
T&E species protection	threatened and endangered species protection
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
WDM	Wildlife Damage Management
WHM	Wildlife Hazard Management
WS	USDA-APHIS-Wildlife Services
WS-California	USDA-APHIS-Wildlife Services in the State of California

1 Introduction

1.1 Purpose of Report

The California Department of Food and Agriculture (CDFA) and Wildlife Services (WS-California), a state office within the U.S. Department of Agriculture's (USDA's) Animal and Plant Health Inspection Service (APHIS), entered into a Memorandum of Understanding in April 2017 to provide the framework for carrying out an integrated Wildlife Damage Management (WDM) Project (hereafter, Proposed Project) throughout the State of California. The CDFA has the responsibility to protect the agriculture industry across California, which encompasses the prevention of wildlife damage to agriculture, livestock, and various agriculture and public infrastructure (e.g., roads, water conveyance structures, buildings). Due to the unique system of agriculture protection in California, this responsibility is often carried out by the various counties through their relationship with the CDFA. For simplicity, and because the authority and responsibility at the county level comes from that authority and responsibility at the state level (CDFA), we will generally refer to the Proposed Project as a joint project; this should be understood to include the various counties as agents of the CDFA. WS-California is authorized to enter into Cooperative Service Agreements (CSAs) with counties, state and federal agencies, environmental groups, and private and public entities to perform WDM activities. Under the Proposed Project, these activities would be undertaken in a collaborative effort among WS-California, the CDFA, and California counties to prevent damage to agricultural resources, property, and infrastructure, protect natural resources, and protect human health and safety. WS-California also enters into CSAs with counties, state and federal agencies, environmental groups, and private and public entities to perform WDM activities to protect Threatened and Endangered species (T&E species protection), and to protect human safety at airports.

This Biological Technical Report (hereafter, BTR or Report) evaluates the potential impacts on biological resources associated with WDM activities performed by the CDFA and the various California counties under the Proposed Project as required by the California Environmental Quality Act (CEQA), and by WS-California as required by the National Environmental Policy Act (NEPA). This Report provides analyses of potential impacts to biological resources, including federally-listed and state-listed threatened and endangered species. The Proposed Project analyses are based on WDM data from the WS-California Management Information System (MIS) and county-provided data during the 10-year baseline period (Calendar Years 2010–2019; USDA 2022b).

1.2 Study Area

Counties (under the authority of the CDFA) and WS-California would conduct WDM activities as part of the Proposed Project upon request, throughout the State of California. The actions described could be conducted on private, federal, state, tribal, and municipal lands in California, including but not limited to unincorporated county lands, cities, airports, tribal lands, and military lands. The analyses in this Report are intended to apply to actions taken under the selected alternative that could occur in any locale and at any time within the analysis area. Therefore, the Proposed Project study area includes the entire State of California (Figure 1) and potential environmental impacts to species' state populations will be examined in this Report and the EIR/EIS. To satisfy the requirements of CEQA for the Proposed Project, analyses are also conducted for each county for species with lethal take under county-directed WDM programs. Details on WDM within counties that have CSAs with WS-California (hereafter, "CSA counties") and counties that do not have CSAs with WS-California (hereafter, "non-CSA counties"), and how ecoregions and land ownership vary by county, are provided in Sections 1.2.1 through 1.2.6.

1.2.1 California Ecoregion Descriptions

California contains a wide range of ecological settings, including coastal lowlands, large alluvial valleys, forested mountain ranges, deserts, and various aquatic habitats (Griffith *et al.* 2016) (Figure 2, California Ecoregions). Ecoregions refer to areas with a generally similar type, quality, and relative quantity of environmental resources. Ecoregions can be useful for structuring and implementing ecosystem management strategies across federal and state agencies responsible for different types of resources within the same geographic areas (Griffith *et al.* 2016).

The California Department of Fish and Wildlife (CDFW) generated a statewide assessment of areas that provide essential habitat connectivity with the intent of creating a functional network of connected Natural Landscape Blocks (Spencer *et al.* 2010). Within each of California's eight ecoregions that were used for delineation of Natural Landscape Blocks in the statewide assessment, the Essential Connectivity Areas generally connect the most ecologically intact and well-conserved lands across generally less intact and protected land. Essential Connectivity Areas are expected to serve the majority of species in each ecoregion. There are 850 relatively intact Natural Landscape Blocks interconnected by 192 Essential Connectivity Areas within the study area, as shown on Figure 2. Table 1-1 describes the ecoregions in California (Modoc Plateau, North Coast, Central Coast, South Coast, Great Central Valley, Sierra Nevada, Mojave Desert, and Sonoran Desert) and identifies the counties located within each ecoregion.

Table 1-1. Ecoregion Descriptions and Counties Located within each Ecoregion

Ecoregion Description	Counties Within Ecoregion[4]	
Modoc Plateau: Contains the Cascade Range, which is underlain by Cenozoic volcanics. Much of the region has been affected by alpine glaciation. The Cascade Range has a moist, temperate climate that supports an extensive and highly productive coniferous forest, with large areas intensively managed for logging. Incense cedar, white fir, and Shasta red fir occur along with other Sierran species. The northeastern area of this ecoregion is within the rain shadow of the Cascade Range and has a more continental climate than ecoregions to the west, with greater temperature extremes, less precipitation, and frequent fires. A few areas of cropland and pastureland occur in the lake basins or larger river valleys, which also provide habitat for migrating waterfowl, such as sandhill cranes, ducks, and geese.[1] The southeasternmost part of this ecoregion contains the Lahontan and Tonopah playas, the Sierra Valley, and semiarid hills and basins influenced by the Sierra Nevada. North of this, there are dissected lava plains, rocky uplands, valleys, alluvial fans, and scattered mountain ranges. Valleys support sagebrush steppe or saltbush vegetation. Juniper woodlands occur on rugged, stony uplands.[1] This ecoregion contains 124 Natural Landscape Blocks (100 totally within the region and 24 extending into other regions) ranging from 2,000 to 790,000 acres each, interconnected by 19 Essential Connectivity Areas.[2] A major focus of regional and local connectivity planning in the Modoc Plateau ecoregion should be working to sustain and enhance connectivity of high-integrity forest habitats in the mountains, and restoring ecological integrity to degraded Great Basin communities (e.g., shrub steppe and perennial grass communities).[2]	Butte Lassen Modoc Plumas	Shasta Sierra Siskiyou Tehama
North Coast: Includes much of the coastal mountains of northwestern California, covered by highly productive, rain-drenched evergreen forests. Redwood forests are a dominant component of the region, along with some hardwoods such as tanoak, madrone, bigleaf maple, California bay, and red alder. Coastal headlands, high and low marine terraces, sand dunes, and beaches also characterize the region.[1] The highly dissected ridges, foothills, and valleys of the Klamath and Siskiyou Mountains include the mixed conifer and montane hardwood forests that occur on mostly mesic soils in the North Coast Range mountains. This area includes ultramafic substrates, such as serpentinite and mafic lithologies that directly affect vegetation. The region's diverse flora is rich in endemic and relic species.[1] This ecoregion contains 96 Natural Landscape Blocks ranging from 2,000 to 732,500 acres each, interconnected by 24 Essential Connectivity Areas.[2] Major foci of regional and local connectivity planning in the North Coast ecoregion should be to sustain and enhance high-integrity forest habitats within Natural Landscape Blocks and sustain and enhance their connectivity through the Essential Connectivity Areas.[2]	Colusa Del Norte Glenn Humboldt Lake Mendocino Napa	Shasta Siskiyou Solano Sonoma Tehama Trinity Yolo
Central Coast: The foothills and coastal mountains of central California have a Mediterranean climate of hot dry summers and cool moist winters and associated vegetative cover comprising primarily chaparral and oak woodlands; grasslands occur in some low elevations and patches of pine are found at higher elevations. Most of the region consists of open low mountains or foothills, but there are some areas of irregular plains and some narrow valleys.	Alameda Contra Costa Fresno	San Joaquin San Luis Obispo San Mateo

Table 1-1. Ecoregion Descriptions and Counties Located within each Ecoregion

Ecoregion Description	Counties Within Ecoregion[4]	
Large areas are ranchland and are grazed by domestic livestock. Relatively little land has been cultivated in this area, although some valleys are major agricultural centers. Natural vegetation includes coast live oak woodlands, Coulter pine, and unique native stands of Monterey pine in the west, and blue oak, black oak, and grey pine woodlands in the east. This ecoregion also includes Point Reyes, the Santa Cruz Mountains, and San Mateo coastal hills.[1] The Central Coast includes 129 total Natural Landscape Blocks (including 103 totally within the region and 26 shared with neighboring regions) that are served by 24 Essential Connectivity Areas (12 wholly within the ecoregion and 12 shared with adjacent regions).[2] Regional and local connectivity planning in this ecoregion should continue to focus on sustaining and enhancing connectivity across agricultural lands, roads, and areas of urban development, such as maintaining and preserving remaining movement corridors that are important for wildlife species such as San Joaquin kit fox.[2]	Kern	Santa Barbara
	Kings	Santa Clara
	Marin	Santa Cruz
	Merced	Solano
	Monterey	Sonoma
	Napa	Stanislaus
	San Benito	Ventura
	San Francisco	
South Coast: The coastal area of Southern California includes coastal and alluvial plains, marine terraces, and some low hills. Coastal sage scrub and chaparral vegetation communities with many endemic species once were widespread before overgrazing, clearance for agriculture, and massive urbanization occurred. Coastal sage scrub includes chamise, white sage, black sage, California buckwheat, golden yarrow, and coastal cholla. The chaparral-covered hills include ceanothus, manzanita, scrub oak, and mountain-mahogany. Coast live oak, canyon live oak, poison oak, and California black walnut also occur. [1] The northeastern area of this ecoregion consists of the mountains, which have a Mediterranean climate of hot dry summers and moist cool winters, resulting in denser vegetation and some large areas of coniferous woodlands. Severe erosion problems are common where the vegetation cover has been removed by fire, overgrazing, or land clearing. Large parts of the region are National Forest public land.[1] The South Coast ecoregion contains 116 Natural Landscape Blocks (90 totally within the region and 26 extending into other regions) averaging 23,000 acres in block size, interconnected by 27 Essential Connectivity Areas.[2] Major foci of connectivity planning in this ecoregion should continue to include implementing the South Coast Missing Linkage Project's existing Linkage Designs, developing Linkage Designs for other natural areas in the region, and establishing necessary wildlife crossings over roads and freeways such as Interstate 15.[2]	Kern	San Diego
	Los Angeles	San Luis Obispo
	Orange	Santa Barbara
	Riverside	Ventura
	San Bernardino	
Great Central Valley: Flat, intensively farmed plains with long, hot, dry summers and mild winters. Includes the flat valley basins of deep sediments adjacent to the Sacramento and San Joaquin Rivers, as well as the fans and terraces around the edge of the Great Central Valley. The two major rivers flow from opposite ends of the Central California Valley, entering into the Sacramento–San Joaquin River Delta and San Pablo Bay. More than one-half of the region is now cropland, about three-fourths of which is irrigated. Environmental concerns in the region include salinity due to evaporation of irrigation water, groundwater contamination from heavy use of agricultural chemicals, loss of wildlife and flora habitats, and urban sprawl.[1]	Alameda	Placer
	Amador	Sacramento
	Butte	San Benito
	Calaveras	San Joaquin
	Colusa	San Luis Obispo
	Contra Costa	Santa Barbara

Table 1-1. Ecoregion Descriptions and Counties Located within each Ecoregion

Ecoregion Description	Counties Within Ecoregion[4]	
The 114 Natural Landscape Blocks entirely within the ecoregion tend to be very small and isolated, with the smallest average block size of any ecoregion a less than 9,000 acres. The blocks are connected by 29 Essential Connectivity Areas.[2] Regional and local connectivity planning in the Great Central Valley should focus on restoring continuous natural upland corridors, riparian habitat, and riverine habitat, as well as protecting the few existing Essential Connectivity Areas in the region.[2]	Fresno Glenn Kern Kings Madera Mariposa Merced Napa Nevada	Solano Stanislaus Sutter Tehama Tulare Tuolumne Yolo Yuba
Sierra Nevada: Contains mountainous, deeply dissected, and westerly tilting fault block. The central and southern part of the region is largely composed of granitic rocks. Gently slopes to the Central Valley to the west. The vegetation grades from mostly ponderosa pine and Douglas-fir at low elevations on the western side, to pines and Sierra juniper on the eastern side, and to fir and other conifers at higher elevations. Alpine conditions exist at the highest elevations. Large areas are publicly owned federal land, including several national parks.[1] The eastern part of this ecoregion is composed of north-trending fault-block ranges and intervening, drier basins. In the high-elevation mountains, woodland, mountain brush, and scattered open forest are found. Low-elevation basins, slopes, and alluvial fans are either shrub- and grass-covered, shrub-covered, or barren. The land primarily is used for grazing. Some cropland is irrigated in valleys near mountain water sources.[1] The Sierra Nevada ecoregion contains 197 Natural Landscape Blocks (118 totally within the region and 79 extending into other regions) ranging from 2,000 to 800,000 acres each, interconnected by 45 Essential Connectivity Areas.[2] A major focus of regional and local connectivity planning in the Sierra Nevada ecoregion should be mapping and maintaining Essential Connectivity Areas that provide north–south connectivity especially on the western slope of the mountain range, and improving wildlife crossings over roads, including establishing a north–south crossing over Interstate 80 near Bear River.[2]	Alpine Amador Butte Calaveras El Dorado Fresno Inyo Kern Lassen Los Angeles Madera Mariposa	Merced Mono Nevada Placer Plumas Sacramento San Joaquin Sierra Stanislaus Tulare Tuolumne Yuba
Mojave Desert: Composed of broad basins and scattered mountains. Creosote bush, white bursage, Joshua tree and other yuccas, and blackbrush are typical. On alkali flats, saltbush, saltgrass, alkali sacaton, and iodinebush are found. In the mountains, sagebrush, juniper, and singleleaf pinyon occur. At high elevations, some ponderosa pine, white fir, limber pine, and bristlecone pine can be found. Most is federally owned, and grazing is constrained by the lack of water and forage for livestock. [1] The Mojave Desert contains fewer Natural Landscape Blocks (79 total: 52 totally within the region and 27 extending into other regions) due to the expansive reserve areas in the ecoregion, with the largest average block size at over 135,000 acres. Natural Landscape Blocks are interconnected by 13 Essential Connectivity Areas.[2] A major focus of	Inyo Kern Los Angeles	Riverside San Bernardino

Table 1-1. Ecoregion Descriptions and Counties Located within each Ecoregion

Ecoregion Description	Counties Within Ecoregion[4]	
regional and local connectivity planning in the Mojave Desert ecoregion should be working to restore and maintain essential connectivity of high-integrity desert habitat, including implementation of the Linkage Designs of the California Desert Connectivity Project, while managing stressors such as human recreational activities and renewable energy development.[2,3]		
Sonoran Desert: Contains scattered low mountains and has large tracts of federally owned land, a large portion of which are used for military training. Contains large areas of paloverde-cactus shrub and giant saguaro cactus, white bursage, ocotillo, brittlebrush, creosote, catclaw acacia, cholla, desert saltbush, pricklypear, and mesquite. Microphyll woodland trees and shrubs, such as ironwood, blue paloverde, smoketree, and desert willow, generally are unique to this desert, occupying desert washes with occasional moisture flow. Winter rainfall decreases from west to east, whereas summer rainfall decreases from east to west. [1] The Sonoran Desert contains 37 Natural Landscape Blocks (25 totally within the region and 12 extending into other regions) with a large average block size of about 87,000 acres, interconnected by 13 Essential Connectivity Areas.[2] Similar to the Mojave Desert, connectivity planning efforts in the Sonoran Desert ecoregion should aim to restore and maintain essential connectivity of high-integrity desert habitat, including implementation of the Linkage Designs of the California Desert Connectivity Project to prevent habitat fragmentation, as well as improving wildlife crossing structures and exclusion fencing to protect desert tortoise and other wildlife species from vehicle traffic.[2,3]	Imperial Riverside	San Bernardino San Diego

Notes:

1 Griffith *et al.* 2016.

2 Spencer *et al.* 2010.

3 Penrod *et al.* 2012.

4 Most counties encompass more than one ecoregion; some ecoregions include small portions of certain counties.

Table 1-2 lists several representative target species or species groupings that were identified for each ecoregion based on a general assessment of WDM reported for counties within each ecoregion. Multiple species including coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), and European starling (*Sturnus vulgaris*) were consistently pertinent target species and had moderate WDM take reported across all ecoregions. Species or species groups that may be targeted for WDM under the Project are not limited to those listed below.

Table 1-2. Target Species Located within each Ecoregion

Ecoregion	Representative Target Species	
North Coast	▪ Coyote ▪ Striped skunk ▪ Raccoon (*Procyon lotor*) ▪ Feral pig (Sus scrofa) ▪ Virginia opossum (Didelphis virginiana) ▪ Black bear (*Ursus americanus*)	▪ Gray fox (*Urocyon cinereoargenteus*) ▪ American Badger (*Taxidea taxus*) ▪ Bobcat (*Lynx rufus*) ▪ Blackbirds (*Agelaius* spp.) ▪ European starling (*Sturnus vulgaris*)
Modoc Plateau	▪ Coyote ▪ Striped skunk ▪ Muskrat (*Ondatra zibethicus*) ▪ North American beaver (*Castor canadensis*) ▪ Yellow-bellied marmot (*Marmota flaviventris*) ▪ Black bear	▪ Mountain lion (*Puma concolor*) ▪ American Badger ▪ Blackbirds ▪ European Starling ▪ American coot (*Fulica americana*)
Central Coast	▪ California ground squirrel (*Otospermophilus beecheyi*) ▪ Coyote ▪ Striped skunk ▪ Raccoon ▪ Black-tailed jackrabbit (*Lepus californicus*) ▪ Feral pig	▪ Feral cat (*Felis catus*) ▪ Virginia opossum ▪ Canada goose (*Branta canadensis*) ▪ European starling ▪ American coot
Great Central Valley	▪ California ground squirrel ▪ Coyote ▪ Striped skunk ▪ North American beaver ▪ Raccoon ▪ Black-tailed jackrabbit	▪ Virginia opossum ▪ Feral pig ▪ Rock pigeon (*Columba livia*) ▪ Mallard (*Anas platyrhynchos*) ▪ European starling American coot
Sierra Nevada	▪ Coyote ▪ Striped skunk ▪ Raccoon	▪ Mountain lion ▪ Gray fox ▪ Black bear ▪ Virginia opossum

Table 1-2. Target Species Located within each Ecoregion

Ecoregion	Representative Target Species	
	▪ North American beaver ▪ Feral pig ▪ Muskrat (*Ondatra zibethicus*)	▪ European starling American coot
South Coast	▪ California ground squirrel ▪ Coyote ▪ Virginia opossum ▪ Corvids ▪ American kestrel (*Falco sparverius*) ▪ Desert cottontail	▪ European starling Brown-headed cowbird (*Molothrus ater*) ▪ Upland game birds ▪ Common small rodents ▪ American coot
Mojave Desert	▪ Coyote ▪ California ground squirrel ▪ Desert cottontail ▪ Black-tailed jackrabbit ▪ Common small rodents ▪ American coot	▪ Red-tailed hawk (*Buteo jamaicensis*) ▪ Cooper's hawk (*Accipiter cooperii*) ▪ Upland game birds ▪ Sparrows and finches ▪ European starling
Sonoran Desert	▪ Coyote ▪ California ground squirrel ▪ Virginia opossum ▪ Raccoon ▪ Common small rodents ▪ Striped skunk	▪ Corvids ▪ Upland game birds ▪ Western gull (*Larus occidentalis*) ▪ European starling American coot

Source: USDA 2022b.

1.2.2 Cooperative Service Agreement Counties

As shown on Figure 3, there were 38 counties within California with WS-California CSAs (contracts with WS-California) during the baseline period (CY 2010–2019). Through a cost-sharing service agreement contract with USDA each year, a Wildlife Specialist from WS-California provided professional consultations to assist each CSA county in resolving wildlife-related problems and managing wildlife damage. The number of CSA Counties in California changes over time as counties enter into new CSAs or fail to renew CSAs. As such, the number of CSA Counties at present may be different from that during the analysis period. During the analysis period, WS-California CSA counties include the following: Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Humboldt, Imperial, Kern, Lake, Lassen, Madera, Mariposa, Mendocino, Merced, Modoc, Monterey, Napa, Nevada, Plumas, Sacramento, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Trinity, Tuolumne, Yolo, and Yuba (Figure 3).

Figure 2 shows the ecoregions and wildlife movement corridors within the study area (i.e., the State of California). Ecoregions and wildlife movement corridors within the WS-California CSA counties are shown in Table 1-3.

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
Alameda County	Central Coast	Mt. Allison – Briones Hills
	Great Central Valley	Mountain House – Brushy Peak
Alpine County	Sierra Nevada	Pine Ridge – Lightning Mountain
Amador County	Great Central Valley	Bear Mountains – Middle Fork Cosumnes River
	Sierra Nevada	Pine Ridge – Irish Hill
		Quartz Mountain – Logtown Ridge
		Duck Creek North Fork – Coyote Creek
		Middle Fork Cosumnes River – Big Mountain Ridge
Butte County	Great Central Valley	Big Bar Mountain/Stevens Ridge – Ishi Wilderness
	Modoc Plateau	Colusa Basin – Butte Sink
	Sierra Nevada	North Table Mountain – Ishi Wilderness
		Orland Buttes/Stone Valley/Julian Rocks – Ishi Wilderness
Calaveras County	Great Central Valley	Bear Mountains – Duck Creek
	Sierra Nevada	Bear Mountains – Middle Fork Cosumnes River
		Calaveras Big Trees – Pine Ridge
		Cherokee Creek – Pine Ridge
		Duck Creek North Fork – Coyote Creek
		Pine Ridge – Irish Hill
		Pine Ridge – Lightning Mountain
		Table Top Mountain – Gopher Ridge
Colusa County	Great Central Valley	Colusa Basin – Butte Sink
	North Coast	Colusa National Wildlife Refuge – Sacramento National Wildlife Refuge/Provident Main Canal
		Gube Mountain – Snow Mountain
		Sacramento National Wildlife Refuge – Clark Valley
Contra Costa County	Central Coast	Mt. Allison – Briones Hills
El Dorado County	Sierra Nevada	Bear Mountains – Middle Fork Cosumnes River
		Marble Valley – Sawtooth Ridge
		Middle Fork Cosumnes River – Big Mountain Ridge
		Quartz Mountain – Logtown Ridge
		Sturdevant Ridge – Mosquito Ridge/Crystal Ridge
Humboldt County	North Coast	Charles Mountain – King Range
		Charles Mountain – Salmon Mountains
		Dairy Ridge/Pilot Ridge/South Fork – Redwood Creek/Bald Hills
		Gold Bluffs – Siskiyou Mountains
		Rockefeller Redwood Forest – Dairy Ridge/Pilot Ridge/South Fork
		Salmon Mountains – Redwood/Williams Ridge/Holter Ridge
		Sinkyone – Island Mountain

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
		Sinkyone – King Range
		South Fork Mountain/Chinquapin Butte – Dairy Ridge/Pilot Ridge/South Fork
		Charles Mountain – King Range
Imperial County	Sonoran Desert	Chocolate Mountains – Turtle Mountains/Ward Valley
		Chocolate Mountains South – Chocolate Mountains
		East Mesa Sand Dunes – Chocolate Mountains
		East Mesa Sand Dunes – Chocolate Mountains South
		Yuha Basin – Anza-Borrego Desert
Kern County	Central Coast	Bluestone Ridge – Sand Ridge
	Great Central Valley	Elk Hills – Carrizo Plain/Temblor Range
	Mojave Desert	Five Dog Creek – Gordon Gulch/Sand Canyon
	Sierra Nevada	Kern National Wildlife Refuge – Dudley Ridge
	South Coast	Las Colinas/South Dome – Kettleman Hills
		McKittrick Valley – Pixley National Wildlife Refuge
		Pine Mountain/Sespe Condor – Lucas Creek
		Poso Creek – Five Dog Creek
		Poso Creek – Sequoia National Forest/Greenhorn Mountains
		Rand Mountains – Piute Mountains/Scodie Mountains
		Tehachapi Mountains – Piute Mountains/Scodie Mountains
		Ten Section Oil Field – Elk Hills
Lake County	North Coast	Gube Mountain – Snow Mountain
Lassen County	Modoc Plateau	Adams Peak – Fort Sage Mountains
	Sierra Nevada	Adams Peak – Reconnaissance Peak
		Bald Hills – Beaver Creek Rim/Indian Mountain
		Bald Mountain Range – Reconnaissance Peak
		Beaver Creek Rim/Indian Mountain – Little Hot Spring Valley
		Fort Sage Mountains – Cottonwood Peak
		Lassen Volcanic Wilderness – Beaver Creek Rim/Indian Mountain
		Mill Creek Rim – Lassen Volcanic Wilderness
		Pilot Butte – Knox Mountain
		Reconnaissance Peak – Diamond Mountains
		Warner Mountains – Mount Bidwell/Larkspur Hills
Madera County	Great Central Valley	Ash Slough – Merced National Wildlife Refuge
	Sierra Nevada	Eastman Lake National Recreation Area (NRA) – Bear Creek
		Fresno River – Lone Willow
		Gravelly Ford Canal – Fresno River

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
		Gravelly Ford Canal – Lone Willow
		Lone Willow – Ash Slough
Mariposa County	Great Central Valley	Eastman Lake NRA – Bear Creek
	Sierra Nevada	Flat Top Mountain – Hunter Valley Mountain
		Hunter Valley Mountain – Cardoza Ridge
Mendocino	North Coast	Big River/Hi Chute Ridge – Black Oak Mountain
		Black Oak Mountain – Red Mountain
		Chileno Valley – Sanel Mountain
		Gube Mountain – Snow Mountain
		Sinkyone – Island Mountain
		Sinkyone – King Range
Merced County	Central Coast	Ash Slough – Merced National Wildlife Refuge
	Great Central Valley	Eastman Lake NRA – Bear Creek
	Sierra Nevada	Hunter Valley Mountain – Cardoza Ridge
		Ortigalita Ridge/San Luis Reservoir – Kesterson National Wildlife Refuge
		San Luis Canal – Kesterson National Wildlife Refuge
		San Luis Canal – Ortigalita Ridge/San Luis Reservoir
		San Luis Island – Bear Creek
		Table Top Mountain – Gopher Ridge
Modoc County	Modoc Plateau	Barber Ridge – Double Head Mountain/Timbered Ridge
		Beaver Creek Rim/Indian Mountain – Little Hot Spring Valley
		Double Head Mountain/Timbered Ridge – Lava Beds Wilderness
		Pilot Butte – Knox Mountain
		Pilot Butte – Little Hot Spring Valley
		Timber Mountain – Double Head Mountain/Timbered Ridge
		Warner Mountains – Mount Bidwell/Larkspur Hills
Monterey County	Central Coast	Kettleman Hills/Las Alturas – Table Mountain/Chino Canyon
		Los Padres National Forest – Pilarcitos Canyon
		Pancho Rico Valley – Los Padres National Forest
		Pancho Rico Valley – Pinnacles National Monument
		San Geronimo – Los Padres National Forest
		San Geronimo – Weferling Canyon
Napa County	Central Coast	Blue Ridge/Rocky Ridge – Capay Hills
	Great Central Valley	English Hills – Blue Ridge/Rocky Ridge
	North Coast	Grizzly Island – Lake Marie
		Lake Marie – The Cedars/Adams Ridge

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
		Tolay Creek – Lake Marie
Nevada County	Great Central Valley	Bear River – Chaparral Hill/Yuba River
	Sierra Nevada	Chaparral Hill/Yuba River – Bald Mountain Range
		Coon Creek – Bear River
		Sawtooth Ridge – Lafayette Ridge/Black Buttes
Plumas County	Modoc Plateau	Adams Peak – Fort Sage Mountains
	Sierra Nevada	Adams Peak – Reconnaissance Peak
		Bald Mountain Range – Reconnaissance Peak
		Big Bar Mountain/Stevens Ridge – Ishi Wilderness
		Fort Sage Mountains – Cottonwood Peak
		Grizzly Mountain – Cottonwood Peak
		Grizzly Mountain – Deadwood Canyon
		Lassen Volcanic Wilderness – Beaver Creek Rim/Indian Mountain
		Lassen Volcanic Wilderness – Thousand Lakes
		Mill Creek Rim – Lassen Volcanic Wilderness
		Mt. Killmore – Grizzly Mountain
		Reconnaissance Peak – Diamond Mountains
		Table Mountain – Lassen Volcanic Wilderness
Sacramento County	Great Central Valley	Bear Slough – Browns Creek
	Sierra Nevada	Duck Creek North Fork – Coyote Creek
		Mandeville Island – Staten Island
		Marble Valley – Sawtooth Ridge
		Stone Lake – Yolo Bypass
San Diego County	Sonoran Desert	Burnt Mountain – Black Mountain/Guejito Creek
	South Coast	Canada de San Vicente/Iron Mountain – Black Mountain/Guejito Creek
		Jacumba Peak – Campo Valley
		McGinty Mountain/Lawson Valley – El Capitan
		Miramar – Canada de San Vicente/Iron Mountain
		Palomar Mountains – Camp Pendleton/Santa Rosa
		Yuha Basin – Anza-Borrego Desert
San Joaquin County	Central Coast	Bear Mountains – Duck Creek
	Great Central Valley	Bear Slough – Browns Creek
	Sierra Nevada	Duck Creek North Fork – Coyote Creek
		Mandeville Island – Staten Island
San Luis Obispo County	Central Coast	Elk Hills – Carrizo Plain/Temblor Range
	Great Central Valley	La Panza Range – San Geronimo
	South Coast	San Geronimo – Los Padres National Forest
		San Geronimo – Weferling Canyon
Santa Barbara County	Central Coast	La Panza Range – San Geronimo

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
	Great Central Valley	San Ynez Mountains West – Casmalia Hills
	South Coast	Sulphur Mountain – Sierra Madre Mountains
Shasta County	Modoc Plateau	Bald Hills – Castle Crags
	North Coast	Beaver Creek Rim/Indian Mountain – Little Hot Spring Valley
		Cinder Butte – Popcorn Cave
		Lassen Volcanic Wilderness – Beaver Creek Rim/Indian Mountain
		Lassen Volcanic Wilderness – Thousand Lakes
		McCloud River/Curl Ridge – McConaughy Gulch
		Mill Creek Rim – Lassen Volcanic Wilderness
		Noble Ridge/Beegum Gorge – Salmon Mountains
		Noble Ridge/Beegum Gorge – South Fork Mountain/Chinquapin Butte
		Pilot Butte – Little Hot Spring Valley
		Popcorn Cave – Curl Ridge
		Table Mountain – Lassen Volcanic Wilderness
		Thousand Lakes – Cinder Butte
Sierra County	Modoc Plateau	Bald Mountain Range – Reconnaissance Peak
	Sierra Nevada	Chaparral Hill/Yuba River – Bald Mountain Range
		Mt. Killmore – Grizzly Mountain
Siskiyou County	Modoc Plateau	Bald Hills – Castle Crags
	North Coast	Beaver Creek Rim/Indian Mountain – Little Hot Spring Valley
		Big Cliff Mine – McConaughy Gulch
		Butte Valley – Wadsworth Flat
		Charles Mountain – Salmon Mountains
		Double Head Mountain/Timbered Ridge – Lava Beds Wilderness
		Gold Bluffs – Siskiyou Mountains
		Little Cottonwood Pk – Siskiyou Mountains
		Little Cottonwood Pk – Wadsworth Flat
		Marble Mountains – Siskiyou Mountains
		Martin Hill – Butte Valley
		McCloud River/Curl Ridge – McConaughy Gulch
		Mt. Eddy – Mt. Shasta
		Mt. Shasta – Wadsworth Flat
		Noble Ridge/Beegum Gorge – Salmon Mountains
		Pilot Butte – Little Hot Spring Valley
		Salmon Mountains – Redwood/Williams Ridge/Holter Ridge
		Timbered Crater – Mt. Dome

Table 1-3. Ecoregions and Wildlife Movement Corridors in WS-California CSA Counties

County	Ecoregions	Essential Connectivity Areas
Solano County	Central Coast	English Hills – Blue Ridge/Rocky Ridge
	Great Central Valley	Grizzly Island – Lake Marie
	North Coast	Lake Marie – The Cedars/Adams Ridge
		Montezuma Hills – Hopkins Ravine
		Tolay Creek – Lake Marie
Sonoma County	Central Coast	Chileno Valley – Sanel Mountain
	North Coast	Tolay Creek – Lake Marie
Stanislaus County	Central Coast	Bear Mountains – Duck Creek
	Great Central Valley	Santa Cruz Mountains – Diablo Range
	Sierra Nevada	Table Top Mountain – Gopher Ridge
Sutter County	Great Central Valley	Colusa Basin – Butte Sink
Trinity County	North Coast	Charles Mountain – King Range
		Charles Mountain – Salmon Mountains
		Dairy Ridge/Pilot Ridge/South Fork – Redwood Creek/Bald Hills
		McCloud River/Curl Ridge – McConaughy Gulch
		Mt. Eddy – Mt. Shasta
		Noble Ridge/Beegum Gorge – Salmon Mountains
		Noble Ridge/Beegum Gorge – South Fork Mountain/Chinquapin Butte
		Salmon Mountains – Redwood/Williams Ridge/Holter Ridge
		Sinkyone – Island Mountain
		South Fork Mountain/Chinquapin Butte – Dairy Ridge/Pilot Ridge/South Fork
Tuolumne County	Great Central Valley	Calaveras Big Trees – Pine Ridge
	Sierra Nevada	Pine Ridge – Lightning Mountain
		Table Top Mountain – Gopher Ridge
Yolo County	Great Central Valley	Blue Ridge/Rocky Ridge – Capay Hills
	North Coast	Dunnigan Hills/Smith Creek – Dunnigan Hills
		English Hills – Blue Ridge/Rocky Ridge
		Little Holland Tract/Yolo Bypass – Yolo Bypass
		Stone Lake – Yolo Bypass
		Yolo Bypass – Sacramento Bypass
Yuba County	Great Central Valley	Bear River – Chaparral Hill/Yuba River
	Sierra Nevada	Chaparral Hill/Yuba River – Bald Mountain Range
		Coon Creek – Bear River

Source: Spencer et al. 2010.

1.2.3 County-Directed WDM Programs

As shown on Figure 3, there were six counties within California with county-directed programs (i.e., not under a CSA with WS-California and the county provides a WDM program) during the baseline period (CY 2010–2019). County-directed WDM programs include a variety of approaches, including but not limited to the following: WDM conducted by county personnel; programs that coordinate/share WDM responsibilities with animal control and/or other county departments; grant programs that focus on non-lethal practices, including reimbursement for fencing, non-lethal equipment/methods or economic damages related to wildlife damage; and programs where the counties contract directly with private firms for WDM. The following six counties had their own county-directed WDM programs during the baseline period (2010–2019), as shown on Figure 3: Fresno, Kings, Los Angeles, Marin, Placer, and San Bernardino.

Non-CSA counties can request a Wildlife Specialist from WS-California to provide professional consultations to assist in resolving wildlife-related problems and managing wildlife damage. WS-California is available and qualified to conduct the WDM necessary to accomplish each county's goals.

The following sections provide a summary of the MIS data for the counties with county-directed programs. These data reflect WDM conducted by WS-California outside of CSAs with the counties, including airport Wildlife Hazard Management (WHM) (WDM that is conducted at airports to protect the flying public and aviation property) and threatened and endangered species protection (T&E species protection). Additional non-MIS estimates were requested from each of the six counties with county-directed programs, and quantitative data was received from the following:

- **Fresno:** 2019 WDM data
- **Kings:** 2009–2019 WDM data
- **Sonoma:** 2010–2012 WDM data (data provided were consistent with the data recorded in the WS California MIS, so no additional county data were analyzed)

Figure 3 depicts the six county-directed programs within the study area. Ecoregions and wildlife movement corridors within counties that have county-directed programs are shown in Table 1-4.

Table 1-4. CDFW Ecoregions and Wildlife Movement Corridors in Counties with County-Directed Programs

County	Ecoregions	Essential Connectivity Areas
Fresno County	Central Coast	Anticline Ridge — Joaquin Ridge
	Great Central Valley	Coyote Ridge — Owens Mountain
	Sierra Nevada	Coyote Ridge — Sierra Nevada
		Kettleman Hills/Las Alturas — Table Mountain/Chino Canyon
		Yokohl Valley/Oat Canyon — Sierra Nevada
Kings County	Central Coast	Bluestone Ridge — Sand Ridge
	Great Central Valley	Kern National Wildlife Refuge — Dudley Ridge

Table 1-4. CDFW Ecoregions and Wildlife Movement Corridors in Counties with County-Directed Programs

County	Ecoregions	Essential Connectivity Areas
		Kettleman Hills/Las Alturas — Table Mountain/Chino Canyon
		Las Colinas/South Dome — Kettleman Hills
		McKittrick Valley — Pixley National Wildlife Refuge
		Pixley National Wildlife Refuge — Cross Creek
Los Angeles County	Mojave Desert	Castro Peak/Santa Monica Mtns — Pine Mountain/Sespe Condor
	Sierra Nevada	Contract Point — Santa Susana Mountains
	South Coast	Pine Mountain/Sespe Condor — Lucas Creek
		San Gabriel Mountains West — San Francisquito
		Sugarloaf Mountain/Keller Peak — San Gabriel/Cucamonga
Marin County	Central Coast	Chileno Valley — Sanel Mountain
Placer County	Great Central Valley	Bear River — Chaparral Hill/Yuba River
	Sierra Nevada	Coon Creek — Bear River
		Curry Creek — Coon Creek
		Marble Valley — Sawtooth Ridge
		Sawtooth Ridge — Lafayette Ridge/Black Buttes
		Sturdevant Ridge — Mosquito Ridge/Crystal Ridge
San Bernardino County	Mojave Desert	Calico Mountains — Death Valley/Black Mountains/Amargosa Range
	Sonoran Desert	Chocolate Mountains — Turtle Mountains/Ward Valley
	South Coast	Mid Hills/Ivanpah Valley/New York Mountains — Calico Mountains
		Ord Mountains — Mid Hills/Ivanpah Valley/New York Mountains
		Rand Mountains — Piute Mountains/Scodie Mountains
		San Bernardino Mountains — Calico Mountains
		San Jacinto Mountains — San Bernardino Mountains
		Sugarloaf Mountain/Keller Peak — San Gabriel/Cucamonga

Table 1-4. CDFW Ecoregions and Wildlife Movement Corridors in Counties with County-Directed Programs

County	Ecoregions	Essential Connectivity Areas
		The Badlands West — Box Springs Mountains

Source: Spencer et al. 2010.

1.2.4 Counties with No Government-Provided WDM Program

As shown on Figure 3, there are 14 counties within California with no known county-directed WDM program or CSA with WS-California during the baseline period (CY 2010–2019). However, these and other non-CSA counties can request a Wildlife Specialist from WS-California to provide professional consultations to assist in resolving wildlife-related conflicts. WS-California is available and qualified to conduct the WDM necessary to accomplish each county's goals, but counties without CSAs are typically limited to technical assistance. Some WDM is conducted by WS-California outside of CSAs with the counties, including airport WHM and T&E species protection. WDM data were requested from each of these 14 counties, but no quantitative data were received, which is likely due to the lack of any county-level program to track WDM. Some qualitative information was provided in response to a questionnaire circulated to county agricultural commissioners or others designated to oversee WDM in each county; where available, this information is noted below. No WDM activities are provided by these counties, either directly or through contracts.

The lack of a county-directed WDM program does not suggest a lack of WDM in these counties. Land and resource owners and managers experiencing damage from wildlife typically take some level of WDM action to minimize losses to their resources, including non-lethal and lethal methods. It is impossible to predict exactly how much WDM is conducted and how much lethal take it involved. For this analysis, we expect that a similar amount of non-lethal and lethal WDM was and will continue to be conducted in these counties compared to CSA Counties. Some of these counties have historically contracted with WS-California (historic take data are available for these counties) and some have expressed interest in re-entering into a CSA with WS-California if it were available. As shown on Figure 3, counties with no county-directed WDM program or CSA with WS-California include the following: Del Norte, Glenn, Inyo, Mono, Orange, Riverside, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Tehama, Tulare, and Ventura. Ecoregions and wildlife movement corridors within counties with no existing program are shown in Table 1-5.

Table 1-5. CDFW Ecoregions and Wildlife Movement Corridors in Counties with No Existing Programs

County	Ecoregions	Essential Connectivity Areas
Del Norte	North Coast	Gold Bluffs — Siskiyou Mountains
Glenn	Great Central Valley North Coast	Colusa National Wildlife Refuge — Sacramento National Wildlife Refuge/Provident Main Canal
		Gube Mountain — Snow Mountain
		Orland Buttes/Stone Valley/Julian Rocks — Ishi Wilderness
		Sacramento National Wildlife Refuge — Clark Valley
Inyo	Mojave Desert Sierra Nevada	Calico Mountains — Death Valley/Black Mountains/Amargosa Range
		Silver Mountain/Rose Valley — Death Valley/Panamint Range

Table 1-5. CDFW Ecoregions and Wildlife Movement Corridors in Counties with No Existing Programs

County	Ecoregions	Essential Connectivity Areas
		Silver Mountain/Rose Valley — Inyo Mountains/Saline Valley/Death Valley
Mono	Sierra Nevada	(No Essential Connectivity Areas)
Orange	South Coast	Palomar Mountains — Camp Pendleton/Santa Rosa
Riverside	Mojave Desert Sonoran Desert South Coast	Chocolate Mountains — Turtle Mountains/Ward Valley
		Chocolate Mountains South — Chocolate Mountains
		East Mesa Sand Dunes — Chocolate Mountains
		Estelle Mountain — Lake Matthews
		Indio Hills — San Jacinto Mountains
		Lake Perris — The Badlands East
		Lake Skinner — Cahuilla Mountain/Rouse Ridge
		Palomar Mountains — Camp Pendleton/Santa Rosa
		Riverside Mountains — Pinto Basin/Eagle Mountain
		San Bernardino Mountains — Calico Mountains
		San Jacinto Mountains — San Bernardino Mountains
		Santa Rosa Mountains — Cahuilla Mountain/Rouse Ridge
		The Badlands West — Box Springs Mountains
		Vail Lake — Cahuilla Mountain/Rouse Ridge
		Vail Lake — Lake Skinner
San Benito	Central Coast Great Central Valley	Anticline Ridge — Joaquin Ridge
		Pancho Rico Valley — Pinnacles National Monument
		Santa Cruz Mountains/Pescadero Creek — Pigeon Point
San Francisco	Central Coast	(No Essential Connectivity Areas)
San Mateo	Central Coast	Bonny Doon — Castle Rock
		Sugarloaf Mountain — Montara Mountain
Santa Clara	Central Coast	Bonny Doon — Castle Rock
		Mt. Allison — Briones Hills
		Santa Cruz Mountains — Diablo Range
		Santa Cruz Mountains/Pescadero Creek — Pigeon Point
		Santa Cruz Mountains/Pescadero Creek — Santa Cruz Mountains
		Sugarloaf Mountain — Montara Mountain
Santa Cruz	Central Coast	Bonny Doon — Castle Rock
		Santa Cruz Mountains — Diablo Range
		Santa Cruz Mountains/Pescadero Creek — Santa Cruz Mountains
		Sugarloaf Mountain — Bonny Doon
		Sugarloaf Mountain — Montara Mountain
Tehama	Great Central Valley Modoc Plateau North Coast	Big Bar Mountain/Stevens Ridge — Ishi Wilderness
		McClure Creek — Table Mountain
		Mill Creek Rim — Lassen Volcanic Wilderness
		Mooney Island — Ishi Wilderness
		Noble Ridge/Beegum Gorge — Salmon Mountains

Table 1-5. CDFW Ecoregions and Wildlife Movement Corridors in Counties with No Existing Programs

County	Ecoregions	Essential Connectivity Areas
		Noble Ridge/Beegum Gorge — South Fork Mountain/Chinquapin Butte
		North Table Mountain — Ishi Wilderness
		Orland Buttes/Stone Valley/Julian Rocks — Ishi Wilderness
		Table Mountain — Lassen Volcanic Wilderness
Tulare	Great Central Valley Sierra Nevada	Allensworth — Pixley National Wildlife Refuge
		Coyote Ridge — Sierra Nevada
		Lone Oak Mountain — Redwood Mountain/Pine Ridge
		Lone Oak Mountain — Tucker Mountain
		McKittrick Valley — Pixley National Wildlife Refuge
		Pixley National Wildlife Refuge — Cross Creek
		Tennessee Ridge — Frazier Valley/Rocky Hill
		Yokohl Valley/Oat Canyon — Sierra Nevada
Ventura	Central Coast South Coast	Castro Peak/Santa Monica Mtns — Pine Mountain/Sespe Condor
		Contract Point — Santa Susana Mountains
		Pine Mountain/Sespe Condor — Lucas Creek
		Sulphur Mountain — Pine Mountain/Sespe Condor
		Sulphur Mountain — Sierra Madre Mountains

Source: Spencer *et al.* 2010.

1.3 Tribal Lands

California contains 108 federally recognized Tribes that have governmental authority over their respective lands. For the purposes of this document, tribally managed lands are defined as all lands within the limits of any California reservation lands, territories, or tribal trust lands. Although a historically minor component of WS-California WDM activities, WS-California and potentially county-led WDM assistance on tribally managed lands would be provided when requested. Any Project activities occurring on tribally-managed lands would be subject to an agreement between WS-California and the tribal entity. WDM personnel adhere to tribal and federal policies for the protection of historic and cultural resources on tribally managed lands. Methods used in WDM activities on tribal lands would be the same as those summarized in Appendix C of the EIR/EIS.

1.3.1 Military Lands

The Department of Defense, with assistance from U.S. Fish and Wildlife Service (USFWS) and CDFW, is responsible for implementing programs and management strategies to conserve and protect biological resources within military lands through integrated natural resources management plans. Integrated natural resources management plans are planning documents that allow for management of natural resources, including WDM activities.

Military lands that could potentially request WDM assistance under the Project include but are not limited to the following:

- Air Force bases, Air Reserve bases, Marine Corps air stations, Naval air weapons stations
- Large Army, Navy, and Marine Corps bases including:
  - Fort Irwin
  - Camp Roberts
  - Camp Pendleton
  - Twentynine Palms
  - Marine Corps Logistics Base Barstow
  - Chocolate Mountain Range
- Smaller or urban Army, Navy, and Marine Corps bases including:
  - Mountain Training Center
  - Naval Base Coronado
  - North Island Naval Complex
  - Point Loma
  - Naval Base San Diego
- Coast Guard bases

Assistance on military lands would be provided when requested. Methods used in WDM activities on military lands would be the same as those used outside military lands as summarized in Appendix C of the EIR/EIS.

1.4 Regulatory Setting

Implementation of the Project will also include acquiring all required state and federal permits and adhering to all federal, state, local, and tribal laws and regulations. These are described in detail in Appendix B of the EIR/EIS. A summary of the Section 7 of the FESA WS-California consultation history is included in Appendix A of this Report.

2 Project Description

2.1 Overview of Proposed Project

The purpose of the proposed action is to minimize wildlife damage and threats of damage to agricultural resources (including crops and infrastructure), livestock, property, natural resources, and public health and safety. The CDFA and WS-California provide WDM technical and operational assistance to federal, state, county, tribal, city, and private entities to resolve human-wildlife conflicts caused by wildlife, most frequently birds and mammals. WDM activities may include, but are not limited to, the following:

- Reducing damage to agricultural resources, infrastructure, and property;
- Reducing wildlife strike hazards at airports;
- Managing damage by invasive species;
- Reducing threats to human health and safety associated with wildlife; and
- Protecting threatened and endangered species.

Wildlife conflicts include but are not limited to predation to livestock (e.g., sheep, cattle, goats, and poultry) by coyotes, mountain lions, black bears (*Ursus americanus*), bobcats, skunks, and weasels (*Neogale frenata*), which can cause serious economic hardship, as well as transmission of disease from wildlife to livestock. Wildlife can also pose a risk to public health and safety through direct contact (i.e., bites or attacks) and disease transmission. Agriculture crops, orchards, vineyards, and property can be damaged by wildlife through mass consumption, alteration of watercourses, and unwanted entry. Predatory wildlife species may act as a limiting factor in the recovery of a sensitive, threatened, or endangered species. Sensitive habitats may also be damaged by the destructive behavior of certain wildlife species (i.e., feral swine) (See Chapter 1 of the EIR/EIS for more information).

2.2 Wildlife Damage Management Methods

Refer to Appendix C of the EIR/EIS for a detailed description of all methods used during lethal and non-lethal WDM activities to resolve wildlife damage situations.

2.3 Wildlife Damage Management Fate Categories

As described in Appendix C of the EIR/EIS, both lethal and non-lethal methods can be utilized during WDM activities, and some methods can be either lethal or non-lethal depending on the ultimate fate of the captured animal. As such, WS-California MIS data include "Fate" categories to properly categorize their actions. WS-California uses the following fate categories for lethal WDM: "killed" and "removed/destroyed." The "killed" fate is used to report WDM actions that result in the death of any individual animal, including target and non-target wildlife species. The fate category "removed/destroyed" is used to report the removal or destruction of nests or burrows/dens. This includes both inactive nests or burrows/dens (i.e., unoccupied) and active nests or burrows/dens (i.e., those containing eggs, fledglings or young).

Removal or destruction of an inactive bird nest does not affect individual fledglings or eggs and therefore inactive nest removal is not considered in the effect analyses of this report. When an active nest with fledglings is removed or destroyed, the number of fledging individuals is included under the “killed” fate category in addition to the nest being reported under the “removed/destroyed” fate category. However, when an active nest with eggs is “removed/destroyed,” the number of eggs destroyed is not recorded under the “killed” fate category. Therefore, to avoid duplicate counting, the effect analyses in this Report include only eggs within active nests under the “removed/destroyed” fate category. The number of eggs taken was estimated by multiplying the number of active nests destroyed (from MIS data) by the average clutch size for that species (listed for each bird species in Section 3.3).

Destruction of dens or burrows is typically conducted using a gas cartridge, which emits carbon monoxide, and dens or burrows can be unoccupied or occupied depending on the time of year and the number of burrows used by the species (see USDA 2019 for a more complete description and analysis). For the purposes of this analysis, only occupied dens or burrows are considered in the effect analysis because the result is the lethal removal of individuals within the den or burrow. Unoccupied dens or burrows are not included in the effect analysis because the activity does not result in lethal removal of any individuals. Unoccupied dens or burrows are typically destroyed using hand tools to collapse a den or burrow located under a fence, but this category also includes some unoccupied burrows that are treated with gas cartridges (for more detailed information see USDA 2019). WS-California does not report the exact number of animals lethally removed when a burrow or den is “removed/destroyed” because the animals are underground and the exact number is generally not known. The amount of lethal take associated with “removed/destroyed” burrows or dens is estimated based on the biology of the species in USDA (2019). The amount of lethal take per burrow of den “removed/destroyed” varies by species and also by method. Lethal removal estimates are provided for each applicable species as summarized below (for more detailed information see USDA 2019).

- **Coyote.** On average, 0.5 occupied coyote dens were destroyed per year using gas cartridges during the MIS baseline analysis period (i.e., 2010–2019). In 2019, APHIS finalized a peer-reviewed risk assessment for the use of carbon-monoxide-emitting gas cartridges in WDM (USDA 2019). Table 2 of the risk assessment (USDA 2019) provides the nationwide estimates of individuals killed per den or burrow by species. For coyotes, this estimate is 3.9 individuals. Therefore, a total of 0.5 occupied dens multiplied by the 3.9 average individuals per den would result in lethal removal of 1.9 coyote individuals per year on average. This number was added to the number of coyotes in the “killed” fate category to determine the number of coyotes lethally removed by WS-California as described in Section 3.2.3.
- **Red fox.** On average, 1.5 occupied red fox dens were destroyed per year during the MIS baseline analysis period. Nationwide, USDA (2019) estimates that 3.7 red fox individuals are lethally removed for each occupied den destroyed. Therefore, a total of 1.5 occupied dens multiplied by 3.7 average individuals per den would result in lethal removal of 5.6 red fox individuals per year on average. This number was added to the number of red fox in the “killed” fate category to determine the number of red fox lethally removed by WS-California as described in Section 3.2.5.
- **California ground squirrel.** On average, 316.7 occupied California ground squirrel (*Otospermophilus beecheyi*) burrows were destroyed per year using gas cartridges during the MIS baseline analysis period. Nationwide, USDA (2019) estimates that 2.7 California ground squirrel individuals are lethally removed for each occupied burrow destroyed. Therefore, a total of 316.7 occupied burrows multiplied by 2.7 average individuals per burrow would result in lethal removal of 855.1 California ground squirrel individuals per year on average. This number was added to the number of California ground squirrels in the “killed” fate category

to determine the number of California ground squirrels lethally removed by WS-California as described in Section 3.2.20.

WS-California uses the following fate categories for non-lethal WDM: "dispersed," "freed," "immobilized," "radio-collared," "relocated," "surveyed," and "transfer of custody." These are described below.

- The "dispersed" fate category most frequently applies to bird species but can also include mammal species. This non-lethal activity results in the self-removal of a species from a particular site/location in response to aversive stimuli and most frequently occurs at airports. Techniques for dispersal capitalize on species' sensory capabilities and typically include methods such as pyrotechnics, firearms, and vehicles.
- The "freed" fate category refers to non-lethal release of captured wildlife individuals. These individuals are freed on-site and unharmed.
- The "immobilized" fate category refers to animals which were chemically immobilized using veterinary drugs. The Proposed Project will use this category only for mammals. Infrequently, an immobilized animal might be killed after immobilization or be euthanized due to injury or illness. In these cases, the animal is also listed with the fate "killed." All other mammal individuals under the "immobilized" fate category were released on-site and unharmed. Typically, mammals are immobilized prior to radio collaring activities, when they need to be moved outside a fence, or when they need to be sampled for disease surveillance or other research. Therefore, the immobilization fate category involving mammal species is included as non-lethal take. Immobilized birds were subsequently recorded in the MIS data per the ultimate fate of the individual: either "freed" or "killed." Therefore, immobilization of birds is not included in the effects assessment because all individuals are included within another fate category.
- All individuals under the "radio-collared" fate category were affixed with radio-collars and then released on-site unharmed. The radio-collaring fate category applies to the following species: mule deer (*Odocoileus hemionus*), fallow deer (*Dama dama*), mountain lion, bobcat, and feral swine (a small number of radio-collared feral swine were released to provide data on feral swine movements in California or as Judas pigs to help locate the rest of the sounder; most feral swine are not released). The "radio-collared" fate category is included as non-lethal WDM.
- The "relocated" fate category is typically used in the following situations: wildlife species captured inside a building and then released outside or moved from one location to another as requested by a wildlife management agency (e.g., CDFW, USFWS). The relocated fate category is included as non-lethal WDM.
- The "surveyed" fate category includes individuals documented in the MIS data where no further actions occurred. Therefore, the surveyed fate category is not included as a WDM action (i.e., neither lethal nor non-lethal) because no action was taken on any individual animal.
- The "transfer of custody" fate category refers to those individuals captured by WS-California and transferred to another governmental or non-governmental organization, typically to CDFW or a licensed wildlife rehabilitator. These individuals are transferred from WS-California custody alive and healthy. The vast majority of individuals are anticipated to have been released by CDFW or the licensed rehabilitator, except for non-native or domestic species. Therefore, the transfer of custody fate category is included as non-lethal WDM for this report. However, WS-California does not track the ultimate fate of these individuals after they leave WS-California's custody.

2.4 Categories of Wildlife Damage Management in the Study Area

WDM in California generally falls into one of three categories, based on the resource protected: airport Wildlife Hazard Management, T&E species protection, and county-based WDM (includes WDM under county-directed programs and by WS-California for CSA counties). These categories are described below. They also differ based on the agencies (e.g., federal, state, or county) or individuals involved, and this is discussed in each category below.

2.4.1 Airport Wildlife Hazard Management

WDM to reduce wildlife hazards and protect public safety at airports, referred to as Wildlife Hazard Management (WHM), is managed by the airports, often in cooperation with WS-California through word agreement documents. The Federal Aviation Administration (FAA) encourages all airports to implement Wildlife Hazard Management Plans in order to maintain a safe operating environment; such plans are required for all airports certificated under 14 CFR Part 139. Wildlife Hazard Management Plans identify specific actions to mitigate the risk of wildlife-aircraft strikes on or near airports and have been completed or initiated by 30 airports in California.

If an airport receives federal funding to support operating activities, it will often require the assistance of wildlife professionals to assess and recommend strategies to reduce wildlife hazards. Given the long-term recognition and function of federal agencies in assisting the public with safety and WHM concerns, a series of programs exist in the Department of Defense, FAA, and USDA to assist civil and military airports with wildlife hazards. Specifically, WS-California and its predecessors have provided assistance to airports since the mid-1950s. WS-California conducts WHM pursuant to Wildlife Services' Airport Wildlife Hazards Program[1] to resolve wildlife conflicts that threaten the flying public's health and safety. WS-California employs a network of trained and certified biologists that provide site visits and consultations, develop wildlife hazard assessments and wildlife hazard management plans, provide training to airport staff, and conduct operational WHM on airfields. This work helps airport managers maintain a safe environment and meet FAA regulatory requirements and Department of Defense instructions. Table 2-1 summarizes the WS-California involvement at airports.

Table 2-1. WS-California at Airports in California

Airport Type	Airports Assisted (No.)	Airports provided training (No.)	Personnel Trained (No.)
Civil	19	17	135
Joint-Use	2	0	0
Military	11	5	233
Total	**32**	**22**	**368**

Source: USDA 2018. No. = number.

Any entity implementing wildlife hazard management plans must abide by relevant local, state, and federal laws and regulations concerning natural resources and transportation safety. Lethal removal of wildlife is highly regulated at the state and federal level. At the federal level, recommendations from Wildlife Services are required for the application process to obtain a migratory bird depredation permit administered by the USFWS to lethally

1 Wildlife Services' Airport Wildlife Hazards Program website: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/sa_airport#:~:text=Wildlife%20Services%20(WS)%2C%20a,threaten%20public%20health%20and%20safety.

remove migratory birds. At the state level, permits to lethally remove most mammals and non-migratory birds must be obtained from CDFW. Permits are issued with strict guidelines.

Counties with airports currently receiving assistance from WS-California (i.e., those with operational assistance data collected in the WS-California MIS during the 10-year baseline period) include the following:

- Alameda
- Butte
- Contra Costa
- Imperial
- Kern
- Kings
- Los Angeles
- Merced
- Monterey
- Napa
- Orange
- Placer
- Sacramento
- San Bernardino
- San Diego
- San Joaquin
- San Luis Obispo
- Santa Clara
- Shasta
- Solano
- Tuolumne
- Ventura
- Yuba

WHM for the protection of human safety at airports is separate from county-directed WDM programs and is conducted outside of county CSAs. For airports served by WS-California, we used MIS data to determine WHM take. For airports not served by WS-California, we estimated WHM take. For non-MIS lethal WHM estimates, all public and military airports in the state not served by WS-California were identified (n= 197). Public airports (194) were further divided into general aviation airports[2] (187) and those certificated by the FAA under 14 CFR Part 139 to serve commercial airlines (7). This distinction is important because Part 139-certificated airports are required to develop and implement a Wildlife Hazard Management Plan to address wildlife species that could pose a collision risk to aircraft. General aviation airports are not required to have such a plan, and typically conduct less (or no) WHM. The level of WHM at an airport is typically associated with the amount of flight activity at the airport because the risk of a collision with wildlife increases with increasing flight operations. Therefore, data regarding daily flight operations at each airport were obtained, as aggregated by AirNav.com from FAA data. Using those data, weighting factors were assigned to each airport reflecting how likely they were to conduct lethal WHM activities. Refer to Appendix B.

For military airfields, flight operation data are not available due to national security concerns, so a similar approach could not be used. Therefore, professional judgment was used to assess the activity of various airfields. The minimum weighting for a military airfield was 3 for small island airfields or single airfields within larger complexes; 4 for moderate sized airfields; and 5 or greater for major airfields. For example, El Centro Naval Air Facility was rated a 3, whereas Edwards Air Force Base was rated an 8. Complete details on weighting factors are provided in Appendix B.

Airports that are under agreement with WS-California for WHM assistance (and for which the take would thus be recorded in MIS) were separated out, excluding those where WS-California only provides technical guidance and

2 The FAA defines general aviation airports as those that do not have scheduled service or have less than 2,500 annual passenger boardings. https://www.faa.gov/airports/planning_capacity/categories

does not conduct WHM activities. The weighting factors for the WS-served airports were summed and compared with the sum of non-WS-served airports. This provided a ratio of WS-served to non-WS-served airports for each county. To estimate lethal WHM in counties where there was no WS-served airport, “lethal WHM per weighted unit” was determined for each species based on the sum of weighted units for all WS-served airports and the total lethal take reported in MIS for that species under the airports category.

Below is an example of how this approach was applied for WHM of American crow in El Dorado County where there was no prior WHM by WS-California:

Step 1 - Determine Weighted Factor for American Crow				
183.1	Divided by	241	Equals	0.76
American crows killed per year at WS-served airports in California		Sum of weighted values for WS-served airports in California (Appendix B)		Weighted factor for American crow (i.e., number killed for WHM per weighted value)
Step 2 - Apply Weighted Factor to El Dorado County				
0.76	Multiplied by	4	Equals	3.0
Weighted factor for American crow		Sum of weighted values of airports not served by WS-California in El Dorado County (Appendix B)		Estimated number of American crows killed per year in El Dorado County at airports not served by WS-California

2.4.2 Threatened and Endangered Species Protection

WS-California conducts a variety of WDM to protect federally threatened or endangered species. This work is conducted separately from any and all agreements with the state and the various counties (e.g., CSAs), and is categorized separately. It is likely that the vast majority of lethal WDM for the protection of threatened or endangered species in California is conducted by WS. However, non-governmental entities may be authorized by USFWS or other appropriate wildlife management agency to conduct such work. As such, we estimated WDM take for T&E species protection outside of WS-California MIS data. For non-MIS lethal estimates of target species taken for T&E species protection (e.g., Western snowy plover, California least tern, Ridgeway’s rail [*Rallus obsoletus* sp.]) we estimated that an additional 33% lethal take of each target species beyond that recorded in WS-California MIS occurs statewide by non-WS entities for T&E species protection. It was also estimated that this additional lethal take for T&E species protection was evenly distributed among all the counties within the range of that target species. This is likely a conservative (i.e., high) estimate because we believe that the vast majority of lethal WDM for T&E species protection in California is conducted by WS-California. No other data was provided from any other sources on such take.

2.4.3 County-Based Wildlife Damage Management

The County-based Proposed Project component includes WDM conducted under county-directed programs and by WS-California for CSA counties. For counties that had CSAs (essentially contracts for WDM) with WS-California, no other lethal WDM was likely to be conducted by the county or other governmental entities. For most species, all lethal WDM in these CSA Counties is likely contained within the MIS data from WS-California. Therefore, for most species, a non-MIS lethal estimate is not provided under the County-based Proposed Project component for counties with CSAs. For some animals, such as deer mice and western grey squirrel, some amount of lethal take by individual property owners (mostly home-owners or renters) is likely. For these species we made rough estimates of such take based on the population of each species in each county and professional judgment of WS-California staff.

For counties which had CSAs during only a portion of the 10-year analysis period (Calendar Year [CY] 2010-2019), we used the MIS data only for those years when the CSA was in place and derived an annual average (and 95% confidence interval) utilizing those years. Four counties are in this category: Placer, San Benito, Siskiyou, and Sonoma. Placer County had a CSA with WS-California during CY 2010-2015, so we analyzed only these six years. San Benito County had a CSA during 2010-2012, so we analyzed only these three years. Siskiyou County had a CSA during 2010-2018, so we analyzed only these nine years. Sonoma County had a CSA during 2010-2013, so we analyzed only these four years.

For the 20 counties that did not have a CSA during the analysis period, including those that have county-directed WDM programs, we received little or no WDM data. It is likely that lethal WDM in those counties was similar to that recorded for CSA Counties, and lethal take was estimated for non-CSA counties using the following methods:

- For mammal species, the amount of lethal WDM recorded in MIS under the County-based Proposed Project component was first divided by the estimated population of the species among these CSA counties (38 counties at the time of analysis, including the four counties discussed above with CSAs only during a portion of the analysis period). This provided a percentage of the total estimated population in CSA counties that was taken through lethal WDM, averaged across all CSA counties. That percentage was then applied to the estimated population of that species in each non-CSA county. Using this approach, the percentage of the population removed by lethal WDM in each non-CSA county is equal to the overall percentage of the population removed by lethal WDM among all CSA counties combined. This approach was used because it is based on the one deterministic factor for predicting wildlife damage that we could reasonably estimate: the population of the wildlife species in each county.[3] This approach assumes that the resources damaged by each species (and thus the demand for WDM) are similar among the counties. Whereas this assumption adds some degree of error into our analyses, we determined it to be the most accurate and reasonable method to estimate such unknown WDM take. This number is listed in Section 3.2 as the "County-Based Non--WS Lethal Take Estimate." See Appendices C1–C29 for each mammal species' population estimate.
- For bird species, we used the average annual lethal take among CSA counties as the estimate for lethal take in non-CSA counties which overlapped each species' range.[4] This average was calculated by dividing the sum of all lethal take in CSA counties by the number of CSA counties (38). This number is listed in tables in Section 3.3 as the "County-Based Non-WS Lethal Take Estimate."

2.5 Species Analyzed

All species that were either intentionally (i.e., target species) or unintentionally (i.e., non-target species) taken (lethally or non-lethally) during the analysis period (CY 2010–2019) were analyzed. Target wildlife species include both native and non-native species that pose a risk of damage to humans, pets, livestock, property, other wildlife

3 There are generally only two factors which can be used to predict whether and to what extent wildlife damage will occur in a county: the population of the wildlife species, and the presence of the resources commonly damaged by that species.
4 Species' ranges were derived from The Cornell Lab of Ornithology's Birds of the World: https://birdsoftheworld.org as of May 2022.

(especially special-status species), or the environment. Non-target species are those caught unintentionally during WDM activities. Non-target data, like target data, are largely limited to the WS-California MIS dataset. Special-status species are defined as those that are federally- or state-listed or candidates for listing under the CESA or FESA, vertebrates considered state Fully Protected species (Cal. Fish and Game Code Sections 3511, 4700, 5050, and 5515), and state Species of Special Concern (SSC) (CDFW 2022a).

2.6 Methods of Analysis

The potential for the Proposed Project to affect populations of target and non-target wildlife species is based on a review of publicly available data obtained from the WS-California MIS; informational materials prepared by WS-California made publicly available on the Wildlife Services website; environmental documents prepared by WS-California and CDFW; and scientific publications.[5]

The effects analyses for target species in this report uses the data from CY 2010-2019 collected in the WS-California MIS (USDA 2023), combined with estimates of WDM take by all non-WS entities using the methods described in Section 2.4.3, as reasonable indicators of the future implementation of WDM under the Proposed Project, excepted as noted herein. The one exception is for mountain lion, as described below.

The take of mountain lions under CDFW-issued depredation permits have been limited in recent years (2018-2022) and are expected to remain so because mountain lion is a candidate for listing under the CESA within the Southern California/Central Coast Ecologically Significant Unit (California Fish and Game Commission 2020). CDFW management of depredating mountain lions is limited by CDFW policy (CDFW 2017) as well as the proposed listing of mountain lions under CESA. Mountain lions presenting a threat to human safety are likely to be lethally removed, and take for that purpose is expected to be similar to that during the analysis period (CY 2010-2019). However, the lethal take of mountain lions depredating livestock or pets is likely to decrease by at least 50% in the future. More details are provided in the mountain lion analyses (Sections 3.2.24 and 3.4.13).

Based on the data included in the analysis period of CY2010-2019, 38 counties had CSAs with WS-California for WDM. It is anticipated that additional counties will enter into CSAs with WS-California in the future under the Proposed Project. This would result in an increase in the relative lethal take attributed to WS-California. However, this would not likely result in an increase in cumulative take because we estimated such take in the non-CSA-counties, and this level of take is likely to continue regardless of who is responsible for such take (WS-California, the county, a private contractor, or a variety of individuals within the county).

The analyses below focus on the potential effects of the Proposed Project on 24 mammal species, 14 bird species, and 13 species that have a special status under FESA or CSEA or CDFG code (i.e., California Fully Protected species). Several species were eliminated from further analysis based on certain criteria (See Section 3.1 for details).

The analyses in this report estimate lethal take under the Proposed Project as a percentage of the estimated population for each species, and compare that percentage to the estimated sustainable harvest threshold for each species. For mammal species, population estimates were derived as presented in Appendices C1–C29: the top two-thirds of CDFW suitable habitat data were multiplied by the average species density or divided by the average adjusted female home range size, or both. For most species we used both methods and used whichever number was lower for the population estimate (Appendices C1–C29). For bird species various literature sources were consulted as described in Section 3.3 and only statewide estimates are used. For many species no published

5 Wildlife Services website: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/sa_program_overview

threshold of "sustainable harvest" or "sustainable loss" for populations is available. For species that are hunted or trapped, the CDFW (previously CDFG) prepared population models for several species (i.e., American badger, North American beaver, bobcat, coyote, gray fox, American mink, raccoon, spotted skunk, stiped skunk, and long-tailed weasel) when preparing their Draft Environmental Document for Furbearing and Nongame Mammal Hunting and Trapping (CDFG 2004) and for black bear in their Draft Environmental Document Regarding Bear Hunting (CDFG 2011). These thresholds identified "sustainable" levels of hunting or trapping when considering adult populations, sex ratios, reproductive success, projected natural mortality, and WDM. Several target mammal species were not included in these CDFW sources including red fox, river otter, yellow-bellied marmot, porcupine, black-tailed jackrabbit, desert cottontail, brush rabbit, California ground squirrel, deer mouse, dusky-footed woodrat, black-tailed deer/mule deer, and bird species. The California Fish and Game Commission Section 4152 allows for the following target species to be killed any time of year and in any number: coyote, black-tailed jackrabbit, long-tailed weasel, yellow-bellied marmot, deer mouse, striped skunk, [western] spotted skunk, California ground squirrel, big-eared woodrat, and dusky-footed woodrat. This analysis considered the thresholds provided in CDFG (2004, 2011), by Gese (2005) and Miller (1990), as well as other current peer-reviewed scientific literature and population models to determine sustainable harvest thresholds.

Sustainable harvest thresholds were determined for most target species analyzed in Chapter 3 of this Report. The literature sources and manner by which the thresholds were determined, or not determined if applicable, are described individually for each species in those sections. In addition, to satisfy CEQA requirements for this Project, a county-level analysis for all species taken under county-directed programs is required.

2.6.1 Effect Mechanisms

This section describes the ways in which implementation of WDM activities could affect target and non-target species, as well as effects at a larger scale such as effects to habitat, hydrology, and ecosystems.

2.6.2 Target Species WDM

Although non-lethal methods of WDM are preferred and commonly used, implementation of the Project would include lethal WDM of target species. For bird species, much of the Project WDM would occur on airport properties, as that is where the greatest conflict between human activities and wildlife presence or behavior occurs. For mammal species, population estimates for target mammal species were derived as described in Appendices C1–C29 using published data for population density and home range size and habitat suitability models from CDFW's California Wildlife Habitat Relationships (CWHR) system (CDFW 2016a). Population estimates are only for adults; life tables providing population estimates for various ages were not used in the mammal population estimates. This is a conservative method because WDM take is not limited to only adults, but WDM take is compared only to the estimated adult population. Assessment of take as a proportion of the adult-only population showed that effects would not exceed sustainable threshold for most species even using this conservative approach. Life Tables or further analyses were provided only for those species for which the conservative take analyses (i.e., total take compared to adult-only populations) did not conclusively eliminate the possibility of exceeding sustainable thresholds. Chapter 3 analyzes the effects of WDM activities on target mammal and bird species.

2.6.3 Take of Non-Target Species

Non-target species are those captured or otherwise affected unintentionally during WDM activities which targeted a different species. Historically, unintentional take of non-target species is extremely rare. WS-California wildlife specialists are experts with experience in the techniques described in Appendix C of the EIR/EIS. This expertise, experience, and protective measures used by WS-California (i.e., Wildlife Services Directives[6]) minimizes the risk of capturing non-target wildlife species. Additionally, if a non-target species is caught, every effort is made to release it unharmed unless the non-target animal is injured and determined to be not likely to survive if released. Other state and county-level employees and contractors conducting WDM also have extensive expertise in avoiding take of non-target species, but may not have received levels of training comparable to that of WS-California staff.

Occasionally target species are also caught unintentionally; this take is included in target species take numbers. The effects analyses in this report do not distinguish between unintentional and intentional capture of target species because intent does not alter the potential impacts. Non-target take is analyzed in Chapter 4 of this Report. Most of the non-target species taken by WS-California were also target species during other WDM activities (51 of 66, or 77%), as listed in Table 4-1. This non-target take during the ten-year analysis period is expected to represent the non-target species likely to be unintentionally taken under the Proposed Project.

Potential impacts from non-lethal WDM on non-target species are more likely, and depend on the WDM methods selected, co-occurring species, season, and many other factors. Examples of non-lethal WDM activities that could impact non-target species include: aerial shooting, which could cause wildlife to flee associated aircraft noise and vibration; and firearm noise, which could result in similar disturbance. Dispersal of birds at airports or agricultural fields through pyrotechnics such as shell crackers and screamer sirens could disturb other non-target species using such areas. Many wildlife species occurring at airports are considered undesirable, however, and may be targets for WDM (e.g., burrowing rodents are typically killed to reduce prey abundance for raptors and to minimize damage to infrastructure).

2.6.4 Indirect Effects

This section describes a range of ecological concepts and effects that could potentially result from WDM activities beyond direct effects. Indirect effects generally follow a chain of causation and are therefore not directly related to the action. They are generally removed from the action in time or space. Some of these effects are speculative or not fully understood due to the complex interactions in a mature yet constantly changing ecosystem. For those species for which WDM has the potential to result in indirect effects, a targeted discussion of indirect effects is provided in Sections 3.2, 3.3, and 3.4.

2.6.4.1 Environmental Contamination from Use of Toxicants

WS-California uses some chemical toxicants (refer to Appendix C of the EIR/EIS), but these compounds do not persist in the environment and have limited potential for indirect effects to non-target species, secondary impacts (i.e., those to species which might consume intoxicated target species), or ecosystems. WS has prepared several risk assessments that examine the risk of the use of toxicants in WDM and evaluate alternatives in detail (Risk Assessments are publicly available on the WS website[7]). When used according to the EPA labels, WS-California's use of these toxicants has negligible potential for such indirect impacts.

6 Wildlife Services Directives are provided here: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_WS_Program_Directives
7 Risk Assessments prepared by WS on the risk of the use of toxicants and other methods used during WDM can be found here: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments

2.6.4.2 Ecosystem Function

The discussion below provides an introduction to some of the complicated and in some cases unresolved questions regarding effects of species removal (e.g., hunting, WDM) on ecosystems and non-target species. A complete literature search and summary related to the topic of trophic cascades is provided in Appendix D.

Biodiversity and Ecosystem Resilience

Biodiversity refers to the variety of species within an ecosystem. Ecosystem resilience refers to the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes which control behavior (Gunderson 2000). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes *et al.* 2011). In diverse ecosystems, there is a degree of redundancy in the roles species play within the different ecological levels (e.g., apex predators, mesopredators, herbivores, plants, decomposers). In general, ecosystems that are less complex in terms of biodiversity and trophic levels, are more susceptible to adverse impacts and stressors such as climate change, disease outbreaks, introduction of invasive species, etc. In other words, such less-complex ecosystems have lower ecosystem resilience (Beschta *et al.* 2013; Crooks and Soulé 1999; Ritchie and Johnson 2009; Estes *et al.* 2011; Bergstrom *et al.* 2014).

Predators directly impact ecosystems through predation and indirectly through exclusion/reduction in populations of other predators/mesopredators and alteration of prey behavior and habitat use. These impacts, both direct and indirect, affect the abundance of prey species and alter impacts these species have on other levels of the food web (see discussion of trophic cascades below; Prugh *et al.* 2009; Ritchie and Johnson 2009; Estes *et al.* 2011; Wallach *et al.* 2010; Miller *et al.* 2012). Wallach *et al.* (2010) showed that increases in dingo populations (due to the absence of exclusion and use of toxicants) resulted in decreases in mesopredators and generalist herbivores, and increases in small and intermediate-weight mammals. The complete loss of apex predators from an ecosystem can reduce biodiversity and shorten the food web length in the system, which may alter the presence and abundance of mesopredators (see Mesopredator Release below), increase the intensity of herbivory, and ultimately impact the abundance and composition of plant communities, soil structure, nutrients, and even physical characteristics of the environment (see Trophic Cascades below; Berger *et al.* 2001; Ripple and Beschta 2006; Prugh *et al.* 2009; Estes *et al.* 2011). The presence of native predators in a healthy ecosystem may also improve the ability of the system to resist adverse impacts of invasive species. Large-scale or complete removal of target species can potentially cause unpredictable and unforeseen changes in an ecosystem, reducing its resilience to stochastic (random) or other extrinsic factors such as a new invasive species, increased human presence, extreme weather events, or climate change.

Trophic Cascade

A complete literature search and summary related to the topic of trophic cascades is provided in Appendix D. A trophic cascade is an indirect ecological effect that occurs when one trophic level is modified to an extent that it affects other trophic levels in a food chain or web. In a simple example, predators, their herbivore prey, and plants that provide food for the herbivores are three trophic levels that interact in a food chain. The presence of the predator maintains healthy prey populations or causes the prey population to alter its use of habitat which, in turn, impacts plant community composition and health. Depending on the nature of the impact and the prey species, changes in vegetation and prey behavior can have impacts on abiotic factors such as soil compaction, soil nutrients, and river morphology (Ripple and Beschta 2006; Naiman and Rogers 1997). Large-scale or complete removal of large mammalian predators such as mountain lions or wolves has the potential to change the behavior of more generalist predators like black bears and can affect behavior and density of wild ungulates such as deer or elk.

Increased herbivory of these wild ungulates can substantially affect plant communities and the habitats that are created by those plant communities, as was observed in Yellowstone National Park after the complete removal of mountain lions and wolves in the 1900s (e.g., Grimm 1939; Keigley 2018; Wagner 2006; Beschta and Ripple 2018). Trophic cascade effects from large-scale or complete removal of smaller predators (e.g., coyote, fox, bobcat) can also occur, potentially increasing abundance of prey mammals such as voles, ground squirrels, and others. Removal of larger predator species also has the potential to allow increased abundance of mesopredators (mid-ranking predator in a trophic level that typically preys on smaller animals) such as raccoons and opossums; this is discussed below.

In most ecosystems, the nature and magnitude of these types of relationships varies. For example, Maron and Pearson (2011) found no evidence that the presence of vertebrate predators fundamentally affected primary production or seed survival in a grassland ecosystem. Trophic cascades have been documented after the complete removal of a predator species from an ecosystem (e.g., Grimm 1939; Keigley 2018; Wagner 2006; Beschta and Ripple 2018), but we are not aware of any evidence that the removal of low, modest, or even considerable numbers of predators has the potential to result in such trophic cascades.

Mesopredator Release

The "mesopredator release" hypothesis described by Soulé *et al.* (1988) purports that when top carnivores (e.g., mountain lions, coyotes) are removed (e.g., due to urbanization) from suitable habitat areas, this can result in the increase in abundance of mesopredators (e.g., red fox, opossums, feral cats, striped skunks). Mesopredator release is a type of trophic cascade. The resulting increase in mesopredator populations might result in different impacts on prey populations and other trophic levels (Prugh *et al.* 2009; Brashares *et al.* 2010; Miller *et al.* 2012). For example, the presence of coyotes in an area has been shown to limit the density of smaller predators which may prey more heavily than coyotes on songbirds, ground nesting birds such as ducks and game birds, and some rodents (Levi and Wilmers 2012; Miller *et al.* 2012). Crooks and Soulé (1999), also examined mesopredator response to a variety of predator conditions, both in term of predator abundance and temporal variability of their presence. That study found that the absence or diminished presence of coyotes correlated with increased mesopredator (domestic cat, opossum, and raccoon) predation on scrub bird species in southern California. Recovery of wolf populations and associated long-term declines in coyote populations have been documented to result in an increase in survivorship of pronghorn deer fawns (Berger and Conner 2008). Also, mesocarnivores such as badgers, bobcats, and swift fox (*Vulpes velox*) have been shown to increase in number when coyote populations are reduced (Robinson 1961; Nunley 1977; Crooks and Soulé 1999). These smaller carnivores (e.g., foxes, skunks, raccoons, domestic and feral pets) may be more productive and more successful at predating on other smaller, native bird and mammal species (Ripple *et al.* 2013). WDM activities implemented by the Proposed Project involving the removal of larger predators, such as coyotes, bobcats, and mountain lions have the theoretical potential to result in mesopredator release. The definition of a mesopredator versus an apex predator can also shift in context: coyotes are considered mesopredators in most ecosystems but may be considered an apex predator in others where larger predators have been extirpated (e.g., wolves, mountain lions) (Crooks and Soulé 1999; Roemer *et al.* 2009). However, much like other trophic cascades, most of the available evidence for mesopredator release is limited to the complete removal of the top predator, which is neither the goal nor a likely result of WDM.

Apex Predator

An apex predator is a species at the top of the food chain/web that generally does not have natural predators. Though it may occasionally be killed during conflict by other apex predators (e.g., mountain lion/wolves, wolves/bear), the apex predator is not generally considered a prey target by those other apex predators. Apex predators have the capacity to affect the environment by affecting abundance of prey species, restricting smaller predators, and self-regulating their population in some cases (Prugh *et al.* 2009; Ritchie and Johnson 2009; Estes *et al.* 2011; Miller *et al.* 2012; Wallach *et al.* 2015). Removal of apex predator populations could allow smaller carnivores to hunt and reproduce unchecked and thus cause deleterious ecosystem and biodiversity effects (i.e., mesopredator release as discussed above). However, it should be noted that studies of mesopredator release often fail to demonstrate the link between declines in apex predators and the mesopredator release (Prugh *et al.* 2009). It should also be noted that predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). Whereas the large-scale removal of any species from an ecosystem is likely to have broad impacts to the ecosystem, removal of predator species, particularly apex predators, is thought to have the highest potential for impact on biodiversity and ecosystem resilience(Estes *et al.* 2011). However, research to date has focused on scenarios where apex predators are extirpated, and evidence is not available regarding the effects of removing low, modest, or even substantial numbers of apex predators.

2.6.4.3 Keystone Species

Keystone species are those which have a disproportionate effect on their environment and nearly all species that rely on the resulting habitat or environment (Paine 1969; Mills *et al.* 1993). Examples of keystone species include North American beaver, which dramatically modify their environment to create new ecosystems that support a wide variety of aquatic and avian species (Pollock *et al.* 2004; Pollock *et al.* 2014); sea otters, which control sea urchins, which in turn maintains kelp forests (Smith *et al.* 2021); and wolves, which keep herbivores moving so that they don’t destroy riparian and other habitat communities (Ripple *et al.* 2014; Estes *et al.* 2011; Hebblewhite *et al.* 2005). Ground squirrels may provide this keystone function for burrowing owl by creating burrow systems that the owls can use as a nesting resource (Lenihan 2007) and by providing predator alert services to burrowing owls (Henderson and Trulio 2019). Lethal removal of keystone species has the potential to produce negative effects on habitat, ecosystems, and reliant species. However, we are not aware of evidence that the removal of low, modest, or even considerable numbers of keystone species would necessarily cause these negative effects, as research to date has focused solely on situations wherein keystone species populations have significantly and dramatically declined.

2.6.4.4 Compensatory Mortality

Compensatory mortality considers that some members of a population are continually dying, and that predation (natural or otherwise) replaces some of that mortality with a different type of mortality as opposed to being additive (i.e., instead of dying from lack of food, the individual dies from predation). Additive mortality is that which increases the overall mortality because it does not result in a reduction in other forms of mortality. Compensatory mortality is that which causes a reduction in other forms of mortality, such that overall mortality is not increased (Bartmann *et al.* 1992). For example, when an animal dies, this allows an adjacent animal that might have also died due to resource competition to fill the gap and persist. The concept of compensatory mortality applies to the effect of predation on a population (Bartmann *et al.* 1992; Bender and Rosas-Rosas 2016; Theberge 1990), and also applies to hunter and trapper harvest and WDM (Pope and Powell 2021).

Extreme environmental conditions like drought or poor habitat quality can affect likelihood of death for any individual and thus affect the potential for compensatory mortality as opposed to additive mortality. This may affect species differently depending on their reproductive strategy; species with high reproductive output are more likely to have higher surplus populations, so additional predation may allow for better resource availability for the remaining population, thus reducing their mortality due to resource causes (i.e., compensatory mortality). However, if unsuitable habitat and fewer resources are available and a species is not at carrying capacity, then predation pressures could be additive instead of compensatory. This is particularly true for species that have few offspring and invest extensive resources and time to care of young.

This is a complex topic which has been extensively researched with a variety of seemingly incompatible conclusions even for the same species (Bergman *et al.* 2015). It appears that predation mortality can be additive or compensatory (or a combination of the two) depending on the location, population size, and available resources (Bergman *et al.* 2015). Determining if predation was the primary factor causing a population decline, and the ultimate cause of death, is even more complicated in multiple-predator, multiple-prey systems (Lehman *et al.* 2018; Leblond *et al.* 2016; Latham *et al.* 2013). The interested reader is encouraged to read the literature cited in this section, as well as citations therein.

Whereas the concept of compensatory mortality is acknowledged, it is generally not considered when evaluating the effects of WDM activities due to uncertainty. In other words, we generally assume additive (not compensatory) mortality for WDM take, unless we have evidence to the contrary, because in most cases we cannot verify whether the removal would be compensatory or additive.

2.6.5 Benefits to Native Species from Removal of Non-Natives

Several non-native species that are target species under the Proposed Project compete with, predate on, or otherwise adversely affect native species. For example, the brown-headed cowbird, which is not native to California, parasitizes the nests of native songbirds, including listed species like the least Bell's vireo or California gnatcatcher; non-native red foxes compete with native subspecies for resources and predate on native songbirds, mammals, reptiles, and amphibians; and European starlings can out-compete native cavity nesting birds for nest resources. Removal of these species can allow native species to successfully reproduce or avoid predation.

There are documented MIS baseline data (2010–2019) for feral swine causing adverse effects to snowy plover, a federal-listed and state Species of Species Concern, in San Luis Obispo County. Feral swine are opportunistic omnivores that will consume eggs of ground nesting birds, but very little is known about the effects of feral pigs as predators (Sweitzer 1998). Feral swine have been documented consuming small mammals including dusky-footed woodrat, California ground squirrel, and deer mouse within oak woodlands in the Diablo range of San Benito County, California (Wilcox and van Vuren 2009). Feral swine also cause damage to natural environments that native species rely on. As such, removal of this species under WDM activities would likely result in a net benefit to native small mammal species and avian species and potentially to reptiles, amphibians, and crustaceans (e.g., increased survival rates).

2.6.6 Changes to Habitat

Several target species alter habitat through their behaviors. An example is feral swine, which substantially damage native vegetation and cause increased erosion. Feral swine have been documented over-harvesting acorns, which can halt the recruitment of oak cohorts to the extent that they are unable to outcompete other species and a long-term and irreversible change in vegetation community can result. In addition, nutria can damage wetland habitats, agriculture, and water conveyance/flood protection infrastructure or North American beavers can alter stream hydrology and create areas of reduced flow rates that benefit habitat for other species, but also cause potential increases in flooding of surrounding areas resulting from dam structures blocking flood flows. Large-scale or complete removal of predator species can also allow for increased activity or sedentary foraging of grazing ungulates, which alters the structure of woodland and grassland habitats through herbivory and ultimately alters habitat for other dependent species. Large-scale removal of target predator species could result in either beneficial or adverse effects on habitat depending on the situation.

The methods used for WDM, as described in Appendix C of the EIR/EIS, generally cause little to no effects on habitat themselves. Dispersal and deterrent devices, trapping and removal, and lethal damage management do not cause substantial direct changes in habitat because they are temporary and are oriented toward individual animals rather than habitat features. Minor ground disturbances could result from off-road vehicle use or placement of traps that would require minor vegetation removal, but these would be temporary and typically planned to avoid special-status plant species, sensitive habitats, protected wetlands, wildlife movement corridors, or wildlife nursery sites. Physical exclusion can cause some effects on habitat by reducing connectivity for mammals; however, the use of fencing under the Project would primarily be at airports where health and safety are of paramount importance and connectivity is not desirable. Removal of North American beaver dams can affect upstream and downstream wetland areas and cause localized changes in hydrology.

2.6.7 Cumulative Effects

Project contributions to cumulative effects only include the lethal take of each of the target or non-target species under the Proposed Project because non-lethal take generally does not have the potential to affect populations. Additive mortality is assumed for these analyses rather than compensatory mortality because it is not possible to determine based on available data or research. Assuming additive mortality is the more conservative approach and generally tends to overestimate the potential for impacts rather than underestimate it. Quantitative cumulative analysis was performed on a county level for mammal species to satisfy CEQA requirements. Most important for cumulative analysis of mammal species was the availability of a county population estimate, as detailed in Appendices C1–C29. For target bird species, however, the data necessary to support a cumulative analysis at a county level was unavailable and reasonable assumptions could not be made with the best available published data. Therefore, cumulative analysis of effects on target bird species focused on effects to the statewide population, referring to documented Breeding Bird Survey (BBS) population trends (Sauer *et al.* 2019). Some cumulative take information was available for WDM conducted at airports or to benefit threatened and endangered species, and that is presented in Chapter 5 of this Report.

2.6.7.1 Hunting and Trapping

Legal hunting and trapping of target species by members of the public with valid CDFW hunting licenses would contribute to cumulative effects on target species. However, the 2019–2020 season was the final season that CDFW issued licenses for recreational trapping and for the commercial fur trade. Trapping of fur-bearing mammals was banned by the Wildlife Protection Act of 2019 (AB 273), which became effective January 1, 2020. Therefore, there are no ongoing cumulative effects of trapping for fur-bearing mammals for recreational or commercial fur trade affecting the following species: American badger, North American beaver, bobcat, coyote, gray fox, mink, raccoon, spotted skunk, striped skunk, and long-tailed weasel. Legal hunting activities are subject to a range of limitations, which vary by year and by geography. Examples include seasonal limits, limits on amount of take per hunter or types of equipment allowed to be used, restrictions on using dogs for assistance, and closures within particular zones that may have smaller populations or show signs of being overexploited. In addition to legal hunting activity, some illegal hunting and trapping activities that do not abide by CDFW restrictions certainly occurs, though the extent and geographic locations of those activities are uncertain.

2.6.7.2 Habitat Removal

Habitat removal is one of the most important factors that affect species distribution and abundance. Habitat may be directly removed through development and agricultural conversion or indirectly through diversion or depletion of resources (e.g., water). Climate change can also remove habitat through increased temperatures, drought, periodic intense flooding, and other climatic factors. Habitat fragmentation is another important factor limiting wildlife populations in North America. Even when a large amount of habitat is available, the separation of that habitat into small fragments interspersed with developed areas can render that habitat much less useful for many species, especially for larger-bodied species (with larger home ranges) and migratory terrestrial species (e.g., Williams *et al.* 2021).

2.6.7.3 Timber Harvest, Agriculture, and Other Habitat Modification

Various types of non-urban human activities can cause ongoing disturbance of habitat for target and non-target species. These include extractive uses such as timber harvest or mining, agricultural activities, and renewable energy development (e.g., wind turbines, solar photovoltaic panels). These activities may remove needed resources or make the overall habitat inhospitable (e.g., by thinning or removing slash material and snags).

2.6.7.4 Effects of Human Development

Human development can also cause increased disturbance and mortality to target and non-target species through mechanisms including but not limited to roadkill; lighting; noise; and harassment, attacks, and disease transmission by domestic pets. Human development can also increase food subsidies, which can alter the behavior of target species and bring them into more frequent conflict with humans (e.g., black bear, coyote). Food subsidies can also artificially increase the populations of some species (e.g., common raven [*Corvus corax*]). As discussed previously under Ecosystem Function (Section 2.6.4.2), changes in one species' population often impacts other members of that ecosystem.

2.7 Special-Status Species that Benefit from WS-California WDM Activities

WS-California works in collaboration with USFWS, CDFW, conservation organizations, and other land/resource managers to protect threatened and endangered wildlife and plants from the effects of predation, invasive species, and disease. Lethal removal of target species under the Proposed Project could potentially benefit special-status species which would otherwise be harmed by those target species. WS-California has a robust program for the protection of federal and state threatened and endangered species, which is separate from County-based Project components (WDM conducted under county-directed programs and by WS-California for CSA counties) and airport WHM. The species listed in Table 2-2 are intended beneficiaries of WS-California WDM activities, though others not listed below could become beneficiaries in the future.

Table 2-2. Threatened and Endangered Bird and Mammal Species Intended as Beneficiaries of WS-California Activities (CY2010–2019)

Species Protected	Federal/State Status	Counties Involved1
Salt marsh harvest mouse (*Reithrodontomys raviventris*)	Endangered/Endangered, FP	Solano, Marin, Contra Costa, Alameda, Santa Clara, San Mateo

Table 2-2. Threatened and Endangered Bird and Mammal Species Intended as Beneficiaries of WS-California Activities (CY2010–2019)

Species Protected	Federal/State Status	Counties Involved1
Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*)	Endangered/Endangered, FP	Inyo, Mono
California Ridgway's rail (*Rallus obsoletus obsoletus*)	Endangered/Endangered, FP	Solano, Contra Costa, Alameda, Santa Clara, San Mateo, Marin
Light-footed Ridgway's rail (*Rallus obsoletus levipes*)	Endangered/Endangered, FP	Ventura, San Diego
Western snowy plover (*Charadrius nivosus nivosus*)	Threatened/SSC	Marin, Alameda, Contra Costa, Santa Clara, San Mateo, Monterey, Santa Cruz, San Luis Obispo, Santa Barbara, Ventura, San Diego
California least tern (*Sternula antillarum browni*)	Endangered/Endangered, FP	Alameda, Contra Costa, San Luis Obispo, Ventura, San Diego
California condor (*Gymnogyps californianus*)	Endangered/Endangered, FP	Kern
Marbled murrelet (*Brachyramphus marmoratus*)	Threatened/Endangered	Santa Cruz
Desert tortoise (*Gopherus agassizii*)	Threatened/Threatened	Kern, San Bernardino, Riverside, Los Angeles

Source: USDA 2022b.
Note: FP = Fully Protected; SSC = Species of Special Concern.
1 Counties where WS-California conducts wildlife damage management to protect threatened and endangered species; such work is separate from and does not imply any involvement by state- and county-level wildlife damage management.

Other special-status species that could benefit from the removal of target species under the Proposed Project may include a wide variety of species ranging from smaller species such as kangaroo rats (*Dipodomys* sp.), arroyo toads (*Anaxyrus californicu*s), and Tehachapi slender salamanders (*Batrachoseps stebbinsi*), to medium-sized carnivores such as San Joaquin kit fox (*Vulpes macrotis mutica*), and bird species such as burrowing owl (*Athene cunicularia*). Potential benefits to these species have not been documented by WS-California, but are possible based on the biology of these species and their threats to survival.

3 Target Species Impact Analyses

This section describes the potential adverse, beneficial, and cumulative effects of the Proposed Project on target species, including both special-status and non-special-status. For the purposes of this analysis, target mammal and bird species are analyzed individually to determine potential Proposed Project and cumulative effects on populations at either a county or state level. Both non-lethal and lethal WDM activities are discussed in the analyses. However, the direct effect analyses in this report are based on lethal take only to determine potential effects on species populations.

Under the Proposed Project, WS-California and county-led WDM programs would provide the same services as have historically occurred, though it is expected that some counties that currently conduct their own WDM would enter into a CSA with WS-California to provide those services. No changes to WDM activities are proposed that would increase effects on target species, though the Project does not establish limits on lethal or non-lethal WDM activities. The number of individuals targeted would be a function of the number of requests for assistance by resource owners (e.g., landowners, airports) and the issuance of depredation permits by CDFW or USFWS, if required.

Because there are very limited population data for the target mammal species within the state, population estimates for these species were derived using the CDFW habitat distribution model combined with population densities or home range sizes from peer-reviewed literature sources as described in detail in Appendices C1–C29. Species occurrence databases, including the California Roadkill Observation System (CROS 2023), and the U.S. Geological Survey (USGS) Biodiversity Information Serving Our Nation (USGS 2020), were reviewed to provide a visual confirmation of the distribution models. Species occurrence databases like these rely on public input and may contain errors in identification and location and only present detected data where observers are located. They do not include negative survey data or areas that have not been surveyed (i.e., lack of occurrence data might be due to either lack of occurrence or lack of observers). As such, these occurrence databases often identify where the species and humans interact, as opposed to the species' range overall. Nonetheless, such species occurrence data are useful for verification of likely species ranges based on determinations of suitable habitat. For example, when occurrence data demonstrate species occurrence well outside of their predicted range, this suggests reconsideration of suitable habitat designations.

For most of the target species, there are limited density estimates available for estimating species populations in California. The best data available was used for such estimates, but data are often limited. Likewise, there are limited peer-reviewed data discussing home range size, sex ratio, and percent overlap between home ranges which are used to estimate the multiplication factor for individuals and derive the population estimates by this alternative method. The literature used to generate the target species population estimates include studies from regions throughout North America and sometimes Europe, which may not reflect the actual ecology in California.

For this report we use the most conservative (i.e., lowest) population estimate calculated in Appendices C1–C29 to assess the potential for significant impacts to species' populations.

The MIS database maintained by WS-California quantifies all lethal and non-lethal WDM activities conducted by WS in California and provides information on the species involved, number of individuals, and the resource damaged. Existing WDM tables for all target species are categorized by the three main Project components: airports, T&E

species protection, and County-based.[8] Because MIS baseline data do not include non-WS WDM activities occurring in each county, a non-WS lethal WDM estimate (referred to as the "non-MIS lethal estimate") is provided in addition to the MIS data for each species' impact analysis.

3.1 Species with No Further Analysis

The amount of statewide lethal take for all species anticipated to be intentionally or unintentionally taken was analyzed. Whenever possible, we then estimated the statewide population for each species using the best data available. For some migratory bird species, estimation of statewide populations was not useful because these populations report the breeding population only. When small numbers of the species breed in California but large numbers winter in California (or migrate through California) we considered regional or North American populations as well as the resident breeding population. When lethal take is low compared to the estimated population (e.g., 1% or less), there is no potential for the Proposed Project to contribute to a significant impact at the population level. However, all special-status species that are targeted for lethal and non-lethal WDM are examined in Section 3.4, regardless of the percentage of the population affected. For the purposes of this report, we used the following criteria to determine if a non-special status target species required no further analysis:

1. If there was no lethal take during the analysis period (i.e., all WDM was nonlethal).
2. If the species is considered non-native, domesticated and/or feral in California.
3. If there was no lethal take under County programs and average annual lethal take was below 1% of the species' statewide population during the analysis period.
4. If species population could not be determined and lethal take averaged less than 1 individual per year during the analysis period.

Species that meet at least one of these criteria are listed in Table 3-1 and have been eliminated from further analysis.

Non-native, domesticated and feral species are not an integral part of the natural environment; as such, lethal take of these species has no potential to contribute to any significant impact on the natural biological environment. All non-native, domesticated and feral species have been eliminated from further analysis in this report because this report focuses on the potential impacts to biological resources only. The lethal take of non-native, domesticated and feral species has the potential to influence other issues or resources such as recreation, and those potential impacts will be assessed in other reports or in the EIR/EIS.

Available population estimates for the species with no further analysis are provided in Table 3-1. Bird population estimates were derived from a variety of sources, including Partners in Flight's database (PIF 2022), Global Waterbird Population Estimates 4th Edition, as cited in Cornell Lab of Ornithology 2022), and Breeding Bird Count data 2015-2019 (Sauer *et al.* 2019). Mammal and reptile population estimates were derived from various sources including similar analyses as provided in Appendices C1–C29 (done for muskrat and Botta's pocket gopher), counts of pairs and pups from the four known wolf packs in California (CDFW 2022h), and published literature regarding gopher snakes (Rodriguez-Robles 2003) and rattlesnakes (Beck 1995).

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8 The County-Based Proposed Project component also includes WDM activities that resulted from miscellaneous special requests. Examples include removal of a raccoons from an airport building or removal of geese from a golf course. Such projects are conducted outside of USDA/County CSAs; however, they protect resources which are commonly protected under such CSAs and target species which are commonly targeted under CSAs. Because of these similarities, they are grouped with the County-Based Proposed Project component.

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Corvids				
Steller's Jay (*Cyanocitta stelleri*)	2.2	892,591	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Yellow-Billed Magpie (*Pica nuttalli*)	0.1	70,728	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Raptors				
Sharp-shinned hawk (*Accipiter striatus*)	0	4,660	0%	No lethal take
Short-eared owl (*Asio flammeus*)	0	1,783	0%	No lethal take
Cooper's hawk (*Accipiter cooperii*)	14.6	64,000	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Burrowing owl (*Athene cunicularia*)	0.1	38,533	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Great horned owl (*Bubo virginianus*)	1.5	295,891	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Rough legged hawk (*Buteo lagopus*)[8]	1.1	22,853	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Red-shouldered hawk (*Buteo lineatus*)	0.5	104,802	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Turkey vulture (*Cathartes aura*)	53.4	447,976	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Merlin (*Falco columbarius*)	0	ND	0	No lethal take
Prairie falcon (*Falco mexicanus*)	0	4,855	0	No lethal take
American kestrel (*Falco sparverius*)	20.9	135,898	<0.02%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Western screech owl (*Megascops kennicottii*)	0	48,294	0	No lethal take
Osprey (*Pandion haliaetus*)	3.4	30,345	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Insectivores				
Mountain bluebird (*Sialia currucoides*)	0	141,839	0	No lethal take
Western bluebird (*Sialia mexicana*)	0.4	2,380,863	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Black-headed grosbeak (*Pheucticus melanocephalus*)	0	4,150,150	0	No lethal take
Western kingbird (*Tyrannus verticalis*)	22.5	1,941,744	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Horned lark (*Eremophila alpestris*)	63.1	865,870	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Western meadowlark (*Sturnella neglecta*)	151.1	1,683,973	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Northern mockingbird (*Mimus polyglottos*)	6.7	559,688	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Nighthawks (*Chordeiles* sp.)[2]	0	545,664	0	No lethal take
Bullock's oriole (*Icterus bullockii*)	0	1,359,016	0	No lethal take
Hooded oriole (*Icterus cucullatus*)	0	194,094	0	No lethal take
Black phoebe (*Sayornis nigricans*)	0.1	1,018,607	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Say's phoebe (*Sayornis saya*)	0.9	ND	ND	Lethal take accounts for an average of less than 1 individual per year; not taken under County programs.
American pipit (*Anthus rubescens*)[9]	1.2	76820	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Common poorwill (*Phalaenoptilus nuttallii*)	0	137,286	0	No lethal take
American robin (*Turdus migratorius*)	0	3,568,243	0	No lethal take

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Loggerhead shrike (*Lanius ludovicianus*)	0.2	217,755	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Cliff swallow (*Petrochelidon pyrrhonota*)	92.9	9,700,000	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Barn swallow (*Hirundo rustica*)	4.8	523,424	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Northern rough-winged (*Stelgidopteryx serripennis*)	0	493,815	0	No lethal take
Tree swallow (*Tachycineta bicolor*)	1.2	440,609	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Violet-green swallow (*Tachycineta thalassina*)	0	402,364	0	No lethal take
Swifts (*Chaetura* sp.)[3]	0	359,151	0	No lethal take
Yellow-rumped warbler (*Setophaga coronate*)	0.1	2,738,455	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Marsh wren (*Cistothorus palustris*)	0	759,637	0	No lethal take
Upland Game Birds				
Mourning dove (*Zenaida macroura*)	1,577.10	4,400,000	0.04%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
White-winged dove (*Zenaida asiatica*)	0	118,156	0	No lethal take
Band-tailed pigeon (*Patagioenas fasciata*)	0.1	456,046	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Quail (*Callipepla* sp.)[4]	0	383,569	0	No lethal take
California quail (*Callipepla californica*)	0	1,447,419	0	No lethal take

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Granivores				
House finch (*Haemorhous mexicanus*)	165.3	8,932,938	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
American goldfinch (*Spinus tristis*)	2.5	364,891	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Lesser goldfinch (*Spinus psaltria*)	0.7	2,850,812	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Chipping sparrow (*Spizella passerine*)	0	1,850,185	0	No lethal take
Golden crowned sparrow (*Zonotrichia atricapilla*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Lark sparrow (*Chondestes grammacus*)	0.1	196,478	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Savannah sparrow (*Passerculus sandwichensis*)	3.8	471,022	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Song sparrow (*Melospiza melodia*)	0	2,191,776	0	No lethal take
California towhee (*Melozone crissalis*)	11	5,532,683	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Spotted towhee (*Pipilo maculatus*)	0	10,459,445	0	No lethal take
Great-tailed grackle (*Quiscalus mexicanus*)	0	163,163	0	No lethal take
White-crowned sparrow (*Zonotrichia leucophrys*)	107.5	180,000	0.06%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Waterfowl				
Wood duck (*Aix sponsa*)	0.6	14,471	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Lesser scaup (*Aythya affinis*)	0.1	29,285	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Redhead (*Aythya americana*)	4	26,887	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Ring-necked duck (*Aythya collaris*)	0	7,022	0	No lethal take
Canvasback (*Aythya valisineria*)	0	2,826	0	No lethal take
Barrow's goldeneye (*Bucephala islandica*)	0	ND	0	No lethal take
Gadwall (*Mareca strepera*)	8.8	186,242	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Common merganser (*Mergus merganser*)	0	21,150	0	No lethal take
Tundra swan (*Cygnus columbianus*)	0	ND	0	No lethal take
Northern shoveler (*Spatula clypeata*)	20.6	24,404	0.08%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Blue-winged teal (*Spatula discors*)	0.8	2,312	0.03%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Bufflehead (*Bucephala albeola*)	7	5,183	0.14%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Northern pintail (*Anas acuta*)	5.3	12,721	0.04%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Ruddy duck (*Oxyura jamaicensis*)	14.3	12,523	0.11%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Cinnamon teal (*Spatula cyanoptera*)	22	54,296	0.04%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Green-winged teal (*Anas crecca*)	4.2	3,787	0.11%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Common gallinule (*Gallinula galeata*)	0.3	899	0.03%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
American wigeon	12.5	2,465	0.50%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
American coot (*Fulica americana*)	1,799.50	310,638	0.58%	Lethal take accounts for less than 1% of statewide population; not expected to be taken under County programs under the Proposed Project
Mallard (*Anas platyrhynchos*)	851.3	237,027	0.36%	Lethal take accounts for less than 1% of statewide population; not expected to be taken under County programs under the Proposed Project
Greater scaup (*Aythya marila*)[9]	13.6	337,874	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Hooded merganser (*Lophodytes cucullatus*)	0.8	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Black scoter (*Melanitta americana*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Surf scoter (*Melanitta perspicillata*)[9]	1.3	1,823	0.1%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Greater white-fronted goose (*Anser albifrons*)	0.6	ND	ND	Lethal take accounts for an average of less than 1 individual per year.
Lesser snow goose (*Anser caerulescens caerulescens*)	0.7	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Ross's goose (*Anser rossii*)	0.4	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Black brant (*Branta bernicla*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Cackling goose	0.5	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Non-Game Waterbirds				
Pelagic cormorant (*Phalacrocorax pelagicus*)	0.6	5,619	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Brandt's cormorant (*Phalacrocorax penicillatus*)	0	12,108	0	No lethal take
Western grebe (*Aechmophorus occidentalis*)	0.1	231,068	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Eared grebe (*Podiceps nigricollis*)	0.5	357,391	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Pied-billed grebe (*Podilymbus podiceps*)	0.1	28,097	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Ring-billed gull (*Larus delawarensis*)	39.3	240,444	<0.02%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
American bittern *(Botaurus lentiginosus)*	0	12,587	0	No lethal take
Green heron (Butorides virescens)	0.1	5,732	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Little blue heron *(Egretta caerulea)*	0	ND	0	No lethal take
Reddish egret *(Egretta rufescens)*	0	ND	0	No lethal take
White-faced ibis *(Plegadis chihi)*	2.4	435,431	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Belted kingfisher *(Megaceryle alcyon)*	0	26,964	0	No lethal take
Pacific loon *(Gavia pacifica)*	0	ND	0	No lethal take
American white pelican *(Pelecanus erythrorhynchos)*	0	69,980	0	No lethal take
Mountain plover *(Charadrius montanus)*	0	ND	0	No lethal take
Semipalmated plover *(Charadrius semipalmatus)*	0	ND	0	No lethal take
Virginia rail *(Rallus limicola)*	0	7,080	0	No lethal take

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Sanderling *(Calidris alba)*	0	ND	0	No lethal take
Dunlin *(Calidris alpina)*	0	ND	0	No lethal take
Wilson's snipe *(Gallinago delicata)*	0	45,640	0	No lethal take
Short-billed dowitcher *(Limnodromus griseus)*	0	ND	0	No lethal take
Red-necked phalarope *(Phalaropus lobatus)*	0	ND	0	No lethal take
Lesser yellowlegs *(Tringa flavipes)*	0	ND	0	No lethal take
Willet *(Tringa semipalmata)*	1.1	70,729	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
American avocet (*Recurvirostra americana*)	2	28,600	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Gull-billed tern (*Gelochelidon nilotica*)	0.2	2,826	0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Caspian tern (*Hydroprogne caspia*)	0.1	39,475	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Forster's tern (*Sterna forsteri*)	0.2	34,508	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Double-crested cormorant (*Nannopterum auritum*)	99.5	89,575	0.10%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Long-billed curlew (*Numenius americanus*)	32.3	7,963	0.40%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Great egret (*Ardea alba)*	93.4	88,342	0.10%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Great-blue heron (*Ardea herodias*)	71.3	43,398	0.20%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Killdeer	152.1	165,862	0.10%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Black-necked stilt	20.7	39,389	0.10%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Whimbrel	24.8	15,000	0.20%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Heermann's gull	3.2	856	0.40%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Western gull	458	68,074	0.70%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Snowy egret	171.3	39,394	0.40%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Glaucous-winged gull	19.1	570,000	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Horned grebe (*Podiceps auritus*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year.
Herring gull (*Larus argentatus*)[9]	9	688,087	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Mew gull (*Larus canus*)[9]	6.5	583,988	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Thayer's gull (*Larus glaucoides*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Glaucous gull (*Larus hyperboreus*)[9]	4.6	1,090,799	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Black-bellied plover (*Pluvialis squatarola*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Western sandpiper (*Calidris mauri*)[8]	4.5	1,243,329	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Least sandpiper (*Calidris minutilla*)[8]	6.9	91,761	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Long-billed dowitcher (*Limnodromus scolopaceus*)	0.2	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Marbled godwit (*Limosa fedoa*)	0.6	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Greater yellowlegs (*Tringa melanoleuca*)	0.9	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Mammals				
Bats (various species)	0	ND	0	No lethal take
Gray wolf (*Canis lupus*)[10]	0	47	0	No lethal take
Kit fox (*Vulpes macrotis*)	0	ND	0	No lethal take
American marten (*Martes americana*)	0	ND	0	No lethal take
Douglas squirrel (*Tamiasciurus douglasii*)	0	ND	ND	No lethal take
Muskrat (Ondatra zibethicus)[11]	385.4	176,959	0.2%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Voles (Subfamily Arivicolinae)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Botta's pocket gopher (*Thomomys bottae*)	5,757.4	415,639,432	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Reptiles				
Red diamond rattlesnake (*Crotalus ruber*)	0	ND	0	No lethal take
Western fence lizard (*Sceloporus occidentalis*)	0.2	ND	ND	Lethal take accounts for an average of less than 1 individual per year

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
California king snake (*Lampropeltis getula californiae*)	1.1	ND	ND	Lethal take accounts for an average of less than 2 individuals per year; not taken under County programs
Common garter snake (*Thamnophis sirtalis*)	0.1	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Gopher snake (*Pituophis catenifer*)	7.6	60,195,653	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
South pacific rattlesnake (*Crotalus helleri*)	0.7	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Western rattlesnake (*Crotalus oreganus*)	0.4	ND	ND	Lethal take accounts for an average of less than 1 individual per year
Western diamondback rattlesnake (*Crotalus atrix*)	3.3	13,249,762	<0.01%	Lethal take accounts for less than 1% of statewide population; not taken under County programs
Non-Native Species				
Slider turtle (*Trachemys* sp.)	0	ND	0	Non-native species/no lethal take
Asian carp (various species)	2.4	ND	ND	Non-native species
American alligator (*Alligator mississippiensis*)	0.2	ND	ND	Non-native species
Red fox[6] (*Vulpes vulpes*)	52.3	ND	ND	Non-native species
Woodchucks (*Marmota monax*)	18.8	ND	ND	Non-native species
Feral swine (*Sus scrofa*)	840.6	ND	ND	Non-native species
Fox squirrel (*Sciurus niger*)	79.6	ND	ND	Non-native species
Norway (brown) rat (*Rattus norvegicus*)	74.7	ND	ND	Non-native species
Black (roof) rat (*Rattus rattus*)	162.7	ND	ND	Non-native species
Feral rabbit (*Oryctolagus cuniculus domesticus*)	0.3	ND	ND	Non-native species

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
House mouse (*Mus musculus*)	189.7	ND	ND	Non-native species
Nutria (*Myocastor coypus*)	28.6	ND	ND	Non-native species
Virginia opossum (*Didelphis virginiana*)	853	ND	ND	Non-native species
Feral goat (*Capra aegagrus hircus*)	0.1	ND	ND	Non-native species
House sparrow (*Passer domesticus*)	207.8	3,012,503	0.01%	Non-native species
Feral cat (*Felis catus*)	200.9	ND	ND	Non-native species
Fallow deer (*Dama dama*)	0	ND	0	Non-native species/no lethal take
Feral dog (*Canis lupus familiaris*)	15.8	ND	ND	Non-native species
American bullfrog (*Lithobates catesbeianus*)	0	ND	0	Non-native species; no lethal take
Brown-headed cowbird (*Molothrus ater*)	629.8	2,073,417	0.03%	Non-native species
European starling (*Sturnus vulgaris*)	8479.7	2,842,671	0.3%	Non-native species
Chukar (*Alectoris chukar*)	11.3	5,272	0.2%	Non-native species
Eurasian collared dove (*Streptopelia decaocto*)	130.2	1,573,154	<0.01%	Non-native species
Feral pea fowl (*Pavo cristatus*)	5.8	10,275	0.06	Non-native species
Ring-necked pheasant (*Phasianus colchicus*)	3.5	89,262	<0.01%	Non-native species
Rock pigeon (*Columba livia*)	2858.2	401,002	0.7%	Non-native species
Wild turkey (*Meleagris gallopavo*)	102.9	72,897	0.1%	Non-native species
Feral Amazon parrot (*Amazona* sp.)	0.1	535	0.02%	Non-native species

Table 3-1. Average Lethal Wildlife Damage Management Per Year for Species with No Further Analysis

Species	Average Previous Lethal Take[1]	Population Estimate	Lethal Take of Population (%)	Rationale for Elimination from further Analysis
Feral chicken (*Gallus gallus domesticus*)	4.6	ND	ND	Non-native species
Feral duck (various species)	6.7	ND	ND	Non-native species
Feral geese (various species)	8.6	ND	ND	Non-native species
Mute swan (*Cygnus olor*)	0.5	2,326	0.02%	Non-native species
Cattle egret (*Bubulcus ibis*)	4.8	18,560	0.03%	Non-native species

Notes: 0 = no MIS take occurred during the 10-year baseline period; ND =Not determined.

1 Lethal Take includes all Proposed Project components (i.e., Airports, Threatened and Endangered Species Protection Programs, and County-based) provided in the MIS data and includes the following fate categories: killed and removed/destroyed.

2 The population estimate for nighthawks includes the combined population estimate totals for lesser nighthawk and common nighthawk.

3 The population estimate for swifts (other) includes the combined population estimate totals for black swift, Vaux's swift, and white-throated swift.

4 Population estimate for quail (other) is based on mountain quail and Gambel's quail.

5 The lethal take total for ground squirrel (other) includes the annual average removal of 1.0 occupied burrow provided in the MIS data, which were determined to contain an average of 3.0 individuals according to WS-California (USDA 2019).

6 The lethal take total for the non-native red fox only includes the counties that occur outside the known geographic range of the Sacramento Valley red fox, which includes portions of Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Placer, Sacramento, Solano, and Yolo. Because the Sacramento Valley red fox is a native species, the lethal take occurring within this subspecies known geographic range is analyzed in Section 3.2.5.

7 This species breeds outside California and migrates through the state, which is when much of the lethal WDM (much at airports) occurred. The regional population of glaucous winged gull is much higher, with the north Pacific population estimated at 570,000 (Global Waterbird Population Estimates 4th Edition, as cited in Cornell Lab of Ornithology 2022)

8 Alaska breeding population estimate from Breeding Bird Count data 2015-2019 (Sauer *et al.* 2019). Assumes birds from Alaska migrate throughout the Pacific Flyway.

9 North American population estimate from Breeding Bird Count data 2015-2019 (Sauer *et al.* 2019).

10 Population estimate includes pairs and pups from the four known wolf packs in California (CDFW 2022h). Estimate does not include lone wolves or unknown packs.

11 Native muskrat subspecies occur in Imperial, San Bernardino, Riverside, Mono, Alpine, El Dorado, Placer, and Lassen Counties (Hollister 1911). There was no lethal take of muskrat in its native range in California during the analysis period.

3.2 Target Mammal Species Analyses

3.2.1 Black Bear

Black bear is a game mammal in California (CFGC Section 3950). Black bear is an omnivorous species that occurs in the North Coast Ranges, Cascades, Sierra Nevada, parts of the South Coast Ranges, and in the San Gabriel and San Bernardino mountains in dense mature stands of forest, valley foothill riparian, and wet meadow habitats (CWHR 2022). Black bear is considered an apex predator with wide ranging effects on food webs (Levi *et al.* 2020). Black bears feed largely on grasses and forbs, fruits, nuts, insects, and carrion, as well as human refuse. This species' diet shifts seasonally in response to flora availability (CWHR 2022). Black bear is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Based on the

CDFW habitat modeling for black bear provided in Appendix C2, the estimated population size for California is 20,446 individuals. Also included in Appendix C2 are the population estimates of black bears within each county.

The sustainable harvest threshold for black bear has been estimated at 14.2% of the entire population or 15.9% of the adult (>1 year old) population (Miller 1990). CDFW used this 14.2% threshold in their 2011 environmental document to analyze the potential impact of bear hunting regulations in California (CDFG 2011). Bunnell and Tait (1981) found sustainable mortality rates for black bear from approximately 11% to 24%. Mace and Chilton-Radandt (2011) used the methods of Bunnell and Tait (1981) with local black bear data to estimate a 16% sustainable mortality rate in Montana. Moreover, as noted above, the more recent bear hunting environmental document from CDFW (CDFG 2011) used the 14.2% threshold, ostensibly from Miller (1990). Burton *et al.* (1994) found that the 8% hunter harvest rate in California at the time was sustainable, but they did not attempt to determine the maximum sustainable harvest rate. For this analysis we will use 14.2% as the sustainable harvest rate for black bears in California.

The statewide modeled population estimate for this species is approximately 20,446 individuals (Appendix C2). This is slightly lower than CDFW's statewide estimate of 30,000 to 40,000 black bears (CDFW 2023a). The lowest of these numbers, which is 20,446 black bears in California, will be used as the most conservative estimate. The use of this estimate does not suggest that we doubt or disagree with the CDFW estimate. The population estimate for each county is provided in Appendix C2 and Table 3-2a.

3.2.1.1 Previous Wildlife Damage Management

WDM for black bear comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 115.1 black bears were killed, 2.8 individuals were dispersed, 4.9 individuals were freed, 0.1 individual was immobilized, 0.8 individuals were relocated, and 4.8 individuals were transferred to the custody of another agency or organization per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 128.5 individuals per year based on the WS-California MIS data from 2010 to 2019.[9] WS-California lethal WDM for black bear occurred within 28 counties across the state with averages ranging from 0.1 to 18.4 individuals per year; the majority of WS-California lethal WDM activities (50%, or 57.6 individuals) occurred within El Dorado, Mendocino, Shasta, and Siskiyou Counties. Lethal WDM of black bear accounts for 90% (115.1 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 10% (13.4 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM and by county (Table 3-2a) according to the methods outlined in Section 2.4. Occasional lethal take (by non-WS or any other individual or agent) was also included in counties with no apparent lethal take during the analysis period whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a). During the 10-year baseline period, lethal take of black bear is estimated at 147.2 individuals annually. This total is comprised of the WS-California lethal take of 115.1 individuals per year (78.2%) and the non-WS-California estimates for lethal take of 32.1 individuals per year (21.8%) (Table 3-2a). These estimates of WDM take were used to estimate cumulative take as

9 Average includes activities that both intentionally and unintentionally affect black bear and all potential methods used during WDM activities.

well as county-level WDM take for counties without WS-California MIS data. Total lethal take of black bear (147.2 individuals) represents 0.7% of the statewide population (20,446 bears). WDM lethal take ranged from 0 to 18.4 black bears per county.

Because wildlife cross political boundaries, regional analyses can be more informative than county-level analyses (See Section 3.2.1.4). For example, one black bear was killed in Sacramento County, which has an estimated county population of zero black bears (Table 3-2a). This bear likely came from a neighboring county with an established population. When WDM lethal take of black bears is considered for Sacramento County and its adjacent counties (Placer, Sutter, El Dorado, Amador, San Joaquin, Contra Costa, Solano, and Yolo), 1.8% of black bears (17.9 individuals of 968 estimated regional population) were killed during WDM activities in this region.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide black bear take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For black bear, the average is 110.9,[10] the standard deviation is 43.48, and the 99% confidence high estimate is 223.09, which we rounded up to 224 individuals. This is the highest take we expect under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years. The 99% Confidence Factor was 224/110.9 = 2.02. Average WDM take within each county were multiplied by the 99% Confidence Factor to generate the Proposed Project Maximum Lethal Take Estimate for each county (Table 3-2a).

3.2.1.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of black bear under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 298 black bears taken annually, which represents 1.5% of the population. The statewide modeled low population estimate for this species is approximately 20,446 individuals (Appendix C2). The population estimate for each county is provided in Table 3-2a. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 1.8%[11] (38 individuals of 2,062 estimated county population; Siskiyou County). These numbers are all well below the sustainable harvest threshold of 14.2% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 298. The proportion of take associated with county- directed programs also might increase, up to a maximum annual average

10 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-2a. This small amount of error was accepted for this calculation.
11 Based on 2012-2019 data only for Siskiyou County.

of the total lethal take of 298 individuals. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Black bear is considered to be an omnivorous apex predator (Prugh *et al.* 2009) with wide ranging effects on food webs (Levi *et al.* 2020). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes *et al.* 2011). Furthermore, high species diversity of apex predators, mesopredators, and prey species in an ecosystem can make the mesopredator release less likely to occur (Brashares *et al.* 2010). Harvest of large apex carnivores such as black bears can cause changes to their social structure, the space use of survivors, and population growth rate (Frank *et al.* 2017). However, effects are difficult to predict; studies of hunted versus non-hunted populations of black bear suggested that hunted populations did not show an adverse effect on infanticide or social structure, and that elevated population density had a greater effect on these factors (Czetwertynski *et al.* 2007).

Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal removal of black bears, are not anticipated due to the low percentage of black bears lethally removed by the Project regionally, statewide, and cumulatively. Trophic cascade impacts on ecosystems have been documented after the complete removal or extirpation of a predator species (Grimm 1939; Keigley 2018; Wagner 2006; Beschta and Ripple 2018), but we are not aware of any evidence that the removal of low, modest, or even considerable numbers of predators has the potential to result in such trophic cascades. The greatest percentage of the population annually taken under the Project is 1.8% in Siskiyou County which is highly unlikely to result in indirect effects in context with other sources of mortality including hunting, roadkill, and disease.

3.2.1.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

et al. Lethal removal of black bears for WDM could result in a net benefit to other native mammals with which they compete for food or prey upon, regardless of whether they were the intended beneficiary. In general, however, WDM of black bears is conducted for reasons other than benefits to biological resources.

3.2.1.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting, and illegal harvest (poaching). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-2a).

There may be additional anthropogenic sources of black bear mortality in California, but we are not aware of them, and they are likely to be much lower than the mortality sources we included in our estimates of cumulative mortality. No such other mortality sources have been identified by CDFW (CDFG 1998, 2011). Other anthropogenic factors that can affect black bear are habitat loss from development and climate change, and disruption by human activities such as or agricultural activities affecting areas used for foraging. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in black bear quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat (2) these effects are not expected to significantly increase black bear mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). Moreover, black bears are managed intensively by CDFW (see CDFW 2022b; CDFG 2011, 1998), and if any such added mortality were to result in cumulative impacts to the black bear population, CDFW would regulate hunter harvest to offset those losses and maintain a stable black bear population per the CDFW Black Bear Management Plan (CDFG 1998). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of black bears in California.

Legal hunting of black bear averaged 1,423.5 bears killed per year during the 2010 through 2019 seasons (CDFW 2022b). This equates to an average of 7.0% of the estimated statewide population (20,446 individuals). Hunter harvest is the largest source of mortality for black bears among the factors analyzed. At the county level, hunter harvest ranged from zero (many counties) to 142.9 (Shasta County; 12.5% of the estimated population).

The number of black bears killed by vehicle collisions (roadkill) in California has been reported as 557 from 2016 - 2020 (5 years); an average of approximately 111 per year (UC Davis Road Ecology Center 2021). This represents an annual mortality of approximately 0.5% of the statewide estimated black bear population. This value represents only reported roadkills, so it is likely that true mortality from vehicle collisions is higher. County-level data on roadkills is not available.

The last category of anthropogenic mortality we considered was illegal harvest. CDFW (CDFG 2011) estimated that illegal harvest is no higher than 2% of the population. This number (2%) was used to estimate illegal black bear harvest in California. Estimated illegal harvest averaged 408.9 black bears per year statewide (2% of the population) and ranged from zero (several counties) to 41.2 (Siskiyou County) at the county level.

Cumulative mortality among all of these sources and lethal WDM under the Proposed Project averaged 2,375black bears per year, or 11.6% of the population. This is below the sustainable harvest threshold of 14.2% for black bear. At the county level, analysis of cumulative black bear mortality is more complex, and illustrates the difficulty of estimating mortality at too fine a scale. One of the most obvious examples of this is Yolo County, where the estimated population is one individual, because the vast majority of the county is outside of the species' top two-thirds of suitable habitat as estimated by CDFW (CDFW 2016a). However, the CDFW Central California Black Bear Hunt Zone (CDFW 2019a) includes all of Yolo County, and bears are regularly taken by hunters in this county. The estimated cumulative mortality of black bears in Yolo County, 3.3 individuals per year, is entirely due to hunter harvest, and comprises 330% of the estimated population. Another example is Stanislaus County, where the estimated population is zero individuals, because the county is completely outside of the species' top two-thirds of suitable habitat as estimated by CDFW (2016a). However, the CDFW Southern Sierra Black Bear Hunt Zone (CDFW 2019a) includes about half of Stanislaus County, and bears are regularly taken by hunters in this county. The estimated cumulative mortality of black bears in Stanislaus County, 6.8 individuals per year, is entirely due to hunter harvest, which is greater than the estimated population size in Stanislaus County of zero individuals. Because it is physically impossible for hunters to take more animals that what exist, some of these county population estimates are an underestimate of the black bear population. As such, a regional approach is more appropriate for this species (Table 3-2b).

The Northern California Black Bear Hunt Zone comprises the following counties: Del Norte, Siskiyou, Modoc, Humboldt, Trinity, Shasta, Tehama, Lassen and Plumas (CDFW 2019a). Among these counties, cumulative mortality is estimated at 1,031 black bears, which is 12.4% of the estimated population among these counties (8,320 bears). Within this hunt zone, cumulative anthropogenic mortality is below the mortality threshold of 14.2% for black bear. Lethal WDM under the Proposed Project might take a maximum of 116 black bears in a given year in these counties, or 1.4% of the estimated population among these counties (Table 3-2b).

The Central California Black Bear Hunt Zone comprises the following counties: Mendocino, Glenn, Butte, Sierra, Nevada, Lake, Colusa, Sutter, Yuba, Sonoma, Napa, Yolo, Sacramento, Placer, El Dorado, Amador, Calaveras, and

Alpine (CDFW 2019a). Among these counties, cumulative mortality is estimated at 637 black bears, which is 13.3% of the estimated population among these counties (4,788 bears). Within this hunt zone, cumulative anthropogenic mortality is below the mortality threshold of 14.2% for black bear. Lethal WDM under the Proposed Project might take a maximum of 101 black bears in a given year in these counties, or 2.1% of the estimated population among these counties (Table 3-2b).

The Southern Sierra Black Bear Hunt Zone comprises the following counties: Stanislaus, Tuolumne, Mono, Merced, Mariposa, Madera, Fresno, Inyo, Tulare, and Kern (CDFW 2019a). Among these counties, cumulative mortality is estimated at 477 black bears, which is 13.1% of the estimated population among these counties (3,641 bears). Within this hunt zone, cumulative anthropogenic mortality is below the mortality threshold of 14.2% for black bear. Lethal WDM under the Proposed Project might take a maximum of 52 black bears in a given year in these counties, or 1.4% of the estimated population among these counties (Table 3-2b). The Southeastern Sierra Black Bear Hunt Zone includes portions of Inyo, Mono, and Madera counties that do not fall within the Southern Sierra Black Bear Hunt Zone. For the purposes of this analysis and because WDM take is tracked by county and not by hunt zones, black bear mortality for the Southeastern Sierra Black Bear Hunt Zone is combined with the Southern Sierra Black Bear Hunt Zone.

The Southern California Black Bear Hunt Zone comprises the following counties: Santa Barbara, Ventura, Los Angeles, San Bernardino, and Riverside (CDFW 2019a). Among these counties, cumulative mortality is estimated at 126 black bears, which is 7.3% of the estimated population among these counties (1,718 bears). Within this hunt zone, cumulative anthropogenic mortality is below the mortality threshold of 14.2% for black bear overall and within each county. Lethal WDM under the Proposed Project might take a maximum of 19 black bears in a given year in these counties, or 1.1% of the estimated population among these counties (Table 3-2b).

The remaining 16 counties do not occur within any of the California Bear Hunt Zones: Alameda, Contra Costa, Imperial, Kings, Marin, Monterey, Orange, San Benito, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Clara, Santa Cruz, and Solano (CDFW 2019a). Among these counties, cumulative mortality is estimated at 75 black bears, which is 3.8% of the estimated population among these counties (1,978 black bears). At the county level, cumulative mortality ranged from zero to 23 black bears (3.8% of the population). The counties with the highest cumulative mortality by percentage of the population were Kings (4.7%) and Marin (4.6%). Lethal WDM under the Proposed Project contributed to cumulative mortality in only three of these counties: Kings, Marin, and San Luis Obispo. Cumulative mortality was estimated at 3.8% of the population in San Luis Obispo County. Among these counties, cumulative anthropogenic mortality is below the mortality threshold of 14.2% for black bear overall and within each county. Lethal WDM under the Proposed Project might take a maximum of 12 black bears in a given year in these counties, or 0.6% of the estimated population among these counties (Table 3-2b).

The counties with the highest Maximum Lethal WDM under the Proposed Project are also those with high hunter harvest, which suggests that these counties have the highest populations of bears (hunter success is generally a reflection of the population of the prey species, available hunting area, and weather conditions during the hunting season because hunter effort is not expected to change considerably by county). For instance, maximum lethal WDM under the Proposed Project is highest in Shasta County at 33 black bears and an average of 142.9 black bears killed annually from legal hunting.

The levels of cumulative mortality considered under the Proposed Project are not anticipated to be considerably higher on average than those which have existed during the analysis period of 2010 through 2019. Black bear populations have increased or remained stable in California throughout this period (CDFW 2022b). Therefore, this level of harvest appears to be sustainable, and has determined to be sustainable by CDFW (2022b).

Table 3-2a. Black Bear Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	1.8	0	0	0	0	0	1.8	0	**1.8**	4	21	201	2.0%	NA
AMADOR	0.7	0	0	0	0	0	0.7	0	**0.7**	2	12	98	2.0%	NA
BUTTE	5.7	0	0	0	0	0	5.7	0	**5.7**	12	60	241	5.0%	NA
CALAVERAS	3.5	0	0	0	0	0	3.5	0	**3.5**	8	37	186	4.3%	NA
COLUSA	0	0	0	0	0	0	0	0	**0**	0	5	62	0%	NA
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
DEL NORTE	0.2	2.8	0	0	0	0	0.2	2.8	**3**	7	38	393	1.8%	NA
EL DORADO	11.6	0	0	0	0	0	11.6	0	**11.6**	24	103	493	4.9%	NA
FRESNO	0	4.6	0	0	0	0	0	4.6	**4.6**	10	90	648	1.5%	NA
GLENN	0	1	0	0	0	0	0	1	**1**	3	28	143	2.1%	NA
HUMBOLDT	5.2	0	0	0	0	0	5.2	0	**5.2**	11	149	1,371	0.8%	NA
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
INYO	0	0.7	0	0	0	0	0	0.7	**0.7**	2	9	92	2.2%	NA
KERN	2.1	0	0	0	0	0	2.1	0	**2.1**	5	68	651	0.8%	NA
KINGS	0	2.9	0	0	0	0	0	2.9	**2.9**	6	19	398	1.5%	4.7%
LAKE	2.4	0	0	0	0	0	2.4	0	**2.4**	5	30	398	1.3%	NA
LASSEN	2.4	0	0	0	0	0	2.4	0	**2.4**	5	37	482	1.0%	NA
LOS ANGELES	0	3.8	0	0	0	0	0	3.8	**3.8**	8	35	530	1.5%	6.6%
MADERA	2.5	0	0	0	0	0	2.5	0	**2.5**	6	46	275	2.2%	NA
MARIN	0	0.8	0	0	0	0	0	0.8	**0.8**	2	5	113	1.8%	4.6%
MARIPOSA	5.9	0	0	0	0	0	5.9	0	**5.9**	12	39	311	3.9%	NA
MENDOCINO	11.5	0	0	0	0	0	11.5	0	**11.5**	24	154	1,336	1.8%	NA
MERCED	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MODOC	0.3	0	0	0	0	0	0.3	0	**0.3**	1	14	320	0.3%	NA
MONO	0.4	1.7	0	0	0	0	0.4	1.7	**2.1**	5	25	240	2.1%	NA
MONTEREY	0	0	0	0	0	0	0	0	**0**	0	15	460	0%	3.2%
NAPA	0.6	0	0	0	0	0	0.6	0	**0.6**	2	6	93	2.1%	NA
NEVADA	1.8	0	0	0	0	0	1.8	0	**1.8**	4	35	281	1.4%	NA
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
PLACER[3]	5.5	0	0	0	0	0	5.5	0	**5.5**	12	64	375	3.2%	NA
PLUMAS	5.8	0	0	0	0	0	5.8	0	**5.8**	12	107	923	1.3%	NA
RIVERSIDE	0	1.6	0	0	0	0	0	1.6	**1.6**	4	12	219	1.8%	5.3%
SACRAMENTO[4]	0.1	0	0	0	0	0	0.1	0	**0.1**	1	0	0	0%	0%[3]
SAN BENITO[5]	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN BERNARDINO	0	2	0	0	0	0	0	2	**2**	5	28	286	1.8%	9.9%

Table 3-2a. Black Bear Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	0	0	0	0	0	0	**0**	0	13	412	0%	3.2%
SAN FRANCISCO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN JOAQUIN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN LUIS OBISPO	1.8	0	0	0	0	0	1.8	0	**1.8**	4	23	594	0.7%	3.8%
SAN MATEO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	**0**	0	20	409	0%	4.8%
SANTA CLARA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA CRUZ	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SHASTA	16.1	0	0	0	0	0	16.1	0	**16.1**	33	212	1,145	2.9%	NA
SIERRA	1.3	0	0	0	0	0	1.3	0	**1.3**	3	41	322	0.9%	NA
SISKIYOU[6]	18.4	0	0	0	0	0	18.4	0	**18.4**	38	221	2,062	1.8%	NA
SOLANO	0	0	0	0	0	0	0	0	**0**	0	0	1	0%	3.2%
SONOMA[7]	0.3	0	0	0	0	0	0.3	0	**0.3**	1	16	493	0.2%	3.3%
STANISLAUS	0	0	0	0	0	0	0	0	**0**	0	7	0	0%	NA
SUTTER	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
TEHAMA	0	2.7	0	0	0	0	0	2.7	**2.7**	6	78	372	1.6%	NA
TRINITY	3.3	0	0	0	0	0	3.3	0	**3.3**	7	176	1,251	0.6%	NA
TULARE	0	5.5	0	0	0	0	0	5.5	**5.5**	12	112	765	1.6%	NA
TUOLUMNE	1.9	0	0	0	0	0	1.9	0	**1.9**	4	81	658	0.6%	NA
VENTURA	0	2	0	0	0	0	0	2	**2**	5	31	274	1.8%	11.4%
YOLO	0	0	0	0	0	0	0	0	**0**	0	3	1	0%	NA
YUBA	2	0	0	0	0	0	2	0	**2**	5	20	63	8.0%	NA
Total	**115.1**	**32.1**	**0**	**0**	**0**	**0**	**115.1**	**32.1**	**147.2**	**298**	**2,375**	**20,446**	**1.5%**	**11.6%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS management occurred during the 10-year baseline period, NA = Not Applicable (See note 7).
Totals may not sum due to rounding. A population estimate is provided for each county based on the methods described in detail in Appendix C2. A regional, rather than a county-level, analysis was conducted for several counties due to hunter harvest frequently being greater than the estimated population. See Section 3.2.1.4 and Table 3.2b.

1 Refer to Section 3.2.1.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 The lower population estimate described in Appendix C2 is used here to provide the most conservative effects analysis.
3 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for WDM.
4 Due to the lack of any bear habitat occurring within Sacramento County the population estimate indicates there are 0 black bears in this county. However, lethal take has occurred to an annual average of 0.1 individuals and future take under the Proposed Project is estimated at up to 1 per year. These data illustrate the difficulty of providing county-level population estimates; wild animals do not follow such arbitrary boundaries. The black bear taken in Sacramento County, and the potential future take of black bears in this and other such counties, represents an example of a bear travelling outside of its normal range from a neighboring county. This occasionally occurs with wildlife.
5 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for WDM.
6 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for WDM.
7 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for WDM.

Table 3-2b. Annual Average Black Bear Affected by Lethal Wildlife Damage Management under the Proposed Project by Hunt Zone (CDFW 2019a) and Statewide.

Black Bear Hunt Zone	Proposed Project Max Lethal Take Estimate	Maximum Cumulative Anthropogenic Mortality Estimate	Low Population Estimate	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
NORTHERN CALIFORNIA[1]	116	1,031	8,320	1.4%	12.4%
CENTRAL CALIFORNIA[2,3]	101	637	4,788	2.1%	13.3%
SOUTHERN SIERRA and SOUTHEASTERN SIERRA	52	477	3,641	1.4%	13.1%
SOUTHERN CALIFORNIA	19	125	1,718	1.1%	7.3%
NON-HUNT ZONE COUNTIES[4]	12	75	1,978	0.6%	3.8%
Total	298	2,375	20,446	1.5%	11.6%

Notes: Totals may not sum due to rounding. See Section 3.2.1.4 for list of counties included in each regional analysis. A population estimate is provided for each county based on the methods described in detail in Appendix C2. The lower population estimate described in Appendix C2 is used here to provide the most conservative effects analysis.

1 Siskiyou County (included in the Northern California regional analysis) averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for wildlife damage management.

2 Sonoma County (included in the Central California regional analysis) averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for wildlife damage management.

3 Placer County (included in the Central California regional analysis) averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSACSA with this county for wildlife damage management.

4 San Benito County (included in the Non-Hunt Zone Counties regional analysis) averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.2.2 Bobcat

Bobcat is a native mammal species that occurs throughout most of California and in most habitat types, preferring chaparral vegetation and low- to mid-elevation woodlands and forests (CWHR 2022). Bobcats are an omnivorous species that prey upon a variety of animals including rodents, raccoons, deer fawns, reptiles, amphibians, and invertebrates but sometimes consume plant materials (CWHR 2022). Bobcats are considered mesopredators (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009).

Bobcat is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for bobcat provided in Appendix C3, the estimated low population size for California is 51,088 individuals. Also included in Appendix C3 are the population estimates of bobcats within each county. Bobcats have an expansive range throughout the state, are considered a species of "least concern" by IUCN, and their global population is reported to be stable (IUCN 2022). The estimate provided in Appendix C3 is more conservative than CDFW's statewide estimate of 70,000 to 100,000 bobcats (CDFW 2023b). The use of this estimate does not suggest that we doubt or disagree with the CDFW estimate.

Colorado Parks and Wildlife uses a 17% total mortality as the sustainable mortality threshold for bobcats (e.g., CPW 2016). Therefore, the 17% threshold is used in this analysis. However, this threshold includes all mortality, not just anthropogenic mortality.

3.2.2.1 Previous Wildlife Damage Management

WDM for bobcat comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 38.9 bobcats were killed, 2.9 individuals were dispersed, 3.2 individuals were freed, and 0.1 individuals were radio collared per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 45.1 individuals per year.[12] WS-California lethal WDM for bobcat occurred within 28 counties across the state with averages ranging from 0.1 to 7.5 individuals per year in those counties. Most lethal WDM occurred within Mariposa and Mendocino Counties (33%, or 12.8 individuals). Lethal take of bobcat accounts for 86% (38.9 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 14% (6.2 individuals per year).

Lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-3) according to the methods outlined in Section 2.4.

This analysis also included the potential for occasional lethal take in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

12 Average includes activities that both intentionally and unintentionally affect bobcat and all potential WDM methods used by WS-California.

During the 10-year baseline period, statewide lethal take of bobcat is estimated at 70.1 individuals annually. This total is comprised of the WS-California lethal take of 38.9 individuals per year (55.5%) and the non-WS-California estimates for lethal take of 31.2 individuals per year (44.5%) (Table 3-3). These estimates of WDM lethal take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 51,088 individuals. The population estimate for each county is provided in Table 3-3.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide bobcat take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For bobcat, the average is 33.10,[13] the standard deviation is 25.47, and the 99% confidence high estimate is 98.81, which we rounded up to 99 individuals. The 99% Confidence Factor for bobcat was 99/33.1 = 2.99. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.2.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of bobcat under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 210 bobcats taken annually, which represents 0.4% of the population. The statewide modeled low population estimate for this species is approximately 51,088 individuals. The population estimate for each county is provided in Table 3-3. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (0 individuals of 5 individuals estimated for the San Francisco County population) to 4.8% (23 individuals of 482 individuals estimated for the Sonoma County population). These numbers are all well below the sustainable harvest threshold of 17% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 153. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 153 individuals. The maximum number of bobcats taken by county-level programs are listed for each county in Table 3-3, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

[13] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-3. This small amount of error was accepted for this calculation.

In general bobcats are considered mesopredators (Prugh *et al.* 2009) and are known to coexist with apex predators such as mountain lions, as well as other mesopredators such as coyotes (CWHR 2022). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). In areas where apex predators such as wolves and mountain lions are no longer present, bobcats and other mesopredators can occupy much the same role as an apex predator. In such a circumstance, removal of bobcats could theoretically result in increased populations of mesopredators according to the theory of mesopredator release, although this has not been confirmed in the wild. *et al.* Trophic cascade impacts on ecosystems have been documented after the complete removal or extirpation of an apex predator species (Grimm 1939; Keigley 2018; Wagner 2006; Beschta and Ripple 2018), but we are not aware of any evidence that the removal of low, modest, or even considerable numbers of predators has the potential to result in such trophic cascades. Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal WDM of bobcats are therefore not anticipated due to the low percentage of the bobcat population impacted by the Project regionally, statewide, and cumulatively as shown in Table 3-3 below.

3.2.2.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) have documented bobcat predation of the federal and state-listed, Fully Protected species California condor in Kern County. Evidence of predation on reintroduced California condors by bobcat has been documented since 1997 (Mee and Snyder 2007). Lethal removal of bobcats under WDM activities could result in a net benefit to native special-status avian species (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.2.2.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-3). Other anthropogenic factors that can affect bobcats are habitat loss from development and climate change, and disruption by human activities such as or agricultural activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in bobcats quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat (2) these effects are not expected to significantly increase bobcat mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c).As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of bobcats in California.

Trapping of bobcats for fur is no longer legal in California for most trap types (California AB 273, 09/04/2019); therefore, the lethal removal of bobcats that has historically occurred under trapping licenses no longer contributes to cumulative effects on the species as of 2019. Commercial trapping of bobcats for fur was banned in 2015 when the "Bobcat Protection Act of 2013" became effective (CFG Code 4155). Additionally, as of 2020 there is a hunting ban on bobcats (California AB 1254; 01/01/2020). As such, previous hunting and trapping data are not likely to be representative of future bobcat take from these sources. However, to be conservative in our analysis, and because future hunting and trapping take of bobcat is uncertain, hunting and trapping data from 2015 through 2019 are included in cumulative take. Hunters took an average of 321.4 individuals per year statewide during the 2015 through 2019 seasons (each season is defined by the year it started per CDFW bobcat harvest assessment reports; CDFW 2019b). Hunting take between 2015 and 2019 varied by county and ranged from an average of zero to 33 individuals per year. The highest bobcat hunter harvests were in Kern County (average 33.0 individuals per year, or 1.35% of the low population estimate for Kern County of 2,432 adults) and San Bernardino County (average of 25.2 individuals per year, or 0.30% of low population estimate for San Bernardino County of 8,083 adults). Project contributions to cumulative mortality in these two counties are low, 0.3% (2.2 individuals per year) of the population in Kern County and 0.4% (10.8 individuals per year) of the population in San Bernardino County.

The number of bobcats killed by vehicle collisions (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. A 2018 Colorado Parks and Wildlife Furbearer Management Report reported a high yearly roadkill mortality of 66 bobcats from a 15-year period between 2002 and 2017, with a range of 26 to 66 individuals per year (CPW 2018). Using the reported population density of 1.5 bobcat/km^2 and the estimated core habitat of 138,103 km^2 we calculated that 0.3% of the statewide bobcat population of Colorado was killed by vehicle collisions (CPW 2018). Because total roadkill mortality is unknown in California, we used the highest percentage analyzed in this Report for any species: 1.2% (for mountain lion; see Section 3.2.24). This level of roadkill mortality (1.2% of the population) is four times higher than the maximum recorded over 15 years in Colorado, so we believe this estimate is very conservative (i.e., will err on the side of overestimating bobcat roadkill and cumulative mortality).

Exposure to pesticides, particularly anticoagulant rodenticides (AR) is a potential source for mortality in bobcats; Serieys *et al.* (2015) documented widespread exposure of bobcats to ARs in southern California. While AR exposure alone did not appear to be a significant source of direct mortality, the authors did detect a strong association between multiple exposures of ARs and notoedric mange (Serieys *et al.* 2015). It is unknown what the overall effects of rodenticides and other human disruption are on bobcat. To be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24). This percentage was added to all other known and estimated losses to estimate cumulative anthropogenic mortality.

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein); hunter and trapper harvest (from CDFW reports); roadkill (1.2%); and rodenticides, habitat loss, and human disruption (2.6%). The estimates of cumulative mortality are presented in Table 3-3. Cumulative mortality was 4.8% statewide and ranged from 4.0% to 8.9% by county. These maximum cumulative mortality estimates for bobcat statewide and in each county are all well below the 17% total mortality threshold for bobcats. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.4% of the 4.8% mortality statewide, which is 8% of the cumulative anthropogenic mortality for bobcats.

Moreover, under similar conditions for all other sources of cumulative mortality, hunter and trapper harvest of bobcats in California was much higher during 2010 through 2013. During these four years hunter and trapper harvest averaged 1,564 bobcats per year statewide; this is 4.9 times higher than the average of 321.4 during 2015 through 2019. Cumulative anthropogenic mortality during these years is estimated at 7.3% of the population annually. This higher level of cumulative mortality in the recent past was also well below the sustainable mortality threshold for bobcats (17%) and appears to have been sustainable throughout these years. No evidence was found of bobcat population declines during this timeframe including CDFW furbearer and hunter harvest reports, and hunter and trapper harvest trended higher among these years. Bobcat hunter and trapper harvest decreased after the 2014-2015 season due to the implementation in November of 2015 of the “Bobcat Protection Act of 2013” (CFG Code 4155) (CDFW 2020).

Table 3-3. Bobcat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	0	0	0	0	0	0	0	**0**	1	13	294	0.3%	4.4%
ALPINE	0	0	0	0	0	0	0	0	**0**	1	10	239	0.4%	4.2%
AMADOR	0.1	0	0	0	0	0	0.1	0	**0.1**	1	12	204	0.5%	5.9%
BUTTE	0.3	0	0	0	0	0	0.3	0	**0.3**	1	26	564	0.2%	4.6%
CALAVERAS	1.7	0	0	0	0	0	1.7	0	**1.7**	6	27	367	1.6%	7.4%
COLUSA	0	0	0	0	0	0	0	0	**0**	1	10	224	0.4%	4.5%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	1	19	445	0.2%	4.3%
DEL NORTE	0	0.5	0	0	0	0	0	0.5	**0.5**	2	16	359	0.6%	4.5%
EL DORADO	0.8	0	0	0	0	0	0.8	0	**0.8**	3	35	662	0.5%	5.3%
FRESNO	0	1.5	0	0	0	0	0	1.5	**1.5**	5	52	1,139	0.4%	4.6%
GLENN	0	0.4	0	0	0	0	0	0.4	**0.4**	2	17	307	0.7%	5.5%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	1	52	1,141	0.1%	4.6%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	1	44	1,024	0.1%	4.3%
INYO	0	4.6	0	0	0	0	0	4.6	**4.6**	14	157	3,460	0.4%	4.5%
KERN	1.8	0	0.2	0	0.1	0.1	2.1	0.1	**2.2**	7	133	2,432	0.3%	5.5%
KINGS	0	0.2	0	0	0	0	0	0.2	**0.2**	1	6	132	0.8%	4.5%
LAKE	1	0	0	0	0	0	1	0	**1**	3	27	434	0.7%	6.2%
LASSEN	0.4	0	0	0	0	0	0.4	0	**0.4**	2	72	1,553	0.1%	4.6%
LOS ANGELES	0	2.1	0	0	0	0	0	2.1	**2.1**	7	77	1,563	0.4%	4.9%
MADERA	0.2	0	0	0	0	0	0.2	0	**0.2**	1	29	502	0.2%	5.8%
MARIN	0	0.3	0	0	0	0	0	0.3	**0.3**	1	12	229	0.4%	5.2%
MARIPOSA	5.3	0	0	0	0	0	5.3	0	**5.3**	16	41	510	3.1%	8.0%
MENDOCINO	3.9	0	0	0	0	0	3.9	0	**3.9**	12	63	1,104	1.1%	5.7%
MERCED	0.4	0	0	0	0	0	0.4	0	**0.4**	2	19	336	0.6%	5.7%
MODOC	0.6	0	0	0	0	0	0.6	0	**0.6**	2	57	1,269	0.2%	4.5%
MONO	0	1.3	0	0	0	0	0	1.3	**1.3**	4	45	999	0.4%	4.5%
MONTEREY	1.5	0	0	0	0	0	1.5	0	**1.5**	5	54	1,120	0.4%	4.8%
NAPA	2	0	0	0	0	0	2	0	**2**	6	18	229	2.6%	7.9%
NEVADA	0.4	0	0	0	0	0	0.4	0	**0.4**	2	21	407	0.5%	5.2%
ORANGE	0	0.5	0	0	0	0	0	0.5	**0.5**	2	17	396	0.5%	4.3%
PLACER[1]	1.3	0	0	0	0	0	1.3	0	**1.3**	4	28	538	0.7%	5.2%
PLUMAS	0	0	0	0	0	0	0	0	**0**	1	39	882	0.1%	4.4%
RIVERSIDE	0	3.3	0	0	0	0	0	3.3	**3.3**	10	117	2,462	0.4%	4.8%
SACRAMENTO	0	0	0	0	0.2	0.7	0.2	0.7	**0.9**	3	13	230	1.3%	5.7%
SAN BENITO[3]	1	0	0	0	0	0	1	0	**1**	3	27	463	0.6%	5.8%

Table 3-3. Bobcat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN BERNARDINO	0	10.8	0	0	0	0	0	10.8	**10.8**	33	365	8,083	0.4%	4.5%
SAN DIEGO	1.7	0	0.6	0	0	0	2.3	0	**2.3**	7	94	1,850	0.4%	5.1%
SAN FRANCISCO[4]	0	0	0	0	0	0	0	0	**0**	0	0.200	5	0%	4.0%
SAN JOAQUIN	0	0	0	0	0	0	0	0	**0**	1	5	113	0.9%	4.4%
SAN LUIS OBISPO	0.3	0	0	0	0	0	0.3	0	**0.3**	1	50	1,062	0.1%	4.7%
SAN MATEO	0	0.3	0	0	0	0	0	0.3	**0.3**	1	10	229	0.4%	4.4%
SANTA BARBARA	1.2	0	0	0	0	0	1.2	0	**1.2**	4	41	894	0.4%	4.6%
SANTA CLARA	0	0.6	0	0	0	0	0	0.6	**0.6**	2	23	447	0.4%	5.1%
SANTA CRUZ	0	0.3	0	0	0	0	0	0.3	**0.3**	1	12	254	0.4%	4.7%
SHASTA	0.9	0	0	0	0	0	0.9	0	**0.9**	3	70	1,394	0.2%	5.0%
SIERRA	0	0	0	0	0	0	0	0	**0**	1	14	323	0.3%	4.3%
SISKIYOU[5]	0.9	0	0	0	0	0	0.9	0	**0.9**	3	98	2,188	0.1%	4.5%
SOLANO	0	0	0	0	0	0	0	0	**0**	1	7	143	0.7%	4.9%
SONOMA[6]	7.5	0	0	0	0	0	7.5	0	**7.5**	23	43	482	4.8%	8.9%
STANISLAUS	0.4	0	0	0	0	0	0.4	0	**0.4**	2	17	360	0.6%	4.7%
SUTTER	0	0	0	0	0	0	0	0	**0**	1	4	45	2.2%	8.9%
TEHAMA	0	1.3	0	0	0	0	0	1.3	**1.3**	4	49	982	0.4%	5.0%
TRINITY	0.2	0	0	0	0	0	0.2	0	**0.2**	1	47	1,124	0.1%	4.2%
TULARE	0	1.5	0	0	0	0	0	1.5	**1.5**	5	54	1,123	0.4%	4.8%
TUOLUMNE	1.9	0	0	0	0	0	1.9	0	**1.9**	6	40	760	0.8%	5.3%
VENTURA	0	0.9	0	0	0	0	0	0.9	**0.9**	3	32	701	0.4%	4.6%
YOLO	0.1	0	0	0	0	0	0.1	0	**0.1**	1	8	151	0.7%	5.3%
YUBA	0	0	0	0	0	0	0	0	**0**	1	11	159	0.6%	6.9%
Total	**37.8**	**30.4**	**0.8**	**0**	**0.3**	**0.8**	**38.9**	**31.2**	**70.1**	**210**	**2,473**	**51,088**	**0.4%**	**4.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding. Occasional lethal take of one individual per year is estimated under the Proposed Project for counties with no lethal WDM during the analysis period, but with at least moderate populations (more than 100) and resources commonly be damaged by the species. Statewide total estimated maximum lethal take under the Proposed Project might not match the sum of maximum take in each county because all county numbers were rounded up to the next integer. A population estimate is provided for each county based on the methods described in detail in Appendix C3. The lower population estimate described in Appendix C3 is used here to provide the most conservative effect analysis.

1 Refer to Section 3.2.2.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 San Francisco County cumulative mortality was not rounded up to the next integer, only to the next tenth of an integer due to the low population estimate of five individuals. Rounding up to integer would result in an incorrectly high cumulative mortality estimate.
5 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
6 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.2.3 Coyote

The coyote is legally designated as a non-game mammal (CFGC Section 4150) in California. It occurs in almost all habitats and successional stages up to elevations as high as 3,000 meters, frequenting open brush, scrub, shrub, and herbaceous habitats, as well as forests and woodlands with shrub and grass understory (CWHR 2022). Coyotes are opportunistic omnivores that eat primarily rodents and carrion and occasionally birds, reptiles, and amphibians. (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for this species to be lethally removed any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Coyote is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Based on the CDFW habitat modeling for coyote provided in Appendix C4, the low estimated population size for California is 227,394 individuals. Also included in Appendix C4 are the population estimates of coyotes within each county.

Connolly and Longhurst (1975) developed a model to assess the response of coyote populations to harvest/removal. This model was later revisited by Connolly (1995) and indicated that coyote populations could withstand an annual removal of up to 70% of their population and still maintain a viable population.

Another model developed by Pitt *et al.* (2001) determined that coyote populations recovered within one year after lethal removal of up to 50% of the population. When 60% and 70% of the population was removed it took 2 and 3 years for the population to recover, respectively. These results suggest a 50% sustainable annual harvest rate. These authors also assessed the impact of simulated annual coyote removal over a fifty-year period. They found that removal of "less than 60%" of the population was sustainable over the fifty-year period; based on their study design, we interpret "less than 60%" as a sustainable harvest rate of 50% (i.e., the population was stable at all removal rates up to 50%, but not so at 60% or higher).

Pitt *et al.* (2001) stated that actual coyote populations would recover even more quickly than the model indicated, because the model made several conservative assumptions: (1) coyote territories were retained even at low densities, (2) animals would not move out of their territories to mate, (3) no animals moved in from surrounding areas (no immigration), and (4) natural mortality rates were not reduced at low population densities (all removal was additive). Assumptions like these are generally necessary in order to simplify population models, but in this case, each assumption removes a biological function which would serve to help the population recover more quickly. However, a shift in population structure was noted with sustained removal of large percentages of coyotes. For example, the population with 50% removal had fewer transient animals, a younger age structure, and higher reproduction.

Conner *et al.* (2008) prepared a model based on that of Pitt *et al.* (2001) and found that a 50% reduction in coyote numbers resulted in population recovery within 9 months; this supports a 50% sustainable harvest rate. Gese (2005), found that a 44-51% reduction in coyote populations was sustainable (coyote population and density returned to pre-removal numbers within one year), but resulted in transient demographic and home range size changes. CDFW established a sustainable cumulative annual statewide harvest level for coyotes at 60% of the adult population based on the modeling of Pitt *et al.* (2001).

The studies above demonstrate a high sustainable threshold (50%) for coyote. This is likely due to (1) their social pack structure, which allows nearby packs to rapidly colonize an area where coyotes have been removed; (2) increased reproductive rates after removal; and/or (3) increased pup survival rates after removal. For the purposes of this analysis, we will use a 50% sustainable harvest threshold, which is supported by the available science as discussed above.

3.2.3.1 Previous Wildlife Damage Management

WDM for coyote comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed or removed/destroyed). During the 10-year WS-California MIS baseline, an average of 4,664 coyotes were killed, 2.0 individuals were killed within dens that were removed/destroyed, 122.0 individuals were dispersed, 1.8 individuals were freed, and 0.3 individuals were surveyed per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 4,790.1 individuals per year.[14] WS-California MIS lethal WDM for coyote occurred within 49 counties across the state with averages ranging from 0.1 to 915.8 individuals per year. The largest portion of baseline lethal WDM by WS-California, 19.6% of total lethal WS-California take or 915.8 individuals, occurred within Kern County. Lethal take of coyote accounts for 97.4% (4,664 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 2.6% (126.1 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were prepared for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-4) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of coyote is estimated at 8,111.9 individuals annually. This total is comprised of the WS-California lethal take of 4,664 individuals per year (57.5%) and the non-WS-California estimates for lethal take of 3,447.9 individuals per year (42.5%) (Table 3-4). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 227,394 individuals. The population estimate for each county is provided in Table 3-4. Approximately 3.6% of the statewide population was affected by lethal WDM activities annually (Table 3-4).

To address annual variations, we calculated the standard deviation of the WS-California statewide coyote take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For coyote, the average is 4,392.2,[15] the standard deviation is 961.49, and the 99% confidence high estimate is 6,872.83, which we rounded up to 6,873 individuals. The 99% Confidence Factor for coyote was 6,873/4,392.2 = 1.56. All estimates of total previous WDM within each county were multiplied by the 99% Confidence Factor to estimate the high end of future take under the Proposed Project within each county.

3.2.3.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of coyote under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total

14 Average includes activities that both intentionally and unintentionally affect coyote, and all potential WDM methods used by WS-California.

15 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-4. This small amount of error was accepted for this calculation.

Proposed Project Maximum Lethal Take Estimate is 12,655 coyotes taken annually, which represents 5.6% of the population. The statewide modeled low population estimate for this species is approximately 227,394 individuals (Appendix C4). The population estimate for each county is provided in Table 3-4. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0.1% (3 individuals of 4,802 individuals within the estimated Trinity County population) to 25.5% (433 individuals of 1,700 individuals within the estimated Colusa County population). After Colusa County, the next highest Proposed Project Maximum Lethal Take Estimate by county population is Sacramento County with 14.1% (183 individuals of 1,301 estimated county population) (Table 3-4). These numbers are all well below the sustainable harvest threshold of 50% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 12,655. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 12,655 individuals. The maximum number of coyotes taken by county-level programs are listed for each county in Table 3-4, under the "Proposed Project Max Lethal Take Estimate" column. These possibilities depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Coyotes are considered mesopredators in most ecosystems but may be considered an apex predator in others where larger predators have been extirpated (e.g., wolves, mountain lions) (Crooks and Soulé 1999; Roemer *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). For example, coyotes can influence the abundance and distribution of other mesopredators such as raccoons, skunks, bobcats, and foxes, as well as deer activity and plant community composition (Berger *et al.* 2001; Waser *et al.* 2014). However, some studies suggest that changes to lagomorph abundance is unrelated to short-term coyote removal (Gese 2005; Henke 1995). Regardless, high species diversity of apex predators, mesopredators, and prey species in an ecosystem can make the mesopredator release less likely to occur (Brashares *et al.* 2010). Trophic cascade impacts on ecosystems have been documented after the complete removal or extirpation of an apex predator species (Grimm 1939; Keigley 2018; Wagner 2006; Beschta and Ripple 2018), but we are not aware of any evidence that the removal of low, modest, or even considerable numbers of predators has the potential to result in such trophic cascades. Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to coyotes, are therefore not anticipated due to the low percentage of the coyote population impacted by the Project regionally, statewide, and cumulatively.

3.2.3.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

MIS baseline data (2010–2019) have documented predation to multiple special-status species by coyote in California. Coyote predation on the federally listed desert tortoise occurs in San Bernardino County. Evidence of coyote predation on desert tortoise has been suggested by coyote scat analysis in the Mojave Desert from 2009 to 2014 (Kelly *et al.* 2021). Additionally, coyote predation on the federal- and state-listed snowy plover and California least tern occurs in San Diego County. Snowy plover was predated upon by coyote in San Luis Obispo County as well, while the California least tern was also predated upon in Ventura County. Evidence of coyote predation on California least tern and snowy plover nests has been observed in Bolsa Chica State Ecological Reserve in Orange County (Merkel & Associates Inc. 2010). Coyotes are known to predate on the federal and state listed San Joaquin kit fox and California non-game desert kit fox (*Vulpes macrotis arsipus*) (Ralls and White 1995). Coyote removal has been suggested to benefit ringtails (*Bassariscus astutus*) (Harrison 2013), which is a Fully Protected species in California (CDFW 2022a). Non-listed carnivore species such as badgers, bobcats, and fox have also been shown to increase in number when coyote populations are reduced (Robinson 1961; Nunley 1977; Crooks and Soulé 1999). Evidence of coyote predation on mule deer has been observed east of the Sierra Nevada in eastern California (Pierce *et al.* 2000). As such, removal of this species under WDM activities could result in a net benefit to multiple native special-status and non-special status species (e.g., increased survival rates).

3.2.3.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-4).

Habitat loss, habitat fragmentation, and climate change are not likely to negatively affect coyote populations because they are extremely adaptable and can live in suburban and peri-urban environments that allow them to benefit from human food subsidies. As an ecological generalist, coyotes live in a variety of different ecosystems (Moore and Parker 1992; Santana and Armstrong 2017). Even among ecological generalists, many wildlife biologists characterize coyotes as having a unique resilience to change. In fact, the habitat changes that have occurred over the last two hundred years have generally favored the species. Coyote densities have been found to be higher in human-altered environments (Fedriani *et al.* 2001). Because of their adaptability, coyote populations are likely to increase with the future loss of natural habitats and the potential effects of climate change. Such increases are likely to increase human-coyote conflicts in the future. However, due to the degree to which the environment has already been modified by humans, the likely increases in future coyote populations and conflicts are not expected to be substantial. Therefore, future lethal WDM for coyotes is likely to be similar to that during the analysis period (2010-2019).

Hunting likely remains one of the largest sources of anthropogenic mortality for coyote, though data are not consistently collected regarding coyotes killed during hunting. It is considered a “non-game” species in California and there are no limits or seasonal restrictions on hunting of this species (FGC Division 4 Part 3 Chapter 3 Article 1 — 4152). It is anticipated that much non-reported hunting occurs on private properties and ranches. Coyote hunting was estimated statewide for the 2014-2015 season, with an estimated 33,941 individuals killed by hunters (not counting those killed for WDM like livestock and property protection) (Responsive Management 2015). Coyotes were also historically a minor target for fur trapping, with an average of 136 coyotes trapped per year between 2010 and 2020 (CDFW 2020). However as of January 2020 trapping for furs became illegal in California under most or all circumstances. Elimination of legal trapping removed a minor source of mortality for the species, but coyote hunting will likely continue. The estimated 2014-2015 coyote harvest estimate (33,941 coyotes per year) was used to estimate future coyote hunter harvest. Unfortunately, these data were not compiled by county, so hunter harvest was estimated by county. The statewide percentage of the coyote population harvested by hunters (14.9%) was multiplied by each county population to estimate county-level hunter harvest.

The number of coyotes killed by vehicle collisions (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS) (http://wildlifecrossing.net/california/) contains these data but the entity that owns the data asserts that they are proprietary despite numerous requests and the website stating that information is available to users (CROS 2023). Roadkill data from the California Department of Transportation (Caltrans) were not available but data from the Colorado Department of Transportation are readily available, so we analyzed those data. Coyote roadkill mortality during Calendar Years

2015 through 2019 averaged 63 individuals per year (CDOT 2022), which is 0.043% of the estimated coyote population in Colorado (USDA 2019). Even the maximum roadkill in this timeframe (114 in 2016) was only 0.078% of the population. These data are limited to roadkill known by the Colorado Department of Transportation, which might not be inclusive of all coyotes killed by vehicle collisions. As such, this number might underestimate mortality from this source. However, we are aware of no other available information on coyote roadkill mortality in California. For coyotes, we will use the highest roadkill estimate we found for any species in this Report: 1.2% (for mountain lion; Section 3.2.24).

The final source of anthropogenic mortality we estimated was more general: other anthropogenic mortality, which includes illegal harvest (poaching), accidental poisoning, and other unknown sources of intentional and unintentional mortality. Because there are so many unknowns in this category, we used the highest estimate of this “other” mortality we analyzed in this Report, which was 2.6% for mountain lion (Section 3.2.24) as a conservative estimate.

Cumulative anthropogenic mortality is estimated at 55,387 individuals statewide (24.4% of the statewide population). Maximum lethal WDM under the Proposed Project would contribute 23% of that cumulative mortality (12,655 of 55,387 individuals; Table 3-4). At the county level, cumulative mortality ranged from 18.8% to 44.2% of the county populations. The highest cumulative mortality under the Proposed Project is in San Bernardino County, which includes up to 7,208 coyotes or 24.2% of the population. Maximum lethal WDM under the Proposed Project would contribute only 23% of that cumulative mortality (1,634 of 7,208 individuals; Table 3-4). The highest cumulative mortality as a percentage of the population is in Colusa County: 44.2% of the population (752 individuals. This county also has the highest estimate of maximum lethal WDM under the Proposed Project, which would contribute 58% of that cumulative mortality (433 of 751 individuals; Table 3-4). Cumulative coyote mortality including maximum potential lethal WDM under the Proposed Project is below the 50% sustainable harvest estimate for coyotes statewide and within each county.

Table 3-4. Coyote Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate[1]	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate				
ALAMEDA	1.2	0	1.9	0.3	0	0	3.1	0.3	**3.4**	6	184	952	0.6%	19.3%
ALPINE	24.1	0	0	0.3	0	0	24.1	0.3	**24.4**	39	230	1,023	3.8%	22.5%
AMADOR	40.6	0	0	0.3	0	0	40.6	0.3	**40.9**	64	229	879	7.3%	26.1%
BUTTE	10.8	0	0	0.3	0.7	0.7	11.5	1.0	**12.5**	20	466	2,381	0.8%	19.6%
CALAVERAS	56.4	0	0	0.3	0	0	56.4	0.3	**56.7**	89	379	1,550	5.7%	24.5%
COLUSA	276.9	0	0	0.3	0	0	276.9	0.3	**277.2**	433	752	1,700	25.5%	44.2%
CONTRA COSTA	1.9	0	2.8	0.3	0.5	0	5.2	0.3	**5.5**	9	178	904	1.0%	19.7%
DEL NORTE	0	53.4	0	0.3	0	0	0	53.7	**53.7**	84	371	1,531	5.5%	24.2%
EL DORADO	101.7	0	0	0.3	0	0	101.7	0.3	**102.0**	160	628	2,501	6.4%	25.1%
FRESNO	0	293.6	0	0.3	0	0	0	293.9	**293.9**	459	2,036	8,416	5.5%	24.2%
GLENN	0	69.2	0	0.3	0	0	0	69.5	**69.5**	109	481	1,984	5.5%	24.2%
HUMBOLDT	17.7	0	0	0.3	0	0	17.7	0.3	**18.0**	29	1,050	5,416	0.5%	19.4%
IMPERIAL	121.1	0	0	0.3	0.2	0.1	121.3	0.4	**121.7**	190	1,260	5,695	3.3%	22.1%
INYO	0	514.6	0	0.3	0	0	0	514.9	**514.9**	804	3,570	14,751	5.5%	24.2%
KERN	914.5	0	0.3	0.3	0.5	0.2	915.3	0.5	**915.8**	1,429	3,698	12,080	11.8%	30.6%
KINGS	0	71.7	0	0.3	7.9	1	7.9	73.0	**80.9**	127	512	2,055	6.2%	24.9%
LAKE	62.8	0	0	0.3	0	0	62.8	0.3	**63.1**	99	460	1,918	5.2%	24.0%
LASSEN	350.4	0	0	0.3	0	0	350.4	0.3	**350.7**	548	1,859	6,951	7.9%	26.7%
LOS ANGELES	4.1	185	0	0.3	7.9	7.9	12.0	193.2	**205.2**	321	1,316	5,302	6.1%	24.8%
MADERA	96.9	0	0	0.3	0	0	96.9	0.3	**97.2**	152	734	3,109	4.9%	23.6%
MARIN	0.2	25.5	0	0.3	0	0	0.2	25.8	**26.0**	41	178	732	5.6%	24.3%
MARIPOSA	106.9	0	0	0.3	0	0	106.9	0.3	**107.2**	168	578	2,187	7.7%	26.4%
MENDOCINO	151.4	0	0	0.3	0	0	151.4	0.3	**151.7**	237	1,242	5,368	4.4%	23.1%
MERCED	28.6	0	0	0.3	0.9	1.2	29.5	1.5	**31.0**	49	574	2,759	1.8%	20.8%
MODOC	253.6	0	0	0.3	0	0	253.6	0.3	**253.9**	397	1,522	5,963	6.7%	25.5%
MONO	0	147.8	0	0.3	0	0	0	148.1	**148.1**	232	1,026	4,238	5.5%	24.2%
MONTEREY	142.2	0	0.1	0.3	0.6	0.3	142.9	0.6	**143.5**	224	1,162	4,997	4.5%	23.3%
NAPA	56.5	0	0	0.3	0.2	0.1	56.7	0.4	**57.1**	90	298	1,114	8.1%	26.7%
NEVADA	25.4	0	0	0.3	0	0	25.4	0.3	**25.7**	41	300	1,383	3.0%	21.7%
ORANGE	3.1	32.6	0	0.3	0	0	3.1	32.9	**36.0**	57	232	934	6.1%	24.8%
PLACER[2]	120.8	0	0	0.3	0	0	120.8	0.3	**121.1**	189	572	2,044	9.2%	28.0%
PLUMAS	130.5	0	0	0.3	0	0	130.5	0.3	**130.8**	205	934	3,893	5.3%	24.0%
RIVERSIDE	0.5	355.2	0	0.3	0	0	0.5	355.5	**356.0**	556	2,463	10,183	5.5%	24.2%
SACRAMENTO	75.7	0	0	0.3	18.4	22.6	94.1	22.9	**117.0**	183	427	1,301	14.1%	32.8%

Table 3-4. Coyote Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate[1]	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate				
SAN BENITO[3]	146.3	0	0	0.3	0	0	146.3	0.3	**146.6**	229	629	2,121	10.8%	29.7%
SAN BERNARDINO	0.2	1,038.0	1.4	0.3	2	5.1	3.6	1,043.4	**1,047.0**	1,634	7,208	29,755	5.5%	24.2%
SAN DIEGO	68.4	0	22.8	0.3	1	1.5	92.2	1.8	**94.0**	147	1,255	5,917	2.5%	21.2%
SAN FRANCISCO	0	1.7	0	0.3	0	0	0	2.0	**2.0**	4	13	50	7.9%	25.8%
SAN JOAQUIN	26.9	0	0	0.3	0.1	0.1	27.0	0.4	**27.4**	43	428	2,056	2.1%	20.8%
SAN LUIS OBISPO	141.5	0	11.5	0.3	1.7	2.3	154.7	2.6	**157.3**	246	1,198	4,987	4.9%	24.0%
SAN MATEO	0	20.9	0	0.3	0	0	0	21.2	**21.2**	34	146	598	5.7%	24.4%
SANTA BARBARA	125	0	0	0.3	0	0	125.0	0.3	**125.3**	196	909	3,809	5.1%	23.9%
SANTA CLARA	0	62.6	0	0.3	0.2	0.1	0.2	63.0	**63.2**	99	435	1,794	5.5%	24.2%
SANTA CRUZ	0	21.9	0	0.3	0	0	0	22.2	**22.2**	35	153	627	5.6%	24.4%
SHASTA	49.5	0	0	0.3	1.1	1.7	50.6	2.0	**52.6**	83	1,150	5,694	1.5%	20.2%
SIERRA	74.4	0	0	0.3	0	0	74.4	0.3	**74.7**	117	390	1,456	8.0%	26.8%
SISKIYOU[4]	177.9	0	0	0.3	0	0	177.9	0.3	**178.2**	278	2,103	9,494	2.9%	22.1%
SOLANO	80.3	0	1.2	0.3	3.4	0.3	84.9	0.6	**85.5**	134	336	1,063	12.6%	31.6%
SONOMA[5]	173.8	0	0	0.3	0	0	173.8	0.3	**174.1**	272	707	2,322	11.7%	30.4%
STANISLAUS	60.7	0	0	0.3	0	0	60.7	0.3	**61.0**	96	513	2,229	4.3%	23.0%
SUTTER	55.2	0	0	0.3	0	0	55.2	0.3	**55.5**	87	252	880	9.9%	28.6%
TEHAMA	0.1	157.4	0	0.3	0	0	0.1	157.7	**157.8**	247	1,094	4,512	5.5%	24.2%
TRINITY	1	0	0	0.3	0	0	1.0	0.3	**1.3**	3	904	4,802	0.1%	18.8%
TULARE	0	241.7	0	0.3	0	0	0	242.0	**242.0**	378	1,676	6,928	5.5%	24.2%
TUOLUMNE	83.3	0	0	0.3	0	0	83.3	0.3	**83.6**	131	711	3,068	4.3%	23.2%
VENTURA	0.1	90.8	2.4	0.3	6.3	1.7	8.8	92.8	**101.6**	159	646	2,602	6.1%	24.8%
YOLO	110.2	0	0	0.3	0	0	110.2	0.3	**110.5**	173	452	1,491	11.6%	30.3%
YUBA	5.8	0	0	0.3	8.9	0	14.7	0.3	**15.0**	24	201	941	2.6%	21.4%
Total	**4,557.1**	**3,383.6**	**44.4**	**17.4**	**62.5**	**46.9**	**4,664.0**	**3,447.9**	**8,111.9**	**12,655**	**55,387**	**227,394**	**5.6%**	**24.4%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS wildlife damage management occurred during the 10-year baseline period.
Totals may not sum due to rounding.
1 Refer to Section 3.2.3.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C4. The lower population estimate described in Appendix C4 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.4 Gray Fox

The gray fox is the most common fox in California, mainly populating coastal or mountain forests at lower elevations. This mammalian fur-bearer species (CFGC Section 4000) frequents most shrublands, valley foothill riparian, montane riparian, meadow, forest, and woodland habitats (CWHR 2022). Gray foxes are omnivorous, eating mostly rodents, as well as insects, grains, and herbage. This species is non-migratory and primarily nocturnal, mating in the spring and birthing in dens. Gray fox is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for gray fox provided in Appendix C5, the low estimated population size for California is 240,202 individuals. Also included in Appendix C5 are the population estimates of gray foxes within each county.

No published thresholds were found for the level of anthropogenic mortality that gray fox populations can withstand (sustainable harvest thresholds). CDFW established a sustainable cumulative annual statewide harvest level for gray fox at 25% of the adult low population estimate (CDFG 2004). That harvest level included legal hunting, trapping, and WDM activities. The only other published harvest threshold found during a literature search was by Colorado Parks and Wildlife (CPW 2016), which selected a 15% threshold for combined hunting and trapping but provided no supporting analysis for that threshold. Other relevant values include studies of annual survival rates of gray fox populations, including those in Southern California (Farias *et al.* 2005), Georgia (Temple *et al.* 2010) and South Carolina (Weston and Brisbin 2003). This analysis uses a 20% population effects threshold, which is an average of the 25% (CDFG 2004) and 15% (CPW 2016) values.

3.2.4.1 Previous Wildlife Damage Management

WDM for gray fox comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline period 2010 to 2019, an average of 141.4 gray foxes were killed, 3.7 individuals were dispersed, 78.0 individuals were freed, 0.2 individuals were relocated, and 0.8 individuals underwent a transfer of custody per year by WS-California. Therefore, under the previous WS-California efforts, WDM affected on average approximately 224.1 individuals per year based on the WS-California MIS data.[16] WS-California WDM for gray fox occurred within 36 counties across the state with averages ranging from 0.1 to 21.6 individuals per year. Most WS-California WDM activities (30.4%, or 43 individuals) occurred within Calaveras and Napa Counties. Lethal WDM of gray fox accounts for 63.1% (141.4 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 36.9% (82.7 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were prepared for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-5) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

16 Average includes activities that both intentionally and unintentionally affect gray fox and all potential methods used during WDM activities.

During the 10-year baseline period, statewide lethal take of gray fox is estimated at 282.9 individuals annually. This total is comprised of the WS-California lethal take of 141.4 individuals per year and the non-WS-California estimates for lethal take of 141.5 individuals per year (Table 3-5). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 240,202 individuals. Approximately 0.1% of the statewide low population estimate was taken by lethal WDM activities annually. The population estimate for each county is provided in Table 3-5.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide gray fox take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For gray fox, the average is 135.7,[17] the standard deviation is 49.04, and the 99% confidence high estimate is 262.22, which we rounded up to 263 individuals. The 99% Confidence Factor for gray fox was 263/135.7 = 1.94. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.4.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of gray fox under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 411 gray fox taken annually, which represents 0.2% of the population. The statewide modeled low population estimate for this species is approximately 240,202 individuals (Appendix C5). The population estimate for each county is provided in Table 3-5. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 4.4% (19 individuals of 436 estimated county population; Alameda County). These numbers are all well below the sustainable harvest threshold of 20% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 432. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 432 individuals. The maximum number of gray fox taken by county-level programs are listed for each county in Table 3-5, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

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[17] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-5. This small amount of error was accepted for this calculation.

In general, gray fox are considered mesopredators (Prugh et al. 2009) but are also preyed upon by coyotes. Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al*. 2009). However, indirect impacts to ecosystem function, structure, or dynamics resulting from the Project's lethal WDM of gray fox are not anticipated due to the low percentage of gray fox taken by the Project regionally, statewide, and cumulatively as shown in Table 3-5 below.

3.2.4.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) did not document any gray fox predation to special status species in California. However, gray fox predation to non-game and game mammals, specifically rodents and lagomorphs including the brush rabbit, gopher, and big-eared woodrat, is suggested based on documented prey observations within a den in San Mateo County (Elbroch and Allen 2013). As such, removal of this species under WDM activities could result in a net benefit to native non-game and game mammals (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.2.4.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-5). Among the greatest natural causes of mortality for gray fox is coyote predation, often in competition for prey resources (Egan *et al.* 2021). Another major natural cause of gray fox mortality is canine distemper, which increases in frequency in gray fox populations of higher density and is almost always fatal in this species (Davidson *et al.* 1992).

Other anthropogenic factors that can affect gray fox are habitat loss from development and climate change, and disruption by human activities such as or agricultural activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in gray fox quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase gray fox mortality in the near future, and (3) a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of gray fox in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Trapping of gray fox for fur is no longer legal in California for most trap types (California AB 273, 09/04/2019); therefore, the lethal removal of gray fox that has historically occurred under trapping licenses is not likely to contribute to cumulative mortality as of 2019. However, to be conservative in our analysis, and because future trapping take is uncertain, trapping data from 2010 through 2019 are included in cumulative take. Gray fox trapping harvest is likely to be much lower after the fur trapping ban (AB 273) took effect in 2019. However, to be conservative we will use the 2010-2019 average to estimate future trapping harvest. The 10-year average statewide was 504 gray fox individuals per year, which is 0.2% of the estimated population (CDFW 2020). Trapping data by county ranged from 0 individuals to 272 individuals (CDFW 2020) (Table 3-5). Gray fox have been hunted in California in the past. Although future hunter harvest is likely to be lower than in the past (or nonexistent), we used the best available data of previous hunter harvest to be conservative. Gray fox hunting was estimated statewide for the 2014-2015 season, with an estimated 4,419 individuals killed by hunters (not counting those killed for WDM like livestock and property protection) (Responsive Management 2015). Unfortunately, these data were not compiled by county, so we had to estimate hunter harvest by county. The statewide percentage of the gray fox population harvested by hunters (1.8%) was multiplied by each county population to estimate county-level hunter harvest.

The number of gray fox killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Therefore, we estimated gray fox mortality from vehicle collisions. Roadkill data from the California Department of Transportation (Caltrans) were not available. No available source of gray fox roadkill data was found in California. Therefore, to be the most conservative, we used the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (for mountain lion, see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.2%); hunter and trapper harvest (2% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-5. Cumulative mortality was 6.0% statewide and ranged from 5.7% to 9.9% by county. Lethal WDM under the Proposed Project would be responsible for only 2.8% (411 of 14,505 individuals) of cumulative anthropogenic mortality statewide. The county with the highest percentage of cumulative mortality is Alameda: 9.9% of the population (43 individuals). Maximum lethal WDM under the Proposed Project contributed 44% of this cumulative mortality (19 of 43 individuals). Cumulative mortality ranged from 1 to 2,566 by county. The county with the highest cumulative mortality estimate is San Bernardino: 2,566 individuals (5.8% of the population). Maximum lethal WDM under the Proposed Project contributed 1.7% of this cumulative mortality (44 of 2,566 individuals). Maximum cumulative mortality estimates for gray fox statewide and in each county are all well below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-5.

Table 3-5. Gray Fox Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	5.6	0	0.2	0	2	1.5	7.8	1.5	**9.3**	19	43	436	4.4%	9.9%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	60	1,056	0%	5.7%
AMADOR	1.6	0	0	0	0	0	1.6	0	**1.6**	4	50	825	0.5%	6.1%
BUTTE	2.3	0	0	0	0	0	2.3	0	**2.3**	5	116	1,941	0.3%	6.0%
CALAVERAS	21.6	0	0	0	0	0	21.6	0	**21.6**	42	139	1,710	2.5%	8.1%
COLUSA	0.1	0	0	0	0	0	0.1	0	**0.1**	1	89	1,504	0.1%	5.9%
CONTRA COSTA	0.4	0	1.7	0	0	0	2.1	0	**2.1**	5	26	373	1.3%	7.0%
DEL NORTE	0	1.2	0	0	0	0	0	1.2	**1.2**	3	60	1,034	0.3%	5.8%
EL DORADO	9.7	0	0	0	0	0	9.7	0	**9.7**	19	174	2,739	0.7%	6.4%
FRESNO	0	8.2	0	0	0	0	0	8.2	**8.2**	8	429	7,343	0.1%	5.8%
GLENN	0	1.7	0	0	0	0	0	1.7	**1.7**	2	115	1,550	0.1%	7.4%
HUMBOLDT	1.3	0	0	0	0	0	1.3	0	**1.3**	3	182	3,173	0.1%	5.7%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	460	8,094	0%	5.7%
INYO	0	25.4	0	0	0	0	0	25.4	**25.4**	21	1,318	22,725	0.1%	5.8%
KERN	0.3	0	0.1	0	0	0	0.4	0	**0.4**	1	711	12,015	0.0%	5.9%
KINGS	0	2.4	0	0	0	0	0	2.4	**2.4**	3	125	2,172	0.1%	5.8%
LAKE	2.7	0	0	0	0	0	2.7	0	**2.7**	6	156	2,230	0.3%	7.0%
LASSEN	0.2	0	0	0	0	0	0.2	0	**0.2**	1	163	2,744	<0.1%	5.9%
LOS ANGELES	0.1	6.1	0	0	0.3	0.3	0.4	6.4	**6.8**	14	435	5,442	0.2%	8.0%
MADERA	4	0	0	0	0	0	4.0	0	**4.0**	8	162	2,723	0.3%	5.9%
MARIN	0	0.7	0	0	0	0	0	0.7	**0.7**	1	34	588	0.2%	5.8%
MARIPOSA	4.4	0	0	0	0	0	4.4	0	**4.4**	9	133	2,177	0.4%	6.1%
MENDOCINO	11.8	0	0	0	0	0	11.8	0	**11.8**	23	243	3,797	0.6%	6.4%
MERCED	5.9	0	0	0	0.1	0.1	6.0	0.1	**6.1**	12	142	2,302	0.5%	6.2%
MODOC	0	0	0	0	0	0	0	0	**0**	0	50	805	0%	6.2%
MONO	0	6.6	0	0	0	0	0	6.6	**6.6**	6	342	5,875	0.1%	5.8%
MONTEREY	0	0	0	0	0	0	0	0	**0**	0	295	5,207	0%	5.7%
NAPA	21.4	0	0	0	0	0	21.4	0	**21.4**	42	107	1,159	3.6%	9.2%
NEVADA	1.8	0	0	0	0	0	1.8	0	**1.8**	4	85	1,391	0.3%	6.1%
ORANGE	0	0.4	0	0	0	0	0	0.4	**0.4**	2	24	388	0.5%	6.2%
PLACER[3]	8.3	0	0	0	0	0	8.3	0	**8.3**	19	144	2,131	0.9%	6.8%
PLUMAS	0.9	0	0	0	0	0	0.9	0	**0.9**	2	324	5,607	<0.1%	5.8%
RIVERSIDE	0	15.4	0	0	0	0	0	15.4	**15.4**	15	799	13,718	0.1%	5.8%
SACRAMENTO	0	0	0	0	0.1	0.4	0.1	0.4	**0.5**	1	51	869	0.1%	5.9%
SAN BENITO[4]	0	1.9	0	0	0	0	0	1.9	**1.9**	2	111	1,721	0.1%	6.4%

Table 3-5. Gray Fox Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN BERNARDINO	0	49.5	0	0	0	0	0	49.5	**49.5**	44	2,566	44,225	0.1%	5.8%
SAN DIEGO	0	0	1.5	0	0.1	0.2	1.6	0.2	**1.8**	4	418	7,230	0.1%	5.8%
SAN FRANCISCO[5]	0	<0.1	0	0	0	0	0	0.01	**0.01**	0.2	0.5	6	3.3%	8.8%
SAN JOAQUIN	0.3	0	0	0	0	0	0.3	0	**0.3**	1	105	1,835	0.1%	5.7%
SAN LUIS OBISPO	0.1	0	0	0	0	0	0.1	0	**0.1**	1	249	4,396	0.0%	5.7%
SAN MATEO	0	0.5	0	0	0	0	0	0.5	**0.5**	1	26	441	0.2%	5.9%
SANTA BARBARA	0.4	0	0	0	0	0	0.4	0	**0.4**	1	286	4,992	<0.1%	5.7%
SANTA CLARA	0	1.7	0.7	0	1.6	0.9	2.3	2.6	**4.9**	9	96	1,525	0.6%	6.3%
SANTA CRUZ	0	0.5	0	0	0	0	0	0.5	**0.5**	1	27	438	0.2%	6.2%
SHASTA	1	0	0	0	0	0	1.0	0	**1.0**	2	375	6,248	<0.1%	6.0%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	109	1,920	0%	5.7%
SISKIYOU[6]	9.2	0	0	0	0	0	9.2	0	**9.2**	18	654	9,427	0.2%	6.9%
SOLANO	0	0	0	0	0.1	0.1	0.1	0.1	**0.2**	1	89	1,059	0.1%	8.4%
SONOMA[7]	2.5	0	0	0	0	0	2.5	0	**2.5**	7	103	1,685	0.4%	6.1%
STANISLAUS	6.8	0	0	0	0	0	6.8	0	**6.8**	14	101	1,555	0.9%	6.5%
SUTTER	0.6	0	0	0	0	0	0.6	0	**0.6**	2	37	631	0.3%	5.9%
TEHAMA	0	5.1	0	0	0	0	0	5.1	**5.1**	5	284	4,599	0.1%	6.2%
TRINITY	0.3	0	0	0	0	0	0.3	0	**0.3**	1	217	3,334	0.1%	6.5%
TULARE	0	7.1	0	0	0	0	0	7.1	**7.1**	7	368	6,326	0.1%	5.8%
TUOLUMNE	4.6	0	0	0	0	0	4.6	0	**4.6**	9	189	3,167	0.3%	6.0%
VENTURA	0	3.6	0	0	0	0	0	3.6	**3.6**	4	187	3,174	0.1%	5.9%
YOLO	0.3	0	0	0	0	0	0.3	0	**0.3**	1	96	1,677	0.1%	5.7%
YUBA	2.4	0	0	0	0	0	2.4	0	**2.4**	5	47	750	0.7%	6.3%
Total	**132.9**	**138.0**	**4.2**	**0**	**4.3**	**3.5**	**141.4**	**141.5**	**282.9**	**411**	**14,505**	**240,202**	**0.2%**	**6.0%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS wildlife damage management occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.4.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.

2 A population estimate is provided for each county based on the methods described in detail in Appendix C5. The lower population estimate described in Appendix C5 is used here to provide the most conservative effects analysis.

3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.

4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.

5 Estimates of lethal WDM under the Proposed Project and cumulative mortality were not rounded up to the next integer for San Francisco County due to the low population estimate. Rounding up these numbers would have resulted in inaccurately high estimates compared to the population.

6 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.

7 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.5 Red Fox

Red fox is a fur bearing mammalian species regulated under CFGC Section 4000. Red foxes can be found in a variety of habitats including lowland valleys, farmlands, semi-desert terrain, coastal wetlands, and urban areas (CWHR 2022). California is home to two native red fox subspecies, the Sierra Nevada red fox (*Vulpes vulpes necator*) and the Sacramento Valley red fox (*Vulpes vulpes patwin*) (CDFW 2022a), as well as the non-native red fox (*Vulpes vulpes*) which have been introduced both purposely (for hunting) and inadvertently (from fur farms) over the years (Lewis *et al.* 1999).

Non-native red foxes have expanded their range exponentially throughout California over the last 100 years as shown in the increase in distribution across counties within the state: 5 counties in 1937 (Grinnell *et al.* 1937), 17 counties in 1975 (Gray 1975), 36 counties in 1993 (Lewis *et al.* 1993), and 46 counties based on the most currently available data (CWHR 2022). Captive breeding of red foxes for pelts during the 1920s to the 1940s likely accounts for the widespread distribution of the species across the State of California (Lewis *et al.* 1999). The non-native red fox populations are not part of the natural fauna of California and are therefore not considered in this analysis. Lethal removal of non-native red fox does not have the potential to negatively impact native wildlife species in California.

The federally endangered and state threatened Sierra Nevada Distinct Population Segment (DPS) of the Sierra Nevada red fox is only found in subalpine habitat near the Sonora Pass within Tuolumne, Mono, Alpine, Madera, Fresno, and Inyo Counties (USFWS 2021). The population size for the Sierra Nevada DPS is estimated to be approximately 18 to 39 individuals (USFWS 2021). The state threatened Southern Cascades DPS of Sierra Nevada red fox is presumed to be extant within Shasta, Lassen, Plumas, and Tehama Counties and extirpated from the historical Cascade Range within northern California (USFWS 2015; CDFW 2022g). The population size for the Southern Cascades DPS is estimated to be approximately 42 adults (USFWS 2015). WDM activities have the potential to incidentally capture a non-target Sierra Nevada red fox if conducted within the subspecies' range (T. Felix, pers. comm. 2022b; CDFG 2005). The Sierra Nevada Red Fox is not targeted during WDM in California due to its protected status (State Threatened and Federal Endangered in the Sierra Nevada Distinct Population Segment (86 FR 41743; CDFW 2022a). WDM activities targeting other mesopredators have the potential to incidentally capture a non-target Sierra Nevada Red Fox if such activities are performed within the subspecies' range. As such, limitations have been placed on WDM methods by CDFW and USFWS within the range of this subspecies which render incidental take extremely unlikely (e.g., 14 CCR 465.5, CDFG 2005; CDFW 2016b; USFWS 2022). Because no Sierra Nevada red fox has even been taken by WS-California for WDM, and because there appears to be no potential for future lethal take of Sierra Nevada red fox from WDM given the limitations places by CDFW and USFWS, there is no potential for impact to this subspecies from WDM in California.

The Sacramento Valley red fox has been recognized as a subspecies by USFWS (80FR60990) but has not been assessed as a candidate under FESA. The State of California has designated the subspecies a "special animal" which is not a legal status designation under CESA but instead means it is tracked by the CDFW California Natural Diversity Database for conservation reasons (CDFW 2022a). This subspecies appears to have a limited population (Sacks *et al.* 2010a; Sacks *et al.* 2010b; Black *et al.* 2018), but because it has no special status under any state or federal law or regulation, the subspecies is currently managed in the same manner as non-native red fox in California.

The Sacramento Valley red fox (*Vulpes vulpes patwin*) occurs within the Sacramento Valley in portions of Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Placer, Sacramento, Solano, Yolo, and Yuba Counties according to the range published by Sacks *et al.* (2010a, 2010b). However, three of these counties (Sacramento, Placer, and Yuba) have been eliminated from this analysis because no genetically distinct Sacramento Valley red fox have ever been reported from these counties in the published literature. All published occurrences of red fox in Placer, Sacramento, and Yuba Counties have been either non-natives or hybrids between native and non-native red fox, rather than Sacramento Valley red fox. Because one of the primary threats to the native species is hybridization with non-natives and the resulting dilution of the native genes (Sacks *et al.* 2010; Black *et al.* 2018), any lethal removal of non-native or hybrid red foxes would benefit the Sacramento Valley red fox subspecies. Therefore, these counties were not included in the analysis for Sacramento Valley red fox.

Sacramento Valley red fox is generally associated with grasslands and is known to avoid flooded agriculture and wetlands (Sacks *et al.* 2010a; Sacks *et al.* 2010b). Based on the genetic evidence provided in Sacks *et al.* (2010a, 2010b), it was determined that this subspecies is native and related to the Sierra Nevada red fox (CDFW 2022a). However, this subspecies currently has no legal protection under state or federal law and therefore WDM activities do not distinguish between the Sacramento Valley red fox and the non-native species (CDFW 2022a). The genetic effective population size of the Sacramento Valley red fox is estimated to be between 50 and 80 breeding individuals and evidence suggests that the population is declining (Sacks *et al.* 2010a; Sacks *et al.* 2010b). Based on the CDFW habitat modeling for red fox provided in Appendix C6, the estimated population size for the counties where the Sacramento Valley red fox could occur (i.e., Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Solano, and Yolo) is 228 individuals. However, this population estimate may include both Sacramento Valley red fox individuals and non-native red fox individuals since there is known geographical overlap between the non-native and native subspecies.

While the non-native population of red fox has the ability to overlap and hybridize with the Sacramento Valley red fox, mitochondrial DNA (mtDNA) and nuclear marker DNA studies indicate that non-native foxes have not colonized the Sacramento Valley red fox native range and there is high reproductive and spatial separation between these two fox populations (Perrine *et al.* 2007; Sacks *et al.* 2010a). In Sacks *et al.* (2010a), not a single pure non-native red fox was detected in the Sacramento valley and 98% of the mtDNA haplotypes and 96% of genomic composition in the Sacramento Valley red fox population were native (Sacks *et al.* 2010a). Additionally, 100% mtDNA haplotypes and 99% genomic composition outside the Sacramento Valley were non-native (Sacks *et al.* 2010a). There also appears to be a very narrow hybridization zone, which seems to have remained relatively stationary for more than 40 years along Interstate-80 (Sacks *et al.* 2010a; Sacks *et al.* 2010b; Perrine *et al.* 2007). Perrine *et al.* (2007) also found that the Sacramento Valley red fox was genetically distinct from the other two recently founded lowland populations and that haplotypes found among lowland foxes strongly suggest no to little integration (either interbreeding or founders) of the Sacramento Valley foxes with other lowland fox populations. Taken together, these results indicate virtually no overlap between the non-native red fox and the Sacramento Valley red fox. Sacks *et al.* (2010a) suggest there is no evidence that the native range of Sacramento Valley red fox was reduced via encroachment by the non-native red fox. Maps of the Sacramento Valley fox, non-native red fox, and the hybridization zone indicate that managers could roughly use the latitudinal separation between the native (north) and nonnative (south) population corresponding approximately to the San Francisco Bay-Delta Estuary and American River and/or Interstate-80 (Figure 1b in Sacks *et al.* 2010a). It should be noted that these studies are over 10 years old, and much land use change has occurred so the amount of separation may have changed. If these studies are still accurate, lethal take north of these markers are likely to be Sacramento Valley red fox and anything south of these markers non-native red fox.

No long-term sustainable harvest estimate is available for the Sacramento Valley red fox subspecies. However, numerous estimates are available at the species level. Layne and McKeon (1956) and Davis (1974) reported sustainable harvest levels between 64% and 76%. More recently, Frederic (2020) identified sustainable harvest at greater than 35% in European red fox, which is the same species, *Vulpes vulpes*. More locally, Harding *et al.* (2001) determined that removal of 50% of adult and 25% of juvenile red foxes was the tipping point between a stable and declining managed non-native red fox population in central California. Additionally, they found that adult survivorship had little effect on long-term population growth and that control of population needed to focus on juveniles and immigrant animals. For this analysis we will use the lowest reported sustainable harvest rate for the species: 25%. Using this lowest reported rate should provide a conservative assessment of the potential for impact to red fox populations in California. However, we have little information regarding the ability of the Sacramento Valley red fox subspecies to withstand harvest or other mortality. Moreover, the subspecies appears to have a very limited population (Sacks *et al.* 2010a; Black *et al.* 2018). Still, without any more specific information for the Sacramento Valley red fox subspecies, we will use the best information available for the red fox species. The 25% threshold is expected to be conservative because this was reported only for juveniles, whereas the threshold for adult red fox was 50% (Harding *et al.* 2001).

3.2.5.1 Previous Wildlife Damage Management

Because effects on non-native species are not considered in this analysis, the discussion herein only includes the counties where existing lethal WDM for the non-native red fox overlaps the range for the native Sacramento Valley red fox subspecies (i.e., Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Solano, and Yolo Counties). As stated in the Section 3.2.5, none of the WDM activities occurred within the range of the Sierra Nevada red fox. Therefore, the Sierra Nevada red fox subspecies is not included in this discussion.

WDM for red fox within the range of the Sacramento Valley red fox comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 4.2 red foxes were killed, 0.1 individuals were freed, and 0.1 individuals underwent a transfer of custody per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 4.4 individuals per year.[18] Whereas some or all of these foxes might have been non-native or hybrid red fox, subspecies-level identification, which requires genetic analysis, was not conducted. Consequently, we take the most conservative approach by assuming that all take within this range was the Sacramento Valley red fox subspecies. Some take within these counties was eliminated from this list when the exact location was recorded and determined outside of the subspecies' range. This amounted to a total of 13 red foxes from Solano County during the 10-year baseline period (USDA 2022). WS-California MIS baseline WDM for red fox occurred within four counties across the state with averages ranging from 0.1 to 3.2 individuals per year; most baseline WS-California WDM (90.5%, or 3.8 individuals) occurred within Colusa and Sutter County. Lethal take of red fox accounts for 95.5% (4.2 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 4.5% (0.2 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-6) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources

[18] Average includes activities that both intentionally and unintentionally affect red fox and all potential WDM methods used by WS-California.

expected in each county (T. Felix, pers. comm. 2022a). During the 10-year baseline period, statewide lethal take of red fox is estimated at 5.5 individuals annually. This total is comprised of the WS-California lethal take of 4.2 individuals per year and the non-WS-California estimates for lethal take of 1.3 individuals per year (Table 3-6). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 228 individuals. The population estimate for each county is provided in Table 3-6. Approximately 2.4% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide red fox take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For red fox, the average is 54.0,[19] the standard deviation is 10.73, and the 99% confidence high estimate is 81.68, which we rounded up to 82 individuals. The 99% Confidence Factor for red fox was 82/54.0 = 1.52. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.5.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of red fox under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 9 red foxes taken annually, which represents 4.0% of the population. The statewide modeled low population estimate for this species is approximately 228 individuals (Appendix C6). The population estimate for each county is provided in Table 3-6. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 13.5% (5 individuals of 37 individuals estimated in the Colusa County population). These numbers are all well below the sustainable harvest threshold of 25% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 9. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 9 individuals. The maximum number of red foxes taken by county-level programs are listed for each county in Table 3-6, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

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19 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-6. This small amount of error was accepted for this calculation.

Red foxes are considered mesopredators (Prugh *et al.* 2009) and are known to coexist with other mesopredators such as gray foxes, kit foxes, and coyotes in lowland California (CWHR 2022). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (e.g., trophic cascade, etc.) (Roemer *et al.* 2009). *et al.*

Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal WDM to Sacramento Valley red foxes are not anticipated due to the percentage of Sacramento Valley red foxes impacted by the Project regionally, statewide, and cumulatively is below the sustainable harvest threshold of 25%. Furthermore, it was assumed that all WDM take occurred to the Sacramento Valley subspecies; however, it is likely that at least some or potentially all of the foxes killed might would be non-native red fox. Subspecies-level identification, which requires genetic analysis, was not conducted.

3.2.5.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The non-native red fox has been documented throughout California adversely effecting special-status species such as ground-nesting birds (e.g., California Ridgway's rail, California least tern, snowy plover) and rodents (e.g., salt marsh harvest mouse), and also outcompeting and displacing other mammalian species (e.g., San Joaquin kit fox) (Jurek 1992; see Table 1 in Lewis *et al.* 1999; Ralls and White 1995). The non-native red fox often poses a threat to native species by disrupting the natural predator-prey relationship, particularly in ecosystems already under stress from human-related activities (Jurek 1992). Interbreeding of the non-native red fox with the listed Sierra Nevada DPS red fox has been documented (USFWS 2021). In 2012, two non-native male red foxes immigrated into the Sierra Nevada DPS population (USFWS 2021). Interbreeding is of concern for species conservation, as hybridization may affect fitness (i.e., can potentially lower survivorship or reproductive success by interfering with adaptive native genes or gene complexes) and range expansion of the non-native red fox could increase competition and disease transmission. Relatively local hybridization between the native Sacramento Valley red fox and the non-native red fox has been observed within a relatively small portion of the native population and is considered the most immediate threat to that native Sacramento Valley red fox population (Sacks *et al.* 2010a; Sacks *et al.* 2010b). Non-native red foxes can also pose a threat to human health through transmission of disease, typically through transmission of rabies to their pets (Lewis *et al.* 1999). Removal of this non-native species under WDM activities could result in a net benefit to native sub-species populations (e.g., increased survival rates) and restore balance to natural predator-prey relationships.

3.2.5.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-6). It should be noted that both the Proposed Project activities and legal trapping and hunting policies do not differentiate between non-native red fox and the Sacramento Valley red fox.

Other anthropogenic factors that can affect red fox are habitat loss from development and climate change, and disruption by human activities such as conversion of native grasslands to agricultural lands and farming activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in red fox quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase red fox mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of red fox in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

CFGC Section 4152 historically stated (i.e., during the Project's 10-year baseline period) that red fox, that are not the native Sierra Nevada red fox subspecies, found to be taking livestock or damaging property may be taken at any time or in any manner. There are no trapping or hunting data for red fox collected by CDFW. In absence of that information, we estimate that hunter take of gray fox (1.8% of the population) is similar, or 4.1 individuals per year based on a population of 228 Sacramento Valley red fox.

The number of red foxes killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available red fox roadkill data in California. Therefore, we estimated red fox mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (for mountain lion, see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 4% statewide, variable by county); hunter and trapper harvest (estimated from gray fox harvest of 1.8%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-6. When all values are rounded up to provide a conservative estimate, cumulative mortality was 12.7% statewide and ranged from 7.7% to 21.6% by county. Lethal WDM under the Proposed Project would be responsible for a maximum of 31% (9 of 29 individuals) of cumulative anthropogenic mortality statewide in a year of maximum take. The county with the highest cumulative mortality and highest percentage of cumulative mortality is Colusa County (8 individuals, 21.6% of the county population). Maximum lethal WDM under the Proposed Project would contribute 63% of this cumulative mortality (5 of 8 individuals). Maximum cumulative mortality estimates for red fox statewide and in each county are all below the conservative 25% sustainable harvest threshold estimated above. These data are presented in Table 3-6.

Table 3-6. Red Fox Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate [3]	Low Population Estimate[4]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take[1]	Non-WS Lethal Take Estimate[1]	WS Lethal Take[1]	Non-WS Lethal Take Estimate[1]	WS Lethal Take[1]	Non-WS Lethal Take Estimate[1]	WS Lethal Take[1]	Non-WS Lethal Take Estimate[1]	Total[1]	Proposed Project Max Annual Lethal Take Estimate[2]				
BUTTE	0.3	0	0	0	0	0	0.3	0	**0.3**	1	3	29	3.4%	10.3%
COLUSA	3.2	0	0	0	0	0	3.2	0	**3.2**	5	8	37	13.5%	21.6%
GLENN	0	0.8	0	0	0	0	0	0.8	**0.8**	2	4	34	6.0%	11.8%
SHASTA	0	0	0	0	0	0	0	0	**0**	0	2	18	0%	11.1%
SOLANO	0.1	0	0	0	0	<0.1	0.1	<0.1	**0.1**	1	3	18	5.5%	16.7%
SUTTER	0.6	0	0	0	0	0	0.6	0	**0.6**	1	3	32	3.1%	9.4%
TEHAMA	0	0.5	0	0	0	0	0	0.5	**0.5**	1	3	21	4.9%	14.3%
YOLO	0	0	0	0	0	0	0	0	**0**	0	3	39	0%	7.7%
Total	**4.2**	**1.3**	**0**	**0**	**0**	**<0.1**	**4.2**	**1.3**	**5.5**	**9**	**29**	**228**	**4.0%**	**12.7%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 All known and estimated numbers are for red fox (*Vulpes vulpes*) within the counties known to contain Sacramento Valley red fox (*Vulpes vulpes patwin*) as well as non-native red fox and potentially hybrids between the native and non-native red fox. Because the Sacramento Valley red fox subspecies cannot be reliably distinguished from non-native red fox or native-non-native hybrids without genetic analysis, it is unknown how much, if any, of this take was Sacramento Valley red fox. Because we cannot be certain, we include all take in these counties, only portions of which contain Sacramento Valley red fox.

2 Lethal take of non-native and hybrid red fox is expected to continue in these counties; these numbers are not reflected in the table because they have no potential to impact native red fox populations in California. Refer to Section 3.2.5.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.

3 Cumulative lethal take estimates are always rounded up, typically resulting in an estimated percentage greater than the component factors.

4 A population estimate is provided for each county based on the methods described in detail in Appendix C6. The lower population estimate described in Appendix C6 is used here to provide the most conservative effects analysis.

3.2.6 Long-Tailed Weasel

The long-tailed weasel is a carnivorous non-game mammal regulated under CFGC Section 4000. It is a widespread species that occurs in most habitats, except xeric brush, shrub, and scrub in the Mojave and Colorado deserts (CWHR 2022). Long-tailed weasels use coniferous and deciduous habitats interspersed with open forests, and woodland areas from sea level to alpine meadows. This species feeds largely on small mammals such as rodents but also eats birds, insects, and salamanders (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Long-tailed weasel is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for long-tailed weasel provided in Appendix C7, the estimated population size for California is 95,685 individuals. Also included in Appendix C7 are the population estimates of long-tailed weasel within each county.

CDFW has not established sustainable harvest levels for long-tailed weasel and the California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Long-term sustainable harvest rates were reported by Banci and Proulx (1999) to be between 10% and 25% for long-tailed weasels. For this analysis we will use the lowest reported sustainable harvest of 10% as a conservative estimate.

3.2.6.1 Previous Wildlife Damage Management

WDM for long-tailed weasel comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 6.8 long-tailed weasels were killed and 0.3 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 7.1 individuals per year based on the WS-California MIS data from 2010 to 2019 (average includes activities that both intentionally and unintentionally affect long-tailed weasel and all potential methods used during WDM activities). WS-California WDM for long-tailed weasel occurred within three counties within the state with averages of 0.1 (Lake County), 0.9 (Ventura County), and 5.8 (San Diego County) individuals per year. Lethal WDM of long-tailed weasel accounts for 95.8% (6.8 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 4.2% (0.3 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-7) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of long-tailed weasel is estimated at 9 individuals annually. This total is comprised of the WS-California lethal take of 6.8 individuals per year and the non-WS-California estimates for lethal take of 2.2 individuals per year (Table 3-7). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 95.685 individuals. The population estimate for each county is provided in Table 3-7. Less than 0.1% (of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide long-tailed weasel take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For long-tailed weasel, the average is 6.80,[20] the standard deviation is 4.29, and the 99% confidence high estimate is 17.87, which we rounded up to 18 individuals. The 99% Confidence Factor for long-tailed weasel was 18/6.80 = 2.65. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.6.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of long-tailed weasel under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 71 long-tailed weasels taken annually, which represents 0.07% of the population. The statewide modeled low population estimate for this species is approximately 95,685 individuals (Appendix C7). The population estimate for each county is provided in Table 3-7. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from <0.1% (several counties) to 2.6% (1 individual of 39 estimated county population; San Francisco County). These numbers are all well below the sustainable harvest threshold of 10% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 71. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 71 individuals. The maximum number of long-tailed weasels taken by county-level programs are listed for each county in Table 3-7, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Long-tailed weasels are considered mesopredators (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). For example, as major predators of voles and mice, long-tailed weasel populations respond to small mammal population numbers (CWHR 2022). However, the Project’s lethal WDM of long-tailed weasels is not expected to result in indirect impacts to ecosystem function,

[20] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-7. This small amount of error was accepted for this calculation.

structure, or dynamics due to the very low percentage of long-tailed weasels taken regionally and statewide (less than 0.1% annually).

3.2.6.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for long-tailed weasel predation to natural resources in California, including special-status species. As such, removal of this species under WDM activities would result in no known benefit to natural biological resources.

3.2.6.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-7).

Other anthropogenic factors that can affect long-tailed weasels are habitat loss from development and climate change, and disruption by human activities such as agricultural activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in long-tailed weasels quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, , (2) these effects are not expected to significantly increase long-tailed weasel mortality in the near future, and (3) a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of long-tailed weasels in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project). This species occupies a wide range of habitats and is tolerant of rural human presence (Tremor *et al.* 2017); therefore, it may benefit from food subsidies (increased rodent populations) in rural-residential and agricultural areas.

The California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). The 2010-2019 average trapping data were used to estimate future trapping harvest. The 10-year average statewide was 1 weasel per year (CDFW 2020), which is <0.01% of the estimated population. Trapping only occurred in Colusa County (7 individuals).

The number of long-tailed weasels killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available long-tailed weasel roadkill data in California. Therefore, we estimated long-tailed weasel mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.07%); trapper harvest (0.01% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-7. Cumulative mortality was 3.8% statewide and ranged from 3.8% to 5.1% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.5% (18 of 3,655 weasels) of estimated cumulative anthropogenic mortality statewide. Maximum cumulative mortality estimates for long-tailed weasel statewide and in each county are all well below the conservative 10% sustainable harvest threshold estimated above.

Table 3-7. Long-Tailed Weasel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide.

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	24	612	0.2%	3.9%
ALPINE	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	23	581	0.2%	4.0%
AMADOR	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	20	502	0.2%	4.0%
BUTTE	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	43	1,114	<0.1%	3.9%
CALAVERAS	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	34	883	0.1%	3.9%
COLUSA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	27	667	0.2%	4.0%
CONTRA COSTA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	24	610	0.2%	3.9%
DEL NORTE	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	34	875	0.1%	3.9%
EL DORADO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	56	1,446	<0.1%	3.9%
FRESNO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	160	4,204	<0.1%	3.8%
GLENN	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	34	885	0.1%	3.8%
HUMBOLDT	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	118	3,095	<0.1%	3.8%
IMPERIAL	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	5	105	1.0%	4.8%
INYO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	57	1,477	<0.1%	3.9%
KERN	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	183	4,788	<0.1%	3.8%
KINGS	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	41	1,067	<0.1%	3.8%
LAKE	0.1	0	0	<0.1	0	0	0.1	<0.1	**0.1**	1	42	1,095	<0.1%	3.8%
LASSEN	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	151	3,957	<0.1%	3.8%
LOS ANGELES	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	102	2,662	<0.1%	3.8%
MADERA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	60	1,567	<0.1%	3.8%
MARIN	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	17	441	0.2%	3.9%
MARIPOSA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	48	1,243	<0.1%	3.9%
MENDOCINO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	117	3,061	<0.1%	3.8%
MERCED	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	52	1,355	<0.1%	3.8%
MODOC	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	130	3,393	<0.1%	3.8%
MONO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	91	2,379	<0.1%	3.8%
MONTEREY	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	110	2,870	<0.1%	3.8%
NAPA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	24	602	0.2%	4.0%
NEVADA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	31	808	0.1%	3.8%
ORANGE	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	27	682	0.2%	4.0%
PLACER3	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	46	1,184	<0.1%	3.9%
PLUMAS	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	85	2,215	<0.1%	3.8%
RIVERSIDE	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	94	2,468	<0.1%	3.8%
SACRAMENTO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	32	813	0.1%	3.9%
SAN BENITO4	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	46	1,205	<0.1%	3.8%
SAN BERNARDINO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	55	1,421	<0.1%	3.9%

Table 3-7. Long-Tailed Weasel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	5.8	<0.1	0	0	5.8	<0.1	**5.8**	12	137	3,288	0.4%	4.2%
SAN FRANCISCO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	2	39	2.6%	5.1%
SAN JOAQUIN	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	38	991	0.1%	3.8%
SAN LUIS OBISPO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	109	2,845	<0.1%	3.8%
SAN MATEO	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	15	381	0.3%	3.9%
SANTA BARBARA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	90	2,343	<0.1%	3.8%
SANTA CLARA	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	43	1,111	<0.1%	3.9%
SANTA CRUZ	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	15	389	0.3%	3.9%
SHASTA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	125	3,266	<0.1%	3.8%
SIERRA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	32	828	0.1%	3.9%
SISKIYOU[5]	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	206	5,406	<0.1%	3.8%
SOLANO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	24	619	0.2%	3.9%
SONOMA[6]	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	52	1,361	<0.1%	3.8%
STANISLAUS	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	40	1,026	0.1%	3.9%
SUTTER	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	11	273	0.4%	4.0%
TEHAMA	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	96	2,497	<0.1%	3.8%
TRINITY	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	104	2,732	<0.1%	3.8%
TULARE	0	<0.1	0	<0.1	0	0	0	<0.1	**<0.1**	1	133	3,494	<0.1%	3.8%
TUOLUMNE	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	67	1,756	<0.1%	3.8%
VENTURA	0	<0.1	0.1	<0.1	0.8	0.2	0.9	0.2	**1.1**	3	60	1,501	0.2%	4.0%
YOLO	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	30	760	0.1%	3.9%
YUBA	0	0	0	<0.1	0	0	0	<0.1	**<0.1**	1	18	451	0.2%	4.0%
Total	**0.1**	**0.1**	**5.9**	**1.9**	**0.8**	**0.2**	**6.8**	**2.2**	**9.0**	**71**	**3,655**	**95,685**	**<0.1%**	**3.9%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.6.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C7. The lower population estimate described in Appendix C7 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.7 American Mink

American mink (*Mustela vison*) is a carnivorous fur-bearing mammal that occurs throughout the northern half of California (CFGC Section 4000) (CWHR 2022). American mink are semiaquatic, inhabiting most aquatic habitats and some coastal areas from elevations up to about 9,000 feet. This species feeds largely on crayfish, frogs, fish, mice, muskrats, and clams, but also eats birds, snakes, salamanders, and invertebrates (CWHR 2022). It uses existing cavities and burrows in wetland and riparian vegetation, reproducing in dens under trees and rocks near water. American mink is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for American mink provided in Appendix C8, the estimated population size for California is 2,383 individuals. Also included in Appendix C8 are the population estimates of American mink within each county.

Long-term sustainable harvest rates for mink were reported by Banci and Proulx (1999) to be no more than 25%, based on their level of "resilience" that considered their distribution, reproductive rate and dispersal rate. Therefore, a sustainable harvest rate of 25% is used in our analyses of potential impact on American mink populations.

3.2.7.1 Previous Wildlife Damage Management

WDM for American mink comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 0.1 American minks were killed and 3.6 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 3.7 individuals per year based on the WS-California MIS data from 2010 to 2019.[21] MIS baseline WDM for American mink occurred within one county. WS-California killed an average of less than 0.1 American mink per year in Placer County. Lethal WDM of American mink accounts for 2.7% (0.1 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 97.3% (3.6 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-8) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of American mink, including both the WS-California MIS data and non-WS-California estimates, is estimated at 0.44 individuals annually. This total is comprised of the WS-California lethal take of 0.2 individuals per year and the non-WS-California estimates for lethal take of 0.24 individuals per year (Table 3-8). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 2,383 individuals. The population estimate for each county is provided in Table 3-8. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

21 Average includes activities that both intentionally and unintentionally affect American mink and all potential methods used during WDM activities.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide American mink take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For American mink the average is 3.7,[22] the standard deviation is 8.65, and the 99% confidence high estimate is 26.03, which we rounded up to 27 individuals. The 99% Confidence Factor for American mink was 27/3.7 = 7.3. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.7.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of American mink under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 39 American mink individuals taken annually, which represents 1.64% of the population. The statewide modeled low population estimate for this species is approximately 2,383 individuals (Appendix C8). The population estimate for each county is provided in Table 3-8. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 12.4% (1 individual of 8 estimated county population; Lake County). These numbers are all well below the sustainable harvest threshold of 25% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 39. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 39 individuals. The maximum number of American mink taken by county-level programs are listed for each county in Table 3-8, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

American mink is considered a mesopredator (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (e.g., trophic cascade, etc.) but do not typically fill the role of keystone species in an ecosystem because multiple mesopredators are present in most ecosystems (Roemer *et al.* 2009). American mink can at times influence prey population numbers, especially muskrats (CWHR 2022). However, the Project’s lethal WDM of American mink is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the very low percentage of American mink taken regionally (ranging from <0.1% to 12.4% by county) and statewide (1.64%).

22 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-8. This small amount of error was accepted for this calculation.

3.2.7.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for American mink predation to special-status species in California. As such, removal of this species under WDM activities would result in no known benefit to natural biological resources.

3.2.7.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-8).

Other anthropogenic factors that can affect American mink are habitat loss from development and climate change, and disruption by human activities such as timber harvest or agricultural activities affecting aquatic areas used for foraging. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in American mink because (1) the effects are difficult or impossible to quantify, (2) these effects are not expected to significantly increase American mink mortality in the near future, and (3) a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c).

American mink cannot be commercially or recreationally trapped for fur in most cases but can be legally trapped by the public under some conditions with a valid CDFW hunting license (California AB 273, 09/04/2019). Mink are not hunted in California so there are no hunter harvest data, but we analyzed trapping harvest of mink during the analysis period (CDFW 2020; excluding 2020 and 2021 data which are potentially confounded by behavioral changes due to COVID-19). American mink trapping harvest is likely to be much lower after the fur trapping ban (AB 273) took effect in 2019. However, to be conservative we will use the 2010-2019 average to estimate future trapping harvest. The 10-year average statewide was 8.1 mink per year, and averages varied by county from zero individuals (numerous counties) to 2.8 individuals per year (Shasta County) (CDFW 2020). As a percentage of the estimated mink population in Shasta County, this equates to 6.2%. These averages statewide and by county were added to all other known and estimated anthropogenic mortality to estimate cumulative anthropogenic mortality.

The number of American mink individuals killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available American mink roadkill data in California. Therefore, we estimated American mink mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

The final source of anthropogenic mortality we estimated was more general: other anthropogenic mortality, which includes illegal harvest (poaching), accidental poisoning, and other unknown sources of intentional and unintentional mortality. Because there are so many unknowns in this category, we used the highest estimate of this "other" mortality, which was 2.6% for mountain lion (Section 3.2.24) as a conservative estimate.

Cumulative anthropogenic mortality is estimated at 101 individuals statewide (4.2% of the statewide population). Maximum lethal WDM under the Proposed Project would contribute 2.0% of that cumulative mortality (2 of 101 individuals; Table 3-8). At the county level, cumulative mortality ranged from zero to 13.2% of the county populations. The highest cumulative mortality under the Proposed Project is in Merced County, which includes up to 14 mink or 4.2% of the population. Maximum lethal WDM under the Proposed Project would contribute only 7% of that cumulative mortality (1 of 14 individuals; Table 3-8). The highest cumulative mortality as a percentage of the population is in Shasta County: 6 individuals or 13.2% of the population. Lethal WDM under the Proposed Project would contribute 17% of that cumulative mortality (1 of 6 individuals; Table 3-8). All cumulative mortality of American mink statewide and in each county is well below the sustainable harvest threshold of 25% estimated above.

Table 3-8. American Mink Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	2	41	2.4%	4.8%
AMADOR	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	12	8.3%	8.3%
BUTTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	7	156	0.6%	4.5%
CALAVERAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	12	8.3%	8.3%
COLUSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	6	145	0.7%	4.1%
CONTRA COSTA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	23	4.3%	4.3%
DEL NORTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	4	93	1.1%	4.3%
EL DORADO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	24	4.1%	4.1%
FRESNO[3]	0	0	0	0	0	0	0	0	**0**	0	0	1	0%	0%
GLENN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	4	85	1.2%	4.7%
HUMBOLDT	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	6	144	0.7%	4.2%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
INYO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	25	4.0%	4.0%
KERN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
KINGS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LAKE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	8	12.4%	12.4%
LASSEN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	2	35	2.8%	5.7%
LOS ANGELES	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MADERA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	20	5.0%	5.0%
MARIN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	22	4.5%	4.5%
MARIPOSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	17	5.8%	5.8%
MENDOCINO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	21	4.7%	4.7%
MERCED	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	14	336	0.3%	4.2%
MODOC	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	2	24	4.1%	8.3%
MONO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	5	118	0.8%	4.2%
MONTEREY	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
NAPA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	2	42	2.4%	4.7%
NEVADA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	1	17	5.8%	5.8%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
PLACER[4]	0.2	0	0	0	0	0	0.2	0	**0.2**	2	5	48	4.1%	10.3%
PLUMAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	3	64	1.6%	4.7%
RIVERSIDE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SACRAMENTO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	3	55	1.8%	5.5%
SAN BENITO[5]	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN BERNARDINO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%

Table 3-8. American Mink Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN JOAQUIN	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	2	51	2.0%	4.0%
SAN LUIS OBISPO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN MATEO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA CLARA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA CRUZ	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SHASTA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	5	45	2.2%	11.0%
SIERRA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	1	18	5.5%	5.5%
SISKIYOU[6]	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	3	38	2.6%	7.8%
SOLANO	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	9	195	0.5%	4.6%
SONOMA[7]	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	2	42	2.4%	4.7%
STANISLAUS	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	2	39	2.5%	5.1%
SUTTER	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	5	92	1.1%	5.4%
TEHAMA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	4	81	1.2%	5.0%
TRINITY	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	1	14	7.1%	7.1%
TULARE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
TUOLUMNE	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	2	39	2.5%	5.1%
VENTURA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
YOLO	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	5	96	1.0%	5.2%
YUBA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	2	45	2.2%	4.4%
Total	**0.2**	**0.24**	**0**	**0**	**0**	**0**	**0.2**	**0.2**	**0.4**	**39**	**119**	**2,383**	**1.64%**	**5.0%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.1.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C8. The lower population estimate described in Appendix C8 is used here to provide the most conservative effects analysis.
3 Cumulative mortality estimate for Fresno County was not rounded up because the estimate was only 0.04 mink per year due to the low population estimate (1 mink). This cumulative mortality estimate was rounded down to zero because no anthropogenic mortality of mink is expected in this county.
4 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
5 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
6 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
7 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.8 Raccoon

The raccoon is a fur-bearing mammal widespread throughout California (CFGC Section 4000) (CWHR 2022). This species occurs most abundantly in riparian and wetland areas at low to middle elevations, inhabiting all except alpine habitats and desert types without water. They are omnivorous and highly opportunistic, changing diet seasonally and frequently feeding in both urban and agricultural areas (CWHR 2022). It uses existing cavities in trees, snags, logs, and rocky areas for dens and other cover. Raccoon is considered a species of “Least Concern” by IUCN, and their global population is reported to be increasing (IUCN 2022). Based on the CDFW habitat modeling for raccoons provided in Appendix C9, the estimated population size for California is 2,557,065 individuals. Also included in Appendix C9 are the population estimates of raccoons within each county.

Sanderson (1999) reported sustainable harvest rates of 49%, 53%, and 59% for raccoon populations with low, medium, and high fecundity, respectively. Rosatte (2000) found no reduction in raccoon populations with removal of nuisance animals ranging from 12% to 29% of the population; this equates to a sustainable harvest rate of at least 29%; however, Rosatte (2000) did not attempt to find the actual threshold for sustainable harvest. For this analysis, we will use the lowest reported harvest rate (49%) as a conservative estimate.

3.2.8.1 Previous Wildlife Damage Management

WDM for raccoon comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 2,071.1 raccoon were killed, 18.2 individuals were dispersed, 49.9 individuals were freed, 0.4 individuals were relocated, and 1.8 individuals underwent a transfer of custody per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 2,141.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[23] MIS baseline WDM for raccoon occurred within 47 counties within the state with averages ranging from 1 to 339.8 individuals per year. Most WS-California WDM activities (30.5%, or 632.6 individuals) occurred within Placer and San Luis Counties. Lethal WDM of raccoon accounts for 96.7% (2,071.1 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 3.3% (70.3 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-9) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a). During the 10-year baseline period, statewide lethal take of raccoon, is estimated at 3,295 individuals annually. This total is comprised of the WS-California lethal take of 2,071.1 individuals per year (62.9%) and the non-WS-California estimates for lethal take of 1,223.9 individuals per year (37.1%) (Table 3-9). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 2,557,065 individuals. The population estimate for each county is provided in

23 Average includes activities that both intentionally and unintentionally affect raccoon and all potential methods used during WDM activities.

Table 3-9. Approximately 0.1% (3,295 individuals) of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide raccoon take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For raccoon, the average is 1,926,[24] the standard deviation is 585, and the 99% confidence high estimate is 3,435.31, which we rounded up to 3,436 individuals. The 99% Confidence Factor for raccoon was 3,436/1,926 = 1.78. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.8.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of raccoon under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 5,892 raccoons taken annually, which represents 0.2% of the population. The statewide modeled low population estimate for this species is approximately 2,557,065 individuals (Appendix C9). The population estimate for each county is provided in Table 3-9. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from <0.1% (several counties) to 1.4% (607 individuals of 43,252 estimated county population; San Luis Obispo County). These numbers are all well below the sustainable harvest threshold of 49% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 5,892. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 5,892 individuals. The maximum number of raccoons taken by county-level programs are listed for each county in Table 3-9, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Raccoons are considered mesopredators (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). However, the Project's lethal WDM of raccoon is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the low percentage

[24] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-9. This small amount of error was accepted for this calculation.

of raccoons taken regionally (ranging from 0.1% to 1.4% of county-level estimated populations) and statewide (0.23% of the statewide population.

3.2.8.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

Raccoon has been documented throughout California adversely affecting special-status species including the federal and state-listed California least tern, as well as the federal-listed and California Species of Special Concern snowy plover. MIS baseline data (2010–2019) on raccoon predation of California least tern has been documented in San Diego County, while raccoon predation of snowy plover has been documented in San Luis Obispo County. Raccoon is a known mammalian predator of snowy plover in San Francisco Bay (SFBO and USFWS 2007). Further, California least tern breeding surveys conducted in 1996 throughout California determined nesting disturbance from raccoons may attribute to increased mortality at San Elijo Lagoon in San Diego, and observed raccoon predation of California least tern at Mussel Rock Dunes in Santa Barbara (Caffrey 1998). As such, removal of this species under WDM activities may result in a net benefit to special-status avian species (e.g., increased survival rates).

3.2.8.4 Potential Cumulative Effects to the Species

Cumulative effects to this species are limited, as raccoons readily adapt to human development and may benefit from the food subsidies that are available in and near cities (CWHR 2022). Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-9).

Other anthropogenic factors that can affect raccoon are habitat loss from development and climate change, and disruption by human activities that result in removal of dens or cover sites. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in raccoon quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase raccoon mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of raccoons in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Trapping of raccoons for fur is no longer legal in California for most trap types (California AB 273, 09/04/2019); therefore, the lethal removal of raccoons that has historically occurred under trapping licenses is not likely to contribute to cumulative mortality as of 2019. However, to be conservative in our analysis, and because future trapping take is uncertain, trapping data from 2010 through 2019 are included in cumulative take. Raccoon trapping harvest is likely to be much lower after the fur trapping ban (AB 273) took effect in 2019. However, to be conservative we will use the 2010-2019 average to estimate future trapping harvest. The 10-year average statewide was 281 individuals per year, which is 0.01% of the estimated population. Trapping data by county ranged from 0 individuals in multiple counties to 64 individuals in Alameda County (CDFW 2020). As a percentage of the estimated raccoon population in Alameda County, this equates to 0.2%. These averages statewide and by county were added to all other known and estimated anthropogenic mortality to estimate cumulative anthropogenic mortality.

The number of raccoons killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available raccoon roadkill data in California. Therefore, we estimated raccoon mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.23%); trapper harvest (0.2% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-9. Cumulative mortality was 4% statewide and ranged from 3.8% to 5.2% by county. Notably, 4.2% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 5.7% (5,892 of 103,343 individuals) of cumulative anthropogenic mortality statewide. The county with the highest percent of cumulative mortality is San Luis Obispo County with a total of 2,251 individuals (5.2% of the population). Maximum lethal WDM under the Proposed Project contributed 27% of this cumulative mortality (607 of 2,251 individuals). Maximum cumulative mortality estimates for raccoon statewide and in each county are all well below the conservative 49% sustainable harvest threshold estimated above. These data are presented in Table 3-9.

Table 3-9. Raccoon Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	101.8	0	34.0	1.2	7.0	5.3	142.8	6.5	**149.3**	266	1,832	39,342	0.7%	4.7%
ALPINE	0.2	0	0	1.2	0	0	0.2	1.2	**1.4**	3	358	9,340	<0.1%	3.8%
AMADOR	9.1	0	0	1.2	0	0	9.1	1.2	**10.3**	19	371	9,280	0.2%	4.0%
BUTTE	63.7	0	0	1.2	0.1	0.1	63.8	1.3	**65.1**	116	1,438	34,759	0.3%	4.1%
CALAVERAS	66.6	0	0	1.2	0	0	66.6	1.2	**67.8**	121	769	17,043	0.7%	4.5%
COLUSA	30.6	0	0	1.2	0	0	30.6	1.2	**31.8**	57	507	10,437	0.6%	4.9%
CONTRA COSTA	2.8	0	31.7	1.2	0	0	34.5	1.2	**35.7**	64	1,830	44,959	0.1%	4.1%
DEL NORTE	0	23.9	0	1.2	0	0	0	25.1	**25.1**	45	844	21,015	0.2%	4.0%
EL DORADO	190.0	0	0	1.2	0	0	190.0	1.2	**191.2**	341	1,875	40,354	0.9%	4.6%
FRESNO	0	105.9	0	1.2	0	0	0	107.1	**107.1**	191	3,735	93,235	0.2%	4.0%
GLENN	0	14.4	0	1.2	0	0	0	15.6	**15.6**	28	510	12,686	0.2%	4.0%
HUMBOLDT	45.0	0	0	1.2	0	0	45.0	1.2	**46.2**	83	2,637	67,184	0.1%	3.9%
IMPERIAL	2.2	0	0	1.2	0	0	2.2	1.2	**3.4**	7	634	16,469	<0.1%	3.8%
INYO	0	4.5	0	1.2	0	0	0	5.7	**5.7**	11	165	4,004	0.3%	4.1%
KERN	29.1	0	0.1	1.2	0	0	29.2	1.2	**30.4**	55	3,087	79,452	<0.1%	3.9%
KINGS	0	22.7	0	1.2	0.1	<0.1	0.1	23.9	**24.0**	43	804	20,024	0.2%	4.0%
LAKE	23.3	0	0	1.2	0	0	23.3	1.2	**24.5**	44	971	24,250	0.2%	4.0%
LASSEN	5.6	0	0	1.2	0	0	5.6	1.2	**6.8**	13	1,408	36,685	<0.1%	3.8%
LOS ANGELES	0	262.0	0	1.2	7.7	7.7	7.7	270.9	**278.6**	496	9,266	230,727	0.2%	4.0%
MADERA	9.0	0	0	1.2	0	0	9.0	1.2	**10.2**	19	1,239	32,113	<0.1%	3.9%
MARIN	4.7	18.6	0	1.2	0	0	4.7	19.8	**24.5**	44	667	16,398	0.3%	4.1%
MARIPOSA	43.4	0	0	1.2	0	0	43.4	1.2	**44.6**	80	933	22,422	0.4%	4.2%
MENDOCINO	41.3	0	0	1.2	0	0	41.3	1.2	**42.5**	76	2,521	64,098	0.1%	3.9%
MERCED	12.8	0	0	1.2	0.5	0.7	13.3	1.9	**15.2**	28	724	18,314	0.2%	4.0%
MODOC	5.4	0	0	1.2	0	0	5.4	1.2	**6.6**	12	1,348	35,127	<0.1%	3.8%
MONO	0	16.9	0	1.2	0	0	0	18.1	**18.1**	33	598	14,859	0.2%	4.0%
MONTEREY	0.8	0	0.1	1.2	0.1	<0.1	1.0	1.2	**2.2**	4	2,097	55,049	<0.1%	3.8%
NAPA	70.6	0	0	1.2	0	0	70.6	1.2	**71.8**	128	760	16,623	0.8%	4.6%
NEVADA	22.2	0	0	1.2	0	0	22.2	1.2	**23.4**	42	1,040	26,154	0.2%	4.0%
ORANGE	0	99.2	0	1.2	0	0	0	100.4	**100.4**	179	3,500	87,354	0.2%	4.0%
PLACER[3]	292.8	0	0	1.2	0	0	292.8	1.2	**294.0**	524	2,089	40,876	1.3%	5.1%
PLUMAS	18.9	0	0	1.2	0	0	18.9	1.2	**20.1**	36	1,700	43,728	<0.1%	3.9%
RIVERSIDE	0	152.3	0	1.2	0	0	0	153.5	**153.5**	274	5,368	134,062	0.2%	4.0%
SACRAMENTO	68.8	0	0	1.2	1.4	4.9	70.2	6.1	**76.3**	136	2,136	52,445	0.3%	4.1%
SAN BENITO[4]	28.7	0	0	1.2	0	0	28.7	1.2	**29.9**	54	576	13,654	0.4%	4.2%
SAN BERNARDINO	0	87.0	0	1.2	0	0	0	88.2	**88.2**	157	3,069	76,610	0.2%	4.0%

Table 3-9. Raccoon Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	20.6	0	40.0	1.2	1.2	1.8	61.8	3.0	**64.8**	116	6,606	170,768	<0.1%	3.9%
SAN FRANCISCO	3.7	7.4	0	1.2	0	0	3.7	8.6	**12.3**	22	268	6,475	0.3%	4.1%
SAN JOAQUIN	4.4	0	0	1.2	0	0	4.4	1.2	**5.6**	10	1,199	31,269	<0.1%	3.8%
SAN LUIS OBISPO	333.1	0	6.7	1.2	0	0	339.8	1.2	**341.0**	607	2,251	43,252	1.4%	5.2%
SAN MATEO	3.7	30.7	12.2	1.2	0	0	15.9	31.9	**47.8**	86	1,112	26,998	0.3%	4.1%
SANTA BARBARA	30.7	0	4.4	1.2	0	0	35.1	1.2	**36.3**	65	2,303	58,884	0.1%	3.9%
SANTA CLARA	0	66.5	37.9	1.2	3.1	1.7	41.0	69.4	**110.4**	197	2,422	58,541	0.3%	4.1%
SANTA CRUZ	0	25.1	0	1.2	0	0	0	26.3	**26.3**	47	893	22,141	0.2%	4.0%
SHASTA	2.7	0	0	1.2	0	0	2.7	1.2	**3.9**	7	2,949	77,187	<0.1%	3.8%
SIERRA	2.3	0	0	1.2	0	0	2.3	1.2	**3.5**	7	602	15,662	<0.1%	3.8%
SISKIYOU[5]	53.2	0	0	1.2	0	0	53.2	1.2	**54.4**	97	4,080	104,492	<0.1%	3.9%
SOLANO	3.9	0	33.0	1.2	0.6	<0.1	37.5	1.2	**38.7**	69	790	18,854	0.4%	4.2%
SONOMA[6]	4.3	0	0	1.2	0	0	4.3	1.2	**5.5**	10	1,433	37,403	<0.1%	3.8%
STANISLAUS	61.8	0	0	1.2	0	0	61.8	1.2	**63.0**	113	981	22,844	0.5%	4.3%
SUTTER	13.6	0	0	1.2	0	0	13.6	1.2	**14.8**	27	250	5,590	0.5%	4.5%
TEHAMA	0	45.6	0	1.2	0	0	0	46.8	**46.8**	84	1,612	40,148	0.2%	4.0%
TRINITY	1.6	0	0	1.2	0	0	1.6	1.2	**2.8**	5	2,272	59,560	<0.1%	3.8%
TULARE	59.6	80.4	0	1.2	0	0	59.6	81.6	**141.2**	252	2,941	70,765	0.4%	4.2%
TUOLUMNE	0	0	0	1.2	0	0	0	1.2	**1.2**	3	1,487	39,021	<0.1%	3.8%
VENTURA	0	69.0	3.7	1.2	1.8	<0.1	5.5	70.2	**75.7**	135	2,443	60,722	0.2%	4.0%
YOLO	35.5	0	0	1.2	0	0	35.5	1.2	**36.7**	66	683	16,165	0.4%	4.2%
YUBA	19.6	0	0	1.2	0	0	19.6	1.2	**20.8**	38	388	9,196	0.4%	4.2%
Total	**1,843.7**	**1,132.1**	**203.8**	**69.6**	**23.6**	**22.2**	**2,071.1**	**1,223.9**	**3,295.0**	**5,892.00**	**103,343**	**2,557,065**	**0.2%**	**4.0%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.8.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C9. The lower population estimate described in Appendix C9 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.9 River Otter

The North American river otter is a carnivorous fur-bearing mammal that inhabits rivers, large streams, lakes, wetlands, estuaries, and coastal areas of Northern California (CFGC Section 4000; CWHR 2022). This species primarily feeds on crayfish, fish, and crustaceans, as well as amphibians, insects, and small mammals (CWHR 2022). River otters use existing cavities and burrows in banks, rocks, hollow logs, and stumps near water. River otter is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for river otters provided in Appendix C10, the estimated population size for California is 896 individuals. Also included in Appendix C10 are the population estimates of river otters within each county.

A long-term sustainable harvest of 20% was estimated by Nielsen (2016), beyond any natural mortality or other human-caused mortality (e.g., roadkill, poisoning, habitat loss). Therefore, a sustainable harvest rate of 20% was used for the analyses of potential impact to river otter populations.

3.2.9.1 Previous Wildlife Damage Management

WDM for river otter comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 3.4 river otters were killed and 0.8 individuals were freed per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 4.2 individuals per year.[25] WS-California MIS baseline WDM for river otter occurred within 10 counties across the state with averages ranging from 0.1 to 1.2 individuals per year; most baseline WDM (55.9%, or 1.9 individuals) occurred within Butte and Napa County. Lethal take of river otter accounts for 81% (3.4 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 19% (0.8 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-10) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a). During the 10-year baseline period, statewide lethal take of river otter, is estimated at 3.9 individuals annually. This total is comprised of the WS-California lethal take of 3.4 individuals per year (87.2%) and the non-WS-California estimates for lethal take of 0.5 individuals per year (12.8%) (Table 3-10). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 896 individuals. The population estimate for each county is provided in Table 3-10. Approximately 0.4% (3.9 individuals) of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide river otter take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). For river otter we did not round this number up to the

[25] Average includes activities that both intentionally and unintentionally affect river otter and all potential WDM methods used by WS-California.

next integer due to the small population of the species. For most species we rounded these numbers up to the next integer because it makes little sense to lethally take a fraction of an animal. However, due to the low population size, rounding up would artificially inflate the anticipated take under the Proposed Project. Therefore, we report fractions of individuals lethally taken for this species; these numbers should be taken to mean that the 10-year average will not exceed this fraction. For example, an average of 0.4 river otters may be taken per year in Fresno County, meaning no more than 4 otters will be taken in a 10-year time span. The relationship of the 99% confidence interval high estimate to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For river otter, the average is 3.4,[26] the standard deviation is 3.81, and the 99% confidence high estimate is 13.22. The 99% Confidence Factor for river otter was 13.22/3.4 = 3.89. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.9.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of river otter under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 15.2 river otter taken annually, which represents 1.7% of the population. The statewide modeled low population estimate for this species is approximately 896 individuals (Appendix C10). The population estimate for each county is provided in Table 3-10. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 13.0% (0.4 individuals of 3 estimated county population; Lake County). However, the low population estimate for river otter in Lake County is only 3 individuals, which is not consistent with local reports that include them occupying boat docks around the Clear Lake shoreline, with up to 11 otters described on a single dock.[27] The next highest Proposed Project Maximum Lethal Take Estimate by estimated county population is Yuba County with 9.2% (1.6 individuals of 17 estimated county population) (Table 3-10). These numbers are all well below the sustainable harvest threshold of 20% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 15.2. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 15.2 individuals. The maximum number of river otters taken by county-level programs are listed for each county in Table 3-10, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

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26 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-10. This small amount of error was accepted for this calculation.

27 https://www.record-bee.com/2016/02/24/otters-a-common-sight-at-clear-lake/

River otters are apex predators in many aquatic systems (Lariviere and Walton 1998), preying on mollusks, crayfish, amphibians, birds, fish eggs and small mammals including muskrats and small beavers. Removal of an apex predator can potentially affect ecosystem function, structure, and dynamics (e.g., mesopredator release, trophic cascade, etc. (section 2.6.4) (Roemer *et al.* 2009). However, indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal WDM of river otter are not anticipated due to the low percentage of river otters killed by the Project in a maximum year regionally (ranging from 0% to 9.1% of estimated county populations), statewide (1.7% of the statewide population estimate), and cumulatively (5.5% of the statewide population estimate) are well below the sustainable harvest threshold of 20%.

3.2.9.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented baseline MIS data (2010–2019) for river otter predation in California to special-status listed species. However, the MIS baseline data have documented impacts from river otter to aquaculture and fisheries resources in Tuolumne, Placer, and Napa Counties. As such, rainbow trout and other commercial fish may have an increased survival rate following removal of this species under WDM activities. In addition, river otters are known to prey on some nesting seabirds (e.g., Speich and Pitman 1984) but have not been documented as preying on special-status species such as western snowy plover or California least tern. It is possible, though unconfirmed, that special-status avian species may benefit from removal of river otter under WDM activities through increased survival rate and restored balance to predator-prey relationships.

3.2.9.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next tenth of an integer. This mortality was not rounded up to the next integer for river otter due to the low population estimates for this species; such rounding would result in inaccurate estimates (Table 3-10).

Other anthropogenic factors that can affect river otter are habitat loss from development and climate change, and disruption by human activities such as timber harvest or agricultural activities affecting aquatic areas. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in river otter quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase river otter mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of river otter in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Neither hunting or trapping of river otter is legal in California (California Fish and Game Commission, Section 460). River otter have not been legally trapped for fur in California since 1962. Therefore, no hunting or trapping data were analyzed and no future legal harvest is anticipated from these activities.

The number of river otter killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available river otter roadkill data in California. Therefore, we estimated river otter mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. River otters are unlikely to be accidentally exposed to rodenticides due to the habitats they use, which are typically distant from dense urban and suburban areas where the highest potential for rodenticide use and misuse is likely. However, river otters are susceptible to water pollution, due to their riverine habitat. To be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 1.7%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-10. Cumulative mortality was 5.5% statewide and ranged from zero to 13.4% by county (some county estimates are for regions; see below). Lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; maximum lethal WDM under the Proposed Project would contribute 31% (15.2 of 49.3 individuals) of cumulative anthropogenic mortality statewide at the most. As for all species analyzed, maximum lethal WDM is not likely in most years; this number is a function of the past variation in damage from the species. This is especially true for river otter, which are lethally removed for WDM only occasionally.

A regional analysis of cumulative river otter mortality is provided for Napa County because the WDM take is higher than the county's population estimate. Due to the vast majority of Napa County occurring outside river otter's top two-thirds suitable habitat as estimated by CDFW (CDFW 2016a), the population estimate for this county is zero. Because it is not possible to lethally remove more river otters than what exist, Napa County must have a non-zero population of river otter. Because we do not have any better data for estimation of this county population, a regional population analysis was conducted for Napa County, including all abutting counties (i.e., Lake, Solano, Sonoma, and Yolo). All of the other county cumulative mortality estimates (except for Napa County) and the statewide estimate are below the sustainable harvest threshold of 20% for river otter. The regional estimate for Napa County, including all bordering counties (Lake, Solano, Sonoma, and Yolo), is 5.7% based on the maximum Proposed Project lethal WDM of 3.5 individuals of the population of 181 for this region (1.9%) plus the estimates of other anthropogenic mortality as above (3.8%). This percentage of cumulative mortality was applied to each of the counties in this region in Table 3-10.

The county with the highest cumulative mortality is Butte: 8.2 individuals (8.9% of the population). Maximum lethal WDM under the Proposed Project contributed 57% of this cumulative mortality (4.7 of 8.2 individuals). The highest percentage of cumulative mortality is in Yuba County: 13.4% of the population (2.3 individuals). Maximum lethal WDM under the Proposed Project contributed 70% of this cumulative mortality (1.6 of 2.3 individuals). Maximum cumulative mortality estimates for river otter statewide and in each county (based on county and regional analyses) are all below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-10.

Table 3-10. River Otter Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	0	0	0.2	4	0%	5.6%
ALPINE	0	0	0	0	0	0	0	0	0	0	0.6	14	0%	4.3%
AMADOR	0	0	0	0	0	0	0	0	0	0	0.1	1	0%	7.8%
BUTTE	1.2	0	0	0	0	0	1.2	0	1.2	4.7	8.2	92	5.1%	8.9%
CALAVERAS	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
COLUSA	0	0	0	0	0	0	0	0	0	0	0.7	17	0%	4.1%
CONTRA COSTA	0.4	0	0	0	0	0	0.4	0	0.4	1.6	2.8	31	5.0%	9.1%
DEL NORTE	0	0.2	0	0	0	0	0	0.2	0.2	0.8	2.9	53	1.5%	5.4%
EL DORADO	0	0	0	0	0	0	0	0	0	0	0.3	7	0%	4.2%
FRESNO	0	0.1	0	0	0	0	0	0.1	0.1	0.4	0.9	11	3.5%	7.9%
GLENN	0	0.1	0	0	0	0	0	0.1	0.1	0.4	1.2	20	2.0%	6.0%
HUMBOLDT	0	0	0	0	0	0	0	0	0	0	3.5	90	0%	3.9%
IMPERIAL	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
INYO	0	0	0	0	0	0	0	0	0	0	0.4	8	0%	4.9%
KERN	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
KINGS	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
LAKE	0.1	0	0	0	0	0	0.1	0	0.1	0.4	0.5	3	1.9%[7]	5.7%[7]
LASSEN	0	0	0	0	0	0	0	0	0	0	0.3	7	0%	4.0%
LOS ANGELES	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MADERA	0	0	0	0	0	0	0	0	0	0	0.2	3	0%	6.7%
MARIN	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MARIPOSA	0	0	0	0	0	0	0	0	0	0	0.1	2	0%	4.8%
MENDOCINO	0	0	0	0	0	0	0	0	0	0	0.5	12	0%	4.1%
MERCED	0.1	0	0	0	0	0	0.1	0	0.1	0.4	1.4	26	1.5%	5.3%
MODOC	0	0	0	0	0	0	0	0	0	0	0.1	1	0%	7.4%
MONO	0	0	0	0	0	0	0	0	0	0	0.4	9	0%	4.6%
MONTEREY	0	0	0	0	0	0	0	0	0	0	0.4	8	0%	5.0%
NAPA	0.7	0	0	0	0	0	0.7	0	0.7	2.7	2.8	0	1.9%[7]	5.7%[7]
NEVADA	0	0	0	0	0	0	0	0	0	0	0.2	5	0%	3.9%
ORANGE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
PLACER[3]	0	0	0	0	0	0	0	0	0	0	0.3	6	0%	4.8%
PLUMAS	0	0	0	0	0	0	0	0	0	0	1.0	25	0%	4.0%
RIVERSIDE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SACRAMENTO	0.2	0	0	0	0	0	0.2	0	0.2	0.8	2.1	34	2.3%	6.2%
SAN BENITO[4]	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN BERNARDINO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN DIEGO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%

Table 3-10. River Otter Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN JOAQUIN	0.1	0	0	0	0	0	0.1	0	**0.1**	0.4	1.3	22	1.8%	5.9%
SAN LUIS OBISPO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN MATEO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA CLARA	0	0	0	0	0	0	0	0	**0**	0	0.3	6	0%	5.0%
SANTA CRUZ	0	0	0	0	0	0	0	0	**0**	0	0	1	0%	0%
SHASTA	0.1	0	0	0	0	0	0.1	0	**0.1**	0.4	1.5	28	1.4%	5.4%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	0.3	6	0%	5.2%
SISKIYOU[5]	0	0	0	0	0	0	0	0	**0**	0	0.8	19	0%	4.2%
SOLANO	0	0	0	0	0	0	0	0	**0**	0	5.5	143	1.9%[7]	5.7%[7]
SONOMA[6]	0	0	0	0	0	0	0	0	**0**	0	0.4	10	1.9%[7]	5.7%[7]
STANISLAUS	0	0	0	0	0	0	0	0	**0**	0	0.7	17	0%	4.1%
SUTTER	0	0	0	0	0	0	0	0	**0**	0	1.8	45	0%	4.0%
TEHAMA	0	0.1	0	0	0	0	0	0.1	**0.1**	0.4	1.7	33	1.2%	5.2%
TRINITY	0	0	0	0	0	0	0	0	**0**	0	0.3	7	0%	4.2%
TULARE	0	0	0	0	0	0	0	0	**0**	0	0.1	1	0%	9.8%
TUOLUMNE	0	0	0	0	0	0	0	0	**0**	0	1.0	26	0%	3.8%
VENTURA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
YOLO	0.1	0	0	0	0	0	0.1	0	**0.1**	0.4	1.4	25	1.9%[7]	5.7%[7]
YUBA	0.4	0	0	0	0	0	0.4	0	**0.4**	1.6	2.3	17	9.1%	13.4%
Total	**3.4**	**0.5**	**0**	**0**	**0**	**0**	**3.4**	**0.5**	**3.9**	**15.2**	**49.3**	**896**	**1.7%**	**5.5%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding. A regional analysis was conducted for these counties (Lake, Napa, Solano, Sonoma, and Yolo) to determine mortality as a percentage of the regional population, which is 1.9% under the Proposed Project and 5.7% cumulative mortality. These percentages were applied to all counties in this region. Due to the low-quality habitat occurring within this county (i.e., not within the top two-thirds of the modeled suitable habitat as described in Appendix C10), the population estimate indicates there are zero river otters in this county. However, lethal wildlife damage management has occurred during the 10-year baseline period and potential explanations could include the following: the population total for this county is an underestimate due to a due to lack of top two-thirds suitable modeled habitat; or there is a population sink occurring within this county, in which the population is sustained through replacement of individuals from a nearby source population.

1 Refer to Section 3.2.9.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C10. The lower population estimate described in Appendix C10 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.10 Western Spotted Skunk

Western spotted skunk is an omnivorous (primarily eats insects and small mammals) non-game mammal that occurs in shrub and brush habitats with moderate canopy-closure, forests and woodlands with scattered openings, and riparian habitats, excluding high mountains and deserts (CFGC Section 4152) (CWHR 2022). It uses existing cavities and burrows in trees, using dens for cover and reproduction (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for this species to be lethally removed any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Western spotted skunk is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Based on the CDFW habitat modeling for western spotted skunk provided in Appendix C11, the estimated population size for California is 497,414 individuals. Also included in Appendix C11 are the population estimates of western spotted skunk within each county.

CDFW has not established sustainable harvest levels for spotted skunk. No published literature sources were found containing sustainable harvest threshold data for western spotted skunks. Due to the paucity of information, we will use the lowest reported long-term sustainable harvest rate for any of the target carnivore species analyzed in this document (10%) as an extremely conservative estimate.

3.2.10.1 Previous Wildlife Damage Management

WDM for western spotted skunk comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 3.4 western spotted skunks were killed and 0.3 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 3.7 individuals per year based on the WS-California MIS data from 2010 to 2019.[28] WS-California WDM for western spotted skunk occurred within eight counties within the state with averages ranging from 0.1 to 1.7 individuals per year. Most WS-California WDM activities (50% or 1.7 individuals) occurred within Mendocino County. Lethal WDM of western spotted skunk accounts for 91.9% (3.4 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 8.1% (0.3 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-11) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of western spotted skunk is estimated at 7.14 individuals annually. This total is comprised of the WS-California lethal take of 3.4 individuals per year and the non-WS-California estimates for lethal take of 3.74 individuals per year (Table 3-11). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 497,414 individuals. The

28 Average includes activities that both intentionally and unintentionally affect western spotted skunk and all potential methods used during WDM activities.

population estimate for each county is provided in Table 3-11. Less than 0.1% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide western spotted skunk take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For western spotted skunk, the average is 3.4,[29] the standard deviation is 2.37, and the 99% confidence high estimate is 9.51, which we rounded up to 10 individuals. The 99% Confidence Factor for western spotted skunk was 10/3.4 = 2.94. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.10.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of western spotted skunk under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 63 western spotted skunks taken annually, which represents 0.01% of the population. The statewide modeled low population estimate for this species is approximately 497,414 individuals (Appendix C11). The population estimate for each county is provided in Table 3-11. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.45% (1 individual of 222 estimated county population; San Francisco County). These numbers are all well below the sustainable harvest threshold of 10% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 63. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 63 individuals. The maximum number of western spotted skunks taken by county-level programs are listed for each county in Table 3-11, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Western spotted skunks are considered mesopredators (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). For example, striped skunks are a prey species for great horned, owls, mountain lions, eagles, coyotes, badgers, foxes, and bobcats (CWHR 2022). They also consume large numbers of insects and small mammals/rodents, eggs, fruits, and seeds and thus may compete for food and space with long-tailed weasels, minks, ringtails, raccoons, and gray foxes (CWHR 2022). Indirect

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29 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-11. This small amount of error was accepted for this calculation.

impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to striped skunk, are not anticipated due to the low percentage of striped skunk impacted by the Project regionally, statewide, and cumulatively.

3.2.10.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented baseline MIS data (2010–2019) for western spotted skunk predation in California to special-status listed species. This species is known to carry rabies which could potentially spread to other native species (CWHR 2022). Western spotted skunks may compete for food and space with long-tailed weasels, minks, ringtails, raccoons, and gray foxes (CWHR 2022). Therefore, WDM of western spotted skunk populations are not expected to result in beneficial effects to biological resources, but incremental reductions in spread of rabies to other species and reduction in species competition could result.

3.2.10.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-11). Lethal removal of western spotted skunk for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

Other anthropogenic factors that can affect western spotted skunk are habitat loss from development and climate change, and disruption by human activities that result in removal of dens or cover sites. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in western spotted skunk quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase western spotted skunk mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of western spotted skunk in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

The California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). The 2010-2019 average trapping data are used to estimate future trapping harvest. The 10-year average statewide was 9 western spotted skunks per year (CDFW 2020), which is less than 0.01% of the estimated population. Trapping data by county data ranged from zero individuals in numerous counties to 5 individuals per year in Sacramento County (CDFW 2020).

The number of western spotted skunks killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Therefore, we estimated western spotted skunk mortality from vehicle collisions. Roadkill data from the California Department of Transportation (Caltrans) were not available. No other source of available western spotted skunk roadkill data in California was found. Therefore, to be the most conservative, we used the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.01%); trapper harvest (0.01% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-11. Cumulative mortality was 3.8% statewide and ranged from 3.8% to 4.1% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.3% (63 of 18,929 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Kern County with 1,002 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed 0.1% of this cumulative mortality (1 of 1,002 individuals). The county with the highest percentage of cumulative mortality is San Francisco County: 4.1% of the population (9 individuals). Maximum lethal WDM under the Proposed Project contributed 11% of this cumulative mortality (1 of 9 individuals). Maximum cumulative mortality estimates for western spotted skunk statewide and in each county are all well below the conservative 10% sustainable harvest threshold. These data are presented in Table 3-11.

Table 3-11. Western Spotted Skunk Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	130	3,395	<0.1%	3.8%
ALPINE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	87	2,274	<0.1%	3.8%
AMADOR	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	98	2,558	<0.1%	3.8%
BUTTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	237	6,233	<0.1%	3.8%
CALAVERAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	180	4,718	<0.1%	3.8%
COLUSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	175	4,581	<0.1%	3.8%
CONTRA COSTA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	128	3,342	<0.1%	3.8%
DEL NORTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	169	4,429	<0.1%	3.8%
EL DORADO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	263	6,895	<0.1%	3.8%
FRESNO	0	0.2	0	0	0	0	0	0.2	**0.2**	1	733	19,259	<0.1%	3.8%
GLENN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	194	5,093	<0.1%	3.8%
HUMBOLDT	0.2	0	0	0	0	0	0.2	0	**0.2**	1	589	15,479	<0.1%	3.8%
IMPERIAL	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	150	3,939	<0.1%	3.8%
INYO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	362	9,507	<0.1%	3.8%
KERN	0	0.3	0	0	0	0	0	0.3	**0.3**	1	1,002	26,338	<0.1%	3.8%
KINGS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	220	5,773	<0.1%	3.8%
LAKE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	207	5,430	<0.1%	3.8%
LASSEN	0.6	0	0	0	0	0	0.6	0	**0.6**	2	814	21,378	<0.1%	3.8%
LOS ANGELES	0	0.2	0	0	0	0	0	0.2	**0.2**	1	675	17,741	<0.1%	3.8%
MADERA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	275	7,224	<0.1%	3.8%
MARIN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	79	2,055	<0.1%	3.8%
MARIPOSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	224	5,869	<0.1%	3.8%
MENDOCINO	1.7	0	0	0	0	0	1.7	0	**1.7**	5	587	15,318	<0.1%	3.8%
MERCED	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	270	7,100	<0.1%	3.8%
MODOC	0.1	0	0	0	0	0	0.1	0	**0.1**	1	686	18,025	<0.1%	3.8%
MONO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	419	11,002	<0.1%	3.8%
MONTEREY	0	0.1	0	0	0	0	0	0.1	**0.1**	1	578	15,199	<0.1%	3.8%
NAPA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	128	3,359	<0.1%	3.8%
NEVADA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	124	3,257	<0.1%	3.8%
ORANGE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	145	3,809	<0.1%	3.8%
PLACER[3]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	217	5,668	<0.1%	3.8%
PLUMAS	0	0.1	0	0	0	0	0	0.1	**0.1**	1	422	11,088	<0.1%	3.8%
RIVERSIDE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	488	12,820	<0.1%	3.8%
SACRAMENTO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	168	4,260	<0.1%	3.9%
SAN BENITO[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	246	6,468	<0.1%	3.8%
SAN BERNARDINO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	358	9,398	<0.1%	3.8%
SAN DIEGO	0	0.2	0.1	0	0	0	0.1	0.2	**0.3**	1	623	16,374	<0.1%	3.8%

Table 3-11. Western Spotted Skunk Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN FRANCISCO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	9	222	<0.1%	4.1%
SAN JOAQUIN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	195	5,126	<0.1%	3.8%
SAN LUIS OBISPO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	580	15,239	<0.1%	3.8%
SAN MATEO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	77	2,002	<0.1%	3.8%
SANTA BARBARA	0	0.1	0	0	0	0	0	0.1	**0.12**	1	482	12,674	<0.1%	3.8%
SANTA CLARA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	229	6,004	<0.1%	3.8%
SANTA CRUZ	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	63	1,645	<0.1%	3.8%
SHASTA	0	0.2	0	0	0	0	0	0.2	**0.2**	1	632	16,619	<0.1%	3.8%
SIERRA	0.1	0	0	0	0	0	0.1	0	**0.1**	1	132	3,455	<0.1%	3.8%
SISKIYOU[5]	0.4	0	0	0	0	0	0.4	0	**0.4**	1	989	25,942	<0.1%	3.8%
SOLANO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	115	3,002	<0.1%	3.8%
SONOMA[6]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	245	6,419	<0.1%	3.8%
STANISLAUS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	206	5,402	<0.1%	3.8%
SUTTER	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	79	2,034	<0.1%	3.9%
TEHAMA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	498	13,086	<0.1%	3.8%
TRINITY	0	0.1	0	0	0	0	0	0.1	**0.1**	1	516	13,564	<0.1%	3.8%
TULARE	0	0.2	0	0	0	0	0	0.2	**0.2**	1	643	16,889	<0.1%	3.8%
TUOLUMNE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	263	6,893	<0.1%	3.8%
VENTURA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	308	8,098	<0.1%	3.8%
YOLO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	153	3,998	<0.1%	3.8%
YUBA	0.2	0	0	0	0	0	0.2	0	**0.2**	1	94	2,446	<0.1%	3.8%
Total	**3.3**	**3.7**	**0.1**	**0**	**0**	**0**	**3.4**	**3.7**	**7.1**	**63**	**18,929**	**497,414**	**<0.1%**	**3.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.10.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C11. The lower population estimate described in Appendix C11 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.11 Striped Skunk

Striped skunk is an omnivorous (primarily eats insects and small mammals) non-game mammal that occurs from sea level to timber line in nearly all habitats, but frequents forests, shrub and brush habitats with intermediate canopy stages, riparian areas, and herbaceous shrub and forest ecotones (CFGC Section 4150) (CWHR 2022). This species subsists off insects, small mammals, crustaceans, fruits, seeds, and some carrion. It uses existing cavities and crevices in rock areas, snags, logs, stumps, and abandoned burrows for cover. Striped skunk will excavate burrows in friable, well drained soils and may den aboveground in heavy cover for reproduction. Although a non-game species, the California Fish and Game Commission allows for this species to be lethally removed any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Striped skunk is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for striped skunk provided in Appendix C12, the estimated population size for California is 1,830,939 individuals. Also included in Appendix C12 are the population estimates of striped skunk within each county.

CDFW has not established sustainable harvest levels for striped skunk, nor have any literature sources. Boddicker (1980) cited a 60% long-term sustainable harvest threshold for skunks, but this rate may be based only on experience, rather than on empirical data. No other published sustainable harvest rate was found for striped skunks. Due to the uncertainty of the validity of the Boddicker (1980) harvest threshold, we will use the lowest reported threshold among all of the carnivore species analyzed in this document, which is 10%, as a conservative estimate.

3.2.11.1 Previous Wildlife Damage Management

WDM for striped skunk comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 3,477 striped skunks were killed, 6.8 individuals were dispersed, 41.0 individuals were freed, 0.2 individuals were relocated, 0.9 individuals were surveyed, and 0.4 individuals underwent a transfer of custody per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 3,526.3 individuals per year.[30] WS-California MIS baseline WDM for striped skunk occurred within 48 counties across the state with averages ranging from 0.1 to 553.2 individuals per year; most baseline WDM (28.4%, or 986.2 individuals) occurred within Placer and Sacramento Counties. Lethal take of striped skunk accounts for 98.6% (3,477 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 1.4% (49.3 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-12) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of striped skunk is estimated at 4,896 individuals annually. This total is comprised of the WS-California lethal take of 3,477 individuals per year and the non-WS-

30 Average includes activities that both intentionally and unintentionally affect striped skunk and all potential WDM methods used by WS-California.

California estimates for lethal take of 1,419 individuals per year (Table 3-12). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 1,830,939 individuals. The population estimate for each county is provided in Table 3-12. Approximately 0.3% (4,896 individuals) of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide striped skunk take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For striped skunk, the average is 3,199.1,[31] the standard deviation is 765.54, and the 99% confidence high estimate is 5,174.20, which we rounded up to 5,175 individuals. The 99% Confidence Factor for striped skunk was 5,175/3,199.1 = 1.62. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.11.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of striped skunk under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 7,932 striped skunks taken annually, which represents 0.4% of the population. The statewide modeled low population estimate for this species is approximately 240,202 individuals (Appendix C12). The population estimate for each county is provided in Table 3-12. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from <0.1% (several counties) to 4.5% (757 individuals of 16,680 estimated county population; Sacramento County). These numbers are all well below the sustainable harvest threshold of 10% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 4,896. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 4,896 individuals. The maximum number of striped skunks taken by county-level programs are listed for each county in Table 3-12, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Striped skunks are considered mesopredators (Prugh *et al.* 2009). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). For example, striped skunks are a prey species

31 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-12. This small amount of error was accepted for this calculation.

for great horned, owls, mountain lions, eagles, coyotes, badgers, foxes, and bobcats (CWHR 2022). They also consume large numbers of insects and small mammals/rodents, eggs, fruits, and seeds (Ahlborn 1988-1990). Thus, they may provide some control of insect populations through their consumption while also playing a role in ecosystem structure as a prey species. Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to striped skunk, are not anticipated due to the low percentage of striped skunk impacted by the Project regionally, statewide, and cumulatively.

3.2.11.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are documented MIS baseline data (2010–2019) on striped skunk causing adverse effects to the federal- and state-listed special-status snowy plover in San Diego, Santa Barbara, San Luis Obispo, Monterey, and Santa Cruz Counties in California. Striped skunks are a known mammalian predator of snowy plover and have been observed disturbing nests for snowy plover eggs in San Francisco Bay (SFBO and USFWS 2007). Striped skunk is known to carry rabies, leptospirosis, and tularemia which could potentially spread to other native species (CWHR 2022). As such, removal of striped skunk populations under WDM activities may result in a net benefit to snowy plover (e.g., increased survival rate) and other native species through incremental reductions in spread of diseases.

3.2.11.4 Potential Cumulative Effects to the Species

Cumulative effects to this species are limited, as they readily adapt to logging, agriculture, and urban developments that create open areas, fragmented habitats, and mosaics of vegetation (CWHR 2022). Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-12).

Other anthropogenic factors that can affect striped skunk are habitat loss from development and climate change, and disruption by human activities that result in removal of dens or cover sites. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in striped skunk quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase striped skunk mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of striped skunk in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

The California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). The 2010-2019 average trapping data are used to estimate future trapping harvest. The 10-year average statewide was 230 striped skunks per year (CDFW 2020), which is approximately 0.01% of the estimated population. Trapping data by county data are ranged from zero individuals in numerous counties to 45 individuals per year in Alameda County (CDFW 2020).

The number of striped skunks killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California

Department of Transportation (Caltrans) were not available and we are aware of no other source of available striped skunk roadkill data in California. Therefore, we estimated striped skunk mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.43%); trapper harvest (0.01% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-12. Cumulative mortality was 4.2% statewide and ranged from 3.8% to 8.5% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 10.2% (7,932 of 77,761 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Kern County: 3,843 individuals (3.9% of the population). Maximum lethal WDM under the Proposed Project contributed 1.4% of this cumulative mortality (53 of 3,843 individuals). The county with the highest percentage of cumulative mortality is Alameda County: 8.5% of the population (1,039 individuals. Maximum lethal WDM under the Proposed Project contributed 50% of this cumulative mortality (516 of 1,039 individuals). Maximum cumulative mortality estimates for striped skunk statewide and in each county are all below the conservative 10% sustainable harvest threshold estimated above. These data are presented in Table 3-12.

Table 3-12. Striped Skunk Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	87.4	0	177.9	2.4	28.9	21.7	294.2	24.1	**318.3**	516	1,039	12,250	4.2%	8.5%
ALPINE	0	0	0	2.4	0	0	0	2.4	**2.4**	4	313	8,111	<0.1%	3.9%
AMADOR	36.4	0	0	2.4	0	0	36.4	2.4	**38.8**	63	411	9,150	0.7%	4.5%
BUTTE	205.0	0	0	2.4	0	0	205.0	2.4	**207.4**	336	1,393	27,739	1.2%	5.0%
CALAVERAS	36.9	0	0	2.4	0	0	36.9	2.4	**39.3**	64	708	16,928	0.4%	4.2%
COLUSA	22.4	0	0	2.4	0	0	22.4	2.4	**24.8**	41	831	19,793	0.2%	4.2%
CONTRA COSTA	1.3	0	18.6	2.4	0	0	19.9	2.4	**22.3**	37	540	12,377	0.3%	4.4%
DEL NORTE	0	30.2	0	2.4	0	0	0	32.6	**32.6**	53	558	13,285	0.4%	4.2%
EL DORADO	199.4	0	0	2.4	0	0	199.4	2.4	**201.8**	327	1,294	25,343	1.3%	5.1%
FRESNO	0	190.3	0	2.4	0	0	0	192.7	**192.7**	313	3,495	83,731	0.4%	4.2%
GLENN	0	50.7	0	2.4	0	0	0	53.1	**53.1**	87	935	22,304	0.4%	4.2%
HUMBOLDT	96.3	0	0	2.4	0	0	96.3	2.4	**98.7**	160	1,870	44,892	0.4%	4.2%
IMPERIAL	0	0	0	2.4	0	0	0	2.4	**2.4**	4	627	16,318	<0.1%	3.8%
INYO	0	38.9	0	2.4	0	0	0	41.3	**41.3**	67	719	17,123	0.4%	4.2%
KERN	29.9	0	0.4	2.4	0	0	30.3	2.4	**32.7**	53	3,843	99,261	<0.1%	3.9%
KINGS	0	53.4	0	2.4	0.1	0	0.1	55.8	**55.9**	91	984	23,505	0.4%	4.2%
LAKE	37.5	0	0	2.4	0	0	37.5	2.4	**39.9**	65	857	20,846	0.3%	4.1%
LASSEN	66.5	0	0	2.4	0	0	66.5	2.4	**68.9**	112	3,029	76,546	0.2%	4.0%
LOS ANGELES	0	118.2	0	2.4	14.3	14.3	14.3	134.9	**149.2**	242	2,223	51,997	0.5%	4.3%
MADERA	15.2	0	0	2.4	0	0	15.2	2.4	**17.6**	29	1,228	31,536	<0.1%	3.9%
MARIN	5.6	18.7	0	2.4	0	0	5.6	21.1	**26.7**	44	357	8,239	0.5%	4.3%
MARIPOSA	47.1	0	0	2.4	0	0	47.1	2.4	**49.5**	81	941	22,637	0.4%	4.2%
MENDOCINO	57.2	0	0	2.4	0	0	57.2	2.4	**59.6**	97	1,990	49,727	0.2%	4.0%
MERCED	12.6	0	0	2.4	0.2	0.3	12.8	2.7	**15.5**	26	1,294	33,371	<0.1%	3.9%
MODOC	46.1	0	0	2.4	0	0	46.1	2.4	**48.5**	79	2,623	66,456	0.1%	3.9%
MONO	0	90.1	0	2.4	0	0	0	92.5	**92.5**	150	1,657	39,641	0.4%	4.2%
MONTEREY	0.8	0	12.4	2.4	0	0	13.2	2.4	**15.6**	26	2,179	56,619	<0.1%	3.8%
NAPA	76.8	0	0	2.4	0	0	76.8	2.4	**79.2**	129	608	12,621	1.0%	4.8%
NEVADA	25.9	0	0	2.4	0	0	25.9	2.4	**28.3**	46	572	13,829	0.3%	4.1%
ORANGE	0	30.8	0	2.4	0.5	0.1	0.5	33.3	**33.8**	55	572	13,568	0.4%	4.2%
PLACER3	553.0	0	0	2.4	0.2	0	553.2	2.4	**555.6**	901	1,741	22,022	4.1%	7.9%
PLUMAS	49.1	0	0	2.4	0	0	49.1	2.4	**51.5**	84	1,701	42,365	0.2%	4.0%
RIVERSIDE	0	95.2	0	2.4	0	0	0	97.6	**97.6**	159	1,753	41,917	0.4%	4.2%
SACRAMENTO	424.0	0	0	2.4	9.0	31.5	433.0	33.9	**466.9**	757	1,397	16,680	4.5%	8.4%
SAN BENITO4	65.3	0	0	2.4	0	0	65.3	2.4	**67.7**	110	1,020	23,834	0.5%	4.3%
SAN BERNARDINO	0.7	56.4	0	2.4	2.7	6.9	3.4	65.7	**69.1**	112	1,055	24,805	0.5%	4.3%

Table 3-12. Striped Skunk Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	9.0	0	50.4	2.4	0.3	0.5	59.7	2.9	**62.6**	102	2,306	58,001	0.2%	4.0%
SAN FRANCISCO	0	1.8	0	2.4	0	0	0	4.2	**4.2**	1	37	775	0.1%	4.8%
SAN JOAQUIN	1.2	0	0	2.4	0	0	1.2	2.4	**3.6**	6	921	24,074	<0.1%	3.8%
SAN LUIS OBISPO	226.7	0	7.1	2.4	0	0	233.8	2.4	**236.2**	383	2,483	55,232	0.7%	4.5%
SAN MATEO	0.4	14.2	18.6	2.4	0	0	19.0	16.6	**35.6**	58	295	6,238	0.9%	4.7%
SANTA BARBARA	82.7	0	8.4	2.4	0	0	91.1	2.4	**93.5**	152	1,929	46,743	0.3%	4.1%
SANTA CLARA	0.1	49.4	87.4	2.4	24.4	13.3	111.9	65.1	**177.0**	287	1,114	21,746	1.3%	5.1%
SANTA CRUZ	0	13.9	6.3	2.4	0	0	6.3	16.3	**22.6**	37	270	6,112	0.6%	4.4%
SHASTA	7.6	0	0	2.4	0	0	7.6	2.4	**10.0**	17	2,357	61,427	<0.1%	3.8%
SIERRA	4.5	0	0	2.4	0	0	4.5	2.4	**6.9**	12	576	14,854	<0.1%	3.9%
SISKIYOU[5]	102.0	0	0	2.4	0	0	102.0	2.4	**104.4**	170	3,778	94,556	0.2%	4.0%
SOLANO	0.4	0	27.2	2.4	3.5	0.3	31.1	2.7	**33.8**	55	585	13,933	0.4%	4.2%
SONOMA[6]	1.3	0	0	2.4	0	0	1.3	2.4	**3.7**	6	946	24,714	<0.1%	3.8%
STANISLAUS	9.2	0	0	2.4	0	0	9.2	2.4	**11.6**	19	998	25,762	<0.1%	3.9%
SUTTER	71.2	0	0	2.4	0	0	71.2	2.4	**73.6**	120	516	10,420	1.2%	5.0%
TEHAMA	0	112.5	0	2.4	0	0	0	114.9	**114.9**	187	2,070	49,507	0.4%	4.2%
TRINITY	4.5	0	0	2.4	0	0	4.5	2.4	**6.9**	12	1,583	41,298	<0.1%	3.8%
TULARE	0.7	155.7	0	2.4	0	0	0.7	158.1	**158.8**	258	2,861	68,513	0.4%	4.2%
TUOLUMNE	153.4	0	0	2.4	0	0	153.4	2.4	**155.8**	253	1,281	27,002	0.9%	4.7%
VENTURA	0	70.4	0.4	2.4	0.4	0.1	0.8	72.9	**73.7**	120	1,297	30,970	0.4%	4.2%
YOLO	35.0	0	0	2.4	0	0	35.0	2.4	**37.4**	61	727	17,420	0.4%	4.2%
YUBA	69.0	0	0	2.4	0.1	0	69.1	2.4	**71.5**	116	507	10,274	1.1%	4.9%
Total	2,977.3	1,190.8	415.1	139.2	84.6	89.0	3,477.0	1,419.0	**4,896.0**	7,932	77,761	1,830,939	0.4%	4.2%

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.11.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C12. The lower population estimate described in Appendix C12 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.12 North American Beaver

The North American beaver (*Castor canadensis*) is an herbivorous fur-bearing semi-aquatic rodent found in streams, ponds, and lake margins in eastern Sierra Nevada and Cascades and Central Valley, with isolated populations elsewhere in California (CFGC Section 4000) (CWHR 2022). Optimum habitats for the North American beaver include montane riparian, valley foothill riparian, riverine, lacustrine, aspen, and fresh emergent wetland (CWHR 2022). This species feeds in a variety of other hardwood habitats, as well as montane chaparral, grasslands, and wet meadow (CWHR 2022). This species' diet varies seasonally, preferring aquatic vegetation in the spring and summer while subsisting on bark and cambium of trees in winter (CWHR 2022). It prefers aspen, willow, alder, and cottonwood in California, foraging on or near streambanks (CWHR 2022). Lodges and bank burrows are constructed for shelter and form ponds for feeding areas (CWHR 2022). North American beaver requires permanent water for reproduction, cover, and riparian/aquatic plant food (CWHR 2022). North American beaver is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for North American beaver provided in Appendix C13, the estimated population size for California is 556,612 individuals. Also included in Appendix C13 are the population estimates of North American beaver within each county.

This analysis uses a sustainable cumulative harvest level of 20% (Runge 1999), which was derived through modeling that suggested any removal below that level created space for dispersing individuals rather than causing population decline.

3.2.12.1 Previous Wildlife Damage Management

WDM for North American beaver comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 1,105.2 North American beavers were killed, 0.2 individuals were dispersed, 2.7 individuals were freed, and 0.3 individuals were relocated per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 1,108.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[32] WS-California MIS baseline WDM for North American beaver occurred within 37 counties within the state with averages ranging from 0.1 to 218.7 individuals per year. Lethal WDM of North American beaver accounts for 99.7% (1,105.2 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for less than 0.3% (3.2 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-13) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of North American beaver is estimated at 1,252.1 individuals annually. This total is comprised of the WS-California lethal take of 1,105.2 individuals per year and the

[32] Average includes activities that both intentionally and unintentionally affect beaver and all potential methods used during WDM activities.

non-WS-California estimates for lethal take of 146.9 individuals per year (Table 3-13). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 168,839 individuals. The population estimate for each county is provided in Table 3-13. Approximately 0.7% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide North American beaver take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For North American beaver, the average is 1,124.3,[33] the standard deviation is 202.6, and the 99% confidence high estimate is 1,646.99, which we rounded up to 1,647 individuals. The 99% Confidence Factor for North American beaver was 1,647/1,124.3 = 1.46. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.12.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of North American beaver under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 1,829 North American beaver taken annually, which represents 1.1% of the population. The statewide modeled high population estimate for this species is approximately 556,612 individuals (Appendix C13). The population estimate for each county is provided in Table 3-13. It is important to note that the CDFW habitat model used for this analysis likely underestimates North American beaver populations in California. As seen in Appendix C13, WS-California has lethally taken several North American beavers during the 10-year MIS baseline outside of the suitable habitat defined by the CDFW habitat model. For example, in Sonoma County, 1.8 North American beavers were killed during WDM activities, but the county population estimate using the CDFW habitat model is zero (Table 3-13). The CDFW habitat model is still the best available method for estimating North American beaver populations in California; however, North American beaver have likely expanded out from neighboring counties into suitable habitat not captured by the model. Therefore, regional analyses will be done to examine counties with Proposed Project Maximum Lethal Take Estimates greater than 20% of the county estimated population – Sonoma and Yolo.

When Proposed Project Maximum Lethal Take Estimate of North American beaver is considered for Sonoma County and its adjacent counties (Marin, Napa, Lake, and Mendocino), 1.2% of North American beavers (7 individuals of 590 estimated regional population) could be taken per year during WDM activities in this region. When Proposed Project Maximum Lethal Take Estimate of North American beaver is considered for Yolo County and its adjacent counties (Colusa, Sutter, Sacramento, Solano, Napa, and Lake), 11.6% of North American beavers (786 individuals

33 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-13. This small amount of error was accepted for this calculation.

of 6,795 estimated regional population) could be taken per year during WDM activities in this region. These numbers are all below the sustainable harvest threshold of 20%. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average lethal take of 1,829. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 1,829 individuals. The maximum number of North American beavers taken by county-level programs are listed for each county in Table 3-13, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

North American beaver is a keystone species of the aquatic ecosystem, altering the environment to create habitat for a wide variety of plants, fish, and wildlife, as well as improving water quality (Pollock *et al.* 2018). Beaver dams impound water, and these impoundments slow the flow of the stream and trap sediment helping create diverse and productive wetlands (Pollock *et al.* 2003). If WDM activities were to substantially reduce North American beaver populations at a local level, stream habitat and hydrology could be affected. Fewer in-stream wetlands would be created, which would reduce habitat capacity for species such as salmon (Pollock *et al.* 2004), turtles, frogs, and songbirds. Because water movement is slowed by North American beaver dams and exposure time to aquatic vegetation is increased, removal of North American beaver dams could cause reduced biofiltration and adverse effects on downstream water quality (Pollock *et al.* 2004). Finally, removal of North American beaver dams could cause greater incision of stream channels, bank erosion, and transport power (Pollock *et al.* 2003; Pollock *et al.* 2004; Pollock *et al.* 2018). Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project’s lethal impacts to North American beavers, are not anticipated due to the percentage of North American beavers impacted by the Project regionally, statewide, and cumulatively is below the sustainable harvest threshold of 20%.

3.2.12.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

As noted above, North American beaver activities generally enhance ecosystems by increasing complexity of aquatic habitat (e.g., creating ponds, creating more variety in water flow rates, additional substrate within the water channel) (Pollock *et al.* 2003; Pollock *et al.* 2018). However, introduction of North American beavers into areas where they are not native (e.g., portions of the Mojave River) can create unsuitable habitat for arroyo toad, by providing otherwise unavailable habitat for invasive species like bullfrogs and African clawed frogs (USFWS 2014). Targeted removal of some North American beaver dam structures under WDM activities, may result in a net benefit to arroyo toad (e.g., increased survival rate in the absence of non-native predators).

3.2.12.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-13).

Other anthropogenic factors that can affect North American beaver are aquatic habitat loss from development and climate change, and disruption by human activities resulting in water pollution. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in North American beaver quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase North American beaver mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of North American beaver in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Trapping of North American beaver for fur is no longer legal in California for most trap types (California AB 273, 09/04/2019); therefore, the lethal removal of North American beaver that has historically occurred under trapping licenses is not likely to contribute to cumulative mortality as of 2019. However, to be conservative in our analysis, and because future trapping take is uncertain, trapping data from 2010 through 2019 are included in cumulative take. North American beaver trapping harvest is likely to be much lower after the fur trapping ban (AB 273) took effect in 2019. However, to be conservative we will use the 2010-2019 average to estimate future trapping harvest. The 10-year average statewide was 69 North American beavers per year (CDFW 2020), which is 0.01% of the estimated population. Trapping data by county data are ranged from zero individuals in numerous counties to 41 individuals per year in Butte County (CDFW 2020).

The number of North American beavers killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available North American beaver roadkill data in California. Therefore, we estimated North American beaver mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

CDFW adopted on June 5, 2023 a Beaver Depredation Policy (CDFW 2023e) that established a deliberative, tiered approach when responding to reported beaver depredation (e.g., damage to property, infrastructure). This policy may ultimately results in reduced anthropogenic mortality of beaver through confirmation of depredation, education, and coordination with beaver translocation efforts for restoration projects. However, implementation of this new policy would not necessarily change the number of requests for beaver WDM under the Project, so the conservative analysis in this Report does not assume that cumulative anthropogenic mortality of beaver would be reduced.

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.33%); trapper harvest (0.01% from CDFW reports); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-13. Cumulative mortality was 4.1% statewide and ranged from 0% to 14.3% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 7.9% (1,829 of 23,055 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 4,050 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed 0.25% of this cumulative mortality (10 of 4,050 individuals). The county with the highest percentage of cumulative mortality is Yolo County: 14.3% of the population (326 individuals). Maximum lethal WDM under the Proposed Project contributed 73% of this cumulative mortality (238 of 326 individuals). Maximum cumulative mortality estimates for North American beaver statewide and in each county are all below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-13.

Table 3-13. North American Beaver Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	High Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	3.7	0	0	0	0	0	3.7	0	**3.7**	6	248	6,380	<0.1%	3.9%
AMADOR	0.3	0	0	0	0	0	0.3	0	**0.3**	1	7	158	0.6%	4.4%
BUTTE	76.5	0	0	0	0	0	76.5	0	**76.5**	112	723	14,894	0.8%	4.9%
CALAVERAS	0.1	0	0	0	0	0	0.1	0	**0.1**	1	71	1,856	<0.1%	3.8%
COLUSA*	64.0	0	0	0	0	0	64.0	0	**64.0**	94	208	2,870	3.3%	7.2%
CONTRA COSTA	7.2	0	0	0	0	0	7.2	0	**7.2**	11	91	1,998	0.6%	4.6%
DEL NORTE	0	31.0	0	0	0	0	0	31.0	**31.0**	46	571	13,825	0.3%	4.1%
EL DORADO	10.0	0	0	0	0	0	10.0	0	**10.0**	15	318	7,959	0.2%	4.0%
FRESNO	0	4.6	0	0	0	0	0	4.6	**4.6**	7	86	2,070	0.3%	4.2%
GLENN	0.6	9.1	0	0	0	0	0.6	9.1	**9.7**	15	170	4,082	0.4%	4.2%
HUMBOLDT	0.2	0	0	0	0	0	0.2	0	**0.2**	1	270	7,097	<0.1%	3.8%
IMPERIAL	0.2	0	0	0	0	0	0.2	0	**0.2**	1	32	818	0.1%	3.9%
INYO	0	5.8	0	0	0	0	0	5.8	**5.8**	9	107	2,580	0.4%	4.1%
KERN	7.9	0	0	0	0	0	7.9	0	**7.9**	12	106	2,463	0.5%	4.3%
KINGS	0	0.1	0	0	0	0	0	0.1	**0.1**	1	3	59	1.7%	5.1%
LAKE*7	0.4	0	0	0	0	0	0.4	0	**0.4**	1	46	1,174	0.3%6	4.1%6
LASSEN	17.5	0	0	0	0	0	17.5	0	**17.5**	26	1,703	44,115	<0.1%	3.9%
LOS ANGELES	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MADERA	8.1	0	0	0	0	0	8.1	0	**8.1**	12	156	3,778	0.3%	4.1%
MARIN*	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MARIPOSA	1.1	0	0	0	0	0	1.1	0	**1.1**	2	151	3,914	<0.1%	3.9%
MENDOCINO*7	0	0	0	0	0	0	0	0	**0**	0	4	93	0.3%6	4.1%6
MERCED	45.7	0	0	0	0	0	45.7	0	**45.7**	67	314	6,479	1.0%	4.8%
MODOC	5.6	0	0	0	0	0	5.6	0	**5.6**	9	1,243	32,471	<0.1%	3.8%
MONO	0	24.4	0	0	0	0	0	24.4	**24.4**	36	450	10,874	0.3%	4.1%
MONTEREY	1.0	0	0	0	0	0	1.0	0	**1.0**	2	153	3,974	<0.1%	3.9%
NAPA*7	1.5	0	0	0	0	0	1.5	0	**1.5**	3	29	679	0.3%6	4.1%6
NEVADA	5.7	0	0	0	0	0	5.7	0	**5.7**	9	266	6,772	0.1%	3.9%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
PLACER3	218.7	0	0	0	0	0	218.7	0	**218.7**	320	912	15,522	2.1%	5.9%
PLUMAS	19.0	0	0	0	0	0	19.0	0	**19.0**	28	2,613	67,926	<0.1%	3.8%
RIVERSIDE	0	1.0	0	0	0	0	0	1.0	**1.0**	2	20	432	0.5%	4.6%
SACRAMENTO*	169.4	0	0	0	0.4	1.4	169.8	1.4	**171.2**	250	436	4,836	5.2%	9.0%
SAN BENITO4	0	0	0	0	0	0	0	0	**0**	0	13	329	0%	3.9%
SAN BERNARDINO	0	11.9	0	0	0	0	0	11.9	**11.9**	18	220	5,323	0.3%	4.1%

Table 3-13. North American Beaver Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	High Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	2.3	0	0	0	2.3	0	**2.3**	4	72	1,783	0.2%	4.0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN JOAQUIN	13.8	0	0	0	0	0	13.8	0	**13.8**	21	132	2,919	0.7%	4.5%
SAN LUIS OBISPO	0.2	0	0	0	0	0	0.2	0	**0.2**	1	79	2,055	<0.1%	3.8%
SAN MATEO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA CLARA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA CRUZ	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SHASTA	9.4	0	0	0	0	0	9.4	0	**9.4**	14	2,824	73,857	<0.1%	3.8%
SIERRA	6.5	0	0	0	0	0	6.5	0	**6.5**	10	363	9,269	0.1%	3.9%
SISKIYOU5	6.7	0	0	0	0	0	6.7	0	**6.7**	10	4,050	106,206	<0.1%	3.8%
SOLANO	7.8	0	0	0	0.3	0	8.1	0	**8.1**	12	265	6,606	0.2%	4.0%
SONOMA6, 7	1.8	0	0	0	0	0	1.8	0	**1.8**	3	3	0	0.3%6	4.1%6
STANISLAUS	31.0	0	0	0	0	0	31.0	0	**31.0**	46	120	1,947	2.4%	6.2%
SUTTER*	128.7	0	0	0	0	0	128.7	0	**128.7**	188	339	3,954	4.8%	8.6%
TEHAMA	0	43.7	0	0	0	0	0	43.7	**43.7**	64	806	19,502	0.3%	4.1%
TRINITY	0.3	0	0	0	0	0	0.3	0	**0.3**	1	1,098	28,875	0%	3.8%
TULARE	0	13.9	0	0	0	0	0	13.9	**13.9**	21	256	6,193	0.3%	4.1%
TUOLUMNE	0.3	0	0	0	0	0	0.3	0	**0.3**	1	280	7,332	<0.1%	3.8%
VENTURA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
YOLO*	162.5	0	0	0	0	0	162.5	0	**162.5**	238	326	2,284	10.4%	14.3%
YUBA	68.6	0	0	0	0.2	0	68.8	0	**68.8**	101	330	6,029	1.7%	5.5%
Total	**1,102.0**	**145.5**	**2.3**	**0**	**0.9**	**1.4**	**1,105.2**	**146.9**	**1,252.1**	**1,829**	**23,055**	**556,612**	**0.3%**	**4.1%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

* Population estimate is likely not accurate for these counties. See Section 3.2.12.2 for analysis.

1 Refer to Section 3.2.12.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.

2 A population estimate is provided for each county based on the methods described in detail in Appendix C13. The higher of the two population estimates described in Appendix C13 (i.e., using the home range method) is used here because the North American beaver range analysis by CDFW is outdated and underestimates the range of North American beaver in California. The higher population estimate is used here to address some of the underestimation caused by the constricted range estimate. The use of the higher population estimate addresses most of the population underestimation problems but not all; Sonoma County clearly has a North American beaver population based on wildlife damage management data from USDA-Wildlife Services in this county (it is not possible to remove North American beavers which do not exist), but the outdated range estimate from CDFW does not include this county, so the estimated population is zero. See text in this Report and Appendix C13 for more details.

3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.

4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.

5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.

6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

7 A regional analysis was conducted for these counties (Lake, Mendocino, Napa, and Sonoma; Marin would have been included but the estimated population is zero) to determine mortality as a percentage of the regional population, which is 0.31% under the Proposed Project and .1% cumulative mortality. These percentages were applied to all counties in this region (except Marin where the estimated population is zero and there is no estimated cumulative mortality).

3.2.13 North American Porcupine

The North American porcupine, hereafter porcupine, is an herbivorous mammal found throughout the Sierra Nevada and Cascades and south in the Coast Ranges, with scattered populations occurring in wooded habitats in the eastern Central Valley and Los Angeles and San Bernardino Counties (CWHR 2022). It is most common in forested areas consisting of montane conifer, alpine dwarf-shrub, and wet meadow habitats with a good understory of herbs, grasses, and shrubs, with open stands of conifers (CWHR 2022). In spring, it uses meadows and brushy and riparian habitats for feeding and in winter, it is restricted to forests (CWHR 2022). This species' diet shifts seasonally; in the spring and summer it feeds on herbs, shrubs, fruits, leaves, and buds and its winter diets consists of twigs, bark, and cambium of trees (CWHR 2022). This species uses caves, hollow logs, trees, and other animal burrows for cover and denning (CWHR 2022). North American porcupine is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for porcupine provided in Appendix C14, the estimated population size for California is 314,017 individuals. Also included in Appendix C14 are the population estimates of porcupine within each county.

No long-term sustainable harvest estimates were found for porcupines in the literature, despite an exhaustive search. For species without published sustainable harvest estimates, we can cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable. Still, they provide a guideline for comparing actual harvest rates. If we use the lowest rate reported by Robinson and Redford (1991), we can compare actual harvest rates to the theoretical maximum of 20%.

3.2.13.1 Previous Wildlife Damage Management

WDM for North American porcupine comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 1.2 porcupines were killed, 0.2 individuals were freed, 0.1 individuals were relocated, and 0.1 individuals underwent a transfer of custody per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 1.6 individuals per year based on the WS-California MIS data from 2010 to 2019.[34] WS-California MIS baseline WDM for porcupine occurred within two counties within the state with averages of 0.3 (Mendocino County) and 0.9 (Siskiyou County) individuals per year. Lethal WDM of porcupine accounts for 75% (1.2 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 25% (0.4 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-14) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California

34 Average includes activities that both intentionally and unintentionally affect porcupine and all potential methods used during WDM activities.

entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of porcupine is estimated at 2.52 individuals annually. This total is comprised of the WS-California lethal take of 1.2 individuals per year and the non-WS-California estimates for lethal take of 1.32 individuals per year (Table 3-14). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 314,017 individuals. The population estimate for each county is provided in Table 3-14. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide porcupine take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For porcupine, the average is 1.1,[35] the standard deviation is 1.7, and the 99% confidence high estimate is 5.6, which we rounded up to 6 individuals. The 99% Confidence Factor for porcupine was 6/1.1 = 5.45. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.13.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of porcupine under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 52 porcupines taken annually, which represents 0.01% of the population. The statewide modeled low population estimate for this species is approximately 314,017 individuals (Appendix C14). The population estimate for each county is provided in Table 3-14. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.3% (1 individual of 341 estimated county population; Santa Clara County). These numbers are all well below the sustainable harvest threshold of 20% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 52. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 47 individuals. The maximum number of porcupines taken by county-level programs are listed for each county in Table 3-14, under the “Proposed Project Maximum Lethal Take Estimate”

35 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-14. This small amount of error was accepted for this calculation.

column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Porcupines are known to damage some trees including cultivated fruit trees and ornamental trees; however, their effects on ecosystems are complex. Their actions benefit species that prefer herbaceous understory vegetation and more open tree canopy, but may adversely affect habitat for species that prefer a closed canopy forest (Cox *et al.* 2002). Therefore, lethal WDM of North American porcupine has the potential to alter local ecosystem conditions, especially related to canopy closure and understory composition. However, the very low levels of lethal WDM under the Project (generally 1 or fewer per year in any given county) are not expected to result in such indirect effects, and the individuals likely to be taken are those that are damaging cultivated trees rather than those in forest habitats.

3.2.13.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for porcupine predation to special-status species in California. As such, removal of this species under WDM activities would result in no direct benefits to species. Although porcupines are known to damage some trees including cultivated fruit trees and ornamental trees, their effects on ecosystems are complex. Their actions benefit species that prefer herbaceous understory vegetation and more open tree canopy, but may adversely affect habitat for species that prefer a closed canopy forest (Cox *et al.* 2002).

3.2.13.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill) and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-14).

Cumulative effects to porcupine are probably limited due to the generally remote areas where they occur (i.e., higher elevation montane conifer and wet meadow areas within the Coast Ranges, Klamath Mountains, southern Cascades, Modoc Plateau, Sierra Nevada, and Transverse Ranges) and preference for wooded cover. While their quills help protect it from predation, it Is known to be predated by foxes, bobcats, coyotes, dogs, black bear (Brown and Babb 2009), mountain lion (Sweitzer *et al.* 1997), owls and eagles (Olendorff 1976), but primarily by fishers (USFS 2009; Osburn and Cramer 2013) and likely marten where they co-occur with porcupine.

Anthropogenic factors that can affect North American porcupine are habitat loss from development and climate change, and disruption by human activities such as timber harvest. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in North American porcupine quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase North American porcupine mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of North American porcupine in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Trapping of North American porcupine has not been recorded during the 2010-2019 baseline period in California (CDFW 2020). Trapping of North American porcupine for fur is no longer legal in California for most trap types (California AB 273, 09/04/2019); therefore, any lethal removal of North American porcupine that historically occurred under trapping licenses is not likely to contribute to cumulative mortality as of 2019. Similarly, hunting of North American porcupine has not been recorded in California during the 2010-2019 baseline period. The analysis assumes that any hunting of North American porcupine, if it does occur, is negligible and does not result in cumulative effects to this species.

The number of North American porcupines killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Therefore, we estimated North American porcupine mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. Exposure to pesticides is likely to be low for this species based on its typical diet of herbaceous plants in forest ecosystems. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.01%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-14. Cumulative mortality was 3.8% statewide and ranged from 0% to 4.6% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for less than 0.01% (52 of 11,936 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 1,187 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed less than 0.01% of this cumulative mortality (5 of 1,187 individuals). The county with the highest percentage of cumulative mortality is Merced County: 4.6% of the population (0.4 individuals. Maximum lethal WDM under the Proposed Project contributed 0% of this cumulative mortality (0 of 0.4 individuals). Maximum cumulative mortality estimates for North American porcupine statewide and in each county are all well below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-14.

Table 3-14. Annual Average North American Porcupine Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	126	3,308	<0.1%	3.8%
AMADOR	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	101	2,655	<0.1%	3.8%
BUTTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	239	6,263	<0.1%	3.8%
CALAVERAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	193	5,076	<0.1%	3.8%
COLUSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	33	858	0.1%	3.8%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
DEL NORTE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	215	5,645	<0.1%	3.8%
EL DORADO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	360	9,452	<0.1%	3.8%
FRESNO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	498	13,083	<0.1%	3.8%
GLENN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	74	1,925	<0.1%	3.8%
HUMBOLDT	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	618	16,246	<0.1%	3.8%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
INYO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	88	2,291	<0.1%	3.8%
KERN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	360	9,455	<0.1%	3.8%
KINGS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LAKE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	220	5,779	<0.1%	3.8%
LASSEN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	396	10,409	<0.1%	3.8%
LOS ANGELES	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	279	7,338	<0.1%	3.8%
MADERA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	255	6,701	<0.1%	3.8%
MARIN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	46	1,190	<0.1%	3.9%
MARIPOSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	276	7,242	<0.1%	3.8%
MENDOCINO	0.3	0	0	0	0	0	0.3	0	**0.3**	2	585	15,364	<0.1%	3.8%
MERCED	0	0	0	0	0	0	0	0	**0**	0	0.4	9	0%	4.6%
MODOC	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	279	7,327	<0.1%	3.8%
MONO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	161	4,213	<0.1%	3.8%
MONTEREY	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	123	3,233	<0.1%	3.8%
NAPA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	46	1,210	<0.1%	3.8%
NEVADA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	209	5,491	<0.1%	3.8%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0.0%
PLACER3	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	264	6,928	<0.1%	3.8%
PLUMAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	564	14,836	<0.1%	3.8%
RIVERSIDE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SACRAMENTO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	8	190	0.5%	4.2%
SAN BENITO4	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	36	944	0.1%	3.8%
SAN BERNARDINO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	138	3,608	<0.1%	3.8%

Table 3-14. Annual Average North American Porcupine Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	<0.1	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN FRANCISCO	0	<0.1	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN JOAQUIN	0	<0.1	0	0	0	0	0	0	**0**	0	0.3	8	0%	3.8%
SAN LUIS OBISPO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	166	4,368	<0.1%	3.8%
SAN MATEO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	27	708	0.1%	3.8%
SANTA BARBARA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	224	5,876	<0.1%	3.8%
SANTA CLARA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	13	341	0.3%	3.8%
SANTA CRUZ	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	40	1,047	0.1%	3.8%
SHASTA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	741	19,488	<0.1%	3.8%
SIERRA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	202	5,290	<0.1%	3.8%
SISKIYOU5	0	<0.1	0	0	0	0	0.9	0	**0.9**	5	1,187	31,207	<0.1%	3.8%
SOLANO	0	<0.1	0	0	0	0	0	0	**0**	0	0.6	14	0%	4.4%
SONOMA6	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	147	3,861	<0.1%	3.8%
STANISLAUS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	5	111	0.9%	4.5%
SUTTER	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	15	386	0.3%	3.9%
TEHAMA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	312	8,206	<0.1%	3.8%
TRINITY	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	760	19,973	<0.1%	3.8%
TULARE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	607	15,963	<0.1%	3.8%
TUOLUMNE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	444	11,664	<0.1%	3.8%
VENTURA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	196	5,138	<0.1%	3.8%
YOLO	0	<0.1	0	0	0	0	0	0	**0**	1	3	73	1.4%	4.1%
YUBA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	1	78	2,028	<0.1%	3.8%
Total	**1.2**	**1.3**	**0**	**0**	**0**	**0**	**1.2**	**1.3**	**2.5**	**52**	**11,936**	**314,017**	**<0.1%**	**3.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding. These cumulative mortality estimates were not round up due to the low population estimate. Rounding up would result in inaccurately high cumulative mortality estimates.
1 Refer to Section 3.2.13.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C14. The lower population estimate described in Appendix C14 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.14 Yellow-Bellied Marmot

Yellow-bellied marmot, hereafter marmot, is common in or near rocky areas in the Sierra Nevada Cascades and White Mountains (CWHR 2022). It prefers alpine dwarf-shrub, grassland, wet meadow, conifer and lodgepole pine forest habitats (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for this species to be lethally removed any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Marmot is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for marmot provided in Appendix C15, the estimated population size for California is 348,034 individuals. Also included in Appendix C15 are the population estimates of marmot within each county.

CDFW has not established sustainable harvest levels for marmot, nor have any literature sources. For species with no sustainable harvest threshold, we can cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for long-lived species, 20%, we can compare actual harvest rates to this conservative theoretical maximum.

3.2.14.1 Previous Wildlife Damage Management

WDM for marmot comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). However, over the baseline period, only lethal WDM was used for this species. Under the current WS-California efforts, WDM activities affected on average approximately 27.0 individuals per year based on the WS-California MIS data from 2010 to 2019.[36] WS-California MIS baseline WDM for marmots occurred within three counties across the state with averages at 0.2 individuals (0.7% of total WS-California WDM; El Dorado County), 2.4 individuals (8.9%; Alpine County), and 24.4 individuals (90.4%; Lassen County).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-15) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of marmot is estimated at 55.8 individuals annually. This total is comprised of the WS-California lethal take of 27.0 individuals per year and the non-WS-California estimates for lethal take of 28.8 individuals per year (Table 3-15). These estimates of WDM take were used to estimate

36 Average includes activities that both intentionally and unintentionally affect marmot and all potential methods used during WDM activities.

cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 348,034 individuals. The population estimate for each county is provided in Table 3-15. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide marmot take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For marmot, the average is 27,[37] the standard deviation is 38.66, and the 99% confidence high estimate is 126.73, which we rounded up to 127 individuals. The 99% Confidence Factor for marmot was 127/27 = 4.70. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.14.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of marmot under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 270 marmots taken annually, which represents 0.08% of the population. The statewide modeled low population estimate for this species is approximately 348,034 individuals (Appendix C15). The population estimate for each county is provided in Table 3-15. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.2% (115 individuals of 61,813 estimated county population; Lassen County). These numbers are all below 1% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 270. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 270 individuals. The maximum number of marmots taken by county-level programs are listed for each county in Table 3-15, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale removal of marmot would reduce prey availability for known predator species such as badgers, coyotes, foxes, eagles, owls, and wolverines (CWHR 2022; Johns and Armitage 1979). Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). Additionally, large-scale, or complete removal of marmot can potentially cause unpredictable and unforeseen changes in an

37 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-15. This small amount of error was accepted for this calculation.

ecosystem, reducing its resilience to stochastic (random) or other extrinsic factors such as a new invasive species, increased human presence, extreme weather events, or climate change. However, the Project's lethal WDM of marmots is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the very low percentage of marmots taken regionally and statewide (less than 0.1% annually).

3.2.14.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for marmot predation to special-status species in California. As such, removal of this species under WDM activities would result in no known benefit to natural biological resources.

3.2.14.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-15).

Other anthropogenic factors that can affect marmot are habitat loss from development and climate change, and disruption by human activities such as timber harvest. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in marmot quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase marmot mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of marmot in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Although marmot is a nongame species and not a focus of hunting activities, the California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). In 2015, CDFW documented hunting taking 2,765 individuals (0.8% of the statewide population) within 5 counties (i.e., 1,658 individuals in Fresno County, which represents 7% of the Fresno County population; 232 individuals in Lassen County, which represents 0.4% of the Lassen County population; 201 individuals in Modoc County, which represents 0.4% of the Modoc County population; 31 individuals in San Diego County; and 643 individuals in Siskiyou County, which represents 2.7% of the Siskiyou County population).

The number of marmots killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. Because they occur primarily within higher elevation and more remote areas with less vehicle traffic, they are likely less susceptible to vehicle collisions. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available marmot roadkill data in California. Therefore, we estimated marmot mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.08%); roadkill (1.2%); hunting (variable by county using 2014-2015 season data as described above); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-15. Cumulative mortality was 5.9% statewide and ranged from 0% to 11.2% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 1.3% (270 of 20,619 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Lassen County: 5.2% of the population (3,243 individuals). Maximum lethal WDM under the Proposed Project contributed 3.5% of this cumulative mortality (115 of 3,243 individuals). Maximum cumulative mortality estimates for marmot statewide and in each county are all well below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-15.

Table 3-15. Yellow-Bellied Marmot Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	2.4	0	0	0	0	0	2.4	0	**2.4**	12	618	11,967	0.1%	5.2%
AMADOR	0	0.2	0	0	0	0	0	0.2	**0.2**	1	92	1,790	<0.1%	5.1%
BUTTE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	60	1,172	<0.1%	5.1%
CALAVERAS	0	0.2	0	0	0	0	0	0.2	**0.2**	1	73	1,424	<0.1%	5.1%
COLUSA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
DEL NORTE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
EL DORADO	0.2	0	0	0	0	0	0.2	0	**0.2**	1	444	8,737	<0.1%	5.1%
FRESNO	0	2.5	0	0	0	0	0	2.5	**2.5**	12	2,859	23,477	<0.1%	12.2%
GLENN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
INYO	0	1.5	0	0	0	0	0	1.5	**1.5**	7	695	13,583	<0.1%	5.1%
KERN	0	0.2	0	0	0	0	0	0.2	**0.2**	1	82	1,594	<0.1%	5.1%
KINGS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LAKE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LASSEN	24.4	0	0	0	0	0	24.4	0	**24.4**	115	3,475	61,813	0.2%	5.6%
LOS ANGELES	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MADERA	0	0.8	0	0	0	0	0	0.8	**0.8**	4	380	7,431	<0.1%	5.1%
MARIN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MARIPOSA	0	0.3	0	0	0	0	0	0.3	**0.3**	2	160	3,129	<0.1%	5.1%
MENDOCINO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MERCED	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MODOC	0	5.1	0	0	0	0	0	5.1	**5.1**	24	2,611	47,139	<0.1%	5.5%
MONO	0	3.1	0	0	0	0	0	3.1	**3.1**	15	1,453	28,421	<0.1%	5.1%
MONTEREY	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
NAPA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
NEVADA	0	0.5	0	0	0	0	0	0.5	**0.5**	3	228	4,448	<0.1%	5.1%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
PLACER[2]	0	0.7	0	0	0	0	0	0.7	**0.7**	4	331	6,467	<0.1%	5.1%
PLUMAS	0	3.2	0	0	0	0	0	3.2	**3.2**	16	1,527	29,859	<0.1%	5.1%
RIVERSIDE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SACRAMENTO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN BENITO[3]	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN BERNARDINO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%

Table 3-15. Yellow-Bellied Marmot Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN JOAQUIN	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN LUIS OBISPO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN MATEO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA CLARA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SANTA CRUZ	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SHASTA	0	1.7	0	0	0	0	0	1.7	1.7	8	791	15,466	<0.1%	5.1%
SIERRA	0	0.9	0	0	0	0	0	0.9	0.9	5	420	8,205	<0.1%	5.1%
SISKIYOU[4]	0	2.6	0	0	0	0	0	2.6	2.6	13	1,877	24,130	<0.1%	7.8%
SOLANO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SONOMA[5]	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
STANISLAUS	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SUTTER	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
TEHAMA	0	0.5	0	0	0	0	0	0.5	0.5	3	236	4,609	<0.1%	5.1%
TRINITY	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
TULARE	0	3.0	0	0	0	0	0	3.0	3.0	14	1,405	27,476	<0.1%	5.1%
TUOLUMNE	0	1.7	0	0	0	0	0	1.7	1.7	8	803	15,696	<0.1%	5.1%
VENTURA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
YOLO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
YUBA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
Total	**27.0**	**28.8**	**0**	**0**	**0**	**0**	**27.0**	**28.8**	**55.8**	**270**	**20,619**	**348,034**	**<0.1%**	**5.9%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding. A population estimate is provided for each county based on the methods described in detail in Appendix C15. The lower population estimate described in Appendix C15 is used here to provide the most conservative effects analysis.

1 Refer to Section 3.2.12.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
3 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
4 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
5 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.15 Big-Eared Woodrat

Big-eared woodrat is common in California, found in both the Coast Ranges and interior, as well as along the western slope of the Sierra Nevada (CWHR 2022). This herbivorous non-game rodent consumes woody plants, fungi, flowers, grasses, and acorns, foraging and nesting on the ground or in vegetation in forests of moderate canopy and moderate to dense understory, as well as in chaparral habitats (CFGC Section 4150) (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for individuals to be lethally taken any time of year and in any number. Big-eared woodrat is considered a species of "Least Concern" by IUCN, and their global population trend is unknown (IUCN 2022). Based on the CDFW habitat modeling for big-eared woodrat provided in Appendix C16, the estimated population size for California is 44,017,269 individuals. Also included in Appendix C16 are the population estimates of big-eared woodrat within each county.

CDFW has not established sustainable harvest levels for big-eared woodrat, nor have any literature sources we are aware of. For species with no sustainable harvest threshold, we can cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for very short-lived species, 60%, we can compare actual harvest rates to this conservative theoretical maximum.

3.2.15.1 Previous Wildlife Damage Management

WDM for big-eared woodrat comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). However, over the baseline period, only lethal WDM was used for this species. Under the current WS-California efforts, WDM activities affected on average approximately 2.7 individuals per year based on the WS-California MIS data from 2010 to 2019.[38] WS-California MIS baseline WDM for big-eared woodrats occurred in two counties with averages of 0.1 (Tuolumne County) and 2.6 (San Diego County) individuals per year (Table 3-16). Most WS-California WDM for big-eared woodrat was for T&E species protection.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-16) according to the methods outlined in Section 2.4. WS-California states that woodrat take has increased since the analysis period (CY 2010-2019), which an approximately 10-fold increase in CY 2020 due to increased recognition of the threat of damage to nesting threatened and endangered bird species (T. Felix, pers. comm. 2022c). WS-California anticipates future take to be more similar to CY 2020 numbers than to those during the analysis period for this species. Therefore, we did not use the standard 99% Confidence Factor for big-eared woodrats and instead used a factor of 10 after rounding up the average to the next integer. This accounts for the more recent take numbers.

[38] Average includes activities that both intentionally and unintentionally affect big-eared woodrat and all potential methods used during WDM activities.

During the 10-year baseline period, statewide lethal take of big-eared woodrat is estimated at 2.9 individuals annually. This total is comprised of the WS-California lethal take of 2.7 individuals per year and the non-WS-California estimates for lethal take of 0.16 individuals per year (Table 3-16). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 44,017,269 individuals. The population estimate for each county is provided in Table 3-16. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

3.2.15.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of big-eared woodrat under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 290 big-eared woodrat taken annually, which represents less than 0.1% of the population. The statewide modeled low population estimate for this species is approximately 44,017,269 individuals (Appendix C16). The population estimate for each county is provided in Table 3-16. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 5.5% (10 individuals of 181 estimated county population; Santa Cruz County). The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 290. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 290 individuals. The maximum number of big-eared woodrats taken by county-level programs are listed for each county in Table 3-16, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale removal of big-eared woodrat would reduce prey availability for known predator species such as owls, coyotes, bobcats, hawks, and snakes and could potentially affect other small mammals, amphibians, and reptiles that are known to use woodrat stick houses (CWHR 2022). Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project's lethal WDM of big-eared woodrats is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the very low percentage of big-eared woodrats taken regionally and statewide (less than 0.01% annually).

3.2.15.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) that verified big-eared woodrat damage to special-status species in California. However, all WS-California take of this species was reported specifically as being for the protection of nesting threatened and endangered bird species (California least tern), so the potential for such damage is suspected. Lethal removal of big-eared woodrats under WDM activities could potentially result in a net benefit to native special-status avian species (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.2.15.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-16).

Other anthropogenic factors that can affect big-eared woodrat are habitat loss from development and climate change, and disruption by human activities such as cattle grazing which can remove cover and prescribed burns which can destroy big-eared woodrat stick houses (CWHR 2022). This Report does not directly assess the potential for these factors to add to anthropogenic mortality in big-eared woodrat quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase big-eared woodrat mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of big-eared woodrat in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Although big-eared woodrat is a nongame species and not a focus of hunting activities, the California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Trapping or hunting of big-eared woodrat has not been recorded during the 2010-2019 baseline period in California (CDFW 2020). Therefore, this analysis assumes that any trapping or hunting of big-eared woodrat, if it does occur, is negligible and does not result in cumulative effects to this species.

The number of big-eared woodrats killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available big-eared woodrat roadkill data in California. Therefore, we estimated big-eared woodrat mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.01%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-16. Cumulative mortality was 3.8% statewide and ranged from 0% to 9.4% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.02% (290 of 1,672,868 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is San Diego County: 221,796 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed 0.01% of this cumulative mortality (30 of 221,796 individuals). The county with the highest percentage of cumulative mortality is Santa Cruz County: 9.4% of the population (17 individuals). Maximum lethal WDM under the Proposed Project contributed 59% of this cumulative mortality (10 of 17 individuals). Maximum cumulative mortality estimates for big-eared woodrat statewide and in each county are all well below the conservative 60% sustainable harvest threshold estimated above. These data are presented in Table 3-16.

Table 3-16. Big-Eared Woodrat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
AMADOR	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	29,629	779,427	<0.1%	3.8%
BUTTE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
CALAVERAS	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	68,621	1,805,540	<0.1%	3.8%
COLUSA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
CONTRA COSTA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	108	2,558	0.4%	4.2%
DEL NORTE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
EL DORADO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	103,245	2,716,708	<0.1%	3.8%
FRESNO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	77,513	2,039,552	<0.1%	3.8%
GLENN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	10	671	17,376	<0.1%	3.9%
INYO	0	0	0	0	0	0	0	0	**0**	10	236	5,939	0.2%	4.0%
KERN	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	114,449	3,011,535	0%	3.8%
KINGS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LAKE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LASSEN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LOS ANGELES[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	157,855	4,153,802	<0.1%	3.8%
MADERA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	55,688	1,465,192	<0.1%	3.8%
MARIN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MARIPOSA	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	87,383	2,299,289	<0.1%	3.8%
MENDOCINO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MERCED	0	0	0	0	0	0	0	0	**0**	10	516	13,304	<0.1%	3.9%
MODOC	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MONO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MONTEREY[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	103,267	2,717,289	<0.1%	3.8%
NAPA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
NEVADA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
ORANGE[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	26,228	689,944	<0.1%	3.8%
PLACER[5]	0	0	0	0	0	0	0	0	**0**	0	0	2	0%	0%
PLUMAS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
RIVERSIDE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	138,001	3,631,328	<0.1%	3.8%
SACRAMENTO	0	0	0	0	0	0	0	0	**0**	10	851	22,123	<0.1%	3.8%
SAN BENITO[6]	0	0	0	0	0	0	0	0	**0**	10	83	1,903	0.5%	4.4%
SAN BERNARDINO	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	75,253	1,980,065	<0.1%	3.8%

Table 3-16. Big-Eared Woodrat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO[3]	0	<0.1	2.6	0	0	0	2.6	<0.1	**2.6**	30	221,796	5,835,939	<0.1%	3.8%
SAN FRANCISCO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SAN JOAQUIN	0	0	0	0	0	0	0	0	**0**	10	472	12,158	<0.1%	3.9%
SAN LUIS OBISPO[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	48,441	1,274,482	<0.1%	3.8%
SAN MATEO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA BARBARA[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	76,034	2,000,616	<0.1%	3.8%
SANTA CLARA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SANTA CRUZ	0	0	0	0	0	0	0	0	**0**	10	17	181	5.5%	9.4%
SHASTA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SISKIYOU[7]	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SOLANO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
SONOMA[8]	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
STANISLAUS	0	0	0	0	0	0	0	0	**0**	10	1,444	37,732	<0.1%	3.8%
SUTTER	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
TEHAMA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
TRINITY	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
TULARE	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	143,878	3,785,997	<0.1%	3.8%
TUOLUMNE[3]	0.1	0	0	0	0	0	0.1	0	**0.1**	10	96,068	2,527,837	<0.1%	3.8%
VENTURA[4]	0	<0.1	0	0	0	0	0	<0.1	**<0.1**	10	45,210	1,189,450	<0.1%	3.8%
YOLO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
YUBA	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
Total	**0.1**	**0.2**	**2.6**	**0**	**0**	**0**	**2.7**	**0.2**	**2.9**	**290**	**1,672,868**	**44,017,269**	**<0.1%**	**3.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
1 Refer to Section 3.2.15.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C16. The lower population estimate described in Appendix C16 is used here to provide the most conservative effects analysis.
3 This table reflects the addition of 0.1 big-eared woodrats per year by WS-California in San Diego (T&E species protection) and Tuolumne (County-Based CSA) Counties. MIS data showed the lethal take of 0.1 dusky-footed woodrat per year in these two counties, but California Department of Fish and Wildlife data show no suitable habitat in these counties. WS-California reported that these were species identification errors; this take was actually big-eared woodrat. The WS take has been removed from the dusky-footed woodrat table (T. Felix, pers. comm. 2022d).
4 These coastal counties with large big-eared woodrat populations include increased potential future take compared to prior take to protect nesting threatened and endangered bird species as suggested by WS-California (T. Felix, pers. comm. 2022c).
5 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
6 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
7 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
8 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.16 Dusky-Footed Woodrat

Dusky-footed woodrat is an herbivorous non-game mammal that is common throughout California throughout both the Coast Ranges and interior (CFGC Section 4150) (CWHR 2022). It is generally absent from cultivated land and open grasslands of the Central Valley (CWHR 2022). It prefers moderate canopy in a variety of habitats and feeds on woody plants, especially *Quercus*, *Alnus*, *and Sambucus* species when available (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for individuals to be lethally taken any time of year and in any number. Dusky-footed woodrat is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for dusky-footed woodrat provided in Appendix C17, the estimated population size for California is 80,987,432 individuals. Also included in Appendix C17 are the population estimates of dusky-footed woodrat within each county.

CDFW has not established sustainable harvest levels for dusky-footed woodrat, nor have any literature sources. For species with no sustainable harvest threshold, we can cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for very short-lived species, 60%, we can compare actual harvest rates to this conservative theoretical maximum.

3.2.16.1 Previous Wildlife Damage Management

WDM for dusky—footed comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 0.7 dusky-footed woodrats were killed and 0.7 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 1.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[39] WS-California MIS baseline WDM for dusky-footed woodrats occurred within one county – Lassen County – with an average of 0.7 individuals per year. Lethal WDM of dusky-footed woodrat accounts for 50% (0.7 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 50% (0.7 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-17) according to the methods outlined in Section 2.4. WS-California states that woodrat take has increased since the analysis period (CY 2010-2019), which an approximately 10-fold increase in CY 2020 due to increased recognition of the threat of damage to nesting threatened and endangered bird species (T. Felix, pers. comm. 2022c). WS-California anticipates future take to be more similar to CY 2020 numbers than to those during the analysis period for this species. Therefore, we did not use the standard 99% Confidence Factor for dusky-footed woodrats and instead used a factor of 10 after rounding up the average to the next integer. This accounts for the more recent take numbers.

39 Average includes activities that both intentionally and unintentionally affect dusky-footed woodrat and all potential methods used during WDM activities.

During the 10-year baseline period, statewide lethal take of dusky-footed woodrat including both the WS-California MIS data and non-WS-California estimates, is estimated at 1.5 individuals annually. This total is comprised of the WS-California lethal take of 0.7 individuals per year and the non-WS-California estimates for lethal take of 0.8 individuals per year (Table 3-17). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 80,987,432 individuals. The population estimate for each county is provided in Table 3-17. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

3.2.16.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of dusky-footed woodrat under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 410 dusky-footed woodrats taken annually, which represents less than 0.01% of the population. The statewide modeled low population estimate for this species is approximately 80,987,432 individuals (Appendix C17). The population estimate for each county is provided in Table 3-17. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.19% (10 individuals of 2,130 estimated county population; San Francisco County). These numbers are all below 1% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 410. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 410 individuals. The maximum number of dusky-footed woodrats taken by county-level programs are listed for each county in Table 3-17, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale removal of dusky-footed woodrat would reduce prey availability for known predator species such as owls, coyotes, bobcats, hawks, and snakes and could potentially affect other small mammals, amphibians, and reptiles that are known to use woodrat stick houses (CWHR 2022). Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project’s lethal WDM of dusky-footed woodrats is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the very low percentage of dusky-footed woodrats taken regionally and statewide (less than 0.01% annually).

3.2.16.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for dusky-footed woodrat damage to special-status species in California. As such, removal of this species under WDM activities would result in no known benefit to natural biological resources.

3.2.16.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-17).

Other anthropogenic factors that can affect dusky-footed woodrat are habitat loss from development and climate change, disruption by human activities such as cattle grazing which can remove cover, and prescribed burns which can destroy dusky-footed woodrat stick houses (CWHR 2022). This Report does not directly assess the potential for these factors to add to anthropogenic mortality in dusky-footed woodrat quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase dusky-footed woodrat mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of dusky-footed woodrat in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Although dusky-footed woodrat is a nongame species and not a focus of hunting activities, the California Fish and Game Commission allows for this species to be hunted or trapped at any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Trapping or hunting of dusky-footed woodrat has not been recorded during the 2010-2019 baseline period in California (CDFW 2020). Therefore, this analysis assumes that any trapping or hunting of dusky-footed woodrat, if it does occur, is negligible and does not result in cumulative effects to this species.

The number of dusky-footed woodrat killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but they are considered proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available dusky-footed woodrat roadkill data in California. Therefore, we estimated dusky-footed woodrat mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.01%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-17. Cumulative mortality was 3.8% statewide and ranged from 0% to 4% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.01% (410 of 3,077,888 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 335,100 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed to less than 0.01% of this cumulative mortality (10 of 335,100 individuals). The county with the highest percentage of cumulative mortality is San Francisco County: 4% of the population (205 individuals). Maximum lethal WDM under the Proposed Project contributed 4.9% of this cumulative mortality (10 of 205 individuals). Maximum cumulative mortality estimates for dusky-footed woodrat statewide and in each county are all well below the conservative 60% sustainable harvest threshold estimated above. These data are presented in Table 3-17.

Table 3-17. Dusky-Footed Woodrat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	18,637	490,166	<0.1%	3.8%
ALPINE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
AMADOR	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
BUTTE	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	66,641	1,753,428	<0.1%	3.8%
CALAVERAS	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
COLUSA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	39,985	1,051,971	<0.1%	3.8%
CONTRA COSTA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	14,292	375,833	<0.1%	3.8%
DEL NORTE	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	78,583	2,067,689	<0.1%	3.8%
EL DORADO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	36,655	964,330	<0.1%	3.8%
FRESNO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	28,623	752,962	<0.1%	3.8%
GLENN	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	49,037	1,290,177	<0.1%	3.8%
HUMBOLDT	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	262,499	6,907,591	<0.1%	3.8%
IMPERIAL	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
INYO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
KERN	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	6,462	169,780	<0.1%	3.8%
KINGS	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	2,657	69,636	<0.1%	3.8%
LAKE	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	105,796	2,783,818	<0.1%	3.8%
LASSEN	0.7	0	0	0	0	0	0.7	<0.1	<0.1	10	152,993	4,025,847	<0.1%	3.8%
LOS ANGELES	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MADERA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MARIN	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	23,322	613,452	<0.1%	3.8%
MARIPOSA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MENDOCINO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	288,202	7,583,993	<0.1%	3.8%
MERCED	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	10,646	279,877	<0.1%	3.8%
MODOC	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	86,847	2,285,165	<0.1%	3.8%
MONO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
MONTEREY	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	83,002	2,183,977	<0.1%	3.8%
NAPA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	50,954	1,340,609	<0.1%	3.8%
NEVADA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	48,519	1,276,537	<0.1%	3.8%
ORANGE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
PLACER4	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	58,889	1,549,423	<0.1%	3.8%
PLUMAS	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	23,414	615,884	<0.1%	3.8%
RIVERSIDE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SACRAMENTO	0	0	0	0	0	0	0	0	<0.1	0	30	788	0%	3.8%
SAN BENITO5	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	61,531	1,618,958	<0.1%	3.8%
SAN BERNARDINO	0	0	0	0	0	0	0	0	<0.1	0	0	0	0%	0%

Table 3-17. Dusky-Footed Woodrat Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
SAN DIEGO	0	0	0	0	0	0	0	0	<0.1	0	0	0	0%	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	<0.1	10	205	5,130	0.2%	4.0%
SAN JOAQUIN	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	3,975	104,338	<0.1%	3.8%
SAN LUIS OBISPO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	97,810	2,573,683	<0.1%	3.8%
SAN MATEO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	23,424	616,140	<0.1%	3.8%
SANTA BARBARA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	104,436	2,748,050	<0.1%	3.8%
SANTA CLARA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	66,791	1,757,369	<0.1%	3.8%
SANTA CRUZ	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	34,897	918,054	<0.1%	3.8%
SHASTA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	189,067	4,975,164	<0.1%	3.8%
SIERRA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	26,539	698,128	<0.1%	3.8%
SISKIYOU6	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	335,100	8,818,148	<0.1%	3.8%
SOLANO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	6,676	175,415	<0.1%	3.8%
SONOMA7	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	87,106	2,291,995	<0.1%	3.8%
STANISLAUS	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	27,079	712,338	<0.1%	3.8%
SUTTER	0	0	0	0	0	0	0	0	<0.1	0	0	0	0%	0%
TEHAMA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	139,533	3,671,646	<0.1%	3.8%
TRINITY	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	223,279	5,875,475	<0.1%	3.8%
TULARE	0	0	0	0	0	0	0	0	<0.1	0	0	0	0%	0%
TUOLUMNE3	0	0	0	0	0	0	0	0	<0.1	0	0	0	0%	0%
VENTURA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	68,004	1,789,305	<0.1%	3.8%
YOLO	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	19,420	510,784	<0.1%	3.8%
YUBA	0	<0.1	0	0	0	0	0	<0.1	<0.1	10	26,397	694,379	<0.1%	3.8%
Total	0.7	0.8	0	0	0	0	0.7	0.8	1.5	410	3,077,888	80,987,432	<0.1%	3.8%

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.16.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C17. The lower population estimate described in Appendix C17 is used here to provide the most conservative effects analysis.
3 WS-California MIS data showed the lethal take of 0.1 dusky-footed woodrat per year in this county, but California Department of Fish and Wildlife data show no suitable habitat in this county. WS-California reported that this was a species identification error; this take was actually big-eared woodrat. The WS take has been moved to the big-eared woodrat table (T. Felix, pers. comm. 2022d).
4 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
5 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
6 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
7 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.17 Black-Tailed Jackrabbit

Black-tailed jackrabbit is an herbivorous non-game mammal that occurs throughout California in herbaceous and desert-shrub areas and open, early stages of forest and chaparral habitats, except in the highest elevations (CFGC Section 4150) (CWHR 2022). This species is known to prefer grasses and forbs but will eat almost any vegetation that occurs in the area and their diet shifts with forage availability by season (CWHR 2022). Black-tailed jackrabbit is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Based on the CDFW habitat modeling for black-tailed jackrabbit provided in Appendix C18, the estimated population size for California is 7,236,205 individuals. Also included in Appendix C18 are the population estimates of black-tailed jackrabbit within each county.

No sustainable harvest rates were found for black-tailed jackrabbit reported in the literature, despite an exhaustive search. Sustainable harvest rates for other lagomorphs (rabbits and hares) are also very limited in the literature. However, Fergus (2006a, 2006b) reported a sustainable harvest rate of 40% for eastern cottontails (*Sylvilagus floridanus*). Marboutin *et al.* (2003) found sustainable harvest rates of 20-35% for European hare (*Lepus Europaeus*), depending on the post-breeding population size. More recently, Schai-Braun *et al.* (2020) suggested implementation of a 10% hunter harvest rate for European hare. This is a very low harvest rate for a species with high fecundity, but many European populations have been declining in recent years, and the species has been listed as "Threatened" or "near-Threatened" in many areas of Europe. For these reasons the 10% harvest rate was suggested as a conservation measure for this at-risk species (Schai-Braun *et al.* 2020). This 10% threshold is not applicable to black-tailed jackrabbit populations in California because black-tailed jackrabbit populations have been expanding and increasing in the United States (Brown *et al.* 2020). This is thought to be due to black-tailed jackrabbit's adaptability to human-altered environments (Brown *et al.* 2020). CDFW refers to black-tailed jackrabbits as "common" throughout most of the state and "abundant" at lower elevations with certain habitat types (CWHR 2022).

The smallest estimate found of sustainable harvest for a lagomorph species (20%) among those for stable populations was used (range: 20%–40%; the 10% suggestion was a protective measure for at-risk populations). These estimates are for different species (eastern cottontail, European hare), but these species have similar fecundity to black-tailed jackrabbits, and they represent the best available science. A rate of 20% is an extremely conservative estimate of sustainable harvest for black-tailed jackrabbits in California.

3.2.17.1 Previous Wildlife Damage Management

WDM for black-tailed jackrabbit comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, surveyed, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 591 black-tailed jackrabbits were killed, 119.5 individuals were dispersed, 1.4 individuals were freed, and 2.0 individuals were surveyed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 713.9 individuals per year based on the WS-California MIS data from 2010 to 2019.[40] WS-California MIS baseline WDM for black-tailed jackrabbit occurred within 14 counties across the state with averages ranging from 0.7 to 178.8 individuals per year; most baseline WDM activities (50.5% or 298.6 individuals) occurred within Alameda and Solano Counties.

40 Average includes activities that both intentionally and unintentionally affect black-tailed jackrabbit and all WDM methods used.

Lethal take of black-tailed jackrabbit accounts for 83% (591 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 17% (122.9 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-18) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of black-tailed jackrabbit is estimated at 1,178.3 individuals annually. This total is comprised of the WS-California lethal take of 591 individuals per year and the non-WS-California estimates for lethal take of 587.3 individuals per year (Table 3-18). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 7,236,205 individuals. The population estimate for each county is provided in Table 3-18. Approximately 0.02% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide black-tailed jackrabbit take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For black-tailed jackrabbit, the average is 590.5,[41] the standard deviation is 267.2, and the 99% confidence high estimate is 1,279.9, which we rounded up to 1,280 individuals. The 99% Confidence Factor for black-tailed jackrabbit was 1,280/590.5 = 2.17. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.17.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of black-tailed jackrabbit under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 2,587 black-tailed jackrabbits taken annually, which represents 0.04% of the population. The statewide modeled low population estimate for this species is approximately 7,236,205 individuals (Appendix C18). The population estimate for each county is provided in Table 3-18. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges

41 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-18. This small amount of error was accepted for this calculation.

from 0% (several counties) to 1.92% (680 individuals of 35,473 estimated county population; Alameda County). These numbers are all below the 20% threshold of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 2,587. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 2,587 individuals. The maximum number of black-tailed jackrabbits taken by county-level programs are listed for each county in Table 3-18 under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale or complete removal of black-tailed jackrabbit from the ecosystem has the potential to result in a trophic cascade because it is an important prey species for some predators like coyote (Giusti *et al.* 1992) and bobcat (Gashwiler *et al.* 1960), as well as hawks, owls, and snakes (CWHR 2022). This species is known to be preferred prey for golden eagle and other raptors (Smith and Murphy 1979). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project's lethal WDM of black-tailed jackrabbits is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the very low percentage of black-tailed jackrabbits taken regionally and statewide (less than 0.1% annually).

3.2.17.3 Potential Beneficial Effects of Wildlife Damage Management

There is documented MIS baseline data (2010-2019) on black-tailed jackrabbit causing adverse effects to the federal and state-listed California least tern in Alameda County. Black-tailed jackrabbits can pose a threat to California least terns by trampling their nests (perhaps unintentionally) and possibly predation (Marschalek 2008). As such, removal of black-tailed jackrabbits where California least terns are known to nest may result in a small net benefit to the California least tern (e.g., increased nest success).

3.2.17.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-18). Lethal removal of black-tailed jackrabbit for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

Other anthropogenic factors that can affect black-tailed jackrabbit are habitat loss from development and climate change, and disruption by human activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in black-tailed jackrabbit quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase black-tailed jackrabbit mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of black-tailed jackrabbit in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Black-tailed jackrabbit is a resident small game species and are taken by a variety of means with the general season being open all year with no bag limits. In 2015 CDFW documented hunting of 71,188 jackrabbits in 48 counties (approximately 1% of the statewide population) (Responsive Management 2015). In nine counties hunting affected more than 3,000 black-tailed jackrabbits (Amador, Inyo, Kern, Lassen, Modoc, San Bernardino, Siskiyou, Sonoma, Stanislaus), and hunting in Lassen affected more than 10,000 individuals. This species has not been commercially trapped for fur in California.

The number of black-tailed jackrabbits killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available black-tailed jackrabbit roadkill data in California. Therefore, we estimated black-tailed jackrabbit mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.04%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-18. Cumulative mortality was 5% statewide and ranged from 5% to 6.9% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, hunting and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.7% (2,587 of 366,274 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Inyo County: 28,050 individuals (5% of the population). Maximum lethal WDM under the Proposed Project contributed 0.02% of this cumulative mortality (5 of 28,050 individuals). The county with the highest percentage of cumulative mortality is Alameda County: 6.9% of the population (2,449 individuals. Maximum lethal WDM under the Proposed Project contributed 27.8% of this cumulative mortality (680 of 2,449 individuals). Maximum cumulative mortality estimates for black-tailed jackrabbit statewide and in each county are all well below the conservative 20% sustainable harvest threshold estimated above. These data are presented in Table 3-18.

Table 3-18. Black-Tailed Jackrabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0.1	0.1	0	178.7	134.0	178.8	134.1	**312.9**	680	2,449	35,473	1.9%	6.9%
ALPINE	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	236	3,778	<0.1%	6.2%
AMADOR	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	6,600	21,527	0%	30.7%
BUTTE	0	0.3	0	0	0	0	0	0.3	**0.3**	1	5,887	67,237	0%	8.8%
CALAVERAS	0	0.2	0	0	0	0	0	0.2	**0.2**	1	2,394	41,902	0%	5.7%
COLUSA	0	0.2	0	0	0	0	0	0.2	**0.2**	1	3,502	61,817	0%	5.7%
CONTRA COSTA	0	0.2	0	0	0	0	0	0.2	**0.2**	1	1,912	37,704	0%	5.1%
DEL NORTE	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	771	15,439	<0.1%	4.9%
EL DORADO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	2,166	36,903	0%	5.9%
FRESNO	0	1.0	0	0	0	0	0	1.0	**1.0**	3	13,141	244,587	0%	5.4%
GLENN	0	0.3	0	0	0	0	0	0.3	**0.3**	1	4,008	71,093	0%	5.6%
HUMBOLDT	0	0.2	0	0	0	0	0	0.2	**0.2**	1	3,028	56,339	0%	5.4%
IMPERIAL	0	0.9	0	0	0	0	0	0.9	**0.9**	2	11,984	228,406	0%	5.2%
INYO	0	2.2	0	0	0	0	0	2.2	**2.2**	5	31,138	562,454	0%	5.5%
KERN	11.3	0	0	0	22.2	7.8	33.5	7.8	**41.3**	90	26,256	464,255	<0.1%	5.7%
KINGS	0	0.3	0	0	5.0	0.6	5.0	0.9	**5.9**	13	4,837	83,799	<0.1%	5.8%
LAKE	0	0.2	0	0	0	0	0	0.2	**0.2**	1	3,272	53,838	0%	6.1%
LASSEN	0	0.9	0	0	0	0	0	0.9	**0.9**	2	21,698	233,271	0%	9.3%
LOS ANGELES	0	0.9	0	0	55.8	55.8	55.8	56.7	**112.5**	245	13,737	230,847	0.1%	6.0%
MADERA	0	0.3	0	0	0	0	0	0.3	**0.3**	1	4,892	86,999	0%	5.6%
MARIN	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	1,088	21,785	0%	5.0%
MARIPOSA	0	0.2	0	0	0	0	0	0.2	**0.2**	1	2,537	50,846	0%	5.0%
MENDOCINO	0	0.3	0	0	0	0	0	0.3	**0.3**	1	5,641	74,283	0%	7.6%
MERCED	0	0.4	0	0	2.2	2.9	2.2	3.3	**5.5**	12	6,014	110,617	<0.1%	5.4%
MODOC	0	0.8	0	0	0	0	0	0.8	**0.8**	2	14,122	203,961	0%	6.9%
MONO	0	0.5	0	0	0	0	0	0.5	**0.5**	2	7,176	132,339	0%	5.4%
MONTEREY	0.9	0	0	0	0	0	0.9	0	**0.9**	2	9,527	175,452	0%	5.4%
NAPA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	2,274	34,478	0%	6.6%
NEVADA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	1,099	18,604	<0.1%	5.9%
ORANGE	0	0.2	0	0	0	0	0	0.2	**0.2**	1	2,371	47,518	0%	5.0%
PLACER[3]	0	0.1	0	0	0	0	0	0.1	**0.1**	1	1,946	37,135	0%	5.2%
PLUMAS	0	0.2	0	0	0	0	0	0.2	**0.2**	1	2,710	54,314	0%	5.0%
RIVERSIDE	0	1.6	0	0	0	0	0	1.6	**1.6**	4	21,842	415,972	0%	5.3%
SACRAMENTO	0	0.2	0	0	84.3	295.1	84.3	295.3	**379.6**	824	3,878	58,344	1.4%	6.6%
SAN BENITO[4]	0.7	0	0	0	0	0	0.7	0	**0.7**	2	4,077	78,884	0%	5.2%
SAN BERNARDINO	0	4.6	0	0	0.9	2.3	0.9	6.9	**7.8**	17	66,533	1,194,824	0%	5.6%

Table 3-18. Black-Tailed Jackrabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	0	1.0	0	0	8.0	12.2	8.0	13.2	**21.2**	46	12,855	246,020	<0.1%	5.2%
SAN FRANCISCO	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	136	2,703	<0.1%	5.0%
SAN JOAQUIN	0	0.3	0	0	0	0	0	0.3	**0.3**	1	5,295	84,375	0%	6.3%
SAN LUIS OBISPO	0	0.7	0	0	0	0	0	0.7	**0.7**	2	10,853	191,694	0%	5.7%
SAN MATEO	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	896	17,949	<0.1%	5.0%
SANTA BARBARA	0	0.6	0	0	0	0	0	0.6	**0.6**	2	8,197	143,283	0%	5.7%
SANTA CLARA	0	0.2	0	0	77.9	42.5	77.9	42.7	**120.6**	262	3,024	55,393	0.5%	5.5%
SANTA CRUZ	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	503	10,063	<0.1%	5.0%
SHASTA	0	0.5	0	0	0	0	0	0.5	**0.5**	2	6,965	122,179	0%	5.7%
SIERRA	0	<0.1	0	0	0	0	0	<0.1	<0.1	1	649	12,690	<0.1%	5.1%
SISKIYOU[5]	0	0.8	0	0	0	0	0	0.8	**0.8**	2	12,821	193,997	0%	6.6%
SOLANO	0.3	0	0	0	119.5	9.2	119.8	9.2	**129.0**	280	3,824	43,403	0.7%	8.8%
SONOMA[6]	0	0.2	0	0	0	0	0	0.2	**0.2**	1	7,653	56,675	0%	13.5%
STANISLAUS	0	0.3	0	0	0	0	0	0.3	**0.3**	1	7,882	88,878	0%	8.9%
SUTTER	1.2	0	0	0	0	0	1.2	0	**1.2**	3	1,931	35,361	<0.1%	5.5%
TEHAMA	0	0.5	0	0	0	0	0	0.5	**0.5**	2	7,008	137,089	0%	5.1%
TRINITY	0	0.2	0	0	0	0	0	0.2	**0.2**	1	4,061	54,596	0%	7.4%
TULARE	0	0.6	0	0	0	0	0	0.6	**0.6**	2	9,908	162,256	0%	6.1%
TUOLUMNE	0	0.2	0	0	0	0	0	0.2	**0.2**	1	2,218	41,042	0%	5.4%
VENTURA	0	0.4	0	0	0	0	0	0.4	**0.4**	1	5,530	103,551	0%	5.3%
YOLO	0	0.2	0	0	0	0	0	0.2	**0.2**	1	3,774	57,540	0%	6.6%
YUBA	0	0.1	0	0	22.0	0	22.0	0.1	**22.1**	48	1,869	28,445	0.2%	6.6%
Total	**14.4**	**24.9**	**0.1**	**0**	**576.5**	**562.4**	**591.0**	**587.3**	**1,178.3**	**2,587**	**434,595**	**7,236,205**	**<0.1%**	**1.7%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.17.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C18. Only one population estimate was provided for black-tailed jackrabbits because they are not territorial and home range-based estimate is not applicable to non-territorial animals.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.18 Desert Cottontail Rabbit

The desert cottontail rabbit, also known as Audubon's cottontail (*Sylvilagus audubonii*), is an herbivorous game mammal that inhabits most of the southern two-thirds of California, excluding the higher elevations (CFGC Section 3950) (CWHR 2022). Its range extends north into the Sacramento Valley and surrounding foothills (CWHR 2022). This species is abundant to common in grasslands, open forests, and desert shrub habitats, and found in more open habitats than brush habitats (CWHR 2022). This species' diet consists of a wide variety of grasses, forbs, tree and shrub leaves, twigs, fallen fruit, acorns, and tender bark (CWHR 2022). There is another cottontail species in California, the Nuttall's cottontail (*Sylvilagus nuttallii*), which occurs between 4,500 feet and 10,500 feet within Inyo, Mono, Alpine, Placer, Nevada, Sierra, Plumas, Lassen, Siskiyou, and Modoc Counties (CWHR 2022); however, none of the Proposed Project's WDM activities occurred within the range of Nuttall's cottontail. Therefore, Nuttall's cottontail is not included in our analyses. Another related California rabbit species in the genus *Sylvilagus* is the brush rabbit (*Sylvilagus bachmani*); WDM has been conducted within the range of brush rabbit, and this species is analyzed separately in Section 3.2.19.

Desert cottontail rabbit is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Based on the CDFW habitat modeling for desert cottontail provided in Appendix C19, the estimated population size for California is 25,644,085 individuals. Also included in Appendix C19 are the population estimates of desert cottontail within each county.

No long-term sustainable harvest estimate is available for desert cottontail. However, Fergus (2006a, 2006b) reported a sustainable harvest rate of 40% for eastern cottontails (*Sylvilagus floridanus*), a closely related species (same genus). This analysis will use the 40% threshold to estimate sustainable harvest for desert cottontail.

3.2.18.1 Previous Wildlife Damage Management

WDM for desert cottontail comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). This analysis of desert cottontail WDM is based on two WS-California MIS datasets. The first dataset is WDM for desert cottontail. However, a second, more generic species designation was also included in those MIS data: "cottontail." Because we were unable to verify whether these data refer to desert cottontail or brush rabbit, we included all WDM for "cottontail" for both species. The summary data we report therefore double counts this WDM. But at a species level, this was necessary to determine potential impacts to these two target species. All of the WDM data reported for desert cottontail includes all WDM for both "desert cottontail" and "cottontail."

During the 10-year WS-California MIS baseline, an average of 526.2 desert cottontails were killed, 150.8 individuals were dispersed, and 21.6 individuals were freed per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 698.6 individuals per year.[42] WS-California MIS baseline WDM for desert cottontail occurred within 15 counties across the state with averages ranging from 0.3 to 159.2 individuals per year; most baseline WS-California WDM (48.9% or 257.1 individuals) occurred within Kings and Los Angeles County. Lethal take of desert cottontail accounts for 75% (526.2 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 25% (172.4 individuals per year).

42 Average includes activities that both intentionally and unintentionally affect desert cottontail and all potential WDM methods used by WS-California.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-19) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of desert cottontail is estimated at 26,502.1 individuals annually. This total is comprised of the WS-California lethal take of 526.2 individuals per year and the non-WS-California estimates for lethal take of 25,975.2 individuals per year (Table 3-19). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 25,644,085 individuals. The population estimate for each county is provided in Table 3-19. Approximately 0.1% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide desert cottontail take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this document, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For desert cottontail, the average is 523.6,[43] the standard deviation is 318.44, and the 99% confidence high estimate is 1,345.17, which we rounded up to 1,346 individuals. The 99% Confidence Factor for desert cottontail was 1,346/523.6 = 2.57. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.18.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of desert cottontail under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 68,111 desert cottontail taken annually, which represents 0.3% of the population. The statewide modeled low population estimate for this species is approximately 25,644,085 individuals (Appendix C19). The population estimate for each county is provided in Table 3-19. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.4% (525 individual of 120,208 estimated county population; Yuba County). These numbers are all well below the sustainable harvest threshold of 40% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

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43 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-19. This small amount of error was accepted for this calculation.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 4,180. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 4,180 individuals. The maximum number of desert cottontails taken by county-level programs are listed for each county in Table 3-19, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale or complete removal of desert cottontail from the ecosystem, which is not the goal of modern WDM, has the potential to result in a trophic cascade because it is an important prey species for predators such as foxes, coyotes, bobcats, weasels, hawks, eagles, and owls (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project's lethal WDM of desert cottontails is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the percentage of desert cottontails taken regionally, statewide, and cumulatively by the Project is below the sustainable harvest threshold of 40%.

3.2.18.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010-2019) for desert cottontail damage to special-status species in California. As such, removal of this species under WDM activities would result in no known benefit to natural biological resources.

3.2.18.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-19). Lethal removal of desert cottontail for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

Other anthropogenic factors that can affect desert cottontail are habitat loss from development and climate change, and disruption by human activities. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in black-tailed jackrabbit quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase black-tailed jackrabbit mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of desert cottontail in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Desert cottontail is a resident small game species in California, and the season is open between July and January with some exceptions to protect sensitive species. There is a 5 per day, 10 in possession bag limit. In 2015, CDFW documented hunting taking 65,610 individuals (0.2% of the statewide population). Ten counties had no desert cottontail hunter harvest (i.e., Alameda, Contra Costa, Del Norte, Lake, Marin, Mariposa, Orange, San Francisco, San Mateo, and Tuolumne), 30 counties reported a hunter harvest between 15 and 774 individuals each, and 18 counties had a hunter harvest of more than 1,000 individuals each. Desert cottontail has not been commercially trapped for fur in California.

The number of cottontails taken by hunters during the 2014-2015 season was used to estimate the number of desert cottontail hunter harvest in the future. This estimate is expected to be very conservative because the hunter harvest in 2014-2015 was for all cottontails, which includes brush rabbit. Because we cannot determine how much of each species comprises this total, we applied the total to each species.

Desert cottontails are very tolerant of human activity (CWHR 2022) likely making them highly susceptible to collisions with vehicles. The number of desert cottontail killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available desert cottontail roadkill data in California. Therefore, we estimated desert cottontail mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.3%); hunting (variable by county using 2014-2015 season data as described above); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-19. Cumulative mortality was 4.7% statewide and ranged from 0% to 6.9% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 5.6% (68,111 of 1,213,017 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is San Bernardino: 237,696 individuals (4.5% of the population). Maximum lethal WDM under the Proposed Project contributed 5.9% of this cumulative mortality (14,059 of 237,696 individuals). The county with the highest percentage of cumulative mortality is Mono County: 6.9% of the population (2,870 individuals). Maximum lethal WDM under the Proposed Project contributed 3.8% of this cumulative mortality (108 of 2,870 individuals). Maximum cumulative mortality estimates for desert cottontail statewide and in each county are all well below the conservative 40% sustainable harvest threshold estimated above. These data are presented in Table 3-19.

Table 3-19. Desert Cottontail Rabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0.1	181.4	1.1	0	0	0	1.2	181.4	**182.6**	470	7,828	181,416	0.3%	4.3%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
AMADOR	0	81.2	0	0	0	0	0	81.2	**81.2**	209	3,626	81,189	0.3%	4.5%
BUTTE	0	254.8	0	0	0	0	0	254.8	**254.8**	655	11,848	254,803	0.3%	4.6%
CALAVERAS	0.4	141.0	0	0	0	0	0.4	141.0	**141.4**	364	6,417	141,035	0.3%	4.5%
COLUSA	0	250.6	0	0	0	0	0	250.6	**250.6**	645	11,849	250,635	0.3%	4.7%
CONTRA COSTA	0	187.7	0	0	0	0	0	187.7	**187.7**	483	8,096	187,687	0.3%	4.3%
DEL NORTE	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
EL DORADO	0	95.3	0	0	0	0	0	95.3	**95.3**	245	4,388	95,283	0.3%	4.6%
FRESNO	0	1,022.6	0	0	0	0	0	1,022.6	**1,022.6**	2,629	49,269	1,022,606	0.3%	4.8%
GLENN	0	251.3	0	0	0	0	0	251.3	**251.3**	646	11,178	251,273	0.3%	4.4%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
IMPERIAL	0.7	1,013.9	0	0	0	0	0.7	1,013.9	**1,014.6**	2,608	50,822	1,013,872	0.3%	5.0%
INYO	0	2,267.1	0	0	0	0	0	2,267.1	**2,267.1**	5,827	101,449	2,267,145	0.3%	4.5%
KERN	0	2,012.7	0	0	0	0	0	2,012.7	**2,012.7**	5,173	101,662	2,012,653	0.3%	5.1%
KINGS	0	370.8	0	0	159.2	19.9	159.2	390.7	**549.9**	1,414	21,113	370,786	0.4%	5.7%
LAKE	0	8.9	0	0	0	0	0	8.9	**8.9**	23	386	8,926	0.3%	4.3%
LASSEN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
LOS ANGELES	0	999.8	0	0	97.2	97.2	97.2	1,097.0	**1,194.2**	3,070	46,138	999,822	0.3%	4.6%
MADERA	0	331.9	0	0	0	0	0	331.9	**331.9**	854	15,577	331,929	0.3%	4.7%
MARIN	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MARIPOSA	0	155.9	0	0	0	0	0	155.9	**155.9**	401	6,726	155,946	0.3%	4.3%
MENDOCINO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MERCED	0	491.6	0	0	10.1	13.5	10.1	505.1	**515.2**	1,324	21,881	491,553	0.3%	4.5%
MODOC	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MONO	0	41.7	0	0	0	0	0	41.7	**41.7**	108	2,870	41,698	0.3%	6.9%
MONTEREY	1.2	855.0	0	0	0	0	1.2	855.0	**856.2**	2,201	42,171	854,997	0.3%	4.9%
NAPA	0	31.6	0	0	0	0	0	31.6	**31.6**	82	1,696	31,591	0.3%	5.4%
NEVADA	0	44.7	0	0	0	0	0	44.7	**44.7**	115	2,238	44,700	0.3%	5.0%
ORANGE	0	212.5	0	0	3.5	0.8	3.5	213.3	**216.8**	558	9,176	212,464	0.3%	4.3%
PLACER[3]	0	111.9	0	0	0	0	0	111.9	**111.9**	288	5,075	111,902	0.3%	4.5%
PLUMAS	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
RIVERSIDE	0	1,841.5	0	0	0	0	0	1,841.5	**1,841.5**	4,733	86,933	1,841,480	0.3%	4.7%
SACRAMENTO	0	258.3	0	0	0.3	1.1	0.3	259.4	**259.7**	668	11,944	258,278	0.3%	4.6%
SAN BENITO[4]	3.7	364.2	0	0	0	0	3.7	364.2	**367.9**	946	18,812	364,204	0.3%	5.2%
SAN BERNARDINO	1.0	5,280.0	0	0	53.4	135.9	54.4	5,415.9	**5,470.3**	14,059	237,696	5,279,987	0.3%	4.5%

Table 3-19. Desert Cottontail Rabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	1.9	1,095.6	0.3	0	0	0	2.2	1,095.6	**1,097.8**	2,822	56,246	1,095,637	0.3%	5.1%
SAN FRANCISCO	0	12.2	0	0	0	0	0	12.2	**12.2**	32	527	12,185	0.3%	4.3%
SAN JOAQUIN	0	375.8	0	0	0	0	0	375.8	**375.8**	966	20,946	375,750	0.3%	5.6%
SAN LUIS OBISPO	0.4	885.9	0.2	0	32.2	42.9	32.8	928.8	**961.6**	2,472	40,565	885,899	0.3%	4.6%
SAN MATEO	0	85.4	0	0	0	0	0	85.4	**85.4**	220	3,683	85,363	0.3%	4.3%
SANTA BARBARA	0	663.6	0	0	0	0	0	663.6	**663.6**	1,706	31,073	663,648	0.3%	4.7%
SANTA CLARA	0	317.8	0	0	0	0	0	317.8	**317.8**	817	14,303	317,804	0.3%	4.5%
SANTA CRUZ	0	47.6	0	0	0	0	0	47.6	**47.6**	123	2,332	47,600	0.3%	4.9%
SHASTA	0	175.5	0	0	0	0	0	175.5	**175.5**	452	8,239	175,521	0.3%	4.7%
SIERRA	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SISKIYOU[5]	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SOLANO	0	188.2	0	0	0	0	0	188.2	**188.2**	484	8,428	188,199	0.3%	4.5%
SONOMA[6]	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
STANISLAUS	0	404.0	0	0	0	0	0	404.0	**404.0**	1,039	18,164	404,023	0.3%	4.5%
SUTTER	0	156.4	0	0	0	0	0	156.4	**156.4**	403	7,062	156,434	0.3%	4.5%
TEHAMA	0	526.9	0	0	0	0	0	526.9	**526.9**	1,355	22,912	526,911	0.3%	4.3%
TRINITY	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
TULARE	0	626.5	0	0	0	0	0	626.5	**626.5**	1,611	31,102	626,506	0.3%	5.0%
TUOLUMNE	0	87.6	0	0	0	0	0	87.6	**87.6**	226	3,779	87,589	0.3%	4.3%
VENTURA	0	456.4	0	0	75.3	20.5	75.3	476.9	**552.2**	1,420	23,751	456,390	0.3%	5.2%
YOLO	0	258.6	0	0	0	0	0	258.6	**258.6**	665	15,424	258,556	0.3%	6.0%
YUBA	0	120.2	0	0	84.0	0	84.0	120.2	**204.2**	525	5,617	120,208	0.4%	4.7%
Total	**9.4**	**25,644.1**	**1.6**	**0**	**515.2**	**331.8**	**526.2**	**25,975.9**	**26,502.1**	**68,111**	**1,213,017**	**25,644,085**	**0.3%**	**4.7%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.18.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C19. The lower population estimate described in Appendix C19 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.19 Brush Rabbit

Brush rabbit (*Sylvilagus bachmani*) is an herbivorous game mammal that is an abundant, yearlong resident of dense, brushy areas and of early successional stages of oak and conifer habitats (CFGC Section 3950) (CWHR 2022). It occurs throughout the length of California west of the Sierra Nevada, excluding the dry Central Valley and southern arid regions, extending from sea level to about 3,000 feet (CWHR 2022). Brush rabbit is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for brush rabbit provided in Appendix C20, the estimated population size for California is 11,508,386 individuals. Also included in Appendix C20 are the population estimates of brush rabbit within each county.

The riparian brush rabbit (*Sylvilagus bachmani riparius*) is a federally and state-listed endangered subspecies of the more common brush rabbit. The subspecies inhabits riparian vegetation communities that contain large patches of dense, brushy understory that are proximate to open areas dominated by grasses and herbs (USFWS 2020a). The riparian brush rabbit subspecies occurs only in the following three locations: Caswell Memorial State Park adjacent to the Stanislaus River in San Joaquin County; within the Mossdale Oxbow Preserve along the San Joaquin River outside of Lathrop, California; and the San Joaquin River National Wildlife Refuge in Stanislaus County (reintroduced from breeding pens at the White Slough Wildlife Area) (USFWS 2020a; CDFW 2022g). None of the existing WDM activities occurred within the range of the riparian brush rabbit (CWHR 2022). Therefore, the riparian brush rabbit is not analyzed further in this document.

No long-term sustainable harvest estimate is available for brush rabbit. However, Fergus (2006a, 2006b) reported a sustainable harvest rate of 40% for eastern cottontails (*Sylvilagus floridanus*), a closely related species (same genus). This analysis use the 40% rate to estimate sustainable harvest for brush rabbit.

3.2.19.1 Previous Wildlife Damage Management

Some of the MIS data do not distinguish between brush rabbit and desert cottontail rabbit. Therefore, all lethal WDM targeting "cottontail rabbit" is included in the brush rabbit analysis and also in the desert cottontail analysis (the other common cottontail rabbit in California) because we cannot verify which of these species was taken.

WDM for brush rabbit comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 140.2 brush rabbits were killed, 150.8 individuals were dispersed, and 21.6 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 312.6 individuals per year based on the WS-California MIS data from 2010 to 2019.[44] WS-California MIS baseline WDM for brush rabbit occurred within 12 counties across the state with averages ranging from 0.1 to 62.1 individuals per year; the largest portion of baseline WDM activities (85% or 119.1 individuals) occurred within Kings and Yuba Counties. Lethal WDM of brush rabbit accounts for 44.8% (140.2 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 55.2% (172.4 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-20) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also

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44 Average includes activities that both intentionally and unintentionally affect brush rabbit and all potential methods used during WDM activities.

included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of brush rabbit is estimated at 11,671.3 individuals annually. This total is comprised of the WS-California lethal take of 140.2 individuals per year and the non-WS-California estimates for lethal take of 11,531.1 individuals per year (Table 3-20). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is 11,508,386 individuals. The population estimate for each county is provided in Table 3-20. Approximately 0.02% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide brush rabbit take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For brush rabbit, the average is 137.6,[45] the standard deviation is 119.7, and the 99% confidence high estimate is 446.5, which we rounded up to 447 individuals. The 99% Confidence Factor for brush rabbit was 447/137.6 = 3.25. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.19.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of brush rabbit under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 37,957 brush rabbits taken annually, which represents 0.3% of the population. The statewide modeled low population estimate for this species is approximately 11,508,386 individuals (Appendix C20). The population estimate for each county is provided in Table 3-20. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 1.12% (295 individual of 26,379 estimated county population; Kings County). These numbers are all well below the sustainable harvest threshold of 40% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 37,957.

45 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-20. This small amount of error was accepted for this calculation.

The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 37,957 individuals. The maximum number of brush rabbits taken by county-level programs are listed for each county in Table 3-20, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Large-scale or complete removal of brush rabbit from the ecosystem, which is not the goal of modern WDM, has the potential to result in a trophic cascade because it is an important prey species for predators such as bobcats, coyotes, gray foxes, long-tailed weasels, minks, spotted skunks, striped skunks, red tailed hawks, Cooper’s hawks, barn owls, rattlesnakes, and gopher snakes (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project’s lethal WDM of brush rabbits is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the percentage of brush rabbits taken regionally, statewide, and cumulatively by the Project is below the sustainable harvest threshold of 40%.

3.2.19.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented WS-California MIS data (2010-2019) documenting brush rabbit damage to special-status species in California. As such, removal of this species for WDM would result in no known benefit to natural biological resources.

3.2.19.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-20).

Other anthropogenic factors that can affect brush rabbit are habitat loss from development and climate change, and disruption by human activities that remove areas of brushy cover. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in brush rabbit quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase brush rabbit mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of brush rabbits in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

The number of cottontails taken by hunters during the 2014-2015 season was used to estimate the number of desert cottontail hunter harvest in the future. This estimate is expected to be very conservative because the hunter harvest in 2014-2015 was for all cottontails, which includes brush rabbit. Because we cannot determine how much of each species comprises this total, we applied the total to each species with the exception of counties outside the range of the species or where desert cottontail would vastly outnumber brush rabbit (Imperial and Kings counties). In 2015, CDFW documented hunting taking 54,846 individuals (0.5% of the statewide population). Ten counties had no brush rabbit hunter harvest (i.e., Alameda, Contra Costa, Del Norte, Lake, Marin, Mariposa, Orange, San Francisco, San Mateo, and Tuolumne), 30 counties reported a hunter harvest between 15 and 774 individuals each, and 18 counties had a hunter harvest of more than 1,000 individuals each. Brush rabbit has not been commercially trapped for fur in California.

The number of brush rabbits killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available brush rabbit roadkill data in California. Therefore, we estimated brush rabbit mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.3%); hunting (variable by county using 2014-2015 season data as described above) roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-20. Cumulative mortality was 4.6% statewide and ranged from 0% to 12.7% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 7.2% (37,957 of 524,197 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is San Diego County: 39,130 individuals (4.7% of the population). Maximum lethal WDM under the Proposed Project contributed 7.0% of this cumulative mortality (2,735 of 39,130 individuals). The county with the highest percentage of cumulative mortality is San Joaquin County: 12.7% of the population (3,506 individuals). Maximum lethal WDM under the Proposed Project contributed 8.4% of this cumulative mortality (295 of 3,506 individuals). Maximum cumulative mortality estimates for brush rabbit statewide and in each county are all well below the conservative 40% sustainable harvest threshold estimated above. These data are presented in Table 3-20.

Table 3-20. Brush Rabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0.1	153	0	0	0	0	0.1	152.9	**153.0**	498	6,310	152,938	0.3%	4.1%
ALPINE	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
AMADOR	0	66	0	0	0	0	0	65.8	**65.8**	214	2,779	65,845	0.3%	4.2%
BUTTE	0	132	0	0	0	0	0	132.5	**132.5**	431	5,895	132,494	0.3%	4.4%
CALAVERAS	0	141	0	0	0	0	0	140.8	**140.8**	458	5,974	140,769	0.3%	4.2%
COLUSA	0	107	0	0	0	0	0	106.6	**106.6**	347	4,918	106,618	0.3%	4.6%
CONTRA COSTA	0	129	0	0	0	0	0	128.6	**128.6**	418	5,304	128,576	0.3%	4.1%
DEL NORTE	0	56	0	0	0	0	0	55.6	**55.6**	181	2,295	55,609	0.3%	4.1%
EL DORADO	0	127	0	0	0	0	0	126.6	**126.6**	412	5,361	126,563	0.3%	4.2%
FRESNO	0	330	0	0	0	0	0	330.3	**330.3**	1,074	16,207	330,271	0.3%	4.9%
GLENN	0	241	0	0	0	0	0	240.6	**240.6**	782	10,096	240,613	0.3%	4.2%
HUMBOLDT	0	224	0	0	0	0	0	223.9	**223.9**	728	9,328	223,865	0.3%	4.2%
IMPERIAL	0.7	2	0	0	0	0	0.7	2.1	**2.8**	10	91	2,106	0.5%	4.3%
INYO	0	0	0	0	0	0	0	0	0	0	1,835	0	0%	0%
KERN	0	441	0	0	0	0	0	440.7	**440.7**	1,433	25,610	440,725	0.3%	5.8%
KINGS	0	26	0	0	57	7.1	57.0	33.5	**90.5**	295	1,298	26,379	1.1%	4.9%
LAKE	0	222	0	0	0	0	0	222.1	**222.1**	722	9,163	222,107	0.3%	4.1%
LASSEN	0	0	0	0	0	0	0	0	0	0	1,010	0	0%	0%
LOS ANGELES	0	675	0	0	2.3	2.3	2.3	677.0	**679.3**	2,208	29,106	674,737	0.3%	4.3%
MADERA	0	133	0	0	0	0	0	133.0	**133.0**	433	6,117	132,999	0.3%	4.6%
MARIN	0	98	0	0	0	0	0	98.3	**98.3**	320	4,058	98,345	0.3%	4.1%
MARIPOSA	0	202	0	0	0	0	0	201.8	**201.8**	656	8,326	201,818	0.3%	4.1%
MENDOCINO	0	261	0	0	0	0	0	261.4	**261.4**	850	10,876	261,387	0.3%	4.2%
MERCED	0	104	0	0	10.1	13.5	10.1	117.5	**127.6**	415	4,676	103,957	0.4%	4.5%
MODOC	0	0	0	0	0	0	0	0	0	0	124	0	0%	0%
MONO	0	0	0	0	0	0	0	0	0	0	535	0	0%	0%
MONTEREY	1.2	783	0	0	0	0	1.2	783.0	**784.2**	2,549	34,949	782,984	0.3%	4.5%
NAPA	0	145	0	0	0	0	0	144.6	**144.6**	470	6,132	144,615	0.3%	4.2%
NEVADA	0	62	0	0	0	0	0	61.9	**61.9**	202	2,710	61,898	0.3%	4.4%
ORANGE	0	209	0	0	0.1	0	0.1	209.0	**209.1**	680	8,623	209,015	0.3%	4.1%
PLACER[3]	0	76	0	0	0	0	0	76.4	**76.4**	249	3,277	76,411	0.3%	4.3%
PLUMAS	0	11	0	0	0	0	0	11.2	**11.2**	37	525	11,187	0.3%	4.7%
RIVERSIDE	0	568	0	0	0	0	0	567.5	**567.5**	1,845	27,167	567,517	0.3%	4.8%
SACRAMENTO	0	13	0	0	0	0	0	12.8	**12.8**	42	930	12,821	0.3%	7.3%
SAN BENITO[4]	3.7	347	0	0	0	0	3.7	346.5	**350.2**	1,139	15,854	346,513	0.3%	4.6%
SAN BERNARDINO	1	209	0	0	0	0	1.0	209.1	**210.1**	683	13,374	209,112	0.3%	6.4%

Table 3-20. Brush Rabbit Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	1.6	840	0.2	0	0	0	1.8	839.5	**841.3**	2,735	39,130	839,511	0.3%	4.7%
SAN FRANCISCO	0	12	0	0	0	0	0	11.9	**11.9**	39	491	11,887	0.3%	4.1%
SAN JOAQUIN	0	28	0	0	0	0	0	27.5	**27.5**	90	3,506	27,508	0.3%	12.7%
SAN LUIS OBISPO	0	814	0.1	0	0	0	0.1	813.7	**813.8**	2,645	34,645	813,657	0.3%	4.3%
SAN MATEO	0	78	0	0	0	0	0	77.5	**77.5**	252	3,199	77,530	0.3%	4.1%
SANTA BARBARA	0	619	0	0	0	0	0	618.9	**618.9**	2,012	26,757	618,933	0.3%	4.3%
SANTA CLARA	0	242	0	0	0	0	0	242.0	**242.0**	787	10,282	242,017	0.3%	4.2%
SANTA CRUZ	0	43	0	0	0	0	0	43.3	**43.3**	141	1,926	43,303	0.3%	4.4%
SHASTA	0	320	0	0	0	0	0	320.2	**320.2**	1,041	13,542	320,164	0.3%	4.2%
SIERRA	0	11	0	0	0	0	0	10.8	**10.8**	36	462	10,798	0.3%	4.3%
SISKIYOU[5]	0	234	0	0	0	0	0	234.0	**234.0**	761	9,708	233,993	0.3%	4.1%
SOLANO	0	59	0	0	0	0	0	58.9	**58.9**	192	2,588	58,947	0.3%	4.4%
SONOMA[6]	0	228	0	0	0	0	0	227.8	**227.8**	741	9,557	227,844	0.3%	4.4%
STANISLAUS	0	111	0	0	0	0	0	111.3	**111.3**	362	4,963	111,346	0.3%	4.5%
SUTTER	0	0	0	0	0	0	0	0	0	0	157	0	0%	0%
TEHAMA	0	564	0	0	0	0	0	563.8	**563.8**	1,833	23,352	563,836	0.3%	4.1%
TRINITY	0	165	0	0	0	0	0	165.0	**165.0**	537	7,583	165,045	0.3%	4.6%
TULARE	0	243	0	0	0	0	0	242.9	**242.9**	790	12,060	242,873	0.3%	5.0%
TUOLUMNE	0	122	0	0	0	0	0	121.6	**121.6**	396	5,015	121,551	0.3%	4.1%
VENTURA	0	385	0	0	0	0	0	385.0	**385.0**	1,252	17,793	385,019	0.3%	4.6%
YOLO	0	47	0	0	0	0	0	47.3	**47.3**	154	4,087	47,277	0.3%	8.6%
YUBA	0	55	0	0	62.1	0	62.1	54.6	**116.7**	380	2,561	54,552	0.7%	4.7%
Total	**8.3**	**11,513**	**0.3**	**0**	**131.6**	**22.9**	**140.2**	**11,531.1**	**11,671.3**	**37,957**	**524,197**	**11,508,386**	**0.3%**	**4.5%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.19.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C20. The lower population estimate described in Appendix C20 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.20 California Ground Squirrel

California ground squirrel is common throughout California, excluding parts of the Basin Ranges and the Mojave and Colorado Desert regions (CWHR 2022). This species is widespread throughout almost all habitats in earlier successional stages, using openings and disturbed areas along roadsides, in croplands, and in grazed meadows from sea level to about 11,000 feet in elevation (CWHR 2022). This omnivorous non-game rodent eats seeds, nuts, fruits, bulbs, fungi, grasses and forbs, sometimes eating insects, bird eggs, and carrion (CFGC Section 4150) (CWHR 2022). Cover is provided by burrows excavated in friable soils and can be elaborate, with cup-shaped nests of dried vegetation for reproduction (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for damaging individuals to be lethally taken any time of year and in any number. California ground squirrel is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for California ground squirrel provided in Appendix C22, the estimated population size for California is 138,496,766 individuals. Also included in Appendix C22 are the population estimates of California ground squirrel within each county.

No long-term sustainable harvest estimates for California ground squirrel were found in the literature, despite an exhaustive search. For species without published sustainable harvest estimates, we can cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for short-lived species, 40%, we can compare actual harvest rates to this theoretical maximum. This rate is applied cautiously by using the next lowest rate from Robinson and Redford (1991); California ground squirrel would be considered a "very short lived" species by their criteria, but we used the more conservative threshold for "short-lived" species. The only publication we found that discussed harvest rates was Grinnell and Dixon (1919), which stated that a 90% annual reduction in the population would not recover for 2 years, which means it is not sustainable. They also noted that a 99% reduction would not recover until 3 years. These recovery rates are faster than those reported for coyotes in Pitt *et al.* (2001), which can reportedly withstand a 50% annual harvest rate without impact to the population. These data suggest that our 40% sustainable harvest rate for California ground squirrel is conservative.

3.2.20.1 Previous Wildlife Damage Management

WDM for California ground squirrel comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 6,584 California ground squirrels were killed (including the 855.1 individuals estimated to be killed within burrows that were removed/destroyed), 156.7 individuals were dispersed, and 15.5 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 6,757.2 individuals per year based on the WS-California MIS data from 2010 to 2019.[46] WS-California MIS baseline WDM for California ground squirrel occurred within 31 counties within the state with averages ranging from 0.1 to 1,835.3 individuals per year; the largest portion of baseline WDM activities (47.5% or 3,125.9 individuals) occurred within Contra Costa and Kings Counties. Lethal WDM of California ground squirrel

46 Average includes activities that both intentionally and unintentionally affect California ground squirrel and all potential methods used during WDM activities.

accounts for 97% (6,583 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 3% (172.2 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-21) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species in their homes (i.e., rodent/pest control) without involving WS-California or another WDM entity. Therefore, an additional 100 or 200 California ground squirrels per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (whether the county has less than 10,000 estimated population or more than 10,000 estimate population, respectively) (Table 3-21). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of California ground squirrel is estimated at 21,060.7 individuals annually. This total is comprised of the WS-California lethal take of 6,584 individuals per year and the non-WS-California estimates for lethal take of 14,476.7 individuals per year (Table 3-21). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 138,496,766 individuals. The population estimate for each county is provided in Table 3-21. Approximately 0.01% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide California ground squirrel take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For California ground squirrel, the average is 6,206.3,[47] the standard deviation is 1,220.86, and the 99% confidence high estimate is 9,356.12, which we rounded up to 9,357 individuals. The 99% Confidence Factor for California ground squirrel was 9,357/6,206.3 = 1.51. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.20.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of California ground squirrel under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 31,801 California ground squirrel taken

[47] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-21. This small amount of error was accepted for this calculation.

annually, which represents 0.01% of the population. The statewide modeled low population estimate for this species is approximately 138,496,766 individuals (Appendix C22). The population estimate for each county is provided in Table 3-21. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (Mono County) to 0.15% (3,077 individuals of 947,980 estimated county population; Contra Costa County). These numbers are all below 1% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 31,801 . The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 31,801 individuals. The maximum number of California ground squirrels taken by county-level programs are listed for each county in Table 3-21, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

California ground squirrels are important prey for many carnivores (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). Similarly, large-scale removal of California ground squirrel could alter habitat structure and burrow availability for other species that occupy abandoned small mammal burrows (e.g., burrowing owl, snakes) (CWHR 2022). For example, ground squirrels may provide a keystone function for burrowing owl by creating burrow systems that the owls can use as a nesting resource (Lenihan 2007) and by providing predator alert services to burrowing owls (Henderson and Trulio 2019). However, the Project's lethal WDM of California ground squirrel is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the percentage of California ground squirrels taken regionally, statewide, and cumulatively by the Project is below the sustainable harvest threshold of 40%.

3.2.20.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are documented MIS baseline data (2010–2019) on California ground squirrel predation to the federal-listed and state Species of Special Concern snowy plover in San Diego County, California. California ground squirrels have been recorded causing damage to and predating upon California least tern and snowy plover eggs at shorebird nesting sites on North Beach at Camp Pendleton, contributing to increased nest abandonment and reduced survival rates (Butchko and Small 1992). As such, removal of this species under WDM activities may result in a net benefit to special-status avian shorebirds (e.g., increased survival rate).

3.2.20.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-21). Lethal removal of California ground squirrel for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

Other anthropogenic factors that can affect California ground squirrel are habitat loss from development and climate change, and disruption by human activities that remove areas of friable soil. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in California ground squirrel quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase California ground squirrel mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of California ground squirrel in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

California ground squirrel hunting was estimated statewide for the 2014-2015 season, with an estimated 376,703 individuals killed by hunters (0.3% of the statewide population) (Responsive Management 2015). This total is very conservative because it includes all species of squirrels included in the Responsive Management 2015 report (i.e., western gray, tree squirrel, eastern fox squirrel, eastern gray squirrel, and unknown squirrel) as it may be that hunters included California ground squirrels to their harvest totals (Responsive Management 2015). California ground squirrel has not been commercially trapped for fur in California.

The number of California ground squirrel killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available California ground squirrel roadkill data in California. Therefore, we estimated California ground squirrel mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.02%); hunting (variable by county using 2014-2015 season data as described above); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-21. Cumulative mortality was 3.8% statewide and ranged from 0% to 4.1% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, hunting and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.6% (31,801 of 5,294,679 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 8,207,839 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed 3.8% of this cumulative mortality (312,506 of 8,207,839 individuals). The county with the highest percentage of cumulative mortality is Imperial County: 4.1% of the population (50,343 individuals). Maximum lethal WDM under the Proposed Project contributed 4.1% of this cumulative mortality (2,069 of 50,343 individuals). Maximum cumulative mortality estimates for California ground squirrel statewide and in each county are all well below the conservative 40% sustainable harvest threshold estimated above. These data are presented in Table 3-21.

Table 3-21. California Ground Squirrel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate[6]	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	200	0.4	2.4	413.9	310.4	414.3	512.8	**927.1**	1,400	37,231	942,915	0.2%	3.9%
ALPINE	0	0	0	0	0	0	0	0	**0**	155	4,492	114,130	0.1%	3.9%
AMADOR	4.4	200	0	2.4	0	0	4.4	202.4	**206.8**	313	27,855	724,779	<0.1%	3.8%
BUTTE	26.8	200	0	2.4	0	0	26.8	202.4	**229.2**	347	81,253	2,129,101	<0.1%	3.8%
CALAVERAS	21.5	200	0	2.4	0	0	21.5	202.4	**223.9**	339	51,566	1,348,065	<0.1%	3.8%
COLUSA	4.7	200	0	2.4	0	0	4.7	202.4	**207.1**	313	56,958	1,490,638	<0.1%	3.8%
CONTRA COSTA	1,835.3	200	0	2.4	0	0	1,835.3	202.4	**2,037.7**	3,077	39,101	947,980	0.3%	4.1%
DEL NORTE	0	224	0	2.4	0	0	0	226.4	**226.4**	342	44,227	1,154,858	<0.1%	3.8%
EL DORADO	0	200	0	2.4	0	0	0	202.4	**202.4**	306	79,049	2,072,169	<0.1%	3.8%
FRESNO	0	321.2	0	2.4	0	0	0	323.6	**323.6**	489	222,169	5,833,673	<0.1%	3.8%
GLENN	0	236.3	0	2.4	0	0	0	238.7	**238.7**	361	66,730	1,746,534	<0.1%	3.8%
HUMBOLDT	0	200	0	2.4	0	0	0	202.4	**202.4**	306	147,823	3,882,009	<0.1%	3.8%
IMPERIAL	0	100	0	2.4	0	0	0	102.4	**102.4**	155	2,069	50,343	0.3%	4.1%
INYO	0	214	0	2.4	0	0	0	216.4	**216.4**	327	25,914	673,331	<0.1%	3.8%
KERN	8.0	200	0	2.4	0	0	8.0	202.4	**210.4**	318	294,596	7,744,137	<0.1%	3.8%
KINGS	0	238.2	0	2.4	1,290.6	161.3	1,290.6	401.9	**1,692.5**	2,556	72,511	1,840,909	0.1%	3.9%
LAKE	0	200	0	2.4	0	0	0	202.4	**202.4**	306	63,271	1,656,971	<0.1%	3.8%
LASSEN	4.7	200	0	2.4	0	0	4.7	202.4	**207.1**	313	232,441	6,108,614	<0.1%	3.8%
LOS ANGELES	0	284	0	2.4	428.4	428.4	428.4	714.8	**1,143.2**	1,727	155,417	4,044,465	<0.1%	3.8%
MADERA	33.3	200	0	2.4	0	0	33.3	202.4	**235.7**	356	79,342	2,078,559	<0.1%	3.8%
MARIN	0	213.9	0	2.4	0	0	0	216.3	**216.3**	327	25,665	666,787	<0.1%	3.8%
MARIPOSA	0	200	0	2.4	0	0	0	202.4	**202.4**	306	58,323	1,526,740	<0.1%	3.8%
MENDOCINO	2.0	200	0	2.4	0	0	2.0	202.4	**204.4**	309	144,617	3,797,564	<0.1%	3.8%
MERCED	0.4	200	0	2.4	9.9	13.2	10.3	215.6	**225.9**	342	94,275	2,471,916	<0.1%	3.8%
MODOC	0	200	0	2.4	0	0	0	202.4	**202.4**	306	203,999	5,360,334	<0.1%	3.8%
MONO	0	0	0	0	0	0	0	0	**0**	0	0	0	0%	0%
MONTEREY	2.3	200	0	2.4	183.1	91.6	185.4	294.0	**479.4**	724	169,931	4,452,809	<0.1%	3.8%
NAPA	0	200	0	2.4	0	0	0	202.4	**202.4**	306	37,454	977,569	<0.1%	3.8%
NEVADA	0	200	0	2.4	0	0	0	202.4	**202.4**	306	45,906	1,199,992	<0.1%	3.8%
ORANGE	0	222.2	0	2.4	0	0	0	224.6	**224.6**	340	41,014	1,070,343	<0.1%	3.8%
PLACER[3]	0	200	0	2.4	0	0	0	202.4	**202.4**	306	71,051	1,861,691	<0.1%	3.8%
PLUMAS	1.5	200	0	2.4	0	0	1.5	202.4	**203.9**	308	130,158	3,417,084	<0.1%	3.8%
RIVERSIDE	0	266.6	0	2.4	0	0	0	269.0	**269.0**	407	122,181	3,204,566	<0.1%	3.8%
SACRAMENTO	0	200	0	2.4	72.5	253.8	72.5	456.2	**528.7**	799	49,869	1,291,298	<0.1%	3.9%
SAN BENITO[4]	2.0	200	0	2.4	0	0	2.0	202.4	**204.4**	309	71,493	1,873,250	<0.1%	3.8%
SAN BERNARDINO	5.5	240.8	0	2.4	156.1	397.3	161.6	640.5	**802.1**	1,212	75,827	1,963,531	<0.1%	3.9%

Table 3-21. California Ground Squirrel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate[6]	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	67.4	200	337.9	2.4	53.7	82.1	459.0	284.5	**743.5**	1,123	173,599	4,538,840	<0.1%	3.8%
SAN FRANCISCO	0	101.3	0	0	0	0	0	101.3	**101.3**	153	2,520	62,271	0.3%	4.0%
SAN JOAQUIN	38.9	200	0	2.4	0	0	38.9	202.4	**241.3**	365	71,703	1,877,305	<0.1%	3.8%
SAN LUIS OBISPO	45.2	200	31.2	2.4	0	0	76.4	202.4	**278.8**	421	166,369	4,367,048	<0.1%	3.8%
SAN MATEO	0	210.8	0	2.4	0	0	0	213.2	**213.2**	322	20,035	518,743	<0.1%	3.9%
SANTA BARBARA	0.1	200	0	2.4	0	0	0.1	202.4	**202.5**	306	131,184	3,444,148	<0.1%	3.8%
SANTA CLARA	0	235.4	0.3	2.4	683.4	372.8	683.7	610.6	**1,294.3**	1,955	66,747	1,705,050	0.1%	3.9%
SANTA CRUZ	0	209	0	2.4	0	0	0	211.4	**211.4**	320	16,804	433,788	<0.1%	3.9%
SHASTA	2.2	200	0	2.4	0	0	2.2	202.4	**204.6**	309	193,319	5,079,201	<0.1%	3.8%
SIERRA	0	200	0	2.4	0	0	0	202.4	**202.4**	306	47,807	1,250,022	<0.1%	3.8%
SISKIYOU5	0	400	0	2.4	0	0	0	402.4	**402.4**	608	312,506	8,207,839	<0.1%	3.8%
SOLANO	0	200	0	2.4	103.2	7.9	103.2	210.3	**313.5**	474	38,427	998,747	<0.1%	3.8%
SONOMA6	0	200	0	2.4	0	0	0	202.4	**202.4**	306	73,236	1,919,196	<0.1%	3.8%
STANISLAUS	3.4	200	0	2.4	0	0	3.4	202.4	**205.8**	311	76,775	2,012,198	<0.1%	3.8%
SUTTER	0	200	0	2.4	0	0	0	202.4	**202.4**	306	30,115	784,426	<0.1%	3.8%
TEHAMA	0	282.2	0	2.4	0	0	0	284.6	**284.6**	430	150,767	3,956,211	<0.1%	3.8%
TRINITY	0	200	0	2.4	0	0	0	202.4	**202.4**	306	161,494	4,241,781	<0.1%	3.8%
TULARE	0.6	306.5	0	2.4	0	0	0.6	308.9	**309.5**	468	195,255	5,125,949	<0.1%	3.8%
TUOLUMNE	11.7	200	0	2.4	0	0	11.7	202.4	**214.1**	324	62,518	1,636,664	<0.1%	3.8%
VENTURA	0	251.1	33.4	2.4	608.8	166.0	642.2	419.5	**1,061.7**	1,604	95,142	2,461,518	<0.1%	3.9%
YOLO	2.6	200	0	2.4	0	0	2.6	202.4	**205.0**	310	50,820	1,329,189	<0.1%	3.8%
YUBA	2.0	200	0	2.4	50.7	0	52.7	202.4	**255.1**	385	31,811	826,976	<0.1%	3.8%
Total	**2,126.5**	**12,057.5**	**403.2**	**134.4**	**4,054.3**	**2,284.8**	**6,584.0**	**14,476.7**	**21,060.7**	**31,802**	**5,294,680**	**138,496,766**	**<0.1%**	**3.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding. Additional non-WS lethal take at the county level was estimated by WS-California because they assessed that our methods of estimating non-WS take likely did not account for most of the WDM take of this species, which is expected to occur mostly by individual property owners.
[1] Refer to Section 3.2.20.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
[2] A population estimate is provided for each county based on the methods described in detail in Appendix C22. The lower population estimate described in Appendix C22 is used here to provide the most conservative effects analysis.
[3] Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
[4] San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
[5] Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
[6] Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.21 Western Gray Squirrel

Western gray squirrel is an omnivorous small game rodent that occurs in mature stands of most conifer, hardwood, and mixed hardwood-conifer habitats in the Klamath, Cascade, Transverse, Peninsular, and Sierra Nevada Ranges, as well as in riparian stands within the Sacramento Valley (CFGC Section 4150) (CWHR 2022). This opportunistic feeder varies diet with availability of seasonal and local foods, fungi, pine nuts, acorns, fruits forbs, and leaves (CWHR 2022). They use mature tree stands for nests and require cavities in trees and snags (CWHR 2022). Western gray squirrel is considered a species of "Least Concern" by IUCN, though their global population trend is unknown (IUCN 2022). Based on the CDFW habitat modeling for western gray squirrel provided in Appendix C23, the estimated population size for California is 6,335,022 individuals. Also included in Appendix C23 are the population estimates of western gray squirrel within each county.

No sustainable harvest threshold for western gray squirrel was found in the literature despite an intensive search. Sustained hunter harvest of 45.1% of a population of eastern gray squirrels (*Sciurus carolinensis*), a closely related species (same genus), apparently had a detrimental effect on the population, although most of this effect was due to lower mast crop production (Nixon *et al.* 1975). In fact, in a year when mast crop production was high, an even higher level of hunter harvest (53.2%) had no impact on the population; the population nearly doubled after that harvest. These data suggest that 45-53% harvest can be sustainable for eastern gray squirrels, depending on the availability of food resources (Nixon *et al.* 1975). The hunter harvest of 47.6% of another related squirrel (fox squirrel; *Sciurus niger*) population over 7 years was apparently not sustainable; it led to increased immigration and decreased population density (Nixon *et al.* 1975).

For species with no sustainable harvest threshold, we can also cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for short-lived species, 40%, we can compare actual harvest rates to this theoretical maximum. This rate is applied cautiously by using the next lowest rate from Robinson and Redford (1991); western gray squirrel would be considered a "very short lived" species by their criteria, but we used the more conservative threshold for "short-lived" species. The data above for eastern gray squirrel and fox squirrel support this determination; a 40% harvest rate for western gray squirrel is likely sustainable.

3.2.21.1 Previous Wildlife Damage Management

WDM for western gray squirrel comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 18.4 western gray squirrels were killed, 0.7 individuals were freed, and 0.3 individuals underwent a transfer of custody per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 19.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[48] WS-California MIS baseline WDM for western gray squirrel occurred within eight counties within the state with averages ranging from 0.1 to 11.5 individuals per year; most baseline WDM activities (62.5% or 11.5

[48] Average includes activities that both intentionally and unintentionally affect western gray squirrel and all potential methods used during WDM activities.

individuals) occurred within Placer County. Lethal WDM of western gray squirrel accounts for 94.9% (18.4 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 5.1% (1.0 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-22) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species in their homes (i.e., rodent/pest control) without involving WS-California or another WDM entity. Therefore, an additional 50 or 100 western gray squirrels per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (whether the county has less than 100,000 estimated population or more than 100,000 estimate population, respectively) (Table 3-22). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of western gray squirrel is estimated at 3,421 individuals annually. This total is comprised of the WS-California lethal take of 18.4 individuals per year and the non-WS-California estimates for lethal take of 3,303.1 individuals per year (Table 3-22). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 6,335,022 individuals. The population estimate for each county is provided in Table 3-22. Approximately 0.05% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide western gray squirrel take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this document, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For western gray squirrel the average is 13.8,[49] the standard deviation is 29.52, and the 99% confidence high estimate is 89.96, which we rounded up to 90 individuals. The 99% Confidence Factor for western gray squirrel was 13.8/90 = 6.52. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

49 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-22. This small amount of error was accepted for this calculation.

3.2.21.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of western gray squirrel under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 22,309 western gray squirrels taken annually, which represents 0.4% of the population. The statewide modeled low population estimate for this species is approximately 6,335,022 individuals (Appendix C23). The population estimate for each county is provided in Table 3-22. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 2.1% (326 individuals of 15,590 estimated county population; Alpine County). These numbers are all well below 40% total mortality threshold for all estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to a total annual average of lethal take of 22,309 individuals. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 22,309 individuals. The maximum number of western gray squirrels taken by county-level programs are listed for each county in Table 3-22, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Western gray squirrels are important prey for many carnivores such as coyotes, foxes, bobcats, martens, and large hawks and owls (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). However, the Project's lethal WDM of western gray squirrel is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the percentage of western gray squirrels taken regionally, statewide, and cumulatively by the Project is below the sustainable harvest threshold of 40%.

3.2.21.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for western gray squirrel predation to special-status species in California. As such, removal of this species under WDM activities would result in no known benefit to special-status species.

3.2.21.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-22).

Other anthropogenic factors that can affect western gray squirrel are habitat loss from development and climate change, and disruption by human activities such as timber harvest and removal of snags, duff, slash, or oak trees. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in western grey squirrel quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase western grey squirrel mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of western gray squirrels in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Western grey squirrel is considered a tree squirrel by CDFW and as such, is a resident small game species with varying open season and bag limits. In 2015, CDFW documented hunting taking 35,303 individuals (0.6% of the statewide population). Seventeen counties had no western gray squirrel hunter harvest, 27 counties reported a hunter harvest between 31 and 995 individuals each, and 14 counties had a hunter harvest of more than 1,000 individuals each. There was an additional tally of 200,731 squirrel individuals hunted that were generically identified as “squirrel” so these may have been grey squirrel, ground squirrels, or non-native eastern and other squirrels. These individuals were not included in the totals reported here. Western gray squirrel has not been commercially trapped for fur in California.

The number of western gray squirrels killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available western gray squirrel roadkill data in California. Therefore, we estimated western gray squirrel mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.35%); hunting (variable by county using 2014-2015 season data as described above); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-22. Cumulative mortality was 4.8% statewide and ranged from 0% to 6.6% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, trapping and lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 7.3% (22,309 of 305,790 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 28,529 individuals (4.6% of the population). Maximum lethal WDM under the Proposed Project contributed 2.3% of this cumulative mortality (652 of 28,529 individuals). The county with the highest percentage of cumulative mortality is Alpine County: 6.6% of the population (1,026 individuals). Maximum lethal WDM under the Proposed Project contributed 31.8% of this cumulative mortality (326 of 1,026 individuals). Maximum cumulative mortality estimates for western gray squirrel statewide and in each county are all well below the conservative 40% sustainable harvest threshold estimated above. These data are presented in Table 3-22.

Table 3-22. Western Gray Squirrel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
ALAMEDA	0	0	0	0	0	0	0	0	0	0	0.1	2	0%	4.5%
ALPINE	0	50.0	0	0	0	0	0	50.0	**50.0**	326	1,026	15,590	2.1%	6.6%
AMADOR	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,476	47,936	0.7%	5.2%
BUTTE	0	100.0	0	0	0	0	0	100.0	**100.0**	652	6,998	141,481	0.5%	4.9%
CALAVERAS	0	100.0	0	0	0	0	0	100.0	**100.0**	652	5,171	100,744	0.7%	5.1%
COLUSA	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,272	43,373	0.8%	5.2%
CONTRA COSTA	0	0	0	0	0	0	0	0	0	0	1.3	29	0%	4.5%
DEL NORTE	0	100.5	0	0	0	0	0	100.5	**100.5**	656	6,944	140,192	0.5%	5.0%
EL DORADO	0	100.0	0	0	0	0	0	100.0	**100.0**	652	9,089	188,106	0.4%	4.8%
FRESNO	0	100.6	0	0	0	0	0	100.6	**100.6**	656	8,298	170,375	0.4%	4.9%
GLENN	0	50.2	0	0	0	0	0	50.2	**50.2**	328	2,772	54,490	0.6%	5.1%
HUMBOLDT	0	100.0	0	0	0	0	0	100.0	**100.0**	652	22,844	494,783	0.1%	4.6%
IMPERIAL	0	0	0	0	0	0	0	0	0	0	0.5	11	0%	4.5%
INYO	0	0	0	0	0	0	0	0	0	0	12	252	0%	4.8%
KERN	0	100.0	0	0	0	0	0	100.0	**100.0**	652	6,422	128,644	0.5%	5.0%
KINGS	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
LAKE	1.2	100.0	0	0	0	0	1.2	100.0	**101.2**	660	5,234	101,979	0.7%	5.1%
LASSEN	0.1	100.0	0	0	0	0	0.1	100.0	**100.1**	653	9,566	198,702	0.3%	4.8%
LOS ANGELES	0	100.2	0	0	0	0	0	100.2	**100.2**	654	2,621	43,841	1.5%	6.0%
MADERA	0	100.0	0	0	0	0	0	100.0	**100.0**	652	5,769	114,080	0.6%	5.1%
MARIN	0	50.1	0	0	0	0	0	50.1	**50.1**	327	1,763	32,015	1.0%	5.5%
MARIPOSA	0.2	50.0	0	0	0	0	0.2	50.0	**50.2**	328	6,093	128,533	0.3%	4.7%
MENDOCINO	0	100.0	0	0	0	0	0	100.0	**100.0**	652	22,398	484,841	0.1%	4.6%
MERCED	0	0	0	0	0	0	0	0	0	0	10	207	0%	4.8%
MODOC	0	100.0	0	0	0	0	0	100.0	**100.0**	652	6,985	141,182	0.5%	4.9%
MONO	0	0	0	0	0	0	0	0	0	0	87	1,935	0%	4.5%
MONTEREY	0	100.0	0	0	0	0	0	100.0	**100.0**	652	5,390	105,629	0.6%	5.1%
NAPA	0.1	50.0	0	0	0	0	0.1	50.0	**50.1**	327	3,309	66,468	0.5%	5.0%
NEVADA	0	50.0	0	0	0	0	0	50.0	**50.0**	326	4,276	88,060	0.4%	4.9%
ORANGE	0	0	0	0	0	0	0	0	0	0	99	2,187	0%	4.5%
PLACER[3]	11.5	50.0	0	0	0	0	11.5	50.0	**61.5**	401	4,884	99,932	0.4%	4.9%
PLUMAS	0	100.0	0	0	0	0	0	100.0	**100.0**	652	15,007	320,057	0.2%	4.7%
RIVERSIDE	0	50.1	0	0	0	0	0	50.1	**50.1**	327	1,753	31,776	1.0%	5.5%
SACRAMENTO	0	0	0	0	0	0	0	0	0	0	254	5,641	0%	4.5%
SAN BENITO[4]	0	0	0	0	0	0	0	0	0	0	29	646	0%	4.5%
SAN BERNARDINO	0	50.2	0	0	0	0	0	50.2	**50.2**	328	2,756	54,128	0.6%	5.1%

Table 3-22. Western Gray Squirrel Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,222	42,259	0.8%	5.3%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	12	251	0%	4.8%
SAN JOAQUIN	0	0	0	0	0	0	0	0	0	0	41	903	0%	4.5%
SAN LUIS OBISPO	3.2	100.0	0	0	0	0	3.2	100.0	**103.2**	673	6,357	126,716	0.5%	5.0%
SAN MATEO	0	50.1	0	0	0	0	0	50.1	**50.1**	327	1,619	28,784	1.1%	5.6%
SANTA BARBARA	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,941	58,286	0.6%	5.0%
SANTA CLARA	0	50.1	0	0	0	0	0	50.1	**50.1**	327	1,667	29,863	1.1%	5.6%
SANTA CRUZ	0	50.2	0	0	0	0	0	50.2	**50.2**	328	2,507	48,580	0.7%	5.2%
SHASTA	0	100.0	0	0	0	0	0	100.0	**100.0**	652	20,752	448,139	0.2%	4.6%
SIERRA	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,410	46,445	0.7%	5.2%
SISKIYOU[5]	0	100.0	0	0	0	0	0	100.0	**100.0**	652	28,529	621,527	0.1%	4.6%
SOLANO	0	0	0	0	0	0	0	0	0	0	291	6,482	0%	4.5%
SONOMA[6]	0	100.0	0	0	0	0	0	100.0	**100.0**	652	7,691	156,920	0.4%	4.9%
STANISLAUS	0	0	0	0	0	0	0	0	0	0	120	2,666	0%	4.5%
SUTTER	0	0	0	0	0	0	0	0	0	0	79	1,751	0%	4.5%
TEHAMA	0	100.0	0	0	0	0	0	100.0	**100.0**	652	12,267	258,961	0.3%	4.7%
TRINITY	0	100.0	0	0	0	0	0	100.0	**100.0**	652	20,900	451,427	0.1%	4.6%
TULARE	0	100.7	0	0	0	0	0	100.7	**100.7**	657	10,065	209,752	0.3%	4.8%
TUOLUMNE	0.2	100.0	0	0	0	0	0.2	100.0	**100.2**	654	7,265	147,394	0.4%	4.9%
VENTURA	0	50.1	0	0	0	0	0	50.1	**50.1**	327	1,318	22,093	1.5%	6.0%
YOLO	1.9	50.0	0	0	0	0	1.9	50.0	**51.9**	339	1,617	28,489	1.2%	5.7%
YUBA	0	50.0	0	0	0	0	0	50.0	**50.0**	326	2,546	49,485	0.7%	5.1%
Total	**18.4**	**3,303.1**	**0**	**0**	**0**	**0**	**18.4**	**3,303.1**	**3,421.5**	**22,309**	**305,790**	**6,335,022**	**0.4%**	**4.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.21.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C23. The lower population estimate described in Appendix C23 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.22 Deer Mouse

Deer mouse is an omnivorous non-game mammal that is abundant or common throughout California in virtually all habitats, as the most ubiquitous and abundant mammal in California (CFGC Section 4150) (CWHR 2022). This species consumes a wide variety of food items including seeds, fruits, leaves, fungi, insects, and other animal material (CWHR 2022). Deer mice probably consume insects in springs and summer while switching to grains in winter as insects become scarce (CWHR 2022). Cover is provided by brush piles, litter, logs, rocks, abandoned burrows, and vegetative ground cover, where nests are constructed with a variety of materials (CWHR 2022). Although a non-game species, the California Fish and Game Commission allows for this species to be lethally taken any time of year and in any number (Cal. Code Regs. Tit. 14 § 472(a)). Deer mouse is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for deer mouse provided in Appendix C24, the estimated population size for California is 819,674,844 individuals. Also included in Appendix C24 are the population estimates of deer mouse within each county.

CDFW has not established sustainable harvest levels for deer mouse, and we were not able to find any in the literature despite an expansive search. For species with no sustainable harvest threshold, we can also cautiously apply the criteria defined by Robinson and Redford (1991) in their population growth model: the maximum sustainable harvest for very short-lived species (age of last reproduction less than 5 years) is 60%, the maximum for short-lived species (age of last reproduction 5-<10 years) is 40%, and the maximum for long-lived species (age of last reproduction 10 years or higher) is 20%. These guidelines are used cautiously because (1) they were designed for neotropical forest mammals, and (2) they represent the theoretical maximum, and do not imply that levels below these are sustainable (only that levels above these are not sustainable). Still, they provide us with a guideline for comparing actual harvest rates. If we use the rate reported by Robinson and Redford (1991) for short-lived species, 40%, we can compare actual harvest rates to this theoretical maximum. This rate is applied cautiously by using the next lowest rate from Robinson and Redford (1991); deer mouse would be considered a "very short lived" species by their criteria, but we used the more conservative threshold for "short-lived" species: 40%.

3.2.22.1 Previous Wildlife Damage Management

WDM for deer mouse comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year MIS baseline, an average of 15.4 deer mice were killed and 0.9 individuals were freed per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 16.3 individuals per year based on the WS-California MIS data from 2010 to 2019.[50] WS-California MIS baseline WDM for deer mouse occurred within four counties within the state with averages ranging from 0.1 to 7.2 individuals per year; most baseline WDM activities (85.1% or 13.1 individuals) occurred within San Diego and Solano Counties. Lethal WDM of deer mouse accounts for 94.5% (15.4 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 5.5% (0.9 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-23) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private

50 Average includes activities that both intentionally and unintentionally affect deer mouse and all potential methods used during WDM activities.

citizens lethally take this species in their homes (i.e., rodent/pest control) without involving WS-California or another WDM entity (T. Felix, pers. comm. 2023). Therefore, an additional 1,000 deer mice per year have been added to the Non-WS Lethal Take Estimates for each county (Table 3-23). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of deer mice is estimated at 58,017.8 individuals annually. This total is comprised of the WS-California lethal take of 15.4 individuals per year and the non-WS-California estimates for lethal take of 58,002.4 individuals per year (Table 3-23). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 819,674,844 individuals. The population estimate for each county is provided in Table 3-23. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide deer mouse take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this document, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For deer mouse the average is 15.4,[51] the standard deviation is 15.34, and the 99% confidence high estimate is 54.98, which we rounded up to 55 individuals. The 99% Confidence Factor for deer mouse was 15.4/55 = 3.57. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.22.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of deer mouse under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 207,124 deer mice taken annually, which represents 0.03% of the population. The statewide modeled low population estimate for this species is approximately 819,674,844 individuals (Appendix C24). The population estimate for each county is provided in Table 3-23. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0.01% or less (several counties) to 0.7% (3,570 individuals of 514,002 estimated county population; San Francisco County). These numbers are all well below 40% total mortality threshold for all estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

51 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-23. This small amount of error was accepted for this calculation.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to a total annual average of lethal take of 207,124 individuals. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 207,124 individuals. The maximum number of deer mice taken by county-level programs are listed for each county in Table 3-23, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Deer mice are important prey for many carnivores such as raptorial birds, snakes, and omnivorous mammals (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). Furthermore, deer mice may play an important role by feeding on larvae and pupae of insects detrimental to trees (CWHR 2022). However, the Project's lethal WDM of deer mice is not expected to result in indirect impacts to ecosystem function, structure, or dynamics due to the percentage of deer mice taken regionally, statewide, and cumulatively by the Project is below the sustainable harvest threshold of 40%.

3.2.22.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) have documented no deer mouse damage to federal or state-listed or fully protected species. Lethal removal of deer mouse for WDM is not expected to result in a net benefit to natural biological resources.

3.2.22.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-23). Lethal removal of deer mice for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

Other anthropogenic factors that can affect deer mice are habitat loss from development and climate change, and disruption by human activities such as those that remove cover for nesting. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in deer mouse quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase deer mouse mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of deer mice in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Deer mouse is not a target of hunting activities and has not been commercially trapped for fur in California.

The number of deer mice killed by collisions with vehicles (roadkill) in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Roadkill data from the California Department of Transportation (Caltrans) were not available and we are aware of no other source of available deer mouse roadkill data in California. Therefore, we estimated deer mouse mortality from vehicle collisions using the highest percentage we calculated among all species and methods in this Report: 1.2% of the population (see Section 3.2.24).

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at 0.03%); roadkill (1.2%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-23. Cumulative mortality was 3.8% statewide and ranged from 3.8% to 4.5% by county. Notably, 3.8% is the amount we estimated for roadkill and other anthropogenic mortality; thus, statewide and in many counties, lethal WDM did not add noticeably to cumulative mortality. In addition, lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.7% (207,124 of 31,354,769 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is San Bernardino County: 4,012,964 individuals (3.8% of the population). Maximum lethal WDM under the Proposed Project contributed 0.1% of this cumulative mortality (3,574 of 4,012,964 individuals). The county with the highest percentage of cumulative mortality is San Francisco County: 4.5% of the population (23,103 individuals. Maximum lethal WDM under the Proposed Project contributed 15.5% of this cumulative mortality (3,570 of 23,103 individuals). Maximum cumulative mortality estimates for deer mice statewide and in each county are all well below the conservative 40% sustainable harvest threshold estimated above. These data are presented in Table 3-23.

Table 3-23. Deer Mouse Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	2.2	1,000.0	0	0	0	0	2.2	1,000.0	**1,002.2**	3,578	159,737	4,109,434	<0.1%	3.9%
ALPINE	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	150,309	3,861,530	<0.1%	3.9%
AMADOR	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	122,022	3,117,150	0.1%	3.9%
BUTTE	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	330,397	8,600,693	<0.1%	3.8%
CALAVERAS	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	204,978	5,300,209	<0.1%	3.9%
COLUSA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	232,517	6,024,910	<0.1%	3.9%
CONTRA COSTA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	155,682	4,002,932	<0.1%	3.9%
DEL NORTE	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	203,758	5,268,100	<0.1%	3.9%
EL DORADO	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	343,943	8,957,167	<0.1%	3.8%
FRESNO	0	1,000.1	0	0	0	0	0	1,000.1	**1,000.1**	3,571	1,188,841	31,191,294	<0.1%	3.8%
GLENN	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	265,999	6,906,024	<0.1%	3.9%
HUMBOLDT	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	712,286	18,650,414	<0.1%	3.8%
IMPERIAL	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	838,135	21,962,230	<0.1%	3.8%
INYO	0	1,000.3	0	0	0	0	0	1,000.3	**1,000.3**	3,572	2,043,154	53,673,191	<0.1%	3.8%
KERN	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	1,622,213	42,595,850	<0.1%	3.8%
KINGS	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	274,817	7,138,078	<0.1%	3.9%
LAKE	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	253,513	6,577,431	<0.1%	3.9%
LASSEN	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	907,045	23,775,639	<0.1%	3.8%
LOS ANGELES	0	1,000.1	0	0	0	0	0	1,000.1	**1,000.1**	3,571	813,027	21,301,455	<0.1%	3.8%
MADERA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	428,998	11,195,461	<0.1%	3.8%
MARIN	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	119,988	3,063,622	0.1%	3.9%
MARIPOSA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	292,079	7,592,334	<0.1%	3.8%
MENDOCINO	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	702,448	18,391,509	<0.1%	3.8%
MERCED	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	390,752	10,188,975	<0.1%	3.8%
MODOC	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	795,619	20,843,386	<0.1%	3.8%
MONO	0	1,000.1	0	0	0	0	0	1,000.1	**1,000.1**	3,571	608,452	15,917,911	<0.1%	3.8%
MONTEREY	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	662,932	17,351,620	<0.1%	3.8%
NAPA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	151,874	3,902,727	<0.1%	3.9%
NEVADA	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	194,508	5,024,662	<0.1%	3.9%
ORANGE	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	161,974	4,168,523	<0.1%	3.9%
PLACER[3]	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	283,771	7,373,700	<0.1%	3.8%
PLUMAS	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	512,533	13,393,763	<0.1%	3.8%
RIVERSIDE	0	1,000.2	0	0	0	0	0	1,000.2	**1,000.2**	3,571	1,439,869	37,797,298	<0.1%	3.8%
SACRAMENTO	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	195,913	5,061,637	<0.1%	3.9%
SAN BENITO[4]	0	1,000.0	0	0	0	0	0	1,000.0	**1,000.0**	3,570	280,051	7,275,815	<0.1%	3.8%
SAN BERNARDINO	0	1,000.5	0	0	0.1	0.3	0.1	1,000.8	**1,000.9**	3,574	4,012,964	105,510,245	<0.1%	3.8%

Table 3-23. Deer Mouse Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	0	1,000.0	5.9	0	0	0	5.9	1,000.0	1,005.9	3,592	844,608	22,131,981	<0.1%	3.8%
SAN FRANCISCO	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	23,103	514,002	0.7%	4.5%
SAN JOAQUIN	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	281,590	7,316,301	<0.1%	3.8%
SAN LUIS OBISPO	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	661,696	17,319,086	<0.1%	3.8%
SAN MATEO	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	111,374	2,836,932	0.1%	3.9%
SANTA BARBARA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	549,448	14,365,209	<0.1%	3.8%
SANTA CLARA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	259,332	6,730,571	<0.1%	3.9%
SANTA CRUZ	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	92,302	2,335,035	0.2%	4.0%
SHASTA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	757,628	19,843,616	<0.1%	3.8%
SIERRA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	193,750	5,004,735	<0.1%	3.9%
SISKIYOU[5]	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	1,257,529	32,998,899	<0.1%	3.8%
SOLANO	0	1,000.0	0	0	7.2	0.6	7.2	1,000.6	1,007.8	3,598	177,319	4,571,599	<0.1%	3.9%
SONOMA[6]	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	320,187	8,332,018	<0.1%	3.8%
STANISLAUS	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	300,429	7,812,062	<0.1%	3.8%
SUTTER	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	123,452	3,154,769	0.1%	3.9%
TEHAMA	0	1,000.1	0	0	0	0	0	1,000.1	1,000.1	3,571	589,955	15,431,135	<0.1%	3.8%
TRINITY	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	637,151	16,673,176	<0.1%	3.8%
TULARE	0	1,000.1	0	0	0	0	0	1,000.1	1,000.1	3,571	964,871	25,297,352	<0.1%	3.8%
TUOLUMNE	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	447,214	11,674,839	<0.1%	3.8%
VENTURA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	371,574	9,684,314	<0.1%	3.8%
YOLO	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	204,507	5,287,807	<0.1%	3.9%
YUBA	0	1,000.0	0	0	0	0	0	1,000.0	1,000.0	3,570	128,685	3,292,487	0.1%	3.9%
Total	**2.2**	**58,001.5**	**5.9**	**0**	**7.3**	**0.9**	**15.4**	**58,002.4**	**58,017.8**	**207,124**	**31,354,769**	**819,674,844**	**<0.1%**	**3.8%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.22.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C24. The lower population estimate described in Appendix C24 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.23 Mule Deer

Mule deer are yearlong residents or elevational migrants with a widespread distribution throughout most of California (CWHR 2022). This herbivorous big game mammal occurs in most forest, woodland, and brush habitats in early to intermediate successional stages, preferring a mosaic of various-aged vegetation that provides woody cover, meadow, and free water (CFGC Section 3950) (CWHR 2022). Brushy areas and tree thickets are important for escape cover; fawning occurs in moderately dense shrublands and forests and high elevation riparian and mountain shrub habitats with available water and abundant forage (CWHR 2022).

The distribution model developed by the California Department of Fish and Wildlife (CDFW 2016a), which is the basis for the species population estimate, does not distinguish among the six subspecies of mule deer occurring in California (Higley 2002). Henceforth in this report, “mule deer” refers to all members of *Odocoileus hemionus*, which all six subspecies (see also Appendix C25 for details).

Mule deer is considered a species of “Least Concern” by IUCN, and their global population is reported to be stable (IUCN 2022). Based on the CDFW habitat modeling for mule deer provided in Appendix C25, the estimated population size for California is 562,237 individuals. Also included in Appendix C25 are the population estimates of mule deer within each county (Table 3-24). CDFW (2022d) estimates the mule deer population at 532,621 as of their most recently published estimate (i.e., 2017). For this analysis we will use the estimate: 562,237 mule deer. The use of this estimate does not suggest that we doubt or disagree with the CDFW (2022d) estimate.

No long-term sustainable harvest estimates were found in the literature for mule deer. Mule deer are managed by CDFW. CDFW manages mule deer populations in part by limiting the sale of deer hunting licenses and deer hunting seasons. For mule deer, sustainable harvest rates likely vary enough by region that a published threshold would not likely be useful in many areas of California. Management by CDFW has ensured the stability of the mule deer population in California, which averages around 500,000 individuals over the last 10 years (CDFW 2022d), despite hunting pressures and other sources of anthropogenic mortality such as vehicle collisions. As such, we will use recent harvest estimates to assess the likelihood of significant impact to the mule deer population due to the Proposed Project. The average estimated harvest of mule deer in California during the baseline period was 31,336.4 per year out of an estimated 562,237 statewide population, or 5.6%. Because deer hunting is tightly managed by CDFW to maintain sustainable population levels, the existing level of cumulative take including sources described in Section 3.2.23.4, appears to be below the sustainable harvest threshold. If population declines are observed, the number of tags issued for deer hunting would be reduced and the level of hunting take would decrease (CDFW 2019c).

3.2.23.1 Previous Wildlife Damage Management

WDM for mule deer comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 12.8 mule deer were killed, 2.9 individuals were dispersed, 6.7 individuals were freed, 1.3 individuals were immobilized, 16.2 individuals were radio collared, and 1.3 individuals were relocated per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 41.3 individuals per year based on the WS-California MIS data from 2010 to 2019.[52] WS-California MIS baseline WDM for mule deer occurred within 19 counties within the state with averages ranging from 0.1 to

52 Average includes activities that both intentionally and unintentionally affect mule deer and black-tailed deer and all potential methods used during WDM activities.

2.9 individuals per year; the majority of baseline WDM activities (39.8% or 5.1 individuals) occurred within San Luis Obispo and Napa Counties. Lethal WDM of mule deer accounts for 30% (12.8 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 70% (28.4 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-24) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of mule deer is estimated at 17.7 individuals annually. This total is comprised of the WS-California lethal take of 12.8 individuals per year and the non-WS-California estimates for lethal take of 4.9 individuals per year (Table 3-24). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 562,237 individuals. The population estimate for each county is provided in Table 3-24. Less than 0.01% of the statewide population was affected by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide mule deer take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For mule deer the average is 12.2,[53] the standard deviation is 7.52, and the 99% confidence high estimate is 31.61, which we rounded up to 32 individuals. The 99% Confidence Factor for mule deer was 32/12.2 = 2.62. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.2.23.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of mule deer under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 64 mule deer taken annually, which represents less than 0.01% of the population. The statewide modeled low population estimate for this species is approximately 562,237 individuals (Appendix C25). The population estimate for each county is provided in Table 3-24. The Proposed Project Maximum Lethal Take Estimate in proportion to county estimated population ranges from 0% (several counties) to 0.09% (1 individual of 406 estimated county population; Sutter County). These numbers are all well below the 5.4% mortality threshold for all estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 64. The

53 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-24. This small amount of error was accepted for this calculation.

proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 64 individuals. The maximum number of mule deer taken by county-level programs are listed for each county in Table 3-24, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Mule deer are preyed upon regularly by mountain lions and coyotes, and occasionally by bobcats and black bears (CWHR 2022). As such, high levels of lethal take which result in significant decreases in populations might have a negative effect on these predator species where they co-occur. Predator and prey populations are cyclical and a reduction in prey populations can also reduce predator populations (Stevens 2010). Generally, indirect effects of deer removal or exclusion have suggested beneficial indirect effects to native plant populations, insects, and others because deer populations have rapidly expanded as predation and hunting pressures have dropped (e.g., Russel *et al.* 2001; Côté *et al.* 2014). However, the Project’s lethal WDM of mule deer is not expected to result in adverse or beneficial indirect impacts to ecosystem function, structure, or dynamics due to the low percentage of mule deer taken regionally, statewide, and cumulatively by the Project (Table 3-24).

3.2.23.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

There are no documented MIS data (2010–2019) for mule deer damage to special-status species in California. Natural predators of mule deer have been reduced in numbers in most areas, periodically resulting in overpopulation, with resultant winter die-offs and destruction of habitat (CWHR 2022). As such, removal of this species under WDM activities may result in less habitat destruction in areas where mule deer overpopulation occurs.

3.2.23.4 Potential Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting, and various other sources (e.g., illegal harvest, accidental poisoning). These are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-24).

Other anthropogenic factors that can affect mule deer are habitat loss from development and climate change, and disruption by human activities such as timber harvest. This Report does not directly assess the potential for these factors to add to anthropogenic mortality in mule deer quantitatively because (1) such effects are included in our population estimation method, which is based on actual available habitat, (2) these effects are not expected to significantly increase mule deer mortality in the near future, (3) and a current focus of CDFW is the limitation of future habitat loss and the reversal of past habitat fragmentation (CDFW 2023c). As such, habitat loss and fragmentation are not likely to be significant additional factors affecting the future populations of mule deer in California (those potential current impacts are not expected to significantly increase during the life of the Proposed Project).

Deer species succumb to various sources of anthropogenic and natural mortality. Hunting and roadkill are likely the greatest source of human-caused mortality for mule deer. A highly detailed 2014 Wisconsin study (Wisconsin Department of Natural Resources 2014) found that the main causes of white-tailed deer mortality were human hunting (43%), starvation (9%), coyotes (7%), wolf (6%), and vehicle collision (6%). Poaching added another 8%, but the overall survival rate was 73% for does and 47% for bucks (Wisconsin Department of Natural Resources 2014).

Other regions in the study had varying results, but anthropogenic sources were always at the top. A study of tracked translocated mule deer in New Mexico found that anthropogenic mortality sources only accounted for up to 30% and included poaching, accident, and unknown with the latter two sources accounting for 25% and may not have been anthropogenic (Cain *et al.* 2018). The UC Davis Road Ecology Center (2021) estimates that between 88,000 to 220,000 deer may be hit on California roadways every year, which accounts for 15.7% to 39.1% of the mule deer statewide population. The 15.7% mortality for roadkill will be used in this analysis because it is closer to the values presented in the other studies.

Aside from roadkill, hunter harvest is the largest source of mortality for mule deer among the factors analyzed. Mule deer are considered a big-game species, with highly refined hunting zones, seasons, and bag limits. Legal hunting of mule deer averaged 31,336.4 individuals killed per year during the 2010 through 2019 seasons (CDFW 2019c). This equates to an average of 5.6% of the estimated statewide population (562,237 individuals). Unfortunately, these data were not compiled by county, so we had to estimate hunter harvest by county. The statewide percentage of the mule deer population harvested by hunters (5.6%) was multiplied by each county population to estimate county-level hunter harvest. Deer have not been trapped for fur.

Mortality from accidental poisoning and other anthropogenic sources are unknown. However, to be conservative we estimated these losses at 2.6% of the population, based on the conservative estimate of these sources of mortality for mountain lion (Section 3.2.24).

Cumulative (i.e., total) anthropogenic mortality was assessed by adding all known and estimated anthropogenic mortality sources: WDM take (estimated herein at less than 0.01%); hunter harvest (5.6% from CDFW reports); roadkill (15.7%); and pesticides and other human causes (2.6%). The estimates of cumulative mortality are presented in Table 3-24. Cumulative mortality was 23.9% statewide and ranged from 0% to 24.1% by county. Notably, 23.9% is the amount we estimated for roadkill, hunting, and other anthropogenic mortality; thus, statewide and in many counties, lethal WDM did not add noticeably to cumulative mortality. Lethal WDM under the Proposed Project contributes very little to these cumulative mortality estimates; lethal WDM under the Proposed Project would be responsible for only 0.05% (64 of 134,375 individuals) of cumulative anthropogenic mortality statewide. The county with the highest cumulative mortality is Siskiyou County: 9,853 individuals (23.9% of the population). However, lethal WDM under the Proposed Project did not contribute to this cumulative mortality (0 of 9,853 individuals). The county with the highest percentage of cumulative mortality is Sutter County: 24.1% of the population (97 individuals). Maximum lethal WDM under the Proposed Project contributed approximately 1% of this cumulative mortality (1 of 97 individuals). Maximum cumulative mortality estimates for mule deer statewide and in each county are within the range this species can withstand without substantially affecting the population. Moreover, mule deer are managed intensively by CDFW (California Fish and Game Code Sections 360 and 361), and if any such added mortality were to result in cumulative impacts to the mule deer population, CDFW would regulate hunter harvest to offset those losses. These data are presented in Table 3-24.

Table 3-24. Mule Deer Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0	0	0	0	0	0	0	0	0	0	728	3,044	0%	23.9%
ALPINE	0	0	0	0	0	0	0	0	0	0	1,052	4,401	0%	23.9%
AMADOR	0	0	0	0	0	0	0	0	0	0	714	2,987	0%	23.9%
BUTTE	0.3	0	0	0	0	0	0.3	0	**0.3**	1	1,652	6,913	<0.1%	23.9%
CALAVERAS	0	0	0	0	0	0	0	0	0	0	1,375	5,753	0%	23.9%
COLUSA	0	0	0	0	0	0	0	0	0	0	635	2,656	0%	23.9%
CONTRA COSTA	0.2	0	0	0	0	0	0.2	0	**0.2**	1	663	2,775	<0.1%	23.9%
DEL NORTE	0	0.2	0	0	0	0	0	0.2	**0.2**	1	1,746	7,306	<0.1%	23.9%
EL DORADO	1.5	0	0	0	0	0	1.5	0	**1.5**	4	2,651	11,092	<0.1%	23.9%
FRESNO	0	0.5	0	0	0	0	0	0.5	**0.5**	2	3,997	16,722	<0.1%	23.9%
GLENN	0	0.1	0	0	0	0	0	0.1	**0.1**	1	885	3,703	<0.1%	23.9%
HUMBOLDT	0	0	0	0	0	0	0	0	0	0	5,610	23,471	0%	23.9%
IMPERIAL	0	0	0	0	0	0	0	0	0	0	71	296	0%	23.9%
INYO	0	0.3	0	0	0	0	0	0.3	**0.3**	1	2,427	10,153	<0.1%	23.9%
KERN	0	0	0	0	0	0	0	0	0	0	2,869	12,004	0%	23.9%
KINGS	0	0	0	0	0	0	0	0	0	0	46	191	0%	23.9%
LAKE	0.2	0	0	0	0	0	0.2	0	**0.2**	1	1,966	8,225	<0.1%	23.9%
LASSEN	0	0	0	0	0	0	0	0	0	0	7,131	29,838	0%	23.9%
LOS ANGELES	0.7	0.4	0	0	0	0	0.7	0.4	**1.1**	3	3,246	13,581	<0.1%	23.9%
MADERA	0	0	0	0	0	0	0	0	0	0	1,809	7,568	0%	23.9%
MARIN	0	0.1	0	0	0	0	0	0.1	**0.1**	1	661	2,765	<0.1%	23.9%
MARIPOSA	0	0	0	0	0	0	0	0	0	0	2,004	8,385	0%	23.9%
MENDOCINO	1.0	0	0	0	0	0	1.0	0	**1.0**	3	5,405	22,613	<0.1%	23.9%
MERCED	0	0	0	0	0	0	0	0	0	0	316	1,323	0%	23.9%
MODOC	0	0	0	0	0	0	0	0	0	0	4,266	17,850	0%	23.9%
MONO	0	0.5	0	0	0	0	0	0.5	**0.5**	2	4,082	17,079	<0.1%	23.9%
MONTEREY	0	0	0	0	0	0	0	0	0	0	3,365	14,079	0%	23.9%
NAPA	2.2	0	0	0	0	0	2.2	0	**2.2**	6	961	4,023	<0.1%	24.0%
NEVADA	0	0	0	0	0	0	0	0	0	0	1,543	6,454	0%	23.9%
ORANGE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	619	2,590	<0.1%	23.9%
PLACER[3]	0.2	0	0	0	0	0	0.2	0	**0.2**	1	1,961	8,204	<0.1%	23.9%
PLUMAS	0	0	0	0	0	0	0	0	0	0	4,160	17,406	0%	23.9%
RIVERSIDE	0	0.5	0	0	0	0	0	0.5	**0.5**	2	3,915	16,382	<0.1%	23.9%
SACRAMENTO	0.6	0	0	0	0	0	0.6	0	**0.6**	2	704	2,944	<0.1%	24.0%
SAN BENITO[4]	0.3	0	0	0	0	0	0.3	0	**0.3**	1	1,187	4,965	<0.1%	23.9%
SAN BERNARDINO	0	0.3	0	0	0	0	0	0.3	**0.3**	1	2,699	11,291	<0.1%	23.9%

Table 3-24. Mule Deer Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	0	0	0	0	0.2	0.3	0.2	0.3	**0.5**	2	5,143	21,519	<0.1%	23.9%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
SAN JOAQUIN	0.1	0	0	0	0	0	0.1	0	**0.1**	1	482	2,017	<0.1%	23.9%
SAN LUIS OBISPO	2.9	0	0	0	0	0	2.9	0	**2.9**	8	2,834	11,857	<0.1%	24.0%
SAN MATEO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	617	2,582	<0.1%	23.9%
SANTA BARBARA	0	0	0	0	0	0	0	0	0	0	3,505	14,665	0%	23.9%
SANTA CLARA	0	0.2	0	0	0	0	0	0.2	**0.2**	1	1,723	7,210	<0.1%	23.9%
SANTA CRUZ	0	0.1	0	0	0	0	0	0.1	**0.1**	1	682	2,852	<0.1%	23.9%
SHASTA	0.1	0	0	0	0	0	0.1	0	**0.1**	1	6,083	25,453	<0.1%	23.9%
SIERRA	0	0	0	0	0	0	0	0	0	0	1,551	6,488	0%	23.9%
SISKIYOU[5]	0	0	0	0	0	0	0	0	0	0	9,853	41,225	0%	23.9%
SOLANO	0	0	0	0	0	0	0	0	0	0	125	524	0%	23.9%
SONOMA[6]	0.5	0	0	0	0	0	0.5	0	**0.5**	2	2,024	8,470	<0.1%	23.9%
STANISLAUS	0.1	0	0	0	0	0	0.1	0	**0.1**	1	633	2,649	<0.1%	23.9%
SUTTER	0.2	0	0	0	0	0	0.2	0	**0.2**	1	97	406	<0.1%	24.1%
TEHAMA	0	0.4	0	0	0	0	0	0.4	**0.4**	2	3,346	13,999	<0.1%	23.9%
TRINITY	0	0	0	0	0	0	0	0	0	0	5,312	22,227	0%	23.9%
TULARE	0	0.5	0	0	0	0	0	0.5	**0.5**	2	4,381	18,330	<0.1%	23.9%
TUOLUMNE	1.4	0	0	0	0	0	1.4	0	**1.4**	4	3,168	13,256	<0.1%	23.9%
VENTURA	0	0.3	0	0	0	0	0	0.3	**0.3**	1	2,728	11,416	<0.1%	23.9%
YOLO	0.1	0	0	0	0	0	0.1	0	**0.1**	1	370	1,549	<0.1%	24.0%
YUBA	0	0	0	0	0	0	0	0	0	0	600	2,510	0%	23.9%
Total	**12.6**	**4.6**	**0**	**0**	**0.2**	**0.3**	**12.8**	**4.9**	**17.7**	**64**	**134.375**	**562,237**	**<0.1%**	**23.9%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.23.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C25. The lower population estimate described in Appendix C25 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.2.24 Mountain Lion

Mountain lion is a widespread uncommon permanent resident of California, ranging from sea level to alpine meadows, that is found in all habitats except xeric regions of the Mojave and Colorado deserts that do not support mule deer populations (CWHR 2022). Mountain lion is a specially protected carnivorous mammal under the California Wildlife Protection Act of 1990 and a state candidate species for listing under CESA in the following counties: Alameda, Contra Costa, Imperial, Los Angeles, Monterey, Orange, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, and Ventura (CDFW 2023). Mountain lion is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Based on the CDFW habitat modeling for mountain lion provided in Appendix C27, the estimated population size for California is 5,062 individuals. Also included in Appendix C27 are the population estimates of mountain lion within each county.

Mountain lion densities are expected to remain stable with anthropogenic mortality rates up to 11% and total mortality up to 14% (Logan 2019; Robinson *et al.* 2008; Cooley *et al.* 2009; Beausoleil *et al.* 2013). For the analyses in this Report we used this 11% threshold for anthropogenic mortality. Anthropogenic mortality is likely to be partially compensatory and partially additive (Robinson *et al.* 2008; Cooley *et al.* 2009; Beausoleil *et al.* 2013), as suggested by the difference between the total mortality threshold (14%) and the anthropogenic mortality threshold (11%) (Beausoleil *et al.* 2013).

3.2.24.1 Previous Wildlife Damage Management

WDM for mountain lion comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline, an average of 82 mountain lions were killed, 2.1 individuals were dispersed, 0.7 individuals were freed, 0.9 individuals were immobilized, 6.8 individuals were radio collared, 0.7 individuals were surveyed, and 0.2 individuals underwent a transfer of custody per year. Therefore, under the current WS-California efforts, WDM activities affected on average approximately 99.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[54] WS-California MIS baseline WDM for mountain lion occurred within 35 counties across the state with averages ranging from 0.1 to 11.1 individuals per year; the largest portion of baseline WDM activities (22.6% or 18.5 individuals) occurred within El Dorado and Shasta Counties. Lethal WDM of mountain lion accounts for 82.5% (82 individuals per year) of the WS-California WDM conducted for this species, and non-lethal WDM accounts for 17.5% (11.4 individuals per year).

Total WDM take during CY 2010-2019 is estimated at 113.1 mountain lions per year, which includes WS-California lethal take of 82 individuals and non-WS-California estimates of 31.1 individuals per year (Table 3-25). These estimates of non-WS take are generous; WS-California is generally called upon for the vast majority of lethal mountain lion removal in California, as discussed below. The statewide modeled population estimate for this species is approximately 5,062 individuals, and the population estimate for each county is provided in Table 3-25. Approximately 2.2% (113.1 individuals) of the statewide population was affected by lethal WDM activities annually during the analysis period. Statewide lethal WDM take of mountain lion is well below the 11% sustainable harvest threshold. Lethal WDM for mountain lion was also below the 11% threshold within all California counites (Table 3-25). The counties with the highest percentage of lion take to their populations were El Dorado at 10.3% (11.1 individuals per year of 108 estimated county population), Yuba at 7.6% (1.6 individuals per year of 21 estimated county population), and

54 Average includes activities that both intentionally and unintentionally affect mountain lion and all potential methods used during WDM activities.

Calaveras at 6.8% (4.2 individuals per year of 62 estimated county population) (Table 3-25). Whereas lion take approached the 11% threshold in El Dorado County in some years during the analysis period, average take did not exceed this threshold. Moreover, this level of WDM lethal take (11-12 lions per year) was fairly consistent in El Dorado County for the 13-year period from 2006 to 2018. Lethal WDM take of mountain lion statewide and within each county is below the 11% sustainable harvest threshold.

3.2.24.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of mountain lion under the Proposed Project is likely to be substantially lower than previous WDM take estimated above due to changes in the management of the species by CDFW (CDFW 2017, 2021b). Because of these changes in mountain lion management in California, Calendar Years 2020 and 2021 would be expected to more accurately reflect anticipated mountain lion take in the future under the Proposed Project. However, due to the impacts of COVID-19 during the pandemic, WS-California has opted to not use those years as indicators of future take. As such, and according to WS-California, we anticipate take of 50% or fewer mountain lions in future years under the Proposed Project (T. Felix, pers. comm. 2022e). Due to annual variations in WDM, some years might have higher take than others, but we do not expect mountain lion take for WDM to exceed these levels in the future regardless of the agency, group, or individual taking the WDM action.

All estimates of total previous WDM within each county were divided by two (2) to estimate the high end of future take under the Proposed Project within each county. These numbers were then rounded up to the next integer to represent the maximum potential take. The Proposed Project Maximum Lethal Take Estimate is 57 mountain lions statewide (1.1% of the population), and ranges from zero to 5.6 per year by county (zero to 5.1% of the county populations). The counties with the highest Proposed Project Maximum Lethal Take Estimate by percentage of the county populations are El Dorado at 5.1% (5.6 individuals per year of 108 estimated county population) and Yuba at 3.7% (0.8 individuals per year of 21 estimated county population) (Table 3-25). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years. This is especially pertinent to counties with lower estimated lion populations and lion take in these counties is expected to be occasional over the years. For example, in several, only one or two lions are expected to be taken within a 10-year period in the future, but because a lion might be taken in any year, we estimated a maximum take of one in any one year. The actual percentage of the population effected over decades will be 5-10 times lower than the percentage in any one year.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 57. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 57 individuals. The maximum number of mountain lions taken by county-level programs are listed for each county in Table 3-25, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Mountain lion is considered to be an apex predator and a keystone species (Prugh *et al.* 2009). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes *et al.* 2011). Large-scale or complete removal of apex predators from an ecosystem has the potential to result in trophic cascade and mesopredator release (Ritchie and Johnson 2009; Estes *et al.* 2011; Miller *et al.* 2012; Wallach *et al.* 2015). Mountain lions compete with other California predators, bobcats, coyotes, black bears, and wolverines, though they prey primarily on mule deer, which limits competition with most small and medium-sized predators (CWHR 2022). They are also considered to be subordinate competitors to wolves and black bears (Elbroch and Kulster 2018) but can predate on coyotes (CWHR 2022). They have the ability to affect populations of some ungulates like bighorn sheep (CDFW 2022c; USFWS 2000). High species diversity of apex predators, mesopredators, and prey species in an ecosystem can make the mesopredator release less likely to occur (Brashares *et al.* 2010).

The complex social system of mountain lions responds differently to large-scale removal of individuals depending on the amount of habitat available, seasonal timing of removal, and the sex and age of the population that is removed (Logan 2019). Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to mountain lion, are not anticipated due to the percentage of mountain lions killed by the Project regionally would range from 0 -5.1% of the county population, and statewide lethal WDM would not exceed 1.1% of the estimated population.

3.2.24.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) have documented mountain lion predation to the federally listed species Sierra Nevada bighorn sheep. According to the Sierra Nevada Bighorn Sheep Recovery Program – Predator Monitoring and Management (CDFW 2022c), predation by mountain lions can have a substantial effect on isolated populations of Sierra Nevada bighorn sheep. They also are known to have substantial effects on other populations of desert bighorn sheep, including the endangered peninsular (USFWS 2000). Therefore, removal of mountain lions under for WDM could result in a net benefit to threatened and endangered species populations (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.2.24.4 Potential Cumulative Effects to the Species

Under CFGC Section 4800, mountain lions in California are considered a "specially protected mammal," and are subject to special provisions under the California Fish and Game Commission. Approved sport hunting of mountain lions has not occurred in California since 1972, due to a series of legislative moratoria and lawsuits. Illegal hunting and trapping of mountain lion are potential sources of additional anthropogenic mortality; however, we are aware of no published estimates of such mortality. Lethal removal of mountain lion for WDM may be compensatory rather than additive to natural causes of mortality; however, because we are not aware of data to support this speculation, we assume that all mortality is additive in this analysis.

CFGC Section 4801 authorizes CDFW or an approved local agency with public safety responsibility to remove or take an individual mountain lion that poses a public safety threat, but Section 4801.5 states that "nonlethal procedures shall be used when removing or taking any mountain lion that has not been designated as an imminent threat to public health or safety." During the period between 2010 and 2020, an average of 202 depredation permits were issued per year, and an average of 83 mountain lions were killed each year under those permits (CDFW 2021b). This roughly corresponds to the average of 82 mountain lions lethally taken by WS-California during the baseline analysis period, which demonstrates that WS-California is typically called upon when lethal removal of mountain lion is deemed necessary: WS-California take accounts for 72.5% of the depredation take of mountain lions in California. As such, our estimates of non-WS mountain lion take in Table 3-25 are conservative, and likely overestimate lethal WDM take.

Collisions with vehicles also add to cumulative anthropogenic mortality. At least 302 mountain lions were killed by vehicle collisions between 2016 and 2020, an average of 60.4 per year (UC Davis Road Ecology Center 2021). This represents 1.2% per year of the statewide mountain lion population. Unfortunately, county level roadkill data are not publicly available from this database. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Because these roadkill data were not provided, we made a rough estimate of county level roadkill mortality by multiplying the mountain lion population within each county by the 1.2% reported by UC Davis Road Ecology Center (2021). This crude estimate likely overestimates roadkill mortality in some counties (i.e., those with fewer roads and fewer vehicle miles) and underestimates it in others (i.e., those with more roads and more vehicle miles). However, we are not aware of any better data. These estimates are included in the cumulative mortality column in Table 3-25.

Habitat loss affects mountain lion, especially in Southern California where development is more extensive and results in more conflicts with humans (Benson 2023). Southern California mountain lion populations are proposed for listing under the California Endangered Species Act and are discussed in Section 3.4.13. Much of the habitat loss and fragmentation which might impact mountain lion populations has already occurred in California, whereas our analyses focus on potential *future* cumulative impacts. CDFW is actively addressing habitat fragmentation by protecting and enhancing connectivity corridors as discussed in Section 1.2, which suggests that future increases in habitat fragmentation are likely to be limited, and some improvements may occur in areas identified as important for species connectivity.

Poisoning of rodents, especially with second-generation anticoagulant rodenticides, has the potential to negatively impact individual mountain lions (Moriarty *et al.* 2012), and has been determined to be responsible for the death of multiple urban mountain lions near Los Angeles (Riley *et al.* 2007, National Park Service [NPS] 2020). Second-generation anticoagulant rodenticides were banned for consumer use in 2014 through a reclassification process by the Department of Pesticide Regulation, and restricted more broadly in 2020 (AB 1788); however, many exemptions in these State regulations allow for continued use associated with agricultural sites, wineries, and other land uses. Anticoagulant rodenticides have been detected in other mountain lions tested in California, including the Griffith Park male known as P-22 (NPS 2014) as well as the Santa Monica Mountain female P-54 and her fetal kittens (NPS 2022b), but the effect of this on their overall health is unclear and it was not directly linked to the death of either of those individuals. Testing in 2016 found that 94.5% of the sampled mountain lions from 35 California counties had anticoagulant rodenticides in their liver tissue (Rudd et al. 2018). The full extent of mountain lion mortality due to rodenticides is unknown as it may interact with other sources of mortality (e.g., increased risk of mange, increased risk of vehicle strike), but the risk is likely greater near urban areas where the use of these rodenticides is more ubiquitous and concentrated.

Because we have no quantitative data to assess the contributions of rodenticide poisoning, habitat loss, and illegal harvesting of mountain lions, we estimated these losses using the data from Beausoleil *et al.* (2013). These authors reported that 3% of total mountain lion mortality was due to illegal harvest, and 10% was due to unknown causes (natural and potentially anthropogenic). Together, these sources of mortality represent 13% of overall lion mortality, which is 2.2 times the mortality attributed by these authors to vehicle collisions (6%), which we estimated at 1.2% of the population. Therefore, these other causes of anthropogenic mortality were estimated at 2.6% (1.2% times 2.2 = 2.6%) in each county and statewide. This assessment of an additional 13% of total mortality (2.6% of the population) to these other various anthropogenic sources covers illegal harvest as well as unknown causes of death. Because some of these unknown causes of death were likely natural, this will result in a very conservative analysis of anthropogenic mortality.

Total anthropogenic mortality was estimated by adding up all of the estimates above (3.8% of the population) and adding that number to the maximum WDM lethal take under the Proposed Project. These estimates of cumulative take are presented in Table 3-25, along with the percentage of each population they entail. Cumulative anthropogenic mortality of mountain lions in California represents 4.9% of the statewide population and ranges from 0% to 8.9% of the populations within each county. The highest percentages of estimated cumulative take under the Proposed Project are in El Dorado County at 8.9% (9.7 individuals per year of 108 estimated county population) and Yuba County at 7.5% (1.6 individuals per year of 21 estimated population) (Table 3-25). In both of these counties maximum WDM take under the Proposed Project is low; the higher percentages in these counties are due to the low population estimates. All cumulative mortality estimates statewide and by county are below the 11% anthropogenic mortality threshold for mountain lion.

Table 3-25. Mountain Lion Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]				
ALAMEDA	0.8	0	0	0	0	0	0.8	0	**0.8**	0.4	1.6	31	1.3%	5.1%
ALPINE	0.1	0	0	0	0	0	0.1	0	**0.1**	0.1	1.5	38	0.1%	3.9%
AMADOR	1.5	0	0	0	0	0	1.5	0	**1.5**	0.8	2.0	32	2.3%	6.1%
BUTTE	3.7	0	0	0	0	0	3.7	0	**3.7**	1.9	4.3	64	2.9%	6.7%
CALAVERAS	4.2	0	0	0	0	0	4.2	0	**4.2**	2.1	4.5	62	3.4%	7.2%
COLUSA	0.3	0	0	0	0	0	0.3	0	**0.3**	0.2	1.3	30	0.5%	4.3%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	1.0	27	0%	3.8%
DEL NORTE	0	0.9	0	0	0	0	0	0.9	**0.9**	0.5	2.1	42	1.1%	4.9%
EL DORADO	11.1	0	0	0	0	0	11.1	0	**11.1**	5.6	9.7	108	5.1%	8.9%
FRESNO	0	4.5	0	0	0	0	0	4.5	**4.5**	2.3	10.1	207	1.1%	4.9%
GLENN	0	1.0	0	0	0	0	0	1.0	**1.0**	0.5	2.2	44	1.1%	4.9%
HUMBOLDT	2.3	0	0	0	0	0	2.3	0	**2.3**	1.2	6.7	146	0.8%	4.6%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0.7	18	0%	3.8%
INYO	0.1	1.6	1.1	0	0	0	1.2	1.6	**2.8**	1.4	4.1	71	2.0%	5.8%
KERN	1.7	0	0	0	0	0	1.7	0	**1.7**	0.9	7.2	166	0.5%	4.3%
KINGS	0	0.2	0	0	0	0	0	0.2	**0.2**	0.1	0.4	7	1.5%	5.3%
LAKE	1.1	0	0	0	0	0	1.1	0	**1.1**	0.6	3.4	75	0.7%	4.5%
LASSEN	3.6	0	0	0	0	0	3.6	0	**3.6**	1.8	6.9	135	1.3%	5.1%
LOS ANGELES	0	2.5	0	0	0	0	0	2.5	**2.5**	1.3	5.6	113	1.1%	4.9%
MADERA	1.1	0	0	0	0	0	1.1	0	**1.1**	0.6	3.8	84	0.7%	4.5%
MARIN	0	0.5	0	0	0	0	0	0.5	**0.5**	0.3	1.1	23	1.1%	4.9%
MARIPOSA	3.3	0	0	0	0	0	3.3	0	**3.3**	1.7	5.3	97	1.7%	5.5%
MENDOCINO	5.0	0	0	0	0	0	5.0	0	**5.0**	2.5	9.0	171	1.5%	5.3%
MERCED	0.1	0	0	0	0	0	0.1	0	**0.1**	0.1	1.2	29	0.2%	4.0%
MODOC	3.9	0	0	0	0	0	3.9	0	**3.9**	2.0	7.4	143	1.4%	5.2%
MONO	0	1.9	0	0	0	0	0	1.9	**1.9**	1.0	4.2	85	1.1%	4.9%
MONTEREY	1.3	0	0	0	0	0	1.3	0	**1.3**	0.7	7.9	190	0.3%	4.1%
NAPA	0.7	0	0	0	0	0	0.7	0	**0.7**	0.4	1.7	37	1.0%	4.8%
NEVADA	3.2	0	0	0	0	0	3.2	0	**3.2**	1.6	3.7	55	2.9%	6.7%
ORANGE	0	0.5	0	0	0	0	0	0.5	**0.5**	0.3	1.0	21	1.2%	5.0%
PLACER[3]	1.3	0	0	0	0	0	1.3	0	**1.3**	0.7	3.4	73	0.9%	4.7%
PLUMAS	1.0	0	0	0	0	0	1.0	0	**1.0**	0.5	6.5	158	0.3%	4.1%
RIVERSIDE	0	3.1	0	0	0	0	0	3.1	**3.1**	1.6	6.9	142	1.1%	4.9%
SACRAMENTO	0	0	0	0	0	0	0	0	0	0	0.1	3	0%	3.8%
SAN BENITO[4]	0.7	0	0	0	0	0	0.7	0	**0.7**	0.4	3.7	88	0.4%	4.2%
SAN BERNARDINO	0	2.2	0	0	0	0	0	2.2	**2.2**	1.1	4.9	99	1.1%	4.9%

Table 3-25. Mountain Lion Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide

	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year							
County	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	Proposed Project Max Cumulative Annual Lethal Take Estimate	Low Population Estimate[2]	Maximum % of Population Proposed Project Lethal Take	Maximum % of Population Cumulative Lethal Take
SAN DIEGO	2.3	0	0	0	0	0	2.3	0	**2.3**	1.2	8.0	180	0.6%	4.4%
SAN FRANCISCO	0	0	0	0	0	0	0	0	0	0	0	0	0%	3.8%
SAN JOAQUIN	0	0	0	0	0	0	0	0	0	0	0.3	9	0%	3.8%
SAN LUIS OBISPO	3.1	0	0	0	0	0	3.1	0	**3.1**	1.6	9.1	199	0.8%	4.6%
SAN MATEO	0	0.3	0	0	0	0	0	0.3	**0.3**	0.2	0.7	15	1.0%	4.8%
SANTA BARBARA	0.8	0	0	0	0	0	0.8	0	**0.8**	0.4	6.3	154	0.3%	4.1%
SANTA CLARA	0	1.4	0	0	0	0	0	1.4	**1.4**	0.7	3.1	63	1.1%	4.9%
SANTA CRUZ	0	0.4	0	0	0	0	0	0.4	**0.4**	0.2	0.8	17	1.2%	5.0%
SHASTA	7.4	0	0	0	0	0	7.4	0	**7.4**	3.7	12.4	230	1.6%	5.4%
SIERRA	0.2	0	0	0	0	0	0.2	0	**0.2**	0.1	2.2	56	0.2%	4.0%
SISKIYOU[5]	4.4	0	0	0	0	0	4.4	0	**4.4**	2.2	15.1	339	0.6%	4.4%
SOLANO	0	0	0	0	0	0	0	0	**0**	0	0.2	4	0%	3.8%
SONOMA[6]	2.5	0	0	0	0	0	2.5	0	**2.5**	1.3	3.9	71	1.8%	5.6%
STANISLAUS	0.2	0	0	0	0	0	0.2	0	**0.2**	0.1	1.3	32	0.3%	4.1%
SUTTER	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
TEHAMA	0.4	3.6	0	0	0	0	0.4	3.6	**4.0**	2.0	8.2	164	1.2%	5.0%
TRINITY	1.8	0	0	0	0	0	1.8	0	**1.8**	0.9	6.5	148	0.6%	4.4%
TULARE	0	4.4	0	0	0	0	0	4.4	**4.4**	2.2	9.8	200	1.1%	4.9%
TUOLUMNE	4.1	0	0	0	0	0	4.1	0	**4.1**	2.1	7.2	136	1.5%	5.3%
VENTURA	0	2.1	0	0	0	0	0	2.1	**2.1**	1.1	4.7	97	1.1%	4.9%
YOLO	0	0	0	0	0	0	0	0	0	0	0.5	13	0%	3.8%
YUBA	1.6	0	0	0	0	0	1.6	0	**1.6**	0.8	1.6	21	3.7%	7.5%
Total	**80.9**	**31.1**	**1.1**	**0**	**0**	**0**	**82.0**	**31.1**	**113.1**	**56.6**	**248.9**	**5,062**	**1.1%**	**4.9%**

Notes: USDA = U.S. Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.

1 Refer to Section 3.2.23.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C27. The lower population estimate described in Appendix C27 is used here to provide the most conservative effects analysis.
3 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.
4 San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.
5 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.
6 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

3.3 Target Bird Species Analyses

Several species of migratory birds have historically been targets of WDM activities. These species are targeted for a variety of reasons, from aircraft safety at airports to minimizing property damage or limiting risk to threatened and endangered species.

Corvids

Corvids are a group of native bird species all belonging to the family Corvidae. Corvid target species include American crow, common raven, and California scrub jay (*Aphelocoma californica*). Each are analyzed individually in Sections 3.3.1 through 3.3.3. Corvids are commonly found throughout California. Corvid populations are increasing in California due to their ability to adapt and thrive in human-altered landscapes (Robbins *et al.* 1986; BLM 1990; Marzluff *et al.* 2001; Harju *et al.* 2021).

Raptors

All raptors are protected under state law (CFGC Sections 3503, 3503.5, 3505, and 3513 and 14 CCR 251.1, 652, and 783-786.6). Lethal WDM of non-special status raptors under the Proposed Project is expected to affect a very small proportion of each species' population on a statewide and likely local level, as shown in the analyses in Sections 3.3.4 through 3.3. 6. Species included in this grouping were analyzed individually and include ferruginous hawk, red-tailed hawk, and common barn owl. Effects on special-status raptor species, including bald eagle, golden eagle, northern harrier, Swainson's hawk, and white-tailed kite are described in additional detail in Section 3.4.

The MIS baseline data (2010–2019) have documented raptor predation, damage, and harassment of the following federally listed species: Ridgeway's rail, snowy plover, and California least tern. According to USFWS (2020), peregrine falcons have become increasingly common predators at California least tern nesting sites where they prey primarily on adult or fledgling California least terns. Raptors that habitually prey on least terns can be moved by permitted individuals to locations away from breeding colonies, lessening the threat to least terns (USFWS 2020b). Additionally, American kestrel, merlin, northern harrier, great horned owl, and burrowing owls are known avian predators of western snowy plover chicks (USFWS 2007). Therefore, removal of raptors under WDM activities could result in a net benefit to threatened and endangered species populations (e.g., increased survival and nesting rates). Non-lethal WDM may reduce use of some habitat by raptors; however, much of the raptor WDM is employed at airports to prevent collisions with aircraft. In this way, non-lethal WDM may reduce potential for mortality of these species.

Impacts on populations of non-special-status raptors may occur as a result of effects on individuals or effects from human development on habitat. Since the Proposed Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting raptors; however, lethal WDM of raptors would contribute to cumulative effects on the species. Other sources of mortality for non-special-status raptors include roadkill, incidental poisoning through consumption of rodenticides, collisions with structures (including electrocution), and poaching (Buechley *et al.* 2022; Diffendorfer *et al.* 2021; Hager 2009; Wendell *et al.* 2002).

Granivores

The species that are considered within this category were analyzed individually and include, red-winged blackbird, Brewer's blackbird, yellow-headed blackbird, and tricolored blackbird. As listed in Table 3-1, many granivores were not analyzed in detail because Proposed Project lethal WDM either did not occur or was below levels reasonably considered to cause population effects. Note that effects on the special-status granivore tricolored blackbird are described in additional detail in Section 3.4.1.

Three of the non-special status granivore species had annual lethal WDM that met the criteria for further analysis in this document: red-winged blackbird, Brewer's blackbird, and yellow-headed blackbird. However, even for these species lethal WDM under the Proposed Project is expected to affect a very small proportion of each species' population on a statewide and likely local level (Sections 3.3.7, 3.3.8, and 3.3.9). This low level of mortality (less than 0.2% of each species statewide population) is easily replaced through annual reproductive cycles of these species, which typically lay multiple eggs each season (Martin 2020; Twedt and Crawford 2020; Yasukawa and Searcy 2020). Non-lethal WDM may reduce use of some habitat by flocking granivores; however, much of the flocking granivore WDM is employed at airports to prevent collisions with aircraft. In this way, non-lethal WDM may actually reduce potential for mortality of these species. Where WDM is used to prevent loss of crops, the population level effects are likely short term and reproduction can replace the incremental population reductions caused by Proposed Project WDM (Martin 2020; Twedt and Crawford 2020; Yasukawa and Searcy 2020).

Red-winged blackbird, Brewer's blackbird, and yellow-headed blackbird are classified as migratory nongame birds but can be taken under the USFWS depredation order when concentrated in a manner that cause damage or constitutes a health hazard (50 CFR § 21.43, Depredation order for blackbirds, cowbirds, crows, grackles, and magpies).

Flocking granivores are subject to cumulative effects primarily from habitat loss, especially of wetland nesting habitat, and likely exposure to pesticides or other contaminants (Martin 2020; Twedt and Crawford 2020; Yasukawa and Searcy 2020). However, Brewer's and red-winged blackbirds also frequently occur in urbanized areas (Blair 1996; Martin 2020), which may support larger populations than pre-development conditions in some areas. The common flocking granivore species that are subjects of WDM under the Proposed Project have generally robust population sizes and high reproductive capacities that allow populations to remain stable or increase despite these effects (Sauer *et al.* 2019; Martin 2020; Twedt and Crawford 2020; Yasukawa and Searcy 2020).

Waterfowl

Target species in the waterfowl group include ducks, geese, and rails. It should be noted that waterfowl receive hunting pressure during their respective migration periods. The only species that was considered within this category and analyzed individually was Canada goose. The remaining waterfowl species listed in Table 3-1 were not analyzed in detail because Project lethal WDM either did not occur or was below levels reasonably considered to cause population effects.

One of the waterfowl species had either lethal WDM conducted by a WDM county program under the Proposed Project, which requires a county level analysis under CEQA, or had a lethal take that was above 1% of the state estimated population: Canada goose (analysis in Section 3.3.10).

Waterbirds

Waterbirds is a group of bird species typically associated with water (e.g., shorebirds and freshwater birds) excluding ducks and geese ("waterfowl"). The species that are considered within this category and analyzed individually include California gull and black-crowned night heron. As listed in Table 3-1, most waterbird species were not analyzed in detail because Proposed Project lethal WDM was below levels reasonably considered to cause population effects. Note that effects on special-status water associated non-game birds, including sandhill crane, California brown pelican, western snowy plover, and California least tern, are described in additional detail in Section 3.4.

Two of the water-associated non-game bird species had either lethal WDM conducted by a WDM county program, which requires a county level analysis under CEQA, or had a lethal take that was above 1% of the state estimated population: California gull and black-crowned night heron (analyses in Sections 3.3.11 and 3.3.12). However, even for these species lethal WDM under the Proposed Project is expected to affect a very small proportion of each species' population on a statewide and likely local level.

Non-lethal WDM may reduce use of some habitat by water-associated non-game birds; however, much of the WDM is employed at airports to prevent collisions with aircraft. In this way, non-lethal WDM may actually reduce potential for mortality of these species. A non-substantial effect on populations of water-associated non-game birds would occur.

The MIS baseline data (2010–2019) have documented water-associated non-game bird predation and damage by egrets/herons, gulls, plovers, and terns to the federally listed California least tern and western snowy plover. Therefore, WDM of certain water-associated non-game birds through county Threatened and Endangered Species Programs could result in a net benefit to threatened and endangered species populations (e.g., increased survival and nesting rates). However, many species in this grouping are not known to prey on or otherwise adversely affect special-status species, and Proposed Project WDM is expected to have no beneficial effects to biological resources. Water-associated non-game birds are subject to effects from habitat loss (especially of nesting habitat), pesticides or other contaminants, and human disturbance at nesting colonies (Hothem *et al.* 2020; Winkler 2020).

Other Insectivores

In addition to the target bird groups listed above, target birds include other insectivorous species. The species that are considered within this category and analyzed individually include acorn woodpecker (*Melanerpes formicivorus*) and northern flicker (*Colaptes auratus*) (Section 3.3.13 and 3.3.14).

Lethal WDM of other insectivores under the Project is expected to affect a very small proportion of each species' population on a statewide and likely local level, generally less than 0.01% of the statewide population annually. Non-lethal WDM may reduce use of some habitat by insectivores; however, much of the insectivore WDM is employed at airports to prevent collisions with aircraft. In this way, non-lethal WDM may actually reduce potential for mortality of these species. Where WDM is used to prevent loss of crops, the population level effects are likely short-term and reproduction can rapidly replace the incremental population reductions caused by Project WDM.

The MIS baseline data (2010–2019) have documented insectivore predation by loggerhead shrike of the federally listed western snowy plover. Therefore, WDM of insectivores through county Threatened and Endangered Species Programs could result in a net benefit to threatened and endangered species populations (e.g., increased survival and nesting rates).

Factors influencing mortality of insectivores include habitat loss, particularly nesting cavities, competition with European starlings for nest sites, pesticides and other contaminants, and declines in insect abundance due to pesticide use or other factors (Koenig *et al.* 2020; Wiebe and Moore 2020). However, both acorn woodpecker and northern flicker are adaptable to suburban environments, readily nesting in areas with human habitation (Blair 1996; Koenig *et al.* 2020; Wiebe and Moore 2020). The common insectivore species that are subjects of WDM under the Project have generally robust population sizes and high reproductive capacities that allow populations to remain stable or increase despite these effects (Koenig *et al.* 2020; Sauer *et al.* 2019; Wiebe and Moore 2020).

3.3.1 American Crow

American crow is a migratory bird that occurs abundantly throughout California in valley foothills, riparian, grassland, orchard-vineyard, cropland, pasture, and urban environments (CFGC Section 4150) (CWHR 2022). This species' range includes all 58 California counties (CWHR 2022). American crows are human commensal species and populations have increased across North America, especially in areas of urban growth and sprawl (Marzluff *et al.* 2001; Withey 2005; Withey and Marzluff 2009). Average clutch size is 4.7 (Verbeek and Caffrey 2021) and overall reproductive success is 1.36 fledglings per female in the population per year (northwestern crow, Verbeek and Caffrey 2021). American crow is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). The California population is estimated at 480,000 (PIF 2022). Assuming a 1:1 sex ratio, 480,000 crows would equate to240,000 females. 240,000 females in population x 1.36 fledglings per female in population = 326,400 successful fledglings per year. 326,400/480,000 = additional 68% of population added per year. Total mortality must be below 68% to ensure no impact to crow populations.

American crow can be taken under the USFWS depredation order when concentrated in a manner that cause damage or constitutes a health hazard (50 CFR § 21.43, Depredation order for blackbirds, cowbirds, crows, grackles, and magpies).

3.3.1.1 Previous Wildlife Damage Management

WDM for American crow comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 4,806 American crow individuals were dispersed,[55] 0.7 individuals were freed, and 463 individuals were killed per year. Two inactive American crow nests were removed at airports within Solano and Yuba County during the 10-year baseline period. Because these nests were inactive, they were excluded from the WDM activity totals. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 5,270 individuals per year based on the WS-California MIS data from 2010 to 2019.[56] Baseline WDM for American crow occurred within 21 counties across the state, with the majority, 94% (4,983.5 individuals), occurring at airports within 14 counties. Dispersal of American crow accounts for 91% (4,800.4 individuals) of WDM activities occurring at airports, with Santa Clara County accounting for 29% (1,411.5 individuals) of that total. Approximately 5% (274.4 individuals) of baseline WDM occurred for T&E species protection within the following nine counties: Alameda (11.1 individuals), Monterey (21.6 individuals), San Diego (235.0 individuals), San Luis Obispo (1.3 individuals), San Mateo (1.4 individuals), Santa Barbara (2.8 individuals), Santa Clara (0.1 individual), Santa Cruz (0.3 individuals), and Ventura (0.8 individuals). Of the 274.4 individuals, 269.2 were killed and 5.2 were dispersed. Documented threatened and endangered species protected by American crow WDM include snowy plover and California least tern. Non-lethal activities accounted for 91% (4,807 individuals per year) of the WS-California WDM conducted for this species per year on average, and lethal activities accounted for 9% (463individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-26) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high

55 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

56 Average includes activities that both intentionally and unintentionally affect American crow and all potential methods used during WDM activities.

population of the target species and resources that were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of American crow is estimated at 722.6 individuals annually. This total is comprised of the WS-California lethal take of 465.5 individuals per year and the non-WS-California estimates for lethal take of 257.1 individuals per year (Table 3-26). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 480,000 individuals, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022). Approximately 0.2% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide American crow take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For American crow, the average is 463.4,[57] the standard deviation is 171.8, and the 99% confidence high estimate is 906.8, which we rounded up to 907 individuals. The 99% Confidence Factor for American crow was 907/463.4 = 1.96. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.1.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of American crow under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 1,418 American crows taken annually, which represents 0.3% of the statewide population of 480,000 (PIF 2022), well below the sustainable harvest threshold of 68%. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0 (several counties) to 504 individuals in San Diego County. These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 1,418. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average lethal take statewide of 1,418 individuals. The maximum number of American crows taken by county-level programs are listed for each county in Table 3-26, under the "Proposed Project Maximum Lethal Take

57 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-26. This small amount of error was accepted for this calculation.

Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.1.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The MIS baseline data (2010–2019) have documented American crow nesting predation of the federally listed species snowy plover and California least tern. In San Diego County, 235 American crows per year were lethally removed for TE species protection and eight were lethally removed for human safety protection at airfields. This represents 51% and 2% of the total WS-California lethal take of American crows, respectively. According to USFWS (2020b), American crows are frequently associated with people and have a strong negative effect on California least tern nesting. Marzluff *et al.* (2001) found that increasing crow populations do not necessarily correlate with increasing rates of nest predation due to the complex suite of nest predators within urban areas. However, CDFG (2002) summarizes a literature review that concludes that crows have been conclusively identified as nest predators and that they are often the most important nest predator at a particular site. Additionally, American crows have been consistently documented as a major predator on western snowy plover nests along the California coastline (USFWS 2007). Further, throughout the U.S. corvid populations are increasing simultaneously with increasing urbanization, making their removal even more relevant (Marzluff *et al.* 1994, 2001). Therefore, removal of this species under management activities could result in a net benefit to threatened and endangered species populations (e.g., increased survival rates from reduced nest predation).

3.3.1.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide American crow population may occur from effects on individuals or effects from human development on habitat. However, like other corvids American crow is highly adaptable and populations in urban areas have increased sharply in recent years due to high availability of accessible food and nesting sites coupled with low predation (Benmazouz *et al.* 2021; Marzluff *et al.* 2001; Withey and Marzluff 2009). Urban crows may also be increasing as surplus crows from suburban and rural areas disperse into cities where anthropogenic food sources are abundant and easily located (Marzluff *et al.* 2001). Although recent population trends (2010 to 2019) may suggest significant declines of American crow in California (-3.31% per year) and in the U.S. overall (-2.22% per year), longer-term trends (1966 to 2019) show a slightly increasing population in California (0.5% per year) and a stable population in the US overall (0% per year) (Sauer *et al.* 2019). Population size is estimated to be 480,000 American crows in California, out of a total U.S. population of 18 million (PIF 2022). Since the Proposed Project would not disturb habitat, the proposed management activities would not affect habitat supporting American crow. Lethal management of American crows would contribute to cumulative effects, which would also result from roadkill, collisions with structures, and poaching. The level of mortality associated with these other sources is speculative, but based on the low level of lethal management from the Proposed Project (0.3% of the statewide population estimate per year) and the broad distribution and stable or increasing populations of American crow regionally and across the continent (PIF 2022; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-26. American Crow Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0	10.1	1.6	23.2	17.4	33.3	19.0	**52.3**	103	0.02%
ALPINE	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
AMADOR	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
BUTTE	0.7	0	0	1.6	0	0	0.7	1.6	**2.3**	5	<0.01%
CALAVERAS	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
COLUSA	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
CONTRA COSTA	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
DEL NORTE	0	0.3	0	1.6	0	0	0	1.9	**1.9**	4	<0.01%
EL DORADO	0	0	0	1.6	0	0.3	0	1.9	**1.9**	4	<0.01%
FRESNO	0	0.3	0	1.6	0	0.7	0	2.6	**2.6**	6	<0.01%
GLENN	0	0.3	0	1.6	0	0.2	0	2.1	**2.1**	5	<0.01%
HUMBOLDT	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
IMPERIAL	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
INYO	0	0.3	0	1.6	0	0	0	1.9	**1.9**	4	<0.01%
KERN	5.1	0	0	1.6	0	0	5.1	1.6	**6.7**	14	<0.01%
KINGS	0	0.3	0	1.6	10.4	0.1	10.4	2.0	**12.4**	25	0.01%
LAKE	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
LASSEN	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
LOS ANGELES	0	0.3	0	1.6	62.3	62.3	62.3	64.2	**126.5**	248	0.05%
MADERA	0.2	0	0	1.6	0	0.2	0.2	1.8	**2.0**	4	<0.01%
MARIN	0	0.3	0	1.6	0	0.2	0	2.1	**2.1**	5	<0.01%
MARIPOSA	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
MENDOCINO	0	0.3	0	1.6	0	0.2	0	2.1	**2.1**	5	<0.01%
MERCED	0	0	0	1.6	1.5	2.0	1.5	3.6	**5.1**	10	<0.01%
MODOC	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
MONO	0	0.3	0	1.6	0	0.2	0	2.1	**2.1**	5	<0.01%
MONTEREY	3.8	0	17.6	1.6	0	0.3	21.4	1.9	**23.3**	46	0.01%
NAPA	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
NEVADA	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
ORANGE	0	0.3	0	1.6	15.2	0	15.2	1.9	**17.1**	34	0.01%
PLACER[2]	0	0.3	0	1.6	0	0.5	0	2.4	**2.4**	5	<0.01%
PLUMAS	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
RIVERSIDE	0	0	0	1.6	0	.2	0	1.8	**1.8**	4	<0.01%
SACRAMENTO	0	0	0	1.6	2.6	9.1	2.6	10.7	**13.3**	27	<0.01%
SAN BENITO[3]	3.0	0.3	0	1.6	0	0.2	3.0	2.1	**5.1**	10	<0.01%
SAN BERNARDINO	0	0.3	0	1.6	10.3	26.2	10.3	28.1	**38.4**	76	0.02%
SAN DIEGO	0	0	235.0	1.6	8.0	12.2	243.0	13.8	**256.8**	504	0.11%
SAN FRANCISCO	0	0.3	0	1.6	0	0	0	1.9	**1.9**	4	<0.01%

Table 3-26. American Crow Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	0	0	1.6	0	0.3	0	1.9	**1.9**	4	<0.01%
SAN LUIS OBISPO	0	0	1.3	1.6	3.1	4.1	4.4	5.7	**10.1**	20	<0.01%
SAN MATEO	0	0	1.2	1.6	0	1.1	1.2	2.7	**3.9**	8	<0.01%
SANTA BARBARA	0	0	2.8	1.6	0	0.2	2.8	1.8	**4.6**	10	<0.01%
SANTA CLARA	0	0.3	0.1	1.6	17.7	9.7	17.8	11.6	**29.4**	58	0.01%
SANTA CRUZ	0	0.3	0.3	1.6	0	0.2	0.3	2.1	**2.4**	5	<0.01%
SHASTA	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
SIERRA	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
SISKIYOU[4]	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
SOLANO	0.4	0	0	1.6	3.0	0.2	3.4	1.8	**5.2**	11	<0.01%
SONOMA[5]	0	0.3	0	1.6	0	0.7	0	2.6	**2.6**	6	<0.01%
STANISLAUS	0	0	0	1.6	0	0.2	0	1.8	**1.8**	4	<0.01%
SUTTER	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
TEHAMA	0	0.3	0	1.6	0	0	0	1.9	**1.9**	4	<0.01%
TRINITY	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
TULARE	0	0.3	0	1.6	0	0.5	0	2.4	**2.4**	5	<0.01%
TUOLUMNE	0	0	0	1.6	0	0	0	1.6	**1.6**	4	<0.01%
VENTURA	0	0.3	0.8	1.6	25.0	6.8	25.8	8.7	**34.5**	68	0.01%
YOLO	0	0	0	1.6	0	0.4	0	2.0	**2.0**	4	<0.01%
YUBA	0	0	0	1.6	0.8	0	0.8	1.6	**2.4**	5	<0.01%
Total	**13.2**	**6.0**	**269.2**	**92.8**	**183.1**	**158.3**	**465.5**	**257.1**	**722.6**	**1,418**	**0.29%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
Statewide population estimate from PIF (2022). Statewide population divided evenly among all counties within the species' range.
MIS lethal WDM includes the following fate categories: killed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided above.

1 Refer to Section 3.3.1.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.2 Common Raven

Common raven is a migratory bird species that occurs commonly and at all elevations throughout California (CWHR 2022). This species is known to occur in all 58 counties in California (CWHR 2022). Common raven is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Corvid populations are increasing in California due to their ability to adapt and thrive in human-altered landscapes (Robbins *et al.* 1986; BLM 1990; Marzluff *et al.* 2001). Contemporary desert raven populations exhibit an annual population expansion rate of approximately 1.12 (Currylow *et al.* 2021, Hanley *et al.* 2021, Kristan *et al.* 2005). If we assume that all raven populations in California are experiencing a similar expansion rate, it is appropriate to expect the addition of approximately 39,600 ravens (330,000 ravens in California x 1.12 expansion rate) each year in California. Extrapolating a desert-derived expansion rate to other California ecoregions with higher indexed raven abundance increases ensures that the resulting state-level raven abundance increase, and population expansion rate estimates are conservative relative to the actual increases in abundance experienced in California annually (Harju *et al.* 2021). This equates to a 12% surplus per year. Therefore, mortality rates below 12% would not be expected to negatively impact the raven population.

3.3.2.1 Previous Wildlife Damage Management

WDM for common raven comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 3,070.7 common raven individuals were dispersed,[58] 0.3 individuals were freed, 0.3 individuals were relocated, 0.7 individuals underwent transfer of custody, 338.6 individuals were killed, and 5.9 eggs were removed per year. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 3,416.5 individuals per year based on the WS-California MIS data from 2010 to 2019.[59] Baseline WDM for common raven occurred within 27 counties across the state, with the majority of activities, 85% (2,897.2 individuals), occurring within 13 counties at airports. Approximately 7% (236.1 individuals) of baseline WDM occurred for T&E species protection within the following 11 counties: Alameda (27.7 individuals), Marin (22.6 individuals), Monterey (12.7 individuals), San Bernardino (49.9 individuals), San Diego (89.4 individuals), San Luis Obispo (1.1 individuals), San Mateo (8.0 individuals), Santa Barbara (0.1 individuals), Santa Clara (6.0 individuals), Santa Cruz (3.1 individuals), and Ventura (12.3 individuals). Of the 236.1 individuals, 224.2 were killed and 11.9 were dispersed. Documented threatened and endangered species protected by common raven WDM include the Mojave Desert tortoise (*Gopherus agassizii*), marbled murrelet (*Brachyramphus marmoratus*), snowy plover, and California least tern. Non-lethal activities accounted for 90% (3,072 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 10% (344.5 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-27) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were

58 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
59 Average includes activities that both intentionally and unintentionally affect common raven and all potential methods used during WDM activities.

made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of common raven is estimated at 493.6 individuals annually. This total is comprised of the WS-California lethal take of 344.5 individuals per year and the non-WS-California estimates for lethal take of 149.1 individuals per year (Table 3-27). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 330,000 individuals, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022). Approximately 0.2% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide common raven take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For common raven, the average is 338.6,[60] the standard deviation is 65.8, and the 99% confidence high estimate is 508.5, which we rounded up to 509 individuals. The 99% Confidence Factor for common raven was 509/338.6 = 1.50. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.2.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of common raven under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 742 common ravens taken annually, which represents 0.2% of the population of 330,000 (PIF 2022). The Proposed Project Maximum Lethal Take Estimate by county ranges from to 2 (several counties) to 155 individuals in San Diego County. These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 742. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 742 individuals. The maximum number of common ravens taken by county-level programs are listed for each county in Table 3-27, under the “Proposed Project Maximum Lethal Take

60 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-27. This small amount of error was accepted for this calculation.

Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.2.3 Potential Beneficial Effects of Wildlife Damage Management

The MIS baseline data (2010–2019) have documented common raven predation of the following federally listed species: Mojave Desert tortoise, marbled murrelet, snowy plover, and California least tern. CDFG (2002) summarizes a literature review that concludes that ravens have been conclusively identified as nest predators and that they are often the most important nest predator at particular sites. There is concern that increases in Corvid populations are negatively affecting the populations of some listed species (CDFG 2002, Coates *et al.* 2020).). Additionally, ravens are a significant avian predator of western snowy plover chicks and eggs (USFWS 2007). Therefore, removal of this species under WDM activities could result in a net benefit to threatened and endangered species populations (e.g., increased survival and nesting rates). According to Peebles and Spencer (2020), WDM of common ravens may help reduce human health and safety concerns through the reduction of disease transmission (i.e., common ravens are carriers of West Nile virus, a potentially fatal disease to humans), reduction of health hazards (i.e., deposition of fecal matter near common raven nests), and reduction of fire hazards (i.e., common ravens have caused power outages that have led to rangeland fires and/or loss of residential power).

To conserve the Mojave Desert tortoise, raven densities should be managed such that it does not exceed 0.89 ravens km^{-2}, otherwise, 0- to 10-year-old tortoise survival rates are expected to remain unsustainably depressed (Holcomb *et al.* 2021). Based on unpublished 2022 raven density estimates, restoring raven densities to ≤0.89 ravens km^{-2} and maintaining densities below this threshold is expected to require lethal management of approximately 5,200 breeder and non-breeder ravens (Hanley *et al.* 2021). Restoring raven densities to <0.89 ravens km^{-2} is expected to require lethal management of approximately 4,800 ravens inhabiting the Fremont-Kramer and Superior-Cronese Mojave Desert tortoise Designated Critical Habitat Units, or approximately 4,650 ravens in San Bernardino, 75 ravens in Kern County, 75 ravens in Los Angeles County. Maintaining raven density at <0.89 ravens km^{-2} in other California Mojave Desert tortoise critical habitat units is expected to require the lethal management of approximately 400 ravens or approximately 310 ravens in San Bernardino, 65 ravens in Riverside, 5 ravens in Imperial County, 5 ravens in Kern County, 5 ravens in Los Angeles County. If completed in a single year, this would result in impacts to approximately 1.5 percent of ravens in California (Partners in Flight 2022) or 4.7 percent of ravens in San Bernardino County (Unpublished USFWS data) and would result in a short-term population expansion rate of approximately 1.11 for California raven populations and 1.09 for San Bernardino County raven populations, which is still safely above an equilibrium population expansion rate. Once raven densities in all tortoise conservation areas are restored below 0.89 ravens km^{-2}, the lethal take of ravens will be reduced throughout all desert counties to a maintenance level of approximately 600 ravens of any age class annually. This is expected to result in impacts to approximately 0.2% of ravens inhabiting California and a statewide raven population expansion rate of approximately 1.11.

3.3.2.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide common raven population may occur as a result of effects on individuals or effects from human development on habitat. However, like other corvids common raven is highly adaptable and populations in urban areas have increased sharply in recent years (Benmazouz *et al.* 2021; Knight *et al.* 1993). In a comprehensive trend analysis of raven population abundances across North American ecoregions, Harju *et al.* (2022) documented clear and predictable patterns of increased raven abundance across the continent over the past five decades, corroborating BBS population growth estimates *et al.*(Sauer *et al.* 2019). Population estimates for California are 330,000, out of an estimated U.S. population of 2.5 million common ravens (PIF 2022). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting common ravens. Lethal WDM of common ravens would contribute to cumulative effects. Cumulative effects on this species would also result from roadkill, collisions with structures, secondary poisoning, and poaching. The level of mortality associated with these other sources is speculative and not quantified, but based on the low level of lethal WDM from the Project and the broad distribution and increasing populations of common raven across its range and in the region (Harju *et al.* 2021), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-27. Common Raven Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0	24.0	1.3	3.0	2.3	27.0	3.6	**30.6**	46	0.01%
ALPINE	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
AMADOR	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
BUTTE	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
CALAVERAS	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
COLUSA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
CONTRA COSTA	0.1	0	0	1.3	0	0	0.1	1.3	**1.4**	3	<0.01%
DEL NORTE	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
EL DORADO	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
FRESNO	0	1.6	0	1.3	0	0.2	0	3.1	**3.1**	5	<0.01%
GLENN	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
HUMBOLDT	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
IMPERIAL	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
INYO	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
KERN	15.3	0	0	1.3	1.5	0.5	16.8	1.8	**18.6**	28	<0.01%
KINGS	0	1.6	0	1.3	1.6	0.2	1.6	3.1	**4.7**	8	<0.01%
LAKE	0.9	0	0	1.3	0	0	0.9	1.3	**2.2**	4	<0.01%
LASSEN	24.7	0	0	1.3	0	0	24.7	1.3	**26.0**	39	0.01%
LOS ANGELES	0	1.6	0	1.3	15.1	15.1	15.1	18.0	**33.1**	50	0.02%
MADERA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
MARIN	0	1.6	14.8	1.3	0	0	14.8	2.9	**17.7**	27	<0.01%
MARIPOSA	0.9	0	0	1.3	0	0	0.9	1.3	**2.2**	4	<0.01%
MENDOCINO	0.4	0	0	1.3	0	0	0.4	1.3	**1.7**	3	<0.01%
MERCED	1.8	0	0	1.3	0.2	0.3	2.0	1.6	**3.6**	6	<0.01%
MODOC	2.8	0	0	1.3	0	0	2.8	1.3	**4.1**	7	<0.01%
MONO	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
MONTEREY	0	0	12.3	1.3	0	0	12.3	1.3	**13.6**	21	<0.01%
NAPA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
NEVADA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
ORANGE	0	1.6	0	1.3	0.4	0	0.4	2.9	**3.3**	5	<0.01%
PLACER[2]	0	1.6	0	1.3	0	0.1	0	3.0	**3.0**	5	<0.01%
PLUMAS	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
RIVERSIDE	0	1.6	0	1.3	0	0.2	0	3.1	**3.1**	5	<0.01%
SACRAMENTO	0	0	0	1.3	0.2	0.7	0.2	2.0	**2.2**	4	<0.01%
SAN BENITO[3]	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
SAN BERNARDINO	0	1.6	50.0	1.3	1.0	2.6	51.0	5.5	**56.5**	85	0.03%
SAN DIEGO	0	0	89.4	1.3	4.8	7.3	94.2	8.6	**102.8**	155	0.05%
SAN FRANCISCO	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%

Table 3-27. Common Raven Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
SAN LUIS OBISPO	5.5	0	1.1	1.3	1.5	2.0	8.1	3.3	**11.4**	18	<0.01%
SAN MATEO	0	0	8.0	1.3	0	0.3	8.0	1.6	**9.6**	15	<0.01%
SANTA BARBARA	0.4	0	0.1	1.3	0	0	0.5	1.3	**1.8**	3	<0.01%
SANTA CLARA	0	1.6	6.0	1.3	8.7	4.8	14.7	7.7	**22.4**	34	0.01%
SANTA CRUZ	0	1.6	3.1	1.3	0	0	3.1	2.9	**6.0**	9	<0.01%
SHASTA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
SIERRA	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
SISKIYOU[4]	4.6	1.6	0	1.3	0	0	4.6	2.9	**7.5**	12	<0.01%
SOLANO	5.3	0	0	1.3	2.2	0.2	7.5	1.5	**9.0**	14	<0.01%
SONOMA[5]	0	1.6	0	1.3	0	0.2	0	3.1	**3.1**	5	<0.01%
STANISLAUS	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
SUTTER	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
TEHAMA	0	1.6	0	1.3	0	0	0	2.9	**2.9**	5	<0.01%
TRINITY	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
TULARE	0	1.6	0	1.3	0	0.1	0	3.0	**3.0**	5	<0.01%
TUOLUMNE	0	0	0	1.3	0	0	0	1.3	**1.3**	2	<0.01%
VENTURA	0	1.6	12.3	1.3	10.6	2.9	22.9	5.8	**28.7**	44	0.01%
YOLO	0	0	0	1.3	0	0.1	0	1.4	**1.4**	3	<0.01%
YUBA	0	0	0	1.3	4.6	0	4.6	1.3	**5.9**	9	<0.01%
EGG REMOVAL	1.0	0	3.2	0	1.7	0	5.9	0	**5.9**	9	NA
Total	**62.7**	**33.6**	**221.1**	**75.4**	**55.4**	**40.1**	**345.1**	**149.1**	**494.2**	**742**	**0.22%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; NA = Not Applicable; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4

1 Refer to Section 3.3.2.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.3 California Scrub-Jay

California scrub-jay is a year-round resident species in California that occurs commonly in all counties, except Mono and Inyo, and at lower elevation and drier areas than the Steller's jay (*Cyanocitta stelleri*) (CWHR 2022). This species commonly occurs in dry shrublands, oak woodlands, and residential areas from the State of Washington south to Baja. California scrub-jay is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Clutch size has been reported at 4.8 eggs per nest in California, but other locations average 0.9 to 1.6 independent young per nest, for an average of 1.25. This aligns with the proportion of females successfully rearing at least one fledgling: 52%. Estimated population in California is 1,200,000 (PIF 2022), which is approximately 600,000 females assuming a 1:1 sex ratio. Using the lowest nesting success of 0.9 independent young per nest, this results in an annual addition of 540,000 per year, which is 45% of the population. Thus, total mortality below 45% would not be expected to negatively impact the population.

3.3.3.1 Previous Wildlife Damage Management

WDM for California scrub-jay comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 0.2 California scrub jay individuals were dispersed,[61] 0.5 individuals were freed, 0.6 individuals were relocated, and 0.5 individuals were killed. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 1.8 individuals per year based on the WS-California MIS data from 2010 to 2019.[62] Non-lethal activities accounted for 72% (1.3 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 18% (0.5 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-28) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species in their homes without involving WS-California or another WDM entity. Therefore, an additional 2 California scrub jays per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-28). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of California scrub jay is estimated at 112.8 individuals annually. This total is comprised of the WS-California lethal take of 0.5 individuals per year and the non-WS-California estimates for lethal take of 112.3 individuals per year (Table 3-28). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 1,200,000 individuals, based on Avian Conservation Assessment and Population Estimates Database (PIF 2022). Less than 0.01% of the statewide population was taken by lethal WDM activities annually.

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61 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

62 Average includes activities that both intentionally and unintentionally affect California scrub jay and all potential methods used during WDM activities.

The 99% confidence high estimate WS-California lethal take (average plus 2.58 standard deviations) was not calculated due to the low amount of take. This represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years. Because take of a California scrub jay could occur in any single year, the Proposed Project Maximum Lethal Take Estimate is expected to be 2 individuals per year in each county based on take of an evenly distributed 0.01% of the statewide population.

3.3.3.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of California scrub jay under the Proposed Project is likely to be similar to the total take estimated above on average: the lethal take of a California scrub jay is expected to occur only occasionally. The total Proposed Project Maximum Lethal Take Estimate is 113 California scrub jays taken annually, which represents 0.01% of the statewide population estimate for this species of approximately 1,200,000 individuals (PIF 2022). The Proposed Project Maximum Lethal Take Estimate by county ranges from 2 to 3 individuals – that low level of take would be well below the sustainable harvest threshold of 45%, and represent the highest take of this species expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 113. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 113 individuals. The maximum number of California scrub jays taken by county-level programs are listed for each county in Table 3-28, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.3.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of California scrub jay for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

3.3.3.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide California scrub-jay population may occur from effects on individuals or effects from human development on habitat. However, like many other corvids, California scrub-jays are highly adaptable and are increasing in urban areas (Blair 1996; Marzluff *et al.* 1994). Population trends for California scrub-jay are grouped with Woodhouse's scrub-jay at the national level, as the two species were only recently separated based on genetic studies (Delaney *et al.* 2008), and together show a -0.93% decrease per year in recent terms (2010-2019) and -0.1% decrease over the long term (1966-2019) (Sauer *et al.* 2019). In California, population trend data can be assumed to represent California scrub-jay only, as Woodhouse's scrub-jay are not present, and show a recent (2010-2019) trend of -1.33% decrease per year but long-term (1966-2019) only -0.1% decrease per year (Sauer *et al.* 2019). Given the low the Proposed Project Maximum Lethal Take Estimate (less than 0.01% of the estimated state population), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level. Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting California scrub-jays.

Table 3-28. California Scrub Jay Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
ALPINE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
AMADOR	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
BUTTE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
CALAVERAS	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
COLUSA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
CONTRA COSTA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
DEL NORTE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
EL DORADO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
FRESNO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
GLENN	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
HUMBOLDT	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
IMPERIAL	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
INYO	0	0	0	0	0	0	0	0	**0**	0	0%
KERN	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
KINGS	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
LAKE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
LASSEN	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
LOS ANGELES	0	2.0	0	0	0.3	0.3	0.3	2.3	**2.6**	3	<0.01%
MADERA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MARIN	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MARIPOSA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MENDOCINO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MERCED	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MODOC	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
MONO	0	0	0	0	0	0	0	0	**0**	0	0%
MONTEREY	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
NAPA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
NEVADA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
ORANGE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
PLACER[2]	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
PLUMAS	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
RIVERSIDE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SACRAMENTO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN BENITO[3]	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN BERNARDINO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN DIEGO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN FRANCISCO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%

Table 3-28. California Scrub Jay Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN LUIS OBISPO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SAN MATEO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SANTA BARBARA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SANTA CLARA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SANTA CRUZ	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SHASTA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SIERRA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SISKIYOU[4]	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SOLANO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
SONOMA[5]	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
STANISLAUS	0.2	2.0	0	0	0	0	0.2	2.0	**2.2**	3	<0.01%
SUTTER	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
TEHAMA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
TRINITY	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
TULARE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
TUOLUMNE	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
VENTURA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
YOLO	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
YUBA	0	2.0	0	0	0	0	0	2.0	**2.0**	2	<0.01%
Total	**0.2**	**112.0**	0	0	**0.3**	**0.3**	**0.5**	**112.3**	**112.8**	**113**	**<0.01%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed. Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.3.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.4 Red-Tailed Hawk

Red-tailed hawk is a migratory bird species that occurs commonly and at all elevations throughout California, in almost all habitats. This species breeds throughout California and winters in all areas without heavy snow cover. It eats small mammals up to the size of a hare, as well as small birds, reptiles, and amphibians. This highly adaptable species also uses croplands, fields, and pastures for foraging (CWHR 2022).

Red-tailed hawk is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Average clutch size for red-tailed hawk is 2.92 (Henny and Wight 1972; California) and fledgling success is 1.36 fledglings per pair (Johnson 1975; Montana) in the population per year. The population estimate for red-tailed hawks in California is 230,000 (PIF 2022). Assuming a 1:1 sex ratio, this equates to 115,000 females. As high as 26% of pairs have been reported as non-breeding (Hagar 1957; New York). Assuming 1.36 fledglings per 85,100 breeding pairs (115,000 females minus 26%) equals 115,736 successful fledglings per year and an additional 50% of population added per year. Total mortality must be below 50% to ensure no impact to red-tailed hawk populations.

3.3.4.1 Previous Wildlife Damage Management

WDM for red-tailed hawk comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 3,677.8 red-tailed hawk individuals were dispersed,[63] 0.7 individuals were freed, 89.6 individuals were relocated, 51.2 individuals underwent a transfer of custody, 156.4 individuals were killed, and 1.0 eggs were removed/destroyed per year. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 3,976.7 individuals per year based on the WS-California MIS data from 2010 to 2019.[64] WS-California MIS baseline WDM for red-tailed hawk occurred within 14 counties across the state, with the majority occurring from airport dispersals. WS-California used nonlethal and lethal methods for T&E species protection of 12.4 red-tailed hawk individuals within the following counties: Alameda (6.2 individuals), San Diego (5.8 individuals), and Ventura (0.4 individuals). Of the 12.4 individuals, 2.8 individuals were lethally taken. Documented threatened and endangered species protected by red-tailed hawk WDM include snowy plover, Ridgeway's rail, and California least tern. Non-lethal activities accounted for 96% (3,819.3 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 4% (157.4 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-29.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-29) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species in their homes without involving WS-California or another WDM entity. Therefore, an additional 1 red-tailed hawk every 10 years have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-29). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California

63 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
64 Average includes activities that both intentionally and unintentionally affect red-tailed hawk and all potential methods used during WDM activities

personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of red-tailed hawk is estimated at 296.7 individuals annually. This total is comprised of the WS-California lethal take of 157.4 individuals per year and the non-WS-California estimates for lethal take of 139.3 individuals per year (Table 3-29). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species is approximately 230,000 individuals, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022). Approximately 0.1% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide red-tailed hawk take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For red-tailed hawk, the average is 156.4,[65] the standard deviation is 60.5, and the 99% confidence high estimate is 312.5, which we rounded up to 313 individuals. The 99% Confidence Factor for red-tailed hawk was 313/156.4 = 2.00. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.4.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of red-tailed hawk under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The potential for occasional lethal take was also included in counties with no lethal take during the analysis period whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. These determinations were subjective and qualitative and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

The total Proposed Project Maximum Lethal Take Estimate is 594 taken annually, which represents 0.26% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0.03% (several counties) to 3.6% (143 individuals of 3,966 estimated county population; Los Angeles County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 594. The

65 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-29. This small amount of error was accepted for this calculation.

proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 594 individuals. The maximum number of red-tailed hawks taken by county-level programs are listed for each county in Table 3-29, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.4.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) includes lethal and non-lethal WDM of red-tailed hawk for the benefit of the listed snowy plover, Ridgeway’s rail, and California least tern. Future Project WDM of this species could have beneficial effects to these or other species that are preyed upon by red-tailed hawk.

3.3.4.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide red-tailed hawk population may occur from effects on individuals or effects from human development on habitat. Unlike many raptor species (Kettel *et al.* 2018), red-tailed hawks can successfully occupy urban environments that provide adequate open hunting habitat (Stout *et al.* 2006; White *et al.* 2020a). Population trends of red-tailed hawk across the U.S. show a long-term (1966-2019) increase of 1.5% per year, with slightly lower long-term increases of 0.7% per year in California (Sauer *et al.* 2019). Recent trends from 2010 to 2019 are consistent with the long-term trend, with 1.08% yearly increases across the U.S. overall and 0.55% yearly increases in California (Sauer *et al.* 2019). Cumulative effects to this species would also result from direct persecution/poaching, secondary poisoning, collisions, and electrocution (Preston and Beane 2020). The level of mortality associated with these other sources is patchily quantified but does not appear to affect the species at the population level (Preston and Beane 2020; Sauer *et al.* 2019). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting red-tailed hawks. Given the low the Proposed Project Maximum Lethal Take Estimate (0.3% of the estimated state and county populations) and the broad distribution and increasing populations of red-tailed hawk across its range and the region (Preston and Beane 2020; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-29. Red-Tailed Hawk Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0.1	0.9	0	31.0	23.3	31.9	23.4	**55.3**	111	0.05%
ALPINE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
AMADOR	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
BUTTE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
CALAVERAS	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
COLUSA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
CONTRA COSTA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
DEL NORTE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
EL DORADO	0	0.1	0	0	0	0.3	0	0.4	**0.4**	1	<0.01%
FRESNO	0	0.1	0	0	0	0.6	0	0.7	**0.7**	2	<0.01%
GLENN	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
HUMBOLDT	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
IMPERIAL	0.1	0.1	0	0	0	0.1	0.1	0.2	**0.3**	1	<0.01%
INYO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
KERN	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
KINGS	0	0.1	0	0	16.2	2.0	16.2	2.1	**18.3**	37	0.02%
LAKE	0	0.1	0	0	0	0.2	0	0.3	**0.3**	1	<0.01%
LASSEN	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
LOS ANGELES	0	0.1	0	0	35.6	35.6	35.6	35.7	**71.3**	143	0.06%
MADERA	0	0.1	0	0	0	0.2	0	0.3	**0.3**	1	<0.01%
MARIN	0	0.1	0	0	0	0.2	0	0.3	**0.3**	1	<0.01%
MARIPOSA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
MENDOCINO	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MERCED	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
MODOC	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MONO	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MONTEREY	0	0.1	0	0	0	0.3	0	0.4	**0.4**	1	<0.01%
NAPA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
NEVADA	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
ORANGE	0	0.1	0	0	1.9	0	1.9	0.1	**2.0**	4	<0.01%
PLACER[2]	0	0.1	0	0	0	0.4	0	0.5	**0.5**	1	<0.01%
PLUMAS	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
RIVERSIDE	0	0.1	0	0	0	0.5	0	0.6	**0.6**	2	<0.01%
SACRAMENTO	0	0.1	0	0	1.4	4.9	1.4	5.0	**6.4**	13	<0.01%
SAN BENITO[3]	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SAN BERNARDINO	0	0.1	0	0	11.9	30.3	11.9	30.4	**42.3**	85	0.04%
SAN DIEGO	0	0.1	1.8	0	1.5	2.3	3.3	2.4	**5.7**	12	<0.01%
SAN FRANCISCO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%

Table 3-29. Red-Tailed Hawk Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	0.1	0	0	0	0.3	0	0.4	**0.4**	1	<0.01%
SAN LUIS OBISPO	0	0.1	0	0	14.8	19.7	14.8	19.8	**34.6**	70	0.03%
SAN MATEO	0	0.1	0	0	0	1.0	0	1.1	**1.1**	3	<0.01%
SANTA BARBARA	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SANTA CLARA	0	0.1	0	0	13.4	7.3	13.4	7.4	**20.8**	42	0.02%
SANTA CRUZ	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SHASTA	0	0.1	0	0	0	0.2	0	0.3	**0.3**	1	<0.01%
SIERRA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
SISKIYOU[4]	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
SOLANO	0	0.1	0	0	10.3	0	10.3	0.1	**10.4**	21	<0.01%
SONOMA[5]	0	0.1	0	0	0	0.6	0	0.7	**0.7**	2	<0.01%
STANISLAUS	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SUTTER	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
TEHAMA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
TRINITY	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
TULARE	0	0.1	0	0	0	0.4	0	0.5	**0.5**	1	<0.01%
TUOLUMNE	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
VENTURA	0	0.1	0.1	0	5.1	1.4	5.2	1.5	**6.7**	14	<0.01%
YOLO	0	0.1	0	0	0	0.3	0	0.4	**0.4**	1	<0.01%
YUBA	0	0.1	0	0	10.4	0	10.4	0.1	**10.5**	21	<0.01%
EGG REMOVAL	0	0	0.4	0	0.6	0	1.0	0	**1.0**	2	<0.01%
Total	**0.1**	**5.8**	**3.2**	**0**	**154.1**	**133.5**	**157.4**	**139.3**	**296.7**	**594**	**0.26%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.4.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.5 Ferruginous Hawk

Ferruginous hawk is a winter resident and migrant at lower elevations and open grasslands in the Modoc Plateau, Central Valley, and Coast Ranges of California (CWHR 2022). It frequents open grasslands, sagebrush, flats, desert scrub, low foothills surrounding valleys, and fringes of pinyon-juniper woodlands. It is a fairly common winter resident of grasslands and agricultural areas in southwestern California (Garrett and Dunn 1981).

Ferruginous hawk is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Lowest reported average clutch size in the U.S. is 1.8 (Howard and Wolfe 1976; Idaho) and overall fledgling success is 1.5 fledglings (Lokemoen and Duebbert 1976; South Dakota) per female in the population per year. Assuming a 1:1 sex ratio, 220 ferruginous hawks equates 110 females. As high as 40% of pairs have been reported as non-breeding in a given year (Olendorff (1993); Idaho) and Assuming 1.5 fledglings per 66 breeding pairs (110 females minus 40%) equals 99 successful fledglings per year and an additional 45% of population added per year. Total mortality must be below 45% to ensure no impact to ferruginous hawk populations.

3.3.5.1 Previous Wildlife Damage Management

WDM for ferruginous hawk comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 221.5 ferruginous hawk individuals were dispersed,[66] 0.5 individuals were relocated, and 2.2 individuals were killed per year by WS-California. Baseline WDM for ferruginous hawk occurred within 10 counties across the state, with all WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 224.2 individuals per year based on the WS-California MIS data from 2010 to 2019.[67] Non-lethal activities accounted for 99% (222.0 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 1% (2.2 individuals per year).

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-30) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of ferruginous hawk is estimated at 3.6 individuals annually. This total is comprised of the WS-California lethal take of 2.2 individuals per year and the non-WS-California estimates for lethal take of 1.4 individuals per year. These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for ferruginous hawk based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022) is approximately 220 individuals. Approximately 1.6% of the statewide population was taken by lethal WDM activities annually. Note that this assumes that take was entirely of resident ferruginous hawk and that no migratory individuals were targeted.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide ferruginous hawk take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with

66 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

67 Average includes activities that both intentionally and unintentionally affect ferruginous hawk and all potential methods used during WDM activities.

WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For ferruginous hawk, the average is 2.2,[68] the standard deviation is 1.4, and the 99% confidence high estimate is 5.8, which we rounded up to 6 individuals. The 99% Confidence Factor for ferruginous hawk was 6/42.2 = 2.73. Estimated take of ferruginous hawk is provided for each county in Table 3-30.

3.3.5.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of ferruginous hawk under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 10 taken annually, which represents 4.5% of the population. This number represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 18. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 18 individuals. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.5.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of ferruginous hawk for the benefit of listed species. Project WDM of this species is not likely to provide beneficial effects to other biological resources; however.

3.3.5.4 Potential Cumulative Effects to the Species

Cumulative effects on populations of ferruginous hawk may occur as a result of effects on individuals or effects from human development on habitat. Since the Proposed Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting raptors; however, lethal WDM of ferruginous hawk would contribute to cumulative effects on the species. Proposed Project lethal WDM would exceed 1% of the California breeding population is ferruginous hawk, but that percentage does not account for the fact that many of the ferruginous hawks killed would be wintering individuals, present in much greater numbers and part of regional populations. Population trends for ferruginous hawks show a recent (2010-2019) decrease of -0.89% yearly in California, but an increase of 0.58% yearly for the U.S. overall (Sauer *et al.* 2019). However, the long-term (1966-2019) population trend indicates overall population growth, with 1.8% per year in California and 0.8% per year across the U.S. (Sauer *et al.* 2019). The primary contributor to putative rangewide declines in ferruginous hawk populations is loss or fragmentation of open grassland habitat, primarily in their breeding and year-round habitats outside California (Cornell Lab of Ornithology 2022). Cumulative effects to ferruginous hawk from lethal WDM of primarily wintering individuals in California (averaging just over 2 per year) would not substantially contribute to these cumulative effects. Other sources of cumulative mortality

68 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-30. This small amount of error was accepted for this calculation.

for ferruginous hawk and other non-special-status raptors include roadkill, incidental poisoning through consumption of rodenticides, collisions with structures, and poaching. The level of mortality associated with these other sources is speculative but based on the very low level of lethal take from the Project relative to California and rangewide populations of these species (PIF 2022), Project WDM is not expected to combine with cumulative sources to exceed sustainable mortality thresholds of 45%.

Table 3-30. Ferruginous Hawk Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0	0	0	0	0	0	0	**0**	0	0%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	0%
AMADOR	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
BUTTE	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
CALAVERAS	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
COLUSA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0%
DEL NORTE	0	0	0	0	0	0	0	0	**0**	0	0%
EL DORADO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
FRESNO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
GLENN	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	0	0%
IMPERIAL	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
INYO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
KERN	0	0	0	0	0	0	0	0	**0**	0	0%
KINGS	0	0	0	0	0.2	<0.1	0.2	<0.1	**0.23**	1	0.45%
LAKE	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
LASSEN	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
LOS ANGELES	0	0	0	0	0.5	0.5	0.5	0.5	**1.0**	3	1.36%
MADERA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
MARIN	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
MARIPOSA	0	0	0	0	0	0	0	0	**0**	0	0%
MENDOCINO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
MERCED	0	0	0	0	0	0	0	0	**0**	0	0%
MODOC	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
MONO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
MONTEREY	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
NAPA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
NEVADA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0%
PLACER[2]	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
PLUMAS	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
RIVERSIDE	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SACRAMENTO	0	0	0	0	0.2	0.7	0.2	0.7	**0.9**	3	1.36%
SAN BENITO[3]	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SAN BERNARDINO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN DIEGO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	**0**	0	0%

Table 3-30. Ferruginous Hawk Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SAN LUIS OBISPO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN MATEO	0	0	0	0	0	0.14	0	0.14	**0.14**	1	0.45%
SANTA BARBARA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SANTA CLARA	0	0	0	0	0	0	0	0	**0**	0	0%
SANTA CRUZ	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SHASTA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	0%
SISKIYOU[4]	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SOLANO	0	0	0	0	0.4	<0.1	0.4	<0.1	**0.43**	2	0.91%
SONOMA[5]	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
STANISLAUS	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
SUTTER	0	0	0	0	0	0	0	0	**0**	0	0%
TEHAMA	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
TRINITY	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
TULARE	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
TUOLUMNE	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
VENTURA	0	0	0	0	0	0	0	0	**0**	0	0%
YOLO	0	0	0	0	0	<0.1	0	<0.1	**<0.1**	1	0.45%
YUBA	0	0	0	0	0.9	0	0.9	0	**0.9**	3	1.36%
Total	**0**	**0**	**0**	**0**	**2.2**	**1.4**	**2.2**	**1.4**	**3.6**	**10**	**4.5%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.5.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.6 Barn Owl

Barn owl is a common nonmigratory yearlong resident in open habitats including grassland, chaparral, riparian, and other wetlands throughout California from sea level to 5,500 feet amsl. It is often found in the vicinity of human communities, avoiding dense forests and open desert habitats (CWHR 2022). Most breeding occurs January through November; it nests on ledges, cliffs, artificial structures, trees or snags.

Barn owl is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). Average clutch size ranges from 4.9 to 7.17 eggs and, in California, 72% of nests were successful (Marti *et al.* 2020). In a Utah study, the lowest average fledgling rate in a given year was 3.3 young per nest (Marti *et al.* 2020). Assuming a 1:1 sex ratio, 24,000 barn owls (PIF 2022) equates 12,000 females. Females typically breed in their first year (Marti *et al.* 2020). Assuming 3.3 fledglings per 8,640 successful nests (12,000 females x 72%) equals 28,512 successful fledglings per year and an additional 119% of population added per year. Total mortality must be below 119% to ensure no impact to barn owl populations.

3.3.6.1 Previous Wildlife Damage Management

WDM for barn owl comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 23.9 barn owl individuals were dispersed,[69] 0.9 individuals were freed, 23.2 individuals were relocated, 0.2 individuals were surveyed, 13.2 individuals underwent a transfer of custody, 6.9 individuals were killed, and 0.3 eggs were removed/destroyed per year during WS-California WDM activities. Baseline WDM for barn owl occurred within 14 counties across the state, with most WDM occurring at airports or for T&E species protection. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 68.6 individuals per year based on the WS-California MIS data from 2010 to 2019.[70] Non-lethal activities accounted for 90% (61.4 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 10% (7.2 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-31.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-31) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of barn owl is estimated at 10.5 individuals annually. This total is comprised of the WS-California lethal take of 7.2 individuals per year and the non-WS-California estimates for lethal take of 3.3 individuals per year (Table 3-31). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for barn owl based on the Avian Conservation Assessment and Population Estimates Database

[69] Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
[70] Average includes activities that both intentionally and unintentionally affect barn owl and all potential methods used during WDM activities.

(PIF 2022) is approximately 24,000 individuals. Approximately 0.04% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide barn owl take through the 10-year analysis period (CY 2010-2019) and used it to estimate the 99% confidence high WS-California lethal take (average plus 2.58 standard deviations). This number was rounded up to the next integer. This number was used to represent the 99% confidence high for WS-California lethal take. The 99% Confidence Factor was calculated by dividing the 99% confidence high by the average. This factor was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by this factor to estimate the likely maximum lethal take in any year under the Proposed Project.

For barn owl, the average is 7.3,[71] the standard deviation is 3.6, and the 99% confidence high estimate is 16.6, which we rounded up to 17 individuals. The 99% Confidence Factor for barn owl was 17/7.3 = 2.3. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.6.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of barn owl under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 35 barn owls taken annually, which represents 0.15% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 1.93% per year (8 individuals of 414 estimated county population; San Diego County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 25. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 25 individuals. The maximum number of barn owl s taken by county-level programs are listed for each county in Table 3-31, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.6.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) includes lethal WDM of barn owl for the benefit of the listed western snowy plover and California least tern. Project WDM of this species conducted for this purpose could have beneficial effects to California least tern or other species that are preyed upon by barn owl.

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71 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-31. This small amount of error was accepted for this calculation.

3.3.6.4 Potential Cumulative Effects to the Species

Effects on populations of barn owl may occur as a result of effects on individuals or effects from human development on habitat. The species' nocturnal habits make accurate population assessments difficult, and the available data is too deficient to provide precise trends (Marti *et al.* 2020; Sauer *et al.* 2019). However, for the breeding bird survey data that has been collected, there appears to be short term (2010-2019) yearly increases of 0.99% in California and 3.29% in the U.S. overall (Sauer *et al.* 2019). Long term (1966-2019), populations appear to be decreasing slightly (-0.2% per year) in California but increasing (2.2% per year) in the U.S. overall (Sauer *et al.* 2019). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting barn owl; however, lethal WDM would contribute incrementally to cumulative effects on the species. Other important sources of cumulative mortality for barn owls include loss or degradation of open agricultural habitat and associated rodent prey, incidental poisoning through consumption of rodenticides or pesticides, and collisions with vehicles (Marti *et al.* 2020). Collisions with vehicles are recognized as a significant cause of mortality across the global range that has increased over time as road networks expand (Boves and Belthoff 2012; Massemin and Zorn 1998; Ramsden 2003) and may disproportionately affect female and juvenile owls (Boves and Belthoff 2012). The population-level effects of the mortality associated with these other sources is speculative and variable by location but based on the very low level of lethal take from the Project (0.15% of the population) relative to California and rangewide populations of this species (PIF 2022; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-31. Barn Owl Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0	0.3	0	1.1	0.8	1.4	0.8	**2.2**	6	0.03%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	0%
AMADOR	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
BUTTE	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
CALAVERAS	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
COLUSA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0%
DEL NORTE	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
EL DORADO	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
FRESNO	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
GLENN	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
HUMBOLDT	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
IMPERIAL	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
INYO	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
KERN	0.8	0	0	0	0	0	0.8	0	**0.8**	2	<0.01%
KINGS	0	0.1	0	0	0.3	0.1	0.3	0.2	**0.5**	2	<0.01%
LAKE	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
LASSEN	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
LOS ANGELES	0	0.1	0	0	0.2	0.2	0.2	0.3	**0.5**	2	<0.01%
MADERA	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MARIN	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MARIPOSA	0	0	0	0	0	0	0	0	**0**	0	0%
MENDOCINO	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
MERCED	0	0	0	0	0	0	0	0	**0**	0	0%
MODOC	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
MONO	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
MONTEREY	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
NAPA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
NEVADA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
ORANGE	0	0.1	0	0	0.2	0	0.2	0.1	**0.3**	1	<0.01%
PLACER[2]	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
PLUMAS	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
RIVERSIDE	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SACRAMENTO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN BENITO[3]	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SAN BERNARDINO	0	0.1	0	0	0.1	0.3	0.1	0.4	**0.5**	2	<0.01%
SAN DIEGO	0	0	3.4	0	0	0	3.4	0	**3.4**	8	0.03%
SAN FRANCISCO	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%

Table 3-31. Barn Owl Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SAN LUIS OBISPO	0	0	0	0	0.1	0.1	0.1	0.1	**0.2**	1	<0.01%
SAN MATEO	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SANTA BARBARA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SANTA CLARA	0	0.1	0	0	0.1	0.1	0.1	0.2	**0.3**	1	<0.01%
SANTA CRUZ	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SHASTA	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
SIERRA	0	0.1	0	0	0	0	0	0.1	**0.1**	1	<0.01%
SISKIYOU[4]	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SOLANO	0	0	0	0	0	0	0	0	**0**	0	0%
SONOMA[5]	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
STANISLAUS	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SUTTER	0	0	0	0	0	0	0	0	**0**	0	0%
TEHAMA	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
TRINITY	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
TULARE	0	0.1	0	0	0	0.1	0	0.2	**0.2**	1	<0.01%
TUOLUMNE	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
VENTURA	0	0.1	0	0	0.3	0.1	0.3	0.2	**0.5**	2	<0.01%
YOLO	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
YUBA	0	0	0	0	0	0	0	0	**0**	0	0%
EGG REMOVAL	0.3	0	0	0	0	0	0.3	0	**0.3**	1	NA
Total	**1.1**	**2.5**	**3.7**	**0**	**2.4**	**5.5**	**7.2**	**8.0**	**15.2**	**35**	**0.15%**

Notes: T&E = Threatened and Endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.6.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.7 Red-Winged Blackbird

Red-winged blackbird is a migratory bird species that occurs in wetland habitats throughout most of California, especially fresh or brackish emergent wetlands. This species breeds only locally above 6,000 feet amsl in the Sierra Nevada and elsewhere in Northern California, from early March into late July (CWHR 2022).

Red-winged blackbird is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Average clutch size is 3.49 and fledgling success is 2.67 fledglings per nest (Yasukawa and Searcy 2020) in the population per year. Assuming a 1:1 sex ratio, 14,000,000 red-winged blackbirds (PIF 2022) equate to 7,000,000 females. Females typically breed in their 2nd year and can live up to 15 years (Yasukawa and Searcy 2020); thus, females will breed 86.7% of their life. Assuming 86.7% of females breeding (7,000,000 females x 86.7% = 6,069,000) and 2.67 fledglings, 16,204,230 young will fledge per year, which is an additional 115.7% of the population each year. Thus, total mortality below 115.7% is not expected to negatively impact the population.

3.3.7.1 Previous Wildlife Damage Management

WDM for red-winged blackbird comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California baseline, an average of 370,353.3 red-winged blackbird individuals were dispersed,[72] 1.5 individuals were freed, 0.1 individuals were relocated, and 4,632.5 individuals were killed per year. Baseline WS-California WDM for red-winged blackbird occurred within 18 counties across the state, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 374,987.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[73] Non-lethal activities accounted for 99% (370,354.9 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 1% (4,632.5 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-32.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-32) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species (50 CFR § 21.43, Depredation order for blackbirds, cowbirds, crows, grackles, and magpies) without involving WS-California or another WDM entity. Therefore, an additional 100 red-winged blackbirds per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-32). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of red-winged blackbird is estimated at 12,891.3 individuals annually. This total is comprised of the WS-California lethal take of 4,632.5 individuals per year and the non-WS-California estimates for lethal take of 8,258.8 individuals per year (Table 3-32). These estimates of WDM

72 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
73 Average includes activities that both intentionally and unintentionally affect red-winged blackbird and all potential methods used during WDM activities.

take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for red-winged blackbird, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022), is approximately 14,000,000 individuals. Approximately 0.05% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide red-winged blackbird take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For red-winged blackbird, the average is 4,632.5,[74] the standard deviation is 3,379.7, and the 99% confidence high estimate is 13,352 individuals (which we did not need to round up). The 99% Confidence Factor for red-winged blackbird was 13,352/4,632.5 = 2.88. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.7.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of red-winged blackbird under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 37,127 red-winged blackbird taken annually, which represents 0.3% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0.12% (several counties) to 5.3% (12,379 individuals of 241,379 estimated county population; Shasta County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 37,127. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 37,127 individuals. The maximum number of red-winged blackbird s taken by county-level programs are listed for each county in Table 3-32, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

[74] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-32. This small amount of error was accepted for this calculation.

3.3.7.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of red-winged blackbird for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

3.3.7.4 Potential Cumulative Effects to the Species

Effects on populations of red-winged blackbirds may occur as a result of effects on individuals or effects from human development on habitat. Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting blackbirds; however, lethal WDM of red-winged blackbirds would contribute to cumulative effects on the species. Population trends show decreases across the long term (1966-2019) in California (-0.7% per year) and the U.S. overall (-0.8%) and steeper declines in the short term (2010-2019) in California (-2.54% per year) and the U.S. overall (-0.74% per year) (Sauer *et al.* 2019). Blackbird populations are likely declining due to loss of breeding habitat in wetlands and upland reedy or grassland habitats (Yasukawa and Searcy 2020). Populations may also be affected by climate change, as increasing storm intensities may increase winter mortality, reducing the size of breeding harems and thus reproductive output (Forcey and Thogmartin 2017; Weatherhead 2005). The species is also affected by a variety of pesticides and other contaminants (Yasukawa and Searcy 2020). The level of mortality associated with these other sources is speculative but based on the very low level of lethal take (0.3% of the population) from the Project relative to California and rangewide populations of these species (PIF 2022; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-32. Red-Winged Blackbird Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	100.0	0	0	75.6	56.7	75.6	156.7	**232.3**	670	<0.01%
ALPINE	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
AMADOR	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
BUTTE	22.1	100.0	0	0	0	0.1	22.1	100.1	**122.2**	352	<0.01%
CALAVERAS	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
COLUSA	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
CONTRA COSTA	0	100.0	0	0	23.8	0	23.8	100.0	**123.8**	357	<0.01%
DEL NORTE	0	215.7	0	0	0	0.1	0	215.8	**215.8**	622	<0.01%
EL DORADO	0	100.0	0	0	0	0.4	0	100.4	**100.4**	290	<0.01%
FRESNO	0	215.7	0	0	0	0.9	0	216.6	**216.6**	624	<0.01%
GLENN	0	215.7	0	0	0	0.2	0	215.9	**215.9**	622	<0.01%
HUMBOLDT	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
IMPERIAL	19.2	100.0	0	0	0	0.2	19.2	100.2	**119.4**	344	<0.01%
INYO	0	215.7	0	0	0	0.1	0	215.8	**215.8**	622	<0.01%
KERN	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
KINGS	0	215.7	0	0	31.5	3.9	31.5	219.6	**251.1**	724	<0.01%
LAKE	0	100.0	0	0	0	0.3	0	100.3	**100.3**	289	<0.01%
LASSEN	30.0	100.0	0	0	0	0.1	30.0	100.1	**130.1**	375	<0.01%
LOS ANGELES	0	215.7	0	0	8.1	8.1	8.1	223.8	**231.9**	668	<0.01%
MADERA	0	100.0	0	0	0	0.3	0	100.3	**100.3**	289	<0.01%
MARIN	0	215.7	0	0	0	0.3	0	216.0	**216.0**	623	<0.01%
MARIPOSA	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
MENDOCINO	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
MERCED	0	100.0	0	0	0.1	0.1	0.1	100.1	**100.2**	289	<0.01%
MODOC	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
MONO	0	215.7	0	0	0	0.2	0	215.9	**215.9**	622	<0.01%
MONTEREY	0	100.0	0	0	0	0.4	0	100.4	**100.4**	290	<0.01%
NAPA	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
NEVADA	0.5	100.0	0	0	0	0.2	0.5	100.2	**100.7**	291	<0.01%
ORANGE	0	215.7	0	0	0	0	0	215.7	**215.7**	622	<0.01%
PLACER[2]	0	215.7	0	0	0	0.6	0	216.3	**216.3**	623	<0.01%
PLUMAS	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
RIVERSIDE	0	115.7	0	0	0	0.8	0	116.5	**116.5**	336	<0.01%
SACRAMENTO	0	100.0	0	0	40.5	141.8	40.5	241.8	**282.3**	814	<0.01%
SAN BENITO[3]	0	215.7	0	0	0	0.2	0	215.9	**215.9**	622	<0.01%
SAN BERNARDINO	0	215.7	0	0	0	0	0	215.7	**215.7**	622	<0.01%
SAN DIEGO	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
SAN FRANCISCO	0	215.7	0	0	0	0	0	215.7	**215.7**	622	<0.01%

Table 3-32. Red-Winged Blackbird Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	100.0	0	0	0	0.4	0	100.4	**100.4**	290	<0.01%
SAN LUIS OBISPO	0	100.0	0	0	2.3	3.1	2.3	103.1	**105.4**	304	<0.01%
SAN MATEO	0	100.0	0	0	0	1.5	0	101.5	**101.5**	293	<0.01%
SANTA BARBARA	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
SANTA CLARA	0	215.7	0	0	30.0	16.4	30.0	232.1	**262.1**	755	<0.01%
SANTA CRUZ	0	215.7	0	0	0	0.2	0	215.9	**215.9**	622	<0.01%
SHASTA	4,319.3	100.0	0	0	0	0.3	4,319.3	100.3	**4,419.6**	12,729	0.09%
SIERRA	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
SISKIYOU[4]	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
SOLANO	0	100.0	0	0	20.0	1.5	20.0	101.5	**121.5**	350	<0.01%
SONOMA[5]	0.9	215.7	0	0	0	0.9	0.9	216.6	**217.5**	627	<0.01%
STANISLAUS	0	100.0	0	0	0	0.2	0	100.2	**100.2**	289	<0.01%
SUTTER	0	100.0	0	0	0	0	0	100.0	**100.0**	288	<0.01%
TEHAMA	0	215.7	0	0	0	0.2	0	215.9	**215.9**	622	<0.01%
TRINITY	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
TULARE	0	215.7	0	0	0	0.6	0	216.3	**216.3**	623	<0.01%
TUOLUMNE	0	100.0	0	0	0	0.1	0	100.1	**100.1**	289	<0.01%
VENTURA	0	215.7	0	0	4.6	1.3	4.6	217.0	**221.6**	639	<0.01%
YOLO	0	100.0	0	0	0	0.5	0	100.5	**100.5**	290	<0.01%
YUBA	3.8	100.0	0	0	0.2	0	4.0	100.0	**104.0**	300	<0.01%
Total	**4,395.8**	**8,014.0**	**0**	**0**	**236.7**	**244.8**	**4,632.5**	**8,258.8**	**12,891.3**	**37,127**	**0.27%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and County-Based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.7.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.8 Brewer's Blackbird

Brewer's blackbird is a mostly non-migratory bird species but is locally nomadic in nonbreeding season. It is a common to abundant resident throughout most of California, occurring in herbaceous, urban, and cropland habitats; in sparse woodlands and brushlands; and in the vicinity of lacustrine and riverine habitats. Brewer's blackbird nests from March into early August, preferring moist ground in meadow, grassland, cropland, and urban habitats or the dense foliage of trees at the margins of lakes and streams (CWHR 2022).

Brewer's blackbird is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Lowest reported average clutch size in the U.S. is 3.49 and 1.37[75] fledglings per year (La Rivers 1944; Nevada;). Assuming a 1:1 sex ratio, 4,200,000 Brewer's blackbird (PIF 2022) equates 2,100,000 females. Assuming 1.37 fledglings per 2,100,000 females equals 2,877,000 fledglings per year and an additional 68.5% of the population added per year. Total mortality must be below 68.5% to ensure no impact to Brewer's blackbird populations.

3.3.8.1 Previous Wildlife Damage Management

WDM for Brewer's blackbird comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 13,288.8 Brewer's blackbird individuals were dispersed,[76] 0.1 individuals were freed, 718.1 individuals were killed, and 3.5 eggs were removed/destroyed per year. Baseline WDM for Brewer's blackbird occurred within 16 counties across the state, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 14,010.5 individuals per year based on the WS-California MIS data from 2010 to 2019.[77] Non-lethal activities accounted for 94.9% (13,288.9 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 5.1% (721.6 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-33.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-33) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species (50 CFR § 21.43, Depredation order for blackbirds, cowbirds, crows, grackles, and magpies) without involving WS-California or another WDM entity. Therefore, an additional 100 Brewer's blackbirds per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-33). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of Brewer's blackbird is estimated at 6,920.5 individuals annually. This total is comprised of the WS-California lethal take of 718.1 individuals per year and the non-WS-

75 La Rivers reported 39.3% of young successfully leave the nest. Thus, 3.49 eggs in a clutch x 39.3% = 1.37 fledglings.
76 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
77 Average includes activities that both intentionally and unintentionally affect Brewer's blackbird and all potential methods used during WDM activities.

California estimates for lethal take of 6,202.4 individuals per year (Table 3-33). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for Brewer's blackbird, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022), is approximately 4,200,000 individuals. Approximately 0.03% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide Brewer's blackbird take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For Brewer's blackbird, the average is 662.4,[78] the standard deviation is 565.1, and the 99% confidence high estimate is 2,120.4, which we rounded up to 2,121 individuals. The 99% Confidence Factor for Brewer's blackbird was 2,121/662.4 = 3.20. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.8.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of Brewer's blackbird under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 22,146 Brewer's blackbirds taken annually, which represents 0.53% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0.06% (46 individuals of 72,414 estimated county population; Riverside County) to 2.75% (1,992 individuals of 72,414 estimated county population; Siskiyou County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 22,146. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 22,146 individuals. The maximum number of Brewer's blackbirds taken by county-level programs are listed for each county in Table 3-33, under the "Proposed Project High Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

78 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-33. This small amount of error was accepted for this calculation.

3.3.8.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of Brewer's blackbird for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

3.3.8.4 Potential Cumulative Effects to the Species

Effects on populations of Brewer's blackbirds may occur as a result of effects on individuals or effects from human development on habitat. Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting blackbirds; however, lethal WDM of Brewer's blackbirds would contribute to cumulative effects on the species. Population trends show steady decreases across the long term (1966-2019) in California (-2.2% per year) and the U.S. overall (-1.5% per year) and steeper declines in the short term (2010-2019) in California (-5.43% per year) and the U.S. overall (-3.2% per year) (Sauer *et al.* 2019). However, this species is also commonly found in urbanized environments and has likely expanded in overall range due to human settlement and urbanization (Blair 1996; Martin 2020). Mortality of eggs and nestlings typically result from predation (Martin 2020), and survival of fledglings is estimated to be only 50% after the first month (La Rivers 1944). Adults are likely frequently exposed to pesticides from agricultural operations, but this has not been studied (Martin 2020). While early survival may be low and populations are overall declining, based on the very low level of lethal take (0.53% of the population) from the Project relative to California and rangewide populations of these species (PIF 2022; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-33. Brewer's Blackbird Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
ALPINE	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
AMADOR	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
BUTTE	1.9	100.0	0	0	0	0	1.9	100.0	**101.9**	327	<0.01%
CALAVERAS	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
COLUSA	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
CONTRA COSTA	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
DEL NORTE	0	113.7	0	0	0	0	0	113.7	**113.7**	364	<0.01%
EL DORADO	0	100.0	0	0	0	0.2	0	100.2	**100.2**	321	<0.01%
FRESNO	0	113.7	0	0	0	0.5	0	114.2	**114.2**	366	<0.01%
GLENN	0	113.7	0	0	0	0.1	0	113.8	**113.8**	365	<0.01%
HUMBOLDT	0	100.0	0	0	0	0.1	0	100.1	**100.1**	321	<0.01%
IMPERIAL	0	100.0	0	0	0	0.1	0	100.1	**100.1**	321	<0.01%
INYO	0	113.7	0	0	0	0	0	113.7	**113.7**	364	<0.01%
KERN	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
KINGS	0	113.7	0	0	31.6	4.0	31.6	117.7	**149.3**	478	0.01%
LAKE	0	100.0	0	0	0	0.2	0	100.2	**100.2**	321	<0.01%
LASSEN	15.0	100.0	0	0	0	0	15.0	100.0	**115.0**	368	<0.01%
LOS ANGELES	0	113.7	0	0	1.2	1.2	1.2	114.9	**116.1**	372	<0.01%
MADERA	0	100.0	0	0	0	0.2	0	100.2	**100.2**	321	<0.01%
MARIN	0	113.7	0	0	0	0.2	0	113.9	**113.9**	365	<0.01%
MARIPOSA	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
MENDOCINO	0	100.0	0	0	0	0.1	0	100.1	**100.1**	321	<0.01%
MERCED	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
MODOC	0	100.0	0	0	0	0.1	0	100.1	**100.1**	321	<0.01%
MONO	0	113.7	0	0	0	0.1	0	113.8	**113.8**	365	<0.01%
MONTEREY	0.2	100.0	0	0	0	0.2	0.2	100.2	**100.4**	322	<0.01%
NAPA	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
NEVADA	1.8	100.0	0	0	0	0.1	1.8	100.1	**101.9**	327	<0.01%
ORANGE	0	113.7	0	0	0	0	0	113.7	**113.7**	364	<0.01%
PLACER[2]	0	113.7	0	0	0	0.4	0	114.1	**114.1**	366	<0.01%
PLUMAS	0	100.0	0	0	0	0.1	0	100.1	**100.1**	321	<0.01%
RIVERSIDE	0	13.7	0	0	0	0.5	0	14.2	**14.2**	46	<0.01%
SACRAMENTO	0	100.0	0	0	24.5	85.8	24.5	185.8	**210.3**	673	0.02%
SAN BENITO[3]	0	113.7	0	0	0	0.1	0	113.8	**113.8**	365	<0.01%
SAN BERNARDINO	0	113.7	0	0	2.6	6.6	2.6	120.3	**122.9**	394	<0.01%
SAN DIEGO	0	100.0	0	0	0	0	0	100.0	**100.0**	320	<0.01%
SAN FRANCISCO	0	113.7	0	0	0	0	0	113.7	**113.7**	364	<0.01%

Table 3-33. Brewer's Blackbird Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	100.0	0	0	0	0.2	0	100.2	100.2	321	<0.01%
SAN LUIS OBISPO	0	100.0	0	0	0	0	0	100.0	100.0	320	<0.01%
SAN MATEO	0	100.0	0	0	0	0.9	0	100.9	100.9	323	<0.01%
SANTA BARBARA	0	100.0	0	0	0	0.1	0	100.1	100.1	321	<0.01%
SANTA CLARA	0	113.7	0	0	23.0	12.5	23.0	126.2	149.2	478	0.01%
SANTA CRUZ	0	113.7	0	0	0	0.1	0	113.8	113.8	365	0.009%
SHASTA	30.2	100.0	0	0	0	0.2	30.2	100.2	130.4	418	0.01%
SIERRA	0	100.0	0	0	0	0	0	100.0	100.0	320	<0.01%
SISKIYOU[4]	522.2	100.0	0	0	0	0	522.2	100.0	622.2	1,992	0.05%
SOLANO	0	100.0	0	0	6.0	0.5	6.0	100.5	106.5	341	<0.01%
SONOMA[5]	0	113.7	0	0	0	0.5	0	114.2	114.2	366	<0.01%
STANISLAUS	0	100.0	0	0	0	0.1	0	100.1	100.1	321	<0.01%
SUTTER	0	100.0	0	0	0	0	0	100.0	100.0	320	<0.01%
TEHAMA	0	113.7	0	0	0	0	0	113.7	113.7	364	<0.01%
TRINITY	0	100.0	0	0	0	0	0	100.0	100.0	320	<0.01%
TULARE	0	113.7	0	0	0	0.4	0	114.1	114.1	366	<0.01%
TUOLUMNE	0	100.0	0	0	0	0	0	100.0	100.0	320	<0.01%
VENTURA	0	113.7	0	0	42.9	11.7	42.9	125.4	168.3	539	0.01%
YOLO	0	100.0	0	0	0	0.3	0	100.3	100.3	321	<0.01%
YUBA	1.9	100.0	0	0	9.6	0	11.5	100.0	111.5	357	<0.01%
EGG REMOVAL	0	100.0	0	0	3.5	0	3.5	100.0	103.5	332	NA
Total	**573.2**	**6,074.0**	**0**	**0**	**144.9**	**128.4**	**718.1**	**6,202.4**	**6,920.5**	**22,146**	**0.53%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.8.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.9 Yellow-Headed Blackbird

Yellow-headed blackbird is a migratory bird species that breeds commonly east of the Cascade Range and Sierra Nevada, in the Imperial and Colorado River valleys, and in the Central Valley. It nests and forages in fresh emergent wetlands with dense vegetation and deep water, often along borders of lakes or ponds (CWHR 2022). Yellow-headed blackbird breeds from mid-April to late July, nesting in a large colony.

Yellow-headed blackbird is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Lowest reported average clutch size is 3.2 (Orians 1980) and fledgling success of monogamous pairs is 1.0 fledgling per nest (Lightbody and Weatherhead 1988) in the population per year. Polygynous females may produce multiple clutches and fledge additional young (Lightbody and Weatherhead 1988); however, this conservative estimate will assume one nest per female. Assuming a 1:1 sex ratio, 530,000 yellow-headed blackbird (PIF 2022) equates 265,000 females. Assuming 1.0 fledglings per 265,000 females equals 265,000 fledglings per year and an additional 50% of the population added per year. Total mortality must be below 50% to ensure no impact to yellow-headed blackbird populations.

3.3.9.1 Previous Wildlife Damage Management

WDM for yellow-headed blackbird comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 952.5 yellow-headed blackbird individuals were dispersed,[79] 3.5 individuals were freed, 15.2 individuals were relocated, and 88.9 individuals were killed per year. Baseline WDM for yellow-headed blackbird occurred within five counties within the state, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 1,060.1 individuals per year based on the WS-California MIS data from 2010 to 2019.[80] Non-lethal activities accounted for 92% (971.2 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 8% (88.9 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-34.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-34) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species (50 CFR § 21.43, Depredation order for blackbirds, cowbirds, crows, grackles, and magpies) without involving WS-California or another WDM entity. Therefore, an additional 5 yellow-headed blackbirds per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-34). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of yellow-headed blackbird is estimated at 355.9 individuals annually. This total is comprised of the WS-California lethal take of 88.9 individuals per year and the

79 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

80 Average includes activities that both intentionally and unintentionally affect yellow-headed blackbird and all potential methods used during WDM activities.

non-WS-California estimates for lethal take of 267.0 individuals per year (Table 3-34). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for yellow-headed blackbird, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022), is approximately 530,000 individuals. Approximately 0.07% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide yellow-headed blackbird take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For yellow-headed blackbird, the average is 88.9,[81] the standard deviation is 170.2, and the 99% confidence high estimate is 1,042.6, which we rounded up to 1,043 individuals. The 99% Confidence Factor for yellow-headed blackbird was 1,043/88.9 = 5.94. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.9.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of yellow-headed blackbird under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 1,762 yellow-headed blackbirds taken annually, which represents 0.33% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 3.9% (449 individuals of 11,522 estimated county population; Shasta County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 1,410. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 1,410 individuals. The maximum number of yellow-headed blackbirds taken by county-level programs are listed for each county in Table 3-34, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

[81] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-34. This small amount of error was accepted for this calculation.

3.3.9.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of yellow-headed blackbird for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

3.3.9.4 Potential Cumulative Effects to the Species

Effects on populations of yellow-headed blackbirds may occur as a result of effects on individuals or effects from human development on habitat. Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting blackbirds; however, lethal WDM of yellow-headed blackbirds would contribute to cumulative effects on the species. Population trends in the US appear relatively stable in recent years (2010-2019) at 0.34% increase per year and over the long term (1966-2019) at 0.7% increase per year (Sauer *et al.* 2019). Trends in California show a slight decline in recent years (2010-2019) at -0.84% decrease per year, although long-term (1966-2019) trends show a more stable population at 0.1% increase per year (Sauer *et al.* 2019). The most prominent threat to yellow-headed blackbirds is loss of wetland habitat for breeding, although this species tends to prefer deeper wetlands that are less likely to be converted to agricultural or other uses compared to as compared to habitat for red-winged blackbirds (Twedt and Crawford 2020). Adults are likely frequently exposed to pesticides from agricultural operations and nestlings may be affected if aerial-applied pesticides drift into wetland breeding habitats (Twedt and Crawford 2020). The level of mortality associated with these other sources is speculative but based on the very low level of lethal take (0.3% of the population) from the Project relative to California and rangewide populations of these species (PIF 2022; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-34. Annual Average Yellow-Headed Blackbird Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
ALPINE	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
AMADOR	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
BUTTE	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
CALAVERAS	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
COLUSA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
CONTRA COSTA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
DEL NORTE	0	0	0	0	0	0	0	0	**0**	0	0%
EL DORADO	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
FRESNO	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
GLENN	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
HUMBOLDT	0	0	0	0	0	0	0	0	**0**	0	0%
IMPERIAL	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
INYO	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
KERN	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
KINGS	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
LAKE	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
LASSEN	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
LOS ANGELES	0	7.6	0	0	3.1	3.1	3.1	10.7	**13.8**	69	0.01%
MADERA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
MARIN	0	0	0	0	0	0	0	0	**0**	0	0%
MARIPOSA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
MENDOCINO	0	0	0	0	0	0	0	0	**0**	0	0%
MERCED	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
MODOC	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
MONO	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
MONTEREY	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
NAPA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
NEVADA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
ORANGE	0	0	0	0	0	0	0	0	**0**	0	0%
PLACER[2]	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
PLUMAS	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
RIVERSIDE	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
SACRAMENTO	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SAN BENITO[3]	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
SAN BERNARDINO	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
SAN DIEGO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN FRANCISCO	0	0	0	0	0	0	0	0	**0**	0	0%

Table 3-34. Annual Average Yellow-Headed Blackbird Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SAN LUIS OBISPO	0	5.0	0	0	0.1	0.1	0.1	5.1	**5.2**	26	<0.01%
SAN MATEO	0	0	0	0	0	0	0	0	**0**	0	0%
SANTA BARBARA	0	0	0	0	0	0	0	0	**0**	0	0%
SANTA CLARA	0	7.6	0	0	0.1	0	0.1	7.6	**7.7**	39	<0.01%
SANTA CRUZ	0	0	0	0	0	0	0	0	**0**	0	0%
SHASTA	85.6	5.0	0	0	0	0	85.6	5.0	**90.6**	449	0.08%
SIERRA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SISKIYOU[4]	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SOLANO	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SONOMA[5]	0	0	0	0	0	0	0	0	**0**	0	0%
STANISLAUS	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
SUTTER	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
TEHAMA	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
TRINITY	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
TULARE	0	7.6	0	0	0	0	0	7.6	**7.6**	38	<0.01%
TUOLUMNE	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
VENTURA	0	0	0	0	0	0	0	0	**0**	0	0%
YOLO	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
YUBA	0	5.0	0	0	0	0	0	5.0	**5.0**	25	<0.01%
Total	**85.6**	**263.8**	**0**	**0**	**3.3**	**3.2**	**88.9**	**267.0**	**355.9**	**1,762**	**0.33%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided above.
1 Refer to Section 3.3.9.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
1 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
2 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.10 Canada Goose

Canada goose is a migratory bird species that occurs in lacustrine, fresh emergent wetlands, and moist grasslands, croplands, pastures, and meadows. The Canada geese that occur in California migrate along the Pacific Flyway which includes the Pacific Population of Western Canada Geese and the Rocky Mountain Population of Western Canada Geese (Krohn and Bizeau 1980). The Rocky Mountain Population occur in Montana, Wyoming, Idaho, Utah, Colorado, Nevada, Arizona, and southern California and only a small segment is not migratory (Subcommittee on Rocky Mountain Canada Geese 2000). The Pacific Population breeds in Canada, Idaho, western Montana, northwestern Nevada, Oregon, Washington, and northern California. Segments of this population will migrate to northern Canada and Alaska; however, much of the Pacific Population is not migratory (Subcommittee on Pacific Population of Western Canada Geese 2000).The Pacific and Rocky Mountain Populations have an estimated 537,319 western Canada geese[82] (Olson 2021) and CDFW estimates 51,148 individuals are nonmigratory or "resident" in California (Brady and Weaver 2022). Migratory and resident Canada geese may share space in the winter but have separate breeding ranges. Therefore, these groups rarely interbreed and are typically considered distinct populations (Leonard 2013).

In California, Canada goose breeds on northeastern plateaus and in lakes of the northern Sierra Nevada and Cascades from February to November and migratory Canada geese are absent from California from May to September (CWHR 2022). Nest sites are highly variable but usually on a firm, dry, slightly elevated site near water and feeding areas that is relatively isolated; it prefers islands (Cogswell 1977). In winter, it prefers to feed in fields near safe roosting areas on open water of lakes and ponds.

Canada goose is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Average clutch size ranges from one to nine and lowest reported fledgling success is 0.75 young per nesting female over 5 years old (Mowbray *et al.* 2020). However, resident Canada geese have advantages such as subsidized food, protected nesting sites, and lower migration costs; therefore, can produce an average of 3.1 fledglings per breeding pair (Conover 1998). Assuming a 1:1 sex ratio, 51,148 resident Canada geese (Brady and Weaver 2022) equates 25,574 females. Females begin breeding between the ages of two and five, and once over five years old, typically breed every year (Mowbray *et al.* 2020). Wild Canada geese have been recorded as 33 years old, 28 years old, and 25 years old at the time of hunter harvest (Mowbray *et al.* 2020). For a conservative analysis, we will assume females breed in their 5th year and live to 25 years; thus, females will breed 80% of their life. Assuming 20,459 breeding females (25,574 females x 80%) and 1.9 fledglings,[83] 38,872 young will fledge per year, which is an additional 76% of the population each year. Thus, total mortality below 76% is not expected to negatively impact the population.

3.3.10.1 Previous Wildlife Damage Management

In California, most WDM conflicts other than airport WHM are associated with resident Canada geese (MIS 2019). Resident Canada geese are well adapted to urban landscapes and can cause damage to lawns, parks, golf courses, and other open grassy areas (Smith *et al.* 1999; Mowbray *et al.* 2020). Some migratory Canada geese may be taken each year but it is likely a small portion of the total Canada goose WDM take. Furthermore, the majority of Canada geese take is during airport WHM and not for county-led WDM (Table 3-35). This analysis will use the more

82 3-year average (2017-2019).

83 Average of lowest reported fledgling success rate of 0.75 young (Mowbray *et al.* 2020) and average of 3.1 fledglings per resident goose breeding pair (Conover 1998).

conservative California resident Canada geese breeding population estimate of 51,148 individuals (Brady and Weaver 2022).

WDM for Canada goose comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California baseline, an average of 8,528.0 Canada geese individuals were dispersed,[84] 0.2 individuals were freed, 1.6 individuals underwent a transfer of custody, 224.1 individuals were killed, and 48.5 eggs were removed/destroyed per year. Baseline WDM for Canada geese occurred within 24 counties across the state, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 8,802.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[85] Non-lethal activities accounted for 97% (8,529.8 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 3% (272.6 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-35.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-35) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of Canada geese is estimated at 433.8 individuals annually. This total is comprised of the WS-California lethal take of 272.6 individuals per year and the non-WS-California estimates for lethal take of 161.2 individuals per year (Table 3-35). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. Approximately 0.8% of the state resident breeding population was taken by lethal WDM activities in California annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California Canada geese take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For Canada geese, the average is 224.1,[86] the standard deviation is 63.56, and the 99% confidence high estimate is 388.09, which we rounded up to 389 individuals. The 99% Confidence Factor for Canada geese was 389/224.1 = 1.74. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

84 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
85 Average includes activities that both intentionally and unintentionally affect Canada geese and all potential methods used during WDM activities.
86 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-35. This small amount of error was accepted for this calculation.

3.3.10.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of Canada geese under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 781 Canada geese taken annually, which represents 1.5% of the population. The California breeding population estimate for resident Canada geese is approximately 51,148 individuals (Brady and Weaver 2022). The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 0.8% (390 individuals of 51,148 estimated state resident population; Alameda County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 781. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 781 individuals. The maximum number of Canada geese taken by county-level programs are listed for each county in Table 3-35, under the "Proposed Project Maximum Lethal Take Estimate" column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.10.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) includes WDM of Canada goose for the benefit of listed species in Alameda County. Project WDM of this species may benefit listed species or other biological resources.

3.3.10.4 Potential Cumulative Effects to the Species

Population trends, as tracked by Breeding Bird Surveys, show a long-term (1966-2019) trend of 6.9% annual increases in the U.S. overall and 3.1% annual increases in California (Sauer *et al.* 2019). In the short term (2010-2019), trends are similarly robust, with estimates of 2.15% annual increases in the U.S. overall and 3.13% annual increases in California (Sauer *et al.* 2019). CDFW estimate that the resident Canada goose population long-term average has increased by 25% since 1993 (Brady and Weaver 2022).

Additional sources for Canada goose human-caused mortality include hunter harvest, vehicle strikes, aircraft strikes loss of habitat, predation by domestic animals, and chemical toxins (Pearce and Demers 2019, Mowbray *et al.* 2020, FAA 2023). Hunting is likely the greatest anthropogenic influence on Canada goose mortality. Hunting seasons in California occur from October to February, which coincide with the return of migratory Canada geese. The total number of migratory and resident Canada geese in California during this time is unknown. The three-year average of Canada goose and cackling goose hunter harvest was 280,101 individuals within the Pacific Flyway, which is approximately 37.6% of the estimated Pacific Flyway population of western Canada geese and cackling geese[87] (Olson 2021). An estimated 65,897 western Canada geese and cackling geese were harvested in California (8.9% of the Pacific Flyway population of western Canada geese and cackling geese) (Olson 2021). Because

87 The Pacific Flyway includes two western Canada goose populations: the Rocky Mountain Population and the Pacific Population (Krohn and Bizeau 1980; Subcommittee on Pacific Population of Western Canada Geese 2000, Subcommittee on Rocky Mountain Canada Geese 2000). Cackling geese are often included in hunter harvest estimates as they are difficult to differentiate from Canada geese and were not considered a separate species until 2004. An estimated 206,763 cackling geese occur in the Pacific Flyway (Olson 2021).

California hunting seasons overlap with the return of migratory geese, the extent to which resident Canada geese comprise the total hunter harvest is unknown; however, resident geese typically occur in urban areas where hunting is not allowed. These large regional populations allow such annual hunting levels without resulting in trends of population declines based on long-term population monitoring (Sauer *et al.* 2019).

Pearce and Demers (2019) reported that over a two-year study, 1 of 200 Canada geese monitored was killed by vehicle collisions, or 0.5% of the population. Assuming a state population of 51,148 resident Canada geese, 256 individuals may be killed by vehicle collisions each year. From 2010 to 2019, a total of 251 Canada geese were reported to have been struck at California civil airports (FAA 2023). The highest number of Canada geese struck in a single year, 129 individuals in 2018, account for 0.3% of the resident Canada goose population in California. Other potential contributors to anthropogenic mortality such as loss of habitat, predation by domestic animals, and chemical toxins are more difficult to quantify and mortality estimates were not found in the literature.

Lethal WDM take of Canada goose under the Proposed Project (781 individuals or 1.53% of the resident Canada goose population) is expected to be a very small proportion of the species' population on a statewide and likely local level (Table 3-35). This low level of mortality is easily replaced through annual reproductive cycles of Canada goose, as evidenced by the robust population of this species overall (Olson 2021; Sauer *et al.* 2019). The Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-35. Canada Goose Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	0	1.4	0	127.0	95.3	128.4	95.3	**223.7**	390	0.76%
ALPINE	0	0	0	0	0	0	0	0	**0**	0	0%
AMADOR	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
BUTTE	0.9	0	0	0	0	0.1	0.9	0.1	**1.0**	2	<0.01%
CALAVERAS	0.8	0	0	0	0	0.1	0.8	0.1	**0.9**	2	<0.01%
COLUSA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
CONTRA COSTA	0	0	0	0	0	0	0	0	**0**	0	0%
DEL NORTE	0	0.3	0	0	0	0.1	0	0.4	**0.4**	1	<0.01%
EL DORADO	0.3	0	0	0	0	0.4	0.3	0.4	**0.7**	2	<0.01%
FRESNO	0	0.3	0	0	0	0.8	0	1.1	**1.1**	2	<0.01%
GLENN	0	0.3	0	0	0	0.2	0	0.5	**0.5**	1	<0.01%
HUMBOLDT	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
IMPERIAL	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
INYO	0	0	0	0	0	0	0	0	**0**	0	0%
KERN	0	0	0	0	0	0	0	0	**0**	0	0%
KINGS	0	0.3	0	0	0.2	0.1	0.2	0.4	**0.6**	2	<0.01%
LAKE	0	0	0	0	0	0.3	0	0.3	**0.3**	1	<0.01%
LASSEN	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
LOS ANGELES	0	0.3	0	0	2.9	2.9	2.9	3.2	**6.1**	11	0.02%
MADERA	0	0	0	0	0	0.3	0	0.3	**0.3**	1	<0.01%
MARIN	0	0.3	0	0	0	0.3	0	0.6	**0.6**	2	<0.01%
MARIPOSA	0	0	0	0	0	0	0	0	**0**	0	<0.01%
MENDOCINO	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
MERCED	0	0	0	0	0	0	0	0	**0**	0	0%
MODOC	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
MONO	0	0	0	0	0	0	0	0	**0**	0	0%
MONTEREY	0.1	0	0	0	0	0.4	0.1	0.4	**0.5**	1	<0.01%
NAPA	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
NEVADA	0.6	0	0	0	0	0.2	0.6	0.2	**0.8**	2	<0.01%
ORANGE	0	0.3	0	0	0	0	0	0.3	**0.3**	1	<0.01%
PLACER[2]	0	0.3	0	0	0	0.5	0	0.8	**0.8**	2	<0.01%
PLUMAS	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
RIVERSIDE	0	0.3	0	0	0	0.7	0	1.0	**1.0**	2	<0.01%
SACRAMENTO	5.2	0	0	0	3.7	13.0	8.9	13.0	**21.9**	39	0.08%
SAN BENITO[3]	0	0.3	0	0	0	0.2	0	0.5	**0.5**	1	<0.01%
SAN BERNARDINO	0	0.3	0	0	0.1	0.3	0.1	0.6	**0.7**	2	<0.01%
SAN DIEGO	0	0	0	0	0	0	0	0	**0**	0	0%
SAN FRANCISCO	0	0.3	0	0	0	0	0	0.3	**0.3**	1	<0.01%

Table 3-35. Canada Goose Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0.1	0.3	0	0	0	0	0.1	0.3	**0.4**	1	<0.01%
SAN LUIS OBISPO	0	0	0	0	2.6	3.5	2.6	3.5	**6.1**	11	0.02%
SAN MATEO	0	0	0	0	0	1.3	0	1.3	**1.3**	3	<0.01%
SANTA BARBARA	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
SANTA CLARA	0.1	0.3	0	0	52.2	28.5	52.3	28.8	**81.1**	142	0.28%
SANTA CRUZ	0.8	0.3	0	0	0	0.2	0.8	0.5	**1.3**	3	<0.01%
SHASTA	0	0	0	0	0	0.3	0	0.3	**0.3**	1	<0.01%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	0%
SISKIYOU[4]	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
SOLANO	0.4	0	0	0	4.8	0.4	5.2	0.4	**5.6**	10	0.02%
SONOMA[5]	0	0.3	0	0	0	0.8	0	1.1	**1.1**	2	<0.01%
STANISLAUS	0	0	0	0	0	0.2	0	0.2	**0.2**	1	<0.01%
SUTTER	0	0	0	0	0	0	0	0	**0**	0	0%
TEHAMA	0	0.3	0	0	0	0.1	0	0.4	**0.4**	1	<0.01%
TRINITY	0	0	0	0	0	0.1	0	0.1	**0.1**	1	<0.01%
TULARE	0.1	0.3	0	0	0	0.5	0.1	0.8	**0.9**	2	<0.01%
TUOLUMNE	3.1	0	0	0	0	0.1	3.1	0.1	**3.2**	6	0.01%
VENTURA	0	0.3	0	0	4.2	1.2	4.2	1.5	**5.7**	10	0.02%
YOLO	0	0	0	0	0	0.4	0	0.4	**0.4**	1	<0.01%
YUBA	0	0	0	0	12.5	0	12.5	0	**12.5**	22	0.04%
EGG REMOVAL	0	0	0	0	48.5	0	48.5	0	**48.5**	85	NA
Total	**12.5**	**5.7**	**1.4**	**0**	**258.7**	**155.5**	**272.6**	**161.2**	**433.8**	**781**	**0.53%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period. Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided above in Section 2.4.

1 Refer to Section 3.3.10.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.11 California Gull

California gull is a migratory bird species that occurs in habitats along the coast such as sandy beaches, mudflats, rocky intertidal, and pelagic areas of marine and estuarine habitats, as well as fresh and saline emergent wetlands. Inland, it frequents lacustrine, riverine, and cropland habitats, landfill dumps, and open lawns in urban areas. California gull nests from April through August in colonies, often in association with other water birds (CWHR 2022).

California gull is considered a species of “Least Concern” by IUCN, though their global population is reported to be decreasing (IUCN 2022). The average clutch size for California gull is 2.5 and overall fledgling success in California is 1.04 fledglings per female in the population per year (Winkler 2020). Assuming a 1:1 sex ratio, 112,601 California gulls (Sauer *et al.* 2019) equate to 56,300 females. Females typically breed in their 4th year and live to 20 years (Winkler 2020); thus, females will breed 89% of their life. Assuming 89% of females breeding (56,000 females x 89% = 50,374) and 1.04 fledglings, 52,389 young will fledge per year, which is an additional 46.5% of the population each year. Thus, total mortality below 46.5% is not expected to negatively impact the population.

At least half of the lethal WDM for California gull in California is conducted in the late fall through early spring, when wintering birds from other states and Canada are present in California. The entire North American population is 620,000 (BBS data 2015-2019, Sauer *et al.* 2019), and many of those birds winter in California.

3.3.11.1 Previous Wildlife Damage Management

WDM for California gull comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year baseline, an average of 10,416.5 California gull individuals were dispersed,[88] 0.1 individuals underwent a transfer of custody, and 163.8 individuals were killed per year. Baseline WDM for California gull occurred within 20 counties across the state, with the largest portion of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 10,580.4 individuals per year based on the WS-California MIS data from 2010 to 2019.[89] Non-lethal activities accounted for 98% (3,287.6 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 2% (163.8 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-36.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-36) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of California gull is estimated at 277.2 individuals annually. This total is comprised of the WS-California lethal take of 163.8 individuals per year and the non-WS-California estimates for lethal take of 113.4 individuals per year (Table 3-36). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for California gull, based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019, is approximately 112,601 individuals (Sauer *et al.* 2019). Approximately 0.24% of the statewide population was taken by lethal WDM activities annually.

88 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

89 Average includes activities that both intentionally and unintentionally affect California gull and all potential methods used during WDM activities.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide California gull take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For California gull, the average is 163.8,[90] the standard deviation is 76.07, and the 99% confidence high estimate is 360.66, which we rounded up to 361 individuals. The 99% Confidence Factor for California gull was 361/163.8 = 2.2. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.11.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of California gull under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 610 California gull taken annually, which represents 0.54% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0.03% (several counties) to 6.89% (267 individuals of 3,883 estimated county population; Alameda County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 610. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 610 individuals. The maximum number of California gulls taken by county-level programs are listed for each county in Table 3-36, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.11.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) includes WDM of California gull in several counties for the benefit of listed species. Project WDM of this species may benefit western snowy plover, which experiences egg predation by California gull (Burns *et al.* 2018).

3.3.11.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide California gull population may occur from effects on individuals or effects from human development on habitat. Population trends over the long term (1966-2019) are moving downward, with -

[90] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-36. This small amount of error was accepted for this calculation.

2.7% decreases annually in California and -1% decreases annually in the U.S. overall (Sauer *et al.* 2019). In the short term (2010-2019), trends suggest relatively stable populations in California and the United States as a whole (Sauer *et al.* 2019). Cumulative effects to this species would result from plastic entanglement (for gulls feeding on garbage), loss of breeding habitat, and disturbance of nesting colonies (Winkler 2020). Mortality from territorial disputes from loss of breeding habitat can exceed 1% of the breeding population at an affected breeding site (Jehl 1989), and disturbances at breeding colonies that flush adults off the nests can expose eggs and chicks to high mortality via predation from conspecifics (Winkler 2020). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting California gulls; however, lethal WDM of California gulls would contribute to cumulative effects. However, given the low Proposed Project Maximum Lethal Take Estimate (0.54% of the estimated state population), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-36. California Gull Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALPINE	0	0	0	0.1	0	0	0	0.1	0.1	1	<0.01%
AMADOR	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
BUTTE	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
CALAVERAS	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
COLUSA	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
CONTRA COSTA	0	0	0	0.1	0	0	0	0.1	0.1	1	<0.01%
DEL NORTE	0	0.1	0	0.1	0	0.1	0	0.3	0.3	1	<0.01%
EL DORADO	0	0	0	0.1	0	0.3	0	0.4	0.4	1	<0.01%
FRESNO	0	0.1	0	0.1	0	0.6	0	0.8	0.8	2	<0.01%
GLENN	0	0.1	0	0.1	0	0.1	0	0.3	0.3	1	<0.01%
HUMBOLDT	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
IMPERIAL	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
INYO	0	0.1	0	0.1	0	0.1	0	0.3	0.3	1	<0.01%
KERN	0	0	0	0.1	0	0	0	0.1	0.1	1	<0.01%
KINGS	0	0.1	0	0.1	0.2	0.1	0.2	0.3	0.5	2	<0.01%
LAKE	0	0	0	0.1	0	0.2	0	0.3	0.3	1	<0.01%
LASSEN	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
LOS ANGELES	0	0.1	0	0.1	6.6	6.6	6.6	6.8	13.4	30	0.03%
MADERA	0	0	0	0.1	0	0.2	0	0.3	0.3	1	<0.01%
MARIN	0	0.1	0	0.1	0	0.2	0	0.4	0.4	1	<0.01%
MARIPOSA	0	0	0	0.1	0	0	0	0.1	0.1	1	<0.01%
MENDOCINO	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
MERCED	0	0	0	0.1	4.0	5.3	4.0	5.4	9.4	21	0.02%
MODOC	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
MONO	0	0.1	0	0.1	0	0.1	0	0.3	0.3	1	<0.01%
MONTEREY	1.9	0	0.2	0.1	0	0.3	2.1	0.4	2.5	6	<0.01%
NAPA	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
NEVADA	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
ORANGE	0	0.1	0	0.1	0	0	0	0.2	0.2	1	<0.01%
PLACER[2]	0	0.1	0	0.1	0	0.4	0	0.6	0.6	2	<0.01%
PLUMAS	0	0	0	0.1	0	0.1	0	0.2	0.2	1	<0.01%
RIVERSIDE	0	0.1	0	0.1	0	0.5	0	0.7	0.7	2	<0.01%
SACRAMENTO	0	0	0	0.1	0.1	0.4	0.1	0.5	0.6	2	<0.01%
SAN BENITO[3]	0	0.1	0	0.1	0	0.1	0	0.3	0.3	1	<0.01%
SAN BERNARDINO	0	0.1	0	0.1	0.2	0.5	0.2	0.7	0.9	2	<0.01%
SAN DIEGO	0	0	2.3	0.1	0	0	2.3	0.1	2.4	6	<0.01%
SAN FRANCISCO	0	0.1	0	0.1	0	0	0	0.2	0.2	1	<0.01%
SAN JOAQUIN	0	0	0	0.1	0	0.3	0	0.4	0.4	1	<0.01%

Table 3-36. California Gull Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN LUIS OBISPO	0	0	1.7	0.1	0	0	1.7	0.1	**1.8**	4	<0.01%
SAN MATEO	0	0	0.1	0.1	0	0.9	0.1	1.0	**1.1**	3	<0.01%
SANTA BARBARA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SANTA CLARA	0	0.1	0.2	0.1	65.6	35.8	65.8	36.0	**101.8**	224	0.20%
SANTA CRUZ	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
SHASTA	0	0	0	0.1	0	0.2	0	0.3	**0.3**	1	<0.01%
SIERRA	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
SISKIYOU[4]	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SOLANO	0	0	0	0.1	2.7	0.2	2.7	0.3	**3.0**	7	<0.01%
SONOMA[5]	0	0.1	0	0.1	0	0.6	0	0.8	**0.8**	2	<0.01%
STANISLAUS	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SUTTER	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
TEHAMA	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
TRINITY	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
TULARE	0	0.1	0	0.1	0	0.4	0	0.6	**0.6**	2	<0.01%
TUOLUMNE	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
VENTURA	0	0.1	0.1	0.1	2.6	0.7	2.7	0.9	**3.6**	8	<0.01%
YOLO	0	0	0	0.1	0	0.3	0	0.4	**0.4**	1	<0.01%
YUBA	0	0	0	0.1	2.4	0	2.4	0.1	**2.5**	6	<0.01%
Total	**2.0**	**2.0**	**13.1**	**5.8**	**148.7**	**105.6**	**163.8**	**113.4**	**277.2**	**610**	**0.54%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided above.

1 Refer to Section 3.3.11.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.12 Black-Crowned Night Heron

Black-crowned night heron is a locally migratory bird species that is a fairly common, yearlong resident in lowlands and foothills throughout most of California. It feeds along the margins of lacustrine, large riverine, and fresh and saline emergent habitats (CWHR 2022). Black-crowned night heron nests and roosts in densely foliated trees and dense emergent wetlands. It breeds in colonies from February to July in most of California and from April to August in northeastern California (Cogswell 1977).

Black-crowned night heron is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Average clutch size is 4.5 and lowest reported fledgling success in California was 37% (Hothem *et al.* 2020). The number of fledglings used for this analysis was 1.7 (4.5 x 37%). Assuming a 1:1 sex ratio, 15,740 black-crowned night herons (Sauer *et al.* 2019) equates to 7,870 females. Females typically breed in their 3rd year and live to 21 years (Hothem *et al.* 2020); thus, females will breed 90.1% of their life. Assuming 90.1% of females breeding (7,870 females x 90.1% = 7,091) and 1.7 fledglings, 12,055 young will fledge per year, which is an additional 76.6% of the population each year. Thus, total mortality below 76.6% is not expected to negatively impact the population.

3.3.12.1 Previous Wildlife Damage Management

WDM for black-crowned night heron comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California baseline, an average of 287.5 black-crowned night heron individuals were dispersed,[91] 0.1 individuals were freed, 0.5 individuals were surveyed, and 11.2 individuals were killed per year. Baseline WDM for black-crowned night heron occurred within 10 counties across the state, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 299.3 individuals per year based on the WS-California MIS data from 2010 to 2019.[92] Non-lethal activities accounted for 96% (288.1 individuals per year) of the WS-California WDM conducted for this species, and lethal activities accounted for 4% (11.2 individuals per year). All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-37.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-37) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of black-crowned night heron is estimated at 29 individuals annually. This total is comprised of the WS-California lethal take of 11.2 individuals per year and the non-WS-California estimates for lethal take of 17.8 individuals per year (Table 3-37). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for black-crowned night heron, based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019, is approximately 15,740 individuals (Sauer *et al.* 2019). Approximately 0.2% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide black-crowned night-heron take through the 10-year analysis period and used it to estimate the 99% confidence

91 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

92 Average includes activities that both intentionally and unintentionally affect black-crowned night heron and all potential methods used during WDM activities.

interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For black-crowned night-heron, the average is 11.2,[93] the standard deviation is 5.75, and the 99% Confidence High Estimate is 26.04, which we rounded up to 27 individuals. The 99% Confidence Factor for black-crowned night-heron was 27/11.2 = 2.41. All estimates of total previous WDM within each county were multiplied by this factor to estimate the high end of future take under the Proposed Project within each county.

3.3.12.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of black-crowned night-heron under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 70 black-crowned night-heron taken annually, which represents 0.4% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 5.9% (34 individuals of 583 estimated county population; Alameda County). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 70. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 70 individuals. The maximum number of black-crowned night-herons taken by county-level programs are listed for each county in Table 3-37, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.12.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) includes WDM of black-crowned night heron in San Diego County for the benefit of listed species. Project WDM of this species may benefit western snowy plover or California least tern which may experiences egg predation by this species.

3.3.12.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide black-crowned night heron population may occur from effects on individuals or effects from human development on habitat. Breeding bird surveys likely underestimate the true number of individuals due to their inconspicuous nature (Hothem *et al.* 2020), but available data suggests that over the long term (1966-2019), this species is mostly stable in California, with 0.5% increases annually in California but -0.5%

93 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-37. This small amount of error was accepted for this calculation.

decreases annually in the U.S. overall (Sauer *et al.* 2019). Recent trends (2010-2019) show similar minor declines of -0.05% yearly in California and -0.84% in the U.S. overall (Sauer *et al.* 2019). Regional declines are reported for many areas of the eastern and Midwest U.S. (Hothem *et al.* 2020), but regional breeding populations in California, particularly in the San Francisco Bay Area, are stable or increasing (Kelly *et al.* 2007; Sauer *et al.* 2019). Cumulative effects to this species would result from pesticides or other contaminants and human disturbance at nesting colonies (Hothem *et al.* 2020). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting black-crowned night herons; however, lethal WDM of black-crowned night herons would contribute to cumulative effects. However, given the low Proposed Project Maximum Lethal Take Estimate (0.4% of the estimated state and county populations) and the stable populations within California (Kelly *et al.* 2007; Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-37. Black-Crowned Night-Heron Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate1	
ALAMEDA	0	0	0	0.1	8.0	6.0	8.0	6.1	**14.1**	34	0.22%
ALPINE	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
AMADOR	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
BUTTE	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
CALAVERAS	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
COLUSA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
CONTRA COSTA	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
DEL NORTE	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
EL DORADO	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
FRESNO	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
GLENN	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
HUMBOLDT	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
IMPERIAL	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
INYO	0	0	0	0	0	0	0	0	**0**	0	0%
KERN	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
KINGS	0	0.1	0	0.1	0.1	0.1	0.1	0.3	**0.4**	1	<0.01%
LAKE	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
LASSEN	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
LOS ANGELES	0	0.1	0	0.1	0	0	0	0.2	**0.2**	1	<0.01%
MADERA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
MARIN	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
MARIPOSA	0	0	0	0	0	0	0	0	**0**	0	0%
MENDOCINO	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	0.01%
MERCED	0.4	0	0	0.1	0	0	0.4	0.1	**0.5**	2	0.01%
MODOC	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
MONO	0	0	0	0	0	0	0	0	**0**	0	0%
MONTEREY	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
NAPA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
NEVADA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
ORANGE	0	0.1	0	0.1	0	0	0	0.2	**0.2**	1	<0.01%
PLACER[2]	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
PLUMAS	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
RIVERSIDE	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
SACRAMENTO	0	0	0	0.1	1.0	0.9	1.0	1.0	**2.0**	5	0.03%
SAN BENITO[3]	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
SAN BERNARDINO	0.1	0.1	0	0.1	0	0	0.1	0.2	**0.3**	1	<0.01%
SAN DIEGO	0.9	0	0.6	0.1	0.1	0.2	1.6	0.3	**1.9**	5	0.03%

Table 3-37. Black-Crowned Night-Heron Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate1	
SAN FRANCISCO	0	0.1	0	0.1	0	0	0	0.2	**0.2**	1	<0.01%
SAN JOAQUIN	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SAN LUIS OBISPO	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
SAN MATEO	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SANTA BARBARA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SANTA CLARA	0	0.1	0	0.1	0	0	0	0.2	**0.2**	1	<0.01%
SANTA CRUZ	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
SHASTA	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SIERRA	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
SISKIYOU[4]	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SOLANO	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
SONOMA[5]	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
STANISLAUS	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
SUTTER	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
TEHAMA	0	0.1	0	0.1	0	0.1	0	0.3	**0.3**	1	<0.01%
TRINITY	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
TULARE	0	0	0	0	0	0	0	0	**0**	0	0%
TUOLUMNE	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
VENTURA	0	0.1	0	0.1	0	0	0	0.2	**0.2**	1	<0.01%
YOLO	0	0	0	0.1	0	0.1	0	0.2	**0.2**	1	<0.01%
YUBA	0	0	0	0.1	0	0	0	0.1	**0.1**	1	<0.01%
Total	**1.4**	**1.7**	**0.6**	**5.4**	**9.2**	**10.7**	**11.2**	**17.8**	**29.0**	**70**	**0.44%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided in Section 2.4.
1 Refer to Section 3.3.3.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.13 Acorn Woodpecker

Acorn woodpecker is a common, yearlong resident below 6900 feet amsl in hardwood and hardwood-conifer habitats, primarily in stands with large oaks and snags. It occurs in the western Sierra Nevada foothills, Coast Ranges, Klamath Range, and locally on the eastern Sierra Nevada slope from Modoc County to Nevada County (CWHR 2022). Acorn woodpecker feed primarily on acorns, flying insects, and sap, with the diet changing with seasonal abundances.

Acorn woodpecker is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). Lowest reported average clutch size is 4.37 and 16% of nestlings die before fledging (Koenig *et al.* 2020). The number used for this analysis was 3.67. Assuming a 1:1 sex ratio, 1,900,000 acorn woodpeckers (PIF 2022) equates 950,000 females. Acorn woodpeckers participate in cooperative breeding where several birds may take care of a single nest. Average breeding-group size in California was 4.4 individuals, though most common were two to three individuals (Koenig *et al.* 2020). For this analysis, we will assume one breeder male, one breeder female, one non-breeder helper male, and one non-breeding helper female per nest. Thus, 950,000 females will be halved to account for non-breeder helper females, equaling 475,000 breeding females. Females typically breed in their 2nd year and can live up to 17 years (Koenig *et al.* 2020); thus, females will breed 88% of their life. Assuming 88% of females breeding (475,000 females x 88% = 418,000). Assuming 3.67 fledglings per 418,000 breeding females, a total of 1,534,060 successful fledglings are expected per year and an additional 80.7% of population added per year. Total mortality must be below 80.7% to ensure no impact to acorn woodpecker populations.

3.3.13.1 Previous Wildlife Damage Management

WDM for acorn woodpecker comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). However, only lethal WDM occurred during the baseline period. During the 10-year WS-California baseline, an average of 1.1 acorn woodpecker individuals were killed per year. Baseline WS-California WDM for acorn woodpecker occurred within Kern, Mariposa, and Tulare Counties across the state. All lethal WS-California WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-38.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-38) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species without involving WS-California or another WDM entity. Therefore, an additional 10 acorn woodpeckers per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-38). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of acorn woodpecker is estimated at 491.1 individuals annually. This total is comprised of the WS-California lethal take of 1.1 individuals per year and the non-WS-California estimates for lethal take of 490.0 individuals per year (Table 3-38). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for acorn woodpecker, based on the based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022), is approximately 1,900,000 individuals. Approximately 0.03% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide acorn woodpecker take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For acorn woodpecker, the average is 1.1,[94] the standard deviation is 2.28, and the 99% confidence high estimate is 6.99, which we rounded up to 7 individuals. The 99% Confidence Factor for acorn woodpecker was 7/1.1 = 6.36.

3.3.13.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of acorn woodpecker under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 492 acorn woodpeckers taken annually, which represents 0.03% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 0.03% (several counties). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 492. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 492 individuals. The maximum number of acorn woodpeckers taken by county-level programs are listed for each county in Table 3-38, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.13.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of acorn woodpecker for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

94 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-38. This small amount of error was accepted for this calculation.

3.3.13.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide acorn woodpecker population may occur from effects on individuals or effects from human development on habitat. Populations have been stable from 1966 to 2019, with no measurable yearly changes in California and 0.3% yearly increases in the U.S. range overall (Sauer *et al.* 2019). Adult survivorship ranges from 51.5% to 86.5%, depending on sex and location, and first-year survivorship ranges from 37% to 48.6% (Koenig *et al.* 2020). Cumulative effects to this species would result from habitat loss and degradation, particularly the loss of snags and dead limbs (Koenig *et al.* 2020). However, acorn woodpeckers are adaptable to suburban environments and readily colonize new habitat (Blair 1996; Koenig *et al.* 2020). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting acorn woodpeckers; however, lethal WDM of acorn woodpeckers would contribute to cumulative effects. Given the low Proposed Project Maximum Lethal Take Estimate (0.03% of the estimated state and county populations) and the stable populations within California (Sauer *et al.* 2019), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-38. Acorn Woodpecker Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
ALAMEDA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
ALPINE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
AMADOR	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
BUTTE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
CALAVERAS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
COLUSA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
CONTRA COSTA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
DEL NORTE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
EL DORADO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
FRESNO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
GLENN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
HUMBOLDT	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
IMPERIAL	0	0	0	0	0	0	0	0	**0**	0	0%
INYO	0	0	0	0	0	0	0	0	**0**	0	0%
KERN	0.1	10.0	0	0	0	0	0.1	10.0	**10.1**	11	<0.01%
KINGS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
LAKE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
LASSEN	0	0	0	0	0	0	0	0	**0**	0	0%
LOS ANGELES	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MADERA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MARIN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MARIPOSA	0.5	0	0	0	0	0	0.5	0	**0.5**	1	<0.01%
MENDOCINO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MERCED	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MODOC	0	0	0	0	0	0	0	0	**0**	0	0%
MONO	0	0	0	0	0	0	0	0	**0**	0	0%
MONTEREY	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
NAPA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
NEVADA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
ORANGE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
PLACER[2]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
PLUMAS	0	0	0	0	0	0	0	0	**0**	0	0%
RIVERSIDE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SACRAMENTO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN BENITO[3]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN BERNARDINO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN DIEGO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN FRANCISCO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%

Table 3-38. Acorn Woodpecker Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Max Annual Lethal Take Estimate[1]	
SAN JOAQUIN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN LUIS OBISPO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN MATEO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SANTA BARBARA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SANTA CLARA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SANTA CRUZ	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SHASTA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SIERRA	0	0	0	0	0	0	0	0	**0**	0	0%
SISKIYOU[4]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SOLANO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SONOMA[5]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
STANISLAUS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SUTTER	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TEHAMA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TRINITY	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TULARE	0.5	10.0	0	0	0	0	0.5	10.0	**10.5**	11	<0.01%
TUOLUMNE	0	0	0	0	0	0	0	0	**0**	0	0%
VENTURA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
YOLO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
YUBA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
Total	**1.1**	**490.0**	**0**	**0**	**0**	**0**	**1.1**	**490.0**	**491.1**	**492**	**0.03%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.13.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.3.14 Northern Flicker

Northern flicker is common below 9,000 feet amsl in all forest and shrub habitats (CWHR 2022). It is a yearlong resident except in high mountains and Mojave and Colorado deserts where it is primarily a migrant. They are a primary hole nester that builds nests and roosting cavities in dead trees in riparian deciduous areas and mature, open areas with snags, but in desert areas they also use Joshua trees (Zeiner *et al.* 1990). Northern flicker feeds primarily on insects in the spring and summer (about 55% of the annual diet) but they switch to plant material in the fall and winter (45% of annual diet) (Timossi *et al.* 1995).

Northern flicker is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Average clutch size ranges from 3 to 12 and fledgling success is 5.9 fledglings per successful nest per year (Wiebe and Moore 2020. Assuming a 1:1 sex ratio, 430,000 northern flickers (PIF 2022) equates to 215,000 females. Northern flickers breed in their first year and breed annually (Wiebe and Moore 2020). In the U.S., it was reported that 73% of nests were successful. Assuming 5.9 fledglings per 156,950 successful nests (215,000 females x 73% successful nests) equals 926,005 fledglings per year and an additional 215% of population added per year. Total mortality must be below 215% to ensure no impact to northern flicker populations.

3.3.14.1 Previous Wildlife Damage Management

WDM for northern flicker comprises non-lethal activities (i.e., individuals dispersed, freed, radiocollared, immobilized, relocated, or transferred to another custody) and lethal activities (i.e., individuals killed). During the 10-year WS-California baseline, an average of 1 northern flicker individual was dispersed[95] and 1.2 individuals were killed per year. Baseline WDM for northern flicker occurred within Los Angeles, Santa Clara, Solano and Stanislaus Counties, with the majority of WDM occurring at airports. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 2.2 individuals per year based on the WS-California MIS data from 2010 to 2019.[96] All lethal WDM recorded in the MIS during the 10-year baseline period is provided by county in Table 3-39.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-39) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method whenever there was a moderate or high population of the target species and resources that were frequently damaged by the target species. It is assumed that private citizens lethally take this species without involving WS-California or another WDM entity. Therefore, an additional 10 northern flickers per year have been added to the Non-WS Lethal Take Estimates for each county that has a non-zero population estimate (Table 3-39). These determinations were subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) and were made by WS-California personnel based on the estimated county populations and resources expected in each county (T. Felix, pers. comm. 2022a).

During the 10-year baseline period, statewide lethal take of northern flicker is estimated at 581.4 individuals annually. This total is comprised of the WS-California lethal take of 1.2 individuals per year and the non-WS-California estimates for lethal take of 580.2 individuals per year (Table 3-39). These estimates of WDM take were

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95 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

96 Average includes activities that both intentionally and unintentionally affect northern flickers and all potential methods used during WDM activities.

used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for northern flicker, based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022), is approximately 430,000 individuals. Approximately 0.1% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide northern flicker take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For northern flicker, the average is 1.2,[97] the standard deviation is 2.30, and the 99% confidence high estimate is 7.13, which we rounded up to 8 individuals. The 99% Confidence Factor for northern flicker was 8/1.2 = 6.67.

3.3.14.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of northern flicker under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 582 northern flicker taken annually, which represents 0.03% of the population. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (several counties) to 0.13% (several counties). These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 582. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 582 individuals. The maximum number of northern flickers taken by county-level programs are listed for each county in Table 3-39, under the “Proposed Project Maximum Lethal Take Estimate” column. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.3.14.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) does not include removal of northern flicker for the benefit of listed species. Project WDM of this species is not expected to have beneficial effects to other biological resources.

[97] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-39. This small amount of error was accepted for this calculation.

3.3.14.4 Potential Cumulative Effects to the Species

Cumulative effects on the statewide northern flicker population may occur from effects on individuals or effects from human development on habitat. Populations have recently declined in California by an estimated -0.83% annually between 2010 to 2019 and declined in the U.S. overall by an estimated -1.23% annually in the same time frame (Sauer *et al.* 2019). Long-term (1966-2019) population trends mirror recent declines, with an estimated -0.3% annual decline in California and an estimated -1.6% annual decline in the U.S. overall (Sauer *et al.* 2019). Adult annual survivorship ranges from 42% to 47% (Wiebe 2006). Cumulative effects to this species would result from habitat loss and degradation, particularly the loss of snags and dead limbs; competition with European starlings; and pesticides and other contaminants on grassy habitats such as golf courses, agricultural fields, and suburban lawns (Wiebe and Moore 2020). However, northern flickers are adaptable to suburban environments and readily nests in areas with human habitation (Wiebe and Moore 2020). Since the Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting northern flickers; however, lethal WDM of northern flickers would contribute to cumulative effects. Given the low Proposed Project Maximum Lethal Take Estimate (0.03% of the estimated state and county populations), the Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-39. Northern Flicker Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Annual Max Lethal Take Estimate[1]	
ALAMEDA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
ALPINE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
AMADOR	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
BUTTE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
CALAVERAS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
COLUSA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
CONTRA COSTA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
DEL NORTE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
EL DORADO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
FRESNO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
GLENN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
HUMBOLDT	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
IMPERIAL	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
INYO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
KERN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
KINGS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
LAKE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
LASSEN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
LOS ANGELES	0	10.0	0	0	0.1	0.1	0.1	10.1	**10.2**	11	<0.01%
MADERA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MARIN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MARIPOSA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MENDOCINO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MERCED	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MODOC	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MONO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
MONTEREY	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
NAPA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
NEVADA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
ORANGE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
PLACER[1]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
PLUMAS	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
RIVERSIDE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SACRAMENTO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN BENITO[2]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN BERNARDINO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN DIEGO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN FRANCISCO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%

Table 3-39. Northern Flicker Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide.

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year				Proposed Project Max Annual Lethal Take Estimate of State Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total	Proposed Project Annual Max Lethal Take Estimate[1]	
SAN JOAQUIN	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN LUIS OBISPO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SAN MATEO	0	10.0	0	0	0	0.1	0	10.1	**10.1**	11	<0.01%
SANTA BARBARA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SANTA CLARA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SANTA CRUZ	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SHASTA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SIERRA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SISKIYOU[3]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SOLANO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
SONOMA[4]	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
STANISLAUS	1.1	10.0	0	0	0	0	1.1	10.0	**11.1**	12	<0.01%
SUTTER	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TEHAMA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TRINITY	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TULARE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
TUOLUMNE	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
VENTURA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
YOLO	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
YUBA	0	10.0	0	0	0	0	0	10.0	**10.0**	10	<0.01%
Total	**1.1**	**580.0**	**0**	**0**	**0.1**	**0.2**	**1.2**	**580.2**	**581.4**	**582**	**0.14%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS Lethal WDM includes the following fate categories: killed. Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided in Section 2.4.

1 Refer to Section 3.3.14.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.4 Special-Status Target Species

Special-status target species are defined in this document as those with federal or state listing status (i.e., threatened or endangered, identified as "listed" species), federally proposed listed species, state candidate species, CDFW Species of Special Concern, and state "fully protected" species. Table 3-40 summarizes the California population estimates for the special-status target bird and mammal species. Special-status target species' descriptions are provided below. A summary of lethal WDM for target special-status species is also provided in Table 3-40. Species in the table with no lethal take estimates would be targeted only for non-lethal WDM under the Proposed Project. Species-specific analyses follow.

Table 3-40. Estimated Number and Proportion of Special-Status Bird and Mammal Species Lethally Taken Per Year in California, along with the Population Estimate for Each Species.

Common Name/Status	Previous Lethal WDM, Average	Proposed Project Maximum Lethal Take Estimate[1]	Estimated Statewide Population	Proposed Project Max Lethal Take Estimate of Population (%)
Tricolored blackbird *State Threatened*	0	0	210,042	0%
Sandhill crane[2] *State Threatened, Fully Protected*	0	0	41,788	0%
Bald eagle *State Endangered, Fully Protected*	0	0	10,953	0%
Golden eagle *Fully Protected*	0	0	3,801	0%
Northern Harrier *State Species of Special Concern*	7.8	23	24,000	<0.1%
Swainson's hawk *State Threatened*	3.1	17	44,000	0.4%
White-tailed kite *Fully Protected*	0.4	4	9,700	<0.1%
California brown pelican *Fully Protected*	0.1	1	6,481	<0.1%
Western snowy plover *Federally Threatened*	0	0	1,738	0%
California least tern *Federally and State Endangered, Fully Protected*	0	0	8,190	0%
American badger *State Species of Special Concern*	68.9	184	74,683	0.3%
Mountain lion	21.5	1.6[3]	1,454[5]	0.1%
(State candidate counties) *State Candidate*	21.5	11.4[4]	1,454[5]	0.8%

Table 3-40. Estimated Number and Proportion of Special-Status Bird and Mammal Species Lethally Taken Per Year in California, along with the Population Estimate for Each Species.

Common Name/Status	Previous Lethal WDM, Average	Proposed Project Maximum Lethal Take Estimate1	Estimated Statewide Population	Proposed Project Max Lethal Take Estimate of Population (%)
Ringtail *State Fully Protected*	0	0	389,236	0%

Notes: 0 = no MIS lethal WDM occurred during the 10-year baseline period.
1 Refer to individuals species analyses in Section 3.4 for how the Proposed Project Max Annual Lethal Take Estimate was calculated
2 Because the MIS data does not distinguish between the two sandhill crane subspecies in California, it's assumed that the individuals taken through WDM activities are the greater sandhill crane subspecies. However, the total individuals taken might be combination of the two subspecies.
3 Total Proposed Project Maximum Lethal Take Estimate for all counties under Scenario 1 – the mountain lion is listed under the CESA.
4 Total Proposed Project Maximum Lethal Take Estimate for all counties under Scenario 2 – the mountain lion is *not* listed under the CESA (Section 3.2.24).
5 Estimated population only includes the counties where mountain lion is a candidate species for listing: Alameda, Contra Costa, Imperial, Los Angeles, Monterey, Orange, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, and Ventura. Refer to Section 3.4.13 for details.

3.4.1 Tricolored Blackbird

Tricolored blackbird is a state-threatened insectivore mostly restricted to California, common in the Central Valley and in coastal districts from Sonoma County south (CDFW 2022a; CWHR 2022). It breeds near fresh water, preferably in emergent wetland with tall, dense cattails, feeding in grasslands and croplands (CWHR 2022). It breeds locally in northeastern California, becoming more widespread along the central coast and San Francisco Bay Area in the winter (CWHR 2022). Tricolored blackbird is considered "Endangered" by IUCN, and their global population is reported to be decreasing (IUCN 2022). The statewide population estimate for tricolored blackbird based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 210,042 individuals (Sauer *et al.* 2019).

3.4.1.1 Previous Wildlife Damage Management

WDM for tricolored blackbird includes only non-lethal activities (i.e., individuals dispersed and freed). During the 10-year baseline, an average of 3,826.9 tricolored blackbird individuals were dispersed[98] and 38.5 individuals were freed per year. No lethal WDM of tricolored blackbirds was recorded in the WS-California MIS data from 2010 to 2019. The 38.5 tricolored blackbirds freed per year were non-target captures in live traps which were immediately freed unharmed. The 3,826.9 tricolored blackbirds dispersed annually occurred at airports in Solano and Yuba Counties for the protection of aviation safety.

Lethal WDM of mixed-flock blackbirds, which potentially may contain tricolored blackbird individuals, did occur during the 10-year baseline. However, all lethal WDM of mixed-flock blackbirds occurred in Ventura County and based on the Tricolored Blackbird Portal (UCD 2021) there were no observations of tricolored blackbirds in Ventura County during the MIS baseline period. Lethal WDM of red-winged blackbirds also occurred during the 10-year baseline. However, all individuals killed during lethal activities are identified to species by trained wildlife biologist or wildlife specialists. Therefore, it is concluded that no lethal WDM of tricolored blackbirds was conducted by WS-California during the 10-

98 Because the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

year baseline. Baseline WDM for tricolored blackbird occurred within three counties within the state, with the majority occurring from airport dispersals. Therefore, under the previous WS-California WDM efforts, non-lethal WDM was used on an average of approximately 3,865.4 individuals per year.[99]

Because no lethal WDM of tricolored blackbird occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided and no county-level analysis is provided. Non-lethal WDM was used on an average of approximately 1.8% (3,865.4 individuals) of the estimated population of 210,042 individuals (Sauer *et al.* 2019) annually.

3.4.1.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM of tricolored blackbird under the Proposed Project is likely to be similar to the that analyzed above on average. No lethal take is anticipated. The 99% confidence interval or 99% Confidence Factor was not calculated because there was no lethal take during the analysis period. Lethal take was not analyzed by county under the Proposed Project because no lethal take is expected.

Non-lethal WDM has the potential to adversely impact special-status species if it consistently affects such a large proportion of the population that individuals must consistently expend y more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for tricolored blackbird under the Proposed Project because the number of tricolored blackbirds expected to be impacted by non-lethal WDM is very low compared to the estimated state population (1.8%). Non-lethal WDM is primarily a benefit to the species because most is conducted at airports (see next section).

3.4.1.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by tricolored blackbird. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of tricolored blackbird.

3.4.1.4 Potential Cumulative Effects to the Species

Cumulative effects on tricolored blackbird come from several sources; key factors include incidental killing when mixed flocks are shot or poisoned foraging on crops, loss of wetland breeding habitats as a result of development and climate change, and reductions in abundance of large insect prey they rely on to feed their young. There are an estimated 180,000 tricolored blackbirds throughout their range (PIF 2022). Tricolored blackbird populations are trending downward at an estimated -2% per year in California and -1.9% per year in the U.S. overall between 1966 and 2019 (Sauer *et al.* 2019). Recent trends show more stability, with -0.1% per year in California and 0.16% per year in the U.S. overall (Sauer *et al.* 2019). The Proposed Project would not result in the lethal removal of tricolored blackbirds, and it does not affect habitat or large insect populations. Therefore, the Proposed Project has no potential to contribute to cumulative effects on tricolored blackbird.

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99 Average includes activities that both intentionally and unintentionally affect tricolored blackbird and all potential methods used during non-lethal WDM activities.

3.4.2 Sandhill Crane

There are two subspecies of sandhill crane in California: greater sandhill crane (*Antigone canadensis tabida;* formerly *Grus canadensis tabida*) and lesser sandhill crane (*Antigone canadensis canadensis;* formerly *Grus canadensis canadensis*). Greater sandhill crane is a state threatened and CDFW Fully Protected species that occurs in and near wet meadow, shallow lacustrine, and fresh emergent wetland habitats (CDFW 2022a; CWHR 2022). It migrates over much of interior California and winters primarily in the Sacramento and San Joaquin valleys, where it frequents grassland habitats, moist croplands, and open emergent wetlands (CWHR 2022). The lesser sandhill crane is a similar migrant occurring over a wider range in California and at higher population levels (CWHR 2022). The species prefers relatively treeless plains where predators can be seen and avoids saline waters. This omnivorous bird feeds on grasses, forbs, and cereal crops as well as seeds, grains, earthworms, and insects. It will also consume small birds, snakes, frogs, crayfish, and mice. Lesser sandhill crane is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022); IUCN does not assess the greater sandhill crane subspecies. The statewide population estimate for sandhill crane based on the Pacific Flyway Data Book 2021 (Olson 2021) is approximately 41,788 individuals. No population estimates for the greater and lesser sandhill crane subspecies were found; however, because no lethal take is anticipated under the Proposed Project, we will use the species-level population estimate.

3.4.2.1 Previous Wildlife Damage Management

WS-California MIS records do not distinguish between the two subspecies: greater and lesser sandhill crane. To be conservative, we assumed all WDM was for the state threatened greater sandhill crane. WDM for sandhill crane includes only non-lethal activities (i.e., individuals dispersed). During the 10-year baseline, an average of 444.0 sandhill cranes were dispersed[100] per year. No lethal WDM for sandhill crane was recorded in the WS-California MIS data from 2010 to 2019. Baseline WDM for sandhill crane occurred in three counties (Sacramento, San Joaquin, and Yuba) with the majority occurring in San Joaquin County, some of which was for the protection of aviation safety. Therefore, under the current WS-California efforts, non-lethal WDM affected on average approximately 444.0 individuals per year based on the WS-California MIS data from 2010 to 2019.[101]

Because no lethal WDM of sandhill crane occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided, and no county-level analysis is provided. Approximately 1.06% (444.0 individuals) of the statewide population (41,788 individuals) was affected by non-lethal WDM activities annually. No lethal WDM activities affected the statewide population.

3.4.2.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM for sandhill crane under the Proposed Project is likely to be similar to that analyzed above on average. Due to annual variations in WDM, some years might have more WDM than others. A 99% confidence interval was not calculated for sandhill crane because there was no lethal take during the analysis period. Future WDM under the Proposed Project would be limited to non-lethal methods. No lethal take is anticipated. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large

[100] Because the WS-California MIS data do not distinguish among individuals, the dispersal total may include duplicate recordings of the same individual. As such, the number of dispersals does not necessarily reflect the number of individuals dispersed.

[101] Average includes activities that both intentionally and unintentionally affect sandhill crane and all potential methods used during non-lethal WDM activities.

proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for sandhill crane under the Proposed Project because only 1.1% of the estimated population is expected to be impacted by non-lethal WDM under the Proposed Project. Further, given the larger population of lesser sandhill cranes relative to greater sandhill cranes, it is highly likely that some or many of the individuals subject to non-lethal WDM were lesser sandhill cranes, rather than the state-listed greater sandhill crane.

3.4.2.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) have not documented damage to federal- or state-listed species by sandhill crane. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of sandhill crane. No other evidence was found that sandhill crane WDM would beneficially impact other sensitive species.

3.4.2.4 Potential Cumulative Effects to the Species

As a state threatened (and Fully Protected) species, there is no legal harvest of greater sandhill crane in California. At the species level, sandhill crane populations are trending upward in the U.S. overall, with estimated yearly increases of 3.5% between 1966 and 2019 and more moderate yearly increases of 1.7% when considering only the years between 2010 and 2019 (Sauer *et al.* 2019). In California, recent population trends (2010 to 2019) indicate decreases of -2.2% per year but show stable populations when considered over a longer time frame (1966 to 2019) (Sauer *et al.* 2019). The primary threat to sandhill cranes of all subspecies is habitat loss, whether from direct changes to the habitat or disturbances that prevent cranes from using otherwise suitable habitat (Gerber *et al.* 2020). Direct changes may be caused by expansion of agricultural areas (Gilmer *et al.* 1982), changes in water availability (Gilmer *et al.* 1982), spread of invasive plants such as common reed (*Phragmites australis*; Kessler *et al.* 2011), or changes in food availability, particularly agricultural waste grains (Gilmer *et al.* 1982; Littlefield 2002). Disturbances to otherwise suitable habitat may be caused by the presence of power lines, wind turbines, or hunters in other parts of the species' range (Gerber *et al.* 2020). Sandhill cranes can also be affected by diseases such as botulism and avian cholera, parasites, and exposure to extreme weather conditions such as blizzards, hail, and lightning (Gerber *et al.* 2020). No lethal WDM for sandhill crane is anticipated under the Proposed Project, and non-lethal WDM is expected to affect a small percentage of the population. Therefore, the Proposed Project has no potential to contribute to cumulative effects on sandhill crane, whether greater sandhill crane or lesser sandhill crane.

3.4.3 Bald Eagle

Bald eagle is a state endangered and CDFW Fully Protected Species which is also protected by the Bald and Golden Eagle Protection Act (CDFW 2022a). This species is a permanent resident and uncommon winter migrant with California breeding populations generally restricted to areas north of Fresno County, with the greatest concentration of breeding bald eagle territories in Butte, Lake, Lassen, Modoc, Plumas, Shasta, Siskiyou, and Trinity Counties (CWHR 2022). Approximately half of the California wintering population is in the Klamath basin (CWHR 2022). Bald eagle is more common at lower elevations and is a local winter migrant at some inland waters in Southern California. It requires large, old-growth trees in remote, mixed stands near large bodies of water or free-flowing rivers and adjacent perches to forage for prey including waterfowl, fish, and small mammals (CWHR 2022Bald eagle is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). The statewide population estimate for this species based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 10,953 individuals (Sauer *et al.* 2019).

3.4.3.1 Previous Wildlife Damage Management

WDM for bald eagle includes only non-lethal activities (i.e., individuals dispersed). During the 10-year baseline, an average of 6.8 individuals were dispersed[102] per year at airports within three counties (Alameda, Santa Clara, and Yuba). No lethal WDM of bald eagle was recorded in the WS-California MIS data from 2010 to 2019. Therefore, under previous WS-California efforts, non-lethal WDM affected on average approximately 6.8 individuals per year based on the WS-California MIS data from 2010 to 2019.[103] Because no lethal WDM of bald eagle occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are calculated and no county-level analysis is provided in this Report. Approximately 0.06% (6.8 individuals) of the statewide population (10,953 individuals) was affected by non-lethal WDM activities annually.

3.4.3.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM of bald eagle under the Proposed Project is likely to be similar to that analyzed above on average. Due to annual variations in WDM, some years might have higher WDM than others. A 99% confidence interval was not calculated for bald eagle because there was no lethal take during the analysis period. WDM for bald eagle under the Proposed Project is expected to be limited to non-lethal methods and is projected to be very low compared to the population statewide and in each county (0.06% of the population based on the analysis above). For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for bald eagle under the Proposed Project.

3.4.3.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by bald eagle. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of bald eagle. All previous non-lethal WDM targeting bald eagle was conducted at airports, and all future WDM under the Proposed Project is expected to occur at airports.

3.4.3.4 Potential Cumulative Effects to the Species

As a federal- and state-protected species, there is no legal harvest of bald eagle in California. Bald eagle populations have been increasing dramatically across the U.S., with estimated increases of 5.3% per year between 1966 and 2019 and 8.02% per year when considering only the recent years of 2010 to 2019 (Sauer *et al.* 2019). Within California, populations increased by 6.4% per year from 1966 to 2019 and 5.3% per year when considering only recent trends (2010 to 2019) (Sauer *et al.* 2019). Their naturally low reproductive rate means that changes to adult

[102] Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
[103] Average includes activities that both intentionally and unintentionally affect bald eagle and all potential methods used during non-lethal WDM activities.

survival have a greater effect on population trends than reproduction (Buehler 2022). Humans are the primary threat to bald eagles, either directly or indirectly (Buehler 2022; Russell and Franson 2014). The leading causes of mortality for bald eagles submitted to the National Wildlife Health Center in Wisconsin were poisonings (from lead, organophosphates, famphur, and fenthion) and trauma (impacts with vehicles and structures), although this method of assessing mortality is biased due to the requirement that the deceased bird is both encountered and sent in for necropsy (Russell and Franson 2014). Lead poisoning, despite bans on its use in ammunition for hunting in California, continues to affect eagles (Kramer and Redig 1997; Slabe *et al.* 2022) Human development and activity also contribute to habitat loss, especially along shorelines where eagles forage (Buehler 2022; Fraser *et al.* 1996). Both bald and golden eagles are also susceptible to collisions with wind turbines and other electrical infrastructure, with hundreds of bald and golden eagles known to have been killed due to these collisions, although bald eagles have a lower risk of collision than do golden eagles (Nasman *et al.* 2021). Such collisions can also lead to bald eagle mortality from electrocution (Buehler 2022). However, no lethal WDM is anticipated for bald eagle under the Proposed Project, and the non-lethal WDM is limited in scope (0.06% of the population). Therefore, the Proposed Project has no potential to contribute to cumulative effects on bald eagle.

3.4.4 Golden Eagle

Golden eagle is a Fully Protected species by CDFW that is also covered by the Bald and Golden Eagle Protection Act (CDFW 2022a). This uncommon permanent resident and migrant throughout California ranges from sea level to 11,500 feet in elevation, inhabiting rolling foothills, mountain areas, sage-juniper flats, and desert (CWHR 2022). Diet consists mainly of lagomorphs and rodents, birds, reptiles, and some carrion, with diet most varied in the nonbreeding season. Golden eagles need open terrain such as grasslands, deserts, savannahs, open mountain slopes, rock outcrops, and young successional stages of forests and shrub habitats for hunting (CWHR 2022). Golden eagle is considered a species of “Least Concern” by IUCN, and their global population is reported to be stable (IUCN 2022). The statewide population estimate for this species based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 3,801 individuals (Sauer *et al.* 2019).

3.4.4.1 Previous Wildlife Damage Management

WDM for golden eagle includes only non-lethal activities (i.e., individuals dispersed and freed, and transfer of custody). During the 10-year baseline, an average of 53.2 individuals were dispersed,[104] 0.1 individuals were freed, and 0.1 individuals underwent a transfer of custody per year. No lethal WDM of golden eagle was recorded in the WS-California MIS data from 2010 to 2019. Baseline non-lethal WDM for golden eagle occurred within five counties (Alameda, Butte, Los Angeles, Santa Clara, and Yuba) with the majority occurring at airports. Therefore, under the current WS-California efforts, non-lethal WDM affected on average approximately 53.4 individuals per year or 1.40% of the statewide population (3,801 individuals) based on the WS-California MIS data from 2010 to 2019.[105] Because no lethal WDM of golden eagle occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided for each county.

104 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
105 Average includes activities that both intentionally and unintentionally affect golden eagle and all potential methods used during non-lethal WDM activities.

3.4.4.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM of golden eagle under the Proposed Project is likely to be similar to that analyzed above on average. Due to annual variations in WDM, some years might have higher WDM than others. A 99% confidence interval was not calculated for golden eagle because there was no lethal take during the analysis period. Future WDM under the Proposed Project would be limited to non-lethal methods. No lethal take is anticipated. Because no lethal WDM of golden eagle occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided and no county-level analysis is provided. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for golden eagle under the Proposed Project.

3.4.4.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by golden eagle. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of golden eagle. Most previous and future WDM under the Proposed Project is expected to occur at airports.

3.4.4.4 Potential Cumulative Effects to the Species

As a federal- and state-protected species, there is no legal harvest of golden eagle in California. Population trends are imprecise for this species, but populations in the U.S. overall appear stable, increasing by 0.2% per year between 1966 and 2019 and by 0.46% per year when considering only 2010 to 2019 (Sauer *et al.* 2019). In California, estimates are similarly imprecise due to lack of data, but populations appear to be trending slightly downward, with -0.2% decreases yearly between 1966 to 2019 and -0.29% decreases yearly when considering only recent data from 2010 to 2019 (Sauer *et al.* 2019). While non-anthropogenic starvation and/or disease are a major cause of mortality, especially for hatch year golden eagles, most mortality of adult golden eagles are human caused (USFWS 2016). Of 386 satellite-tagged golden eagles from 1997 to 2013, 56% of eagle mortality was caused by anthropogenic causes (USFWS 2016). The relative importance of anthropogenic mortality increased with eagle age, from 34% of hatch year mortality to 63% of adult mortality (USFWS 2016). Similarly, the leading causes of mortality for golden eagles submitted the National Wildlife Health Center in Wisconsin were trauma, electrocution, gunshot wounds, and poisoning, primarily from lead, although this method of assessing mortality is biased due to the requirement that the deceased bird is both encountered and sent in for necropsy (Russell and Franson 2014). Lead poisoning, despite bans on its use for hunting, continues to affect eagles (Kramer and Redig 1997; Slabe *et al.* 2022) As noted above for bald eagle, golden eagles are susceptible to collisions with wind turbines and other electrical infrastructure, with hundreds of bald and golden eagles known to have been killed due to these collisions (Nasman *et al.* 2021). Golden eagles are also affected by habitat loss, which may result from climate-change driven vegetation changes (thus affecting prey abundance), energy development on shrubland and grassland habitats, and urbanization that renders habitat unsuitable for eagles or increases disturbance around nest sites (Katzner *et al.* 2020). However, no lethal WDM is anticipated for golden eagle under the Proposed Project, and the non-lethal WDM is limited in scope (1.40% of the population). Therefore, the Proposed Project has no potential to contribute to cumulative effects of golden eagle populations.

3.4.5 Northern Harrier

Northern harrier is a migratory bird species that occurs from annual grassland up to lodgepole pine and alpine meadow habitats, and as high as 10,000 feet amsl. It breeds from sea level to 5,700 feet amsl in the Central Valley and Sierra Nevada and up to 3,600 feet amsl in northeastern California. Northern harrier is a permanent resident of the northeastern plateau and coastal areas. It breeds from April to September and nests in emergent wetland or along rivers or lakes, but may nest in grasslands or on sagebrush flats and grain fields several miles from water (CWHR 2022).

Northern harrier is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022). Average clutch size is 4.4 eggs, and in California, an average of 1.8 young fledge per nest (Smith *et al.* 2020). Assuming a 1:1 sex ratio, 24,000 northern harriers (PIF 2022) equates 12,000 females. Only about 16% of females breed in their first year and live to 8 years (Smith *et al.* 2020). For a conservative estimate, this analysis will assume females breed in their 2nd year; thus, females will breed 75% of their life. Assuming 1.8 fledglings per 9,000 females (12,000 females x 75%) equals 16,200 successful fledglings per year and an additional 67.5% of population added per year. Total mortality must be below 67.5% to ensure no impact to northern harrier populations.

3.4.5.1 Previous Wildlife Damage Management

WDM for northern harrier includes lethal activities (i.e., individuals killed and eggs removed/destroyed) and non-lethal activities (i.e., individuals dispersed and relocated, and transfer of custody). During the 10-year baseline, an average of 274.2 northern harrier individuals were dispersed,[106] 1.1 individuals were relocated, 0.5 individuals underwent a transfer of custody, 5.9 individuals were killed, and 0.3 eggs were removed/destroyed per year. Baseline WDM for northern harrier occurred within 12 counties across the state, with all WDM occurring at airports or for T&E species protection. Therefore, under the current efforts, WS-California resolved conflicts with on average approximately 282.0 individuals per year based on the WS-California MIS data from 2010 to 2019.[107] Of the 282.0 individuals, non-lethal activities accounted for 98%, or 275.8 individuals, and lethal activities accounted for 2%, or 6.2 individuals per year.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) was estimated for each Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-41) according to the methods outlined in Section 2.4. During the 10-year baseline period, statewide lethal take of northern harrier is estimated at 8.1 individuals annually. This total is comprised of the WS-California lethal take of 5.9 individuals per year and the non-WS-California estimates for lethal take of 2.2 individuals per year. These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide population estimate for northern harrier based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022) is approximately 24,000 individuals. Approximately 0.03% of the statewide population was taken by lethal WDM activities annually.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide northern harrier take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer,

[106] Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
[107] Average includes activities that both intentionally and unintentionally affect northern harrier and all potential methods used during WDM activities.

was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate.

For northern harrier, the average is 6.2,[108] the standard deviation is 4.5, and the 99% confidence high estimate is 17.8, which we rounded up to 18 individuals. The 99% Confidence Factor for northern harrier was 18/6.2 = 2.9. Estimated take of northern harrier is provided for each county in Table 3-41.

3.4.5.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of northern harrier under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 24 northern harriers taken annually, which represents 0.1% of the population. This number represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 24. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 24 individuals. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

3.4.5.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by northern harrier. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of northern harrier. Most previous and future WDM under the Proposed Project is expected to occur at airports.

3.4.5.4 Potential Cumulative Effects to the Species

Cumulative effects on populations of northern harrier may occur as a result of effects on individuals or effects from human development on habitat. Since the Proposed Project would not disturb habitat, the proposed WDM activities would not affect habitat supporting raptors; however, lethal WDM of raptors would contribute to cumulative effects on the species. Population trends of northern harrier show declines in recent years (2010-2019), both in California (-2.91% per year) and in the U.S. overall (-0.28% per year) (Sauer et al. 2019). This is echoed by long-term trends (1966-2019), which show declines of -1.7% per year in California and -0.4% per year in the U.S. overall (Sauer et al. 2019). The primary contributor to rangewide declines in northern harrier populations is loss or fragmentation of

108 Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-41. This small amount of error was accepted for this calculation.

wetland and open grassland habitats, both in their breeding and wintering ranges (Smith et al. 2020). Other sources of cumulative mortality for northern harrier include poaching, incidental poisoning through consumption of rodenticides or pesticides, collisions with structures, and human disturbance at nest or roost sites (Smith et al. 2020). The level of mortality associated with these other sources is speculative but based on the very low level of lethal take (0.1% of the population) from the Project relative to California and rangewide populations of these species (PIF 2022), The Proposed Project would not cause cumulative exceedance of sustainable mortality levels at a regional or statewide level.

Table 3-41. Northern Harrier Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year			Proposed Project Maximum Annual Lethal Take Estimate[1]	Proposed Project Max Annual Lethal Take Estimate of Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total		
ALAMEDA	0	0	0.1	<0.1	0.7	0.5	0.8	0.5	1.3	2	<0.1%
ALPINE	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
AMADOR	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
BUTTE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
CALAVERAS	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
COLUSA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
CONTRA COSTA	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
DEL NORTE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
EL DORADO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
FRESNO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
GLENN	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
HUMBOLDT	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
IMPERIAL	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
INYO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
KERN	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
KINGS	0	0	0	<0.1	0.1	<0.1	0.1	<0.1	0.1	1	<0.1%
LAKE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
LASSEN	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
LOS ANGELES	0	0	0	<0.1	0.1	0.1	0.1	0.1	0.2	1	<0.1%
MADERA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
MARIN	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
MARIPOSA	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
MENDOCINO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
MERCED	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
MODOC	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
MONO	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
MONTEREY	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
NAPA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
NEVADA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
ORANGE	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
PLACER[2]	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
PLUMAS	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
RIVERSIDE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SACRAMENTO	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
SAN BENITO[3]	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SAN BERNARDINO	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
SAN DIEGO	0	0	3	<0.1	0	0	3	<0.1	3.0	9	<0.1%
SAN FRANCISCO	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
SAN JOAQUIN	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%

Table 3-41. Northern Harrier Annual Average Lethal Wildlife Damage Management under the Proposed Project by County and Statewide

County	County-Based Average Per Year		T&E Species Protection Average Per Year		Airports Average Per Year		Total Average Lethal Take Per Year			Proposed Project Maximum Annual Lethal Take Estimate[1]	Proposed Project Max Annual Lethal Take Estimate of Population
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Total		
SAN LUIS OBISPO	0	0	0.1	<0.1	0	0	0.1	<0.1	0.1	1	<0.1%
SAN MATEO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SANTA BARBARA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SANTA CLARA	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
SANTA CRUZ	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SHASTA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SIERRA	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
SISKIYOU[4]	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SOLANO	0	0	0	<0.1	0.8	<0.1	0.8	<0.1	0.9	3	<0.1%
SONOMA[5]	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
STANISLAUS	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
SUTTER	0	0	0	<0.1	0	0	0	<0.1	<0.1	1	<0.1%
TEHAMA	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
TRINITY	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
TULARE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
TUOLUMNE	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
VENTURA	0	0	0.1	<0.1	0	0	0.1	<0.1	0.1	1	<0.1%
YOLO	0	0	0	<0.1	0	<0.1	0	<0.1	<0.1	1	<0.1%
YUBA	0	0	0	<0.1	0.9	0	0.9	<0.1	0.9	3	<0.1%
Total	**0**	**0**	**3.3**	**1.1**	**2.6**	**0.8**	**5.9**	**1.9**	**7.8**	**23**	**<0.1%**

Notes: T&E = threatened and endangered; USDA = U.S. Department of Agriculture; MIS = Management Information System; 0 = no MIS WDM occurred during the 10-year baseline period.
Totals may not sum due to rounding.
MIS lethal WDM includes the following fate categories: killed and removed/destroyed.
Lethal WDM estimates (i.e., non-MIS) are included to determine cumulative effects. The method to derive an estimate for each Project component (airports, T&E species protection, and county-based) within each county is provided in Section 2.4.

1 Refer to Section 3.4.6.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 Placer County averages includes calendar years 2010 through 2015 only (6 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
3 San Benito County averages includes calendar years 2010 through 2012 only (3 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 Siskiyou County averages includes calendar years 2010 through 2018 only (9 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Sonoma County averages includes calendar years 2010 through 2013 only (4 years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.

3.4.6 Swainson's Hawk

Swainson's hawk is a state-threatened species (CDFW 2022a). It is an uncommon breeding resident and migrant in the Central Valley, Klamath Basin, Northeastern Plateau, Lassen County, and the Mojave Desert (CWHR 2022). It breeds in stands with few trees in juniper-sage flats, riparian areas, and in oak savannah in the Central Valley, and forages in adjacent grasslands, croplands, and livestock pastures (CWHR 2022). Its diet consists of mice, gophers, ground squirrels, rabbits, large arthropods, amphibians, reptiles, and rarely fish (CWHR 2022). It roosts in trees and is usually found near water in the Central Valley, but also nests in the open desert (CWHR 2022). Swainson's hawk is considered a species of "Least Concern" by IUCN, and their global population is reported to be stable (IUCN 2022). The statewide population estimate for Swainson's hawk based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022) is approximately 44,000 individuals.

3.4.6.1 Previous Wildlife Damage Management

WDM for Swainson's hawk is comprised of non-lethal activities (i.e., individuals dispersed, freed, and radio collared) and lethal activities (i.e., individuals killed). During the 10-year WS-California MIS baseline (CY 2010-2019), an average of 493.5 individuals were dispersed[109] and 3.1 were killed per year. Therefore, under the previous WS-California efforts, WDM affected on average approximately 496.6 individuals per year.[110] WS-California MIS baseline WDM for Swainson's hawk occurred within 10 counties across the state (Kings, Los Angeles, Orange, Sacramento, San Bernardino, San Luis Obispo, Santa Clara, Solano, Ventura, and Yuba). Most baseline WDM occurred within Yuba and Kings Counties. Non-lethal WDM accounts for 99.4% and lethal take accounts for 0.6% and of all previous Swainson's hawk WDM by WS-California. Non-lethal WDM affected 1.1% of the estimated population (44,000 individuals; PIF 2022).

Lethal WDM for Swainson's hawk during the 10-year baseline averaged 3.1 individuals killed per year. All lethal WDM of Swainson's hawk was conducted at airports in three counties: Kings, San Bernardino, and Yuba. The statewide population estimate for this species is approximately 44,000 individuals (PIF 2022); therefore, <0.01% of the statewide population was affected by lethal WDM activities annually. All WDM occurred at airports for the protection of aviation safety.

Due to the protected status of Swainson's hawk (State Threatened), we did not estimate lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take). No other entities are likely to have taken Swainson's hawks in California; therefore, we did not analyze lethal take by county.

3.4.6.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of Swainson's hawk under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. To address such annual variations, we calculated the standard deviation of the WS-California statewide Swainson's hawk take during the 10-year analysis period (CY 2010-2019) and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. A 99% Confidence Factor

109 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

110 Average includes activities that both intentionally and unintentionally affect Swainson's hawk and all potential WDM methods used by WS-California.

was not calculated for Swainson's hawk (which would be applied to all non-WS take) because all lethal take is expected to be conducted by WS-California.

For Swainson's hawk, the average is 3.1, the standard deviation is 5.3, and the 99% confidence high estimate is 16.7, which we rounded up to 17 individuals. The Proposed Project Maximum Lethal Take Estimate is 17 Swainson's hawks statewide (0.04% of the population). This represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

Swainson's hawk take was not analyzed by county because WS-California is the only entity likely to conduct lethal take under the Proposed Project. CDFA-directed and county-directed programs are not expected to conduct lethal WDM due to the protected status (State Threatened).

Swainson's hawk take under the Proposed Project is expected to be very low compared to the statewide population based on the analysis above. Given this low level estimated Proposed Project Maximum Lethal Take relative to the estimated population, a sustainable harvest threshold was not established for Swainson's hawk.

Approximately 1.1% (493.5 individuals) of the statewide population is expected to be affected by non-lethal WDM activities annually. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for Swainson's hawk under the Proposed Project.

3.4.6.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by Swainson's hawk. Non-lethal WDM at airports effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of Swainson's hawk. Most previous and future WDM under the Proposed Project is expected to occur at airports.

3.4.6.4 Potential Cumulative Effects to the Species

As a state-threatened species, there is no legal harvest of Swainson's hawk in California. Within the U.S. overall, estimated population trends indicate recent increases of 1.8% per year from 2010 to 2019, and long-term increases of 1.2% per year from 1966 to 2019 (Sauer *et al.* 2019). In California, estimated population trends indicate recent increases of 0.81% per year from 2010 to 2019, and long-term increases of 5.1% per year from 1966 to 2019 (Sauer *et al.* 2019). Swainson's hawk populations are primarily threatened by loss or alteration of habitat (Bechard *et al.* 2020; CWHR 2022). This species preferentially nests in solitary trees along riparian corridors, shelterbelts, or in other planted trees on homesteads, and loss of such nest sites from changing land uses or urbanization reduces available nesting habitat (Bechard *et al.* 2020). Swainson's hawks can nest in certain urban areas within their range, preferring older neighborhoods with mature landscaping or newer neighborhoods with mature trees retained from pre-urbanization (England *et al.* 1995). However, urbanized areas that lack nearby foraging habitat (within 5-8 km) are not suitable, indicating vulnerability to rapid urbanization that separates suitable nesting sites from foraging habitat (England *et al.* 1995). In their wintering range in South America, Swainson's hawks are threatened by shooting by local farmers and poisoning from organophosphate insecticides

(Bechard *et al.* 2020; Goldstein *et al.* 1999), as well as loss of wintering habitat from intensification of agricultural land uses (Bechard *et al.* 2020). Other potential threats are from collisions with vehicles and structures, human disturbance at nest sites during nest-building and incubation, and storms and weather exposure during migration (Bechard *et al.* 2020). Quantitative data on cumulative anthropogenic mortality is sparse; however, because lethal WDM under the Proposed Project is expected to affect a very small percentage of the population (0.04%), and populations are stable or increasing in California (Sauer *et al.* 2019), the Proposed Project has limited potential to contribute to cumulative effects on Swainson's hawk.

3.4.7 White-Tailed Kite

White-tailed kite is a CDFW Fully Protected species that is a yearlong resident in coastal and valley lowlands and is rarely found away from agricultural areas (CDFW 2022a; CWHR 2022). It inhabits herbaceous and open stages of most habitats, mostly in cismontane California. It preys mostly on voles and other small diurnal mammals, occasionally on birds, insects, reptiles, and amphibians. It forages in open grassland, meadows, farmlands, and emergent wetlands. It nests in the top of dense oak, willow, or other tree stands near an open foraging area (CWHR 2022). White-tailed kite is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). The statewide population estimate for this species based on the Avian Conservation Assessment and Population Estimates Database (PIF 2022) is approximately 9,700 individuals.

3.4.7.1 Previous Wildlife Damage Management

WDM for white-tailed kite includes non-lethal activities (i.e., individuals dispersed and relocated) and lethal WDM (i.e., individuals killed). During the 10-year baseline, an average of 114.3 individuals were dispersed,[111] 0.4 individuals were relocated, and 0.4 individuals were killed per year. All lethal WDM of white-tailed kite was conducted at airports in three counties (Alameda, Los Angeles, and Yuba). Therefore, under the previous WS-California efforts, WDM affected on average approximately 115.1 individuals per year.[112] Non-lethal WDM accounts for >99.99% and lethal take accounts for <0.01% and of all annual of white-tailed kite WDM by WS-California. All WDM occurred at airports for the protection of aviation safety. The statewide population estimate for this species is approximately 9,700 individuals (PIF 2022); therefore, <0.01% of the statewide population was affected by lethal WDM activities annually.

Due to the protected status of white-tailed kite (State "Fully Protected"), we did not estimate lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take). No other entities are likely to have taken white-tailed kites in California; therefore, we did not analyze lethal take by county.

3.4.7.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of white-tailed kite under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. To address such annual variations, we calculated the standard deviation of the WS-California statewide white-tailed kite take during the 10-year analysis period (CY 2010-2019) and used it to estimate the 99% confidence interval

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[111] Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.

[112] Average includes activities that both intentionally and unintentionally affect white-tailed kite and all potential WDM methods used by WS-California.

of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. A 99% Confidence Factor was not calculated for white-tailed kite (which would be applied to all non-WS take) because all lethal take is expected to be conducted by WS-California.

For white-tailed kite, the average is 0.4, the standard deviation is 1.3, and the 99% confidence high estimate is 3.7, which we rounded up to 4 individuals. The Proposed Project Maximum Lethal Take Estimate is 4 white-tailed kites statewide (0.04% of the population). This represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

White-tailed kite take was not analyzed by county because WS-California is the only entity likely to conduct lethal take under the Proposed Project. CDFA-directed and county-directed programs are not expected to conduct lethal WDM due to the protected status (State "Fully Protected").

Approximately 1.2% (114.3 individuals) of the statewide population is expected to be affected by non-lethal WDM activities annually. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for white-tailed kite under the Proposed Project.

Lethal take of white-tailed kite under the Proposed Project is expected to be very low compared to the statewide population (0.04%) based on the analysis above. Given this low level of annual lethal WDM relative to the estimated population, a sustainable harvest threshold was not established for white-tailed kite.

3.4.7.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by white-tailed kite. There are no known ecological benefits to lethal WDM of white-tailed kite. All non-lethal WDM for white-tailed kite is expected to be conducted at airports under the Proposed Project. Such non-lethal WDM effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of white-tailed kites.

3.4.7.4 Potential Cumulative Effects to the Species

As a state Fully Protected species, there is no legal harvest of white-tailed kite in California. Populations are trending downward in the U.S. overall, with estimated declines of -4.75% per year from 2010 to 2019 and long-term declines of -1.2% per year from 1966 to 2019 (Sauer *et al.* 2019). Within California, declines are more precipitous, with an estimated -7.06% yearly decrease from 2010 to 2019 and long-term -2% yearly decreases from 1966 to 2019 (Sauer *et al.* 2019). Threats to white-tailed kites are not well studied. The primary known threat is loss of nest trees and foraging habitat due to human development and other causes (Dunk 2020). Populations are known to change predictably in response to fluctuating abundance of California voles (*Microtus californicus*), a primary prey species in California (Dunk and Cooper 1994). Thus, habitat changes that adversely affect vole populations such as land use changes or urbanization likely have detrimental effects on white-tailed kite populations. Reliance on rodent prey may potentially expose white-tailed kites to secondary poisoning from rodenticides, but no data was found to support this. Quantitative data on anthropogenic mortality is sparse; however, because lethal WDM under the Proposed Project is expected to affect a very small percentage of the population (0.04%), the Proposed Project has limited potential to contribute to cumulative effects on white-tailed kite.

3.4.8 California Brown Pelican

California brown pelican is a CDFW Fully Protected species found in estuarine, marine subtidal, and marine pelagic waters along the California coast (CDFW 2022a; CWHR 2022). In southern California, this species is most common along the coast within 19 miles of shore from but can be found up to 109 miles from shore (Briggs *et al.* 1981). Brown pelicans occur year-round in southern California, breeding on the Channel Islands along mudflats, sandy beaches, and jetties, feeding almost entirely on fish (CWHR 2022). The species can be found year-round (but not breeding) between the southern to central California coast and during post-breeding and winter north to the Pacific Northwest (Anderson and Anderson 1976; Shields 2020). California brown pelican is considered a species of "Least Concern" by IUCN, and their global population is reported to be increasing (IUCN 2022). The statewide population estimate for this species based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 6,481 individuals (Sauer *et al.* 2019).

3.4.8.1 Previous Wildlife Damage Management

WDM for California brown pelican includes non-lethal activities (i.e., individuals dispersed and relocated) and lethal WDM (i.e., individuals killed). All WDM occurred at airports for the protection of aviation safety During the 10-year baseline, an average of 999.5 individuals were dispersed,[113] 0.1 individuals were relocated, 0.5 individuals underwent a transfer of custody, and 0.1 individuals were killed per year. WDM of California brown pelican was conducted at airports in five counties: Alameda, Los Angeles, San Diego, Santa Clara, and Ventura. All lethal WDM of California brown pelican was conducted at airports in one county: Ventura Therefore, under the previous WS-California efforts, WDM affected on average approximately 1,000.2 individuals per year.[114] Non-lethal WDM accounts for >99.99% and lethal take accounts for <0.01% and of all annual of California brown pelican WDM by WS-California. The statewide population estimate for this species is approximately 6,481 individuals (Sauer *et al.* 2019); therefore, <0.01% of the statewide population was affected by lethal WDM activities annually.

Lethal WDM for California brown pelican during the 10-year baseline averaged 0.1 individuals killed per year.

Due to the protected status of California brown pelican (State "Fully Protected"), we did not estimate lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take). No other entities are likely to have taken California brown pelicans in California; therefore, we did not analyze lethal take by county.

3.4.8.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of California brown pelican under the Proposed Project is likely to be similar to the total take estimated above on average: the lethal take of a brown pelican is expected to be occur only occasionally. Because take of a brown pelican could occur in any single year, the Proposed Project Maximum Lethal Take Estimate of a brown pelican is expected to be one brown pelican (0.02% of the estimated state population). The 99% confidence high estimate WS-California lethal take (average plus 2.58 standard deviations) was not calculated due to the low

113 Since the MIS data do not distinguish between individuals, the dispersal total may include duplicate recordings of the same individual.
114 Average includes activities that both intentionally and unintentionally affect California brown pelican and all potential WDM methods used by WS-California.

amount of take (one in 10 years). This represents the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

California brown pelican take was not analyzed by county because WS-California is the only entity likely to conduct lethal take under the Proposed Project. CDFA-directed and county-directed programs are not expected to conduct lethal WDM due to the protected status (State "Fully Protected").

Approximately 15.4% (1,000.1 individuals) of the statewide population is expected to be affected by non-lethal WDM activities annually under the Proposed Project. The true number of birds subjected to non-lethal WDM is likely much lower than this, however, because the same bird is often harassed multiple times during airport WHM, which comprises the entirety of likely WDM for California brown pelican. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for brown pelican under the Proposed Project.

3.4.8.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by brown pelican. There are no known ecological benefits to lethal WDM of brown pelican. All non-lethal WDM for brown pelican is expected to be conducted at airports under the Proposed Project. Such non-lethal WDM effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife. As such, non-lethal WDM at airports will result in the protection of brown pelicans.

3.4.8.4 Potential Cumulative Effects to the Species

As a state Fully Protected species, there is no legal harvest of brown pelicans in California. Estimated populations are trending upward in the U.S. overall, with recent increases of 5.02% per year from 2010 to 2019 and long-term increases of 3.5% per year from 1966 to 2019 (Sauer *et al.* 2019). Recent short-term population trends in California show precipitous declines of -17.34% per year from 2010 to 2019, although long-term trends indicate increases of 0.8% per year when tracked from 1966 to 2019 (Sauer *et al.* 2019). Brown pelican populations are affected by El Nino Southern Oscillation (ENSO) events that reduce prey availability and cause mass starvation events (Shields 2020), which may in turn be exacerbated by anthropogenic climate change, although there is insufficient data to determine the extent of this connection at this time (Gergis and Fowler 2009). Direct human-caused mortality is a significant threat to brown pelicans, with 55% of east coast pelicans banded between 1925 and 1983 found deceased from human-caused mortality (Schreiber and Mock 1988). Populations were historically impacted by shooting and organochlorine pesticides such as endrin and DDT, but the most important threat in recent years is entanglement in fishing gear (Schreiber and Mock 1988; Shields 2020). Other sources of mortality for brown pelican include oil pollution, collisions with structures or vehicles, degradation of habitat, and disturbance at nest or roost sites (Schreiber and Mock 1988; Shields 2020). In California, the only breeding colonies of this species are on West Anacapa and Santa Barbara Islands, which are expected to remain protected within Channel Islands National Park (NPS 2022b). Given that the Proposed Project Maximum Lethal Take Estimate is a very small percentage of the population (up to 0.02%), and the population of this species is stable or increasing over the long term (Sauer *et al.* 2019), the Proposed Project has the potential to contribute only a miniscule amount to cumulative effects on California brown pelican.

3.4.9 Western Snowy Plover

Western snowy plover is a federally threatened species that is common on sandy marine and estuarine shores in California (CDFW 2022a; CWHR 2022). Inland nesting areas occur at the Salton Sea, Mono Lake, and at isolated sites on the shores of alkali lakes in northeastern California, in the Central Valley, and southeastern deserts (CWHR 2022). Its diet consists of insects and amphipods from the dry sand of upper beaches along the coast, occasionally foraging in wet sand for sand crabs. It feeds primarily on brine flies in salt ponds and alkali lakes (CWHR 2022). It requires a sandy, gravelly, or friable soil surface for nesting (CWHR 2022). Snowy plover is considered “Near Threatened” by IUCN, and their global population is reported to be decreasing (IUCN 2022); IUCN does not provide a separate assessment for the western subspecies. The statewide population estimate for this species based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 1,738 individuals (Sauer *et al.* 2019).

3.4.9.1 Previous Wildlife Damage Management

WDM for western snowy plover includes only non-lethal activities (i.e., individuals dispersed). During the 10-year baseline, an average of 0.1 individuals were dispersed from an airport in one county: San Diego. No lethal WDM of western snowy plover was recorded in the WS-California MIS data from 2010 to 2019. Therefore, under the current WS-California efforts, non-lethal WDM affected on average approximately 0.1 individuals per year based on the WS-California MIS data from 2010 to 2019 (average includes activities that both intentionally and unintentionally affect western snowy plover and all potential methods used during non-lethal WDM activities). Because no lethal WDM of western snowy plover occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided and county-level analyses are not provided.

3.4.9.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM for western snowy plover under the Proposed Project is likely to be similar to that analyzed above during the 10-year analysis period: no lethal take is expected and nonlethal WDM is expected to be only occasional. Because no lethal take of western snowy plover is expected, 0% of the population would be affected. The 99% confidence high WS-California lethal take (average plus 2.58 standard deviations) was not calculated because there was no lethal take during the analysis period nor expected under the Proposed Project. Non-WS-California take was not estimated and western snowy plover take was not analyzed by county because no lethal take is anticipated under the Proposed Project.

Less than 0.01% (0.1 individuals) of the statewide population (1,738 individuals) is likely to be subjected to non-lethal WDM activities annually under the Proposed Project. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for western snowy plover under the Proposed Project.

3.4.9.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by western snowy plover. All non-lethal WDM for western snowy plover is expected to be conducted at airports under the Proposed Project. Such non-lethal WDM effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife.

3.4.9.4 Potential Cumulative Effects to the Species

Due to the protected status, no western snowy plovers are legally harvested by hunters or trappers. The overall population of snowy plovers on the Pacific Coast has increased gradually between 2005 and 2019, but notable population decreases were noted in 2007-2008, 2012, and 2016- 2018 in one or more localized population recovery units that affected overall population trends (USFWS 2019). The primary threats to western snowy plover are from human use, disturbance, and degradation of beach nesting habitat (Page *et al.* 2020; USFWS 2019a). This species nests in relatively unprotected areas and is vulnerable to direct and indirect disturbances (e.g., humans, horses, dogs) that cause it to flush the nest and waste energy (Page *et al.* 2020; USFWS 2019a). This species is also highly vulnerable to various nest predators, including bird species (e.g., American crow, common raven) and mammalian predators (e.g., coyote, red fox, striped skunk) that have been expanding in range (Page *et al.* 2020; USFWS 2019a). Habitat degradation may be caused by exotic beach grass (*Ammophila arenaria*) and mechanical raking of beaches (Page et al, 2020; USFWS 2019a). Adults and chicks alike are vulnerable to being crushed or run over by off-road vehicles or while crossing highways (Page *et al.* 2020). Adult snowy plover mortality may be additionally caused by entanglement in fishing gear, colliding with nest protection structures, and oiling, although these are less significant mortality factors (Page *et al.* 2020). Additional threats are likely to arise from climate change related factors, especially sea level rise affecting coastal habitat quality, nest success, and survivorship of wintering birds (USFWS 2019a).

Given their federal- and state-listed status, no lethal WDM of this species is expected to occur under the Proposed Project, and only limited non-lethal WDM would occur for the protection of human safety at airports. The Proposed Project would provide beneficial effects for this species through non-lethal and lethal WDM of nest predators. The Proposed Project would also benefit the species by preventing collisions with aircraft which generally result in the death of the bird. Given that only non-lethal WDM will be conducted for this species, the Proposed Project has no potential to contribute to cumulative effects on western snowy plover populations.

3.4.10 California Least Tern

California least tern is a federally and state endangered species that is also Fully Protected by CDFW (CDFW 2022a; 35 FR 8491-8498). Breeding colonies are located in Southern California along marine and estuarine shores and in San Francisco Bay in abandoned salt ponds and along estuarine shores (CWHR 2022). California least tern feeds in shallow estuaries or lagoons where small fish are abundant and prefers undisturbed nest sites in open, sandy or gravelly shores near shallow-water feeding areas in estuaries (CWHR 2022). Least tern is considered a species of "Least Concern" by IUCN, though their global population is reported to be decreasing (IUCN 2022); IUCN does not provide a separate assessment for the California subspecies. The statewide population estimate for this species based on the average USGS North American Breeding Bird Survey data for survey years 2015 through 2019 is approximately 8,190 individuals (Sauer *et al.* 2019).

3.4.10.1 Previous Wildlife Damage Management

WDM for California least tern includes only non-lethal activities (i.e., individuals dispersed). During the 10-year baseline, an average of 32.7 individuals were dispersed from airports in one county (San Diego). No lethal WDM of California least tern was recorded in the WS-California MIS data from 2010 to 2019. Therefore, under previous WS-

California efforts, non-lethal WDM affected on average approximately 32.7 individuals per year based on the WS-California MIS data from 2010 to 2019.[115] This represents 0.40% of the estimated population in California (8,190 individuals; (USFWS 2020b; Sauer *et al.* 2019).

Because no lethal WDM of California least tern occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided for each county. No county-level analysis was conducted due to the lack of any previous or anticipated lethal WDM.

3.4.10.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM under the Proposed Project is likely to be similar to the total take estimated above on average. Due to annual variations in WDM, some years might have more non-lethal WDM than others. Average non-lethal WDM under the Proposed Project would affect a small percentage (0.40%) of the California least tern population. The 99% confidence interval was not calculated (average plus or minus 2.58 standard deviations) for California least tern because no lethal take is anticipated.

Non-WS-California take was not estimated and California least tern take was not analyzed by county because no lethal take is anticipated under the Proposed Project.

Approximately 0.40% of the statewide population is expected to be subjected to non-lethal WDM activities annually under the Proposed Project. For sensitive species, non-lethal WDM has the potential to result in population-level impacts only if it consistently affects such a large proportion of the population that individuals must expend considerably more energy to survive and breed or cannot access quality habitat. Neither of these factors would exist for California least tern under the Proposed Project.

3.4.10.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by California least tern. All non-lethal WDM for California least tern is expected to be conducted at airports under the Proposed Project. Such non-lethal WDM effectively protects aviation safety as well as the target wildlife species because wildlife-aircraft strikes typically result in the death of the wildlife.

3.4.10.4 Potential Cumulative Effects to the Species

Due to the protected status, no California least tern are legally harvested by hunters or trappers. Population trends have been increasing slowly since listing in 1970, with faster rates of increase in the late 1980s, presumably from more intensive management of nesting areas and naturally occurring food abundance during this time (USFWS 2020b). However, more recent trends (2009 to 2017) show a steady decline in California least tern with accompanying shifts in demographics showing older breeding birds and less juvenile recruitment (USFWS 2020b). Threats to California least tern, like those described for western snowy plover, primarily involve human use, disturbance, and degradation of beach nesting habitat (USFWS 2020b). Urban development reduces habitat availability, concentrating breeding terns onto fewer, larger tern colonies, potentially exposing nests to higher predation risk (USFWS 2020b). Predation is a significant threat to nests and chicks, primarily from birds (e.g.,

[115] Average includes activities that both intentionally and unintentionally affect California least tern and all potential methods used during non-lethal WDM activities.

American kestrel, American crow, peregrine falcon, gull-billed tern) and mammals (e.g., coyote, red fox, domestic cat, rats), and predator presence can reduce egg-laying, chick feeding, and fledging success (USFWS 2020b). Human disturbance is also a major factor affecting California least tern nesting colonies, with tern eggs and chicks killed by mechanical grooming/raking activities, off-road vehicles, or simply being stepped on by pedestrians (USFWS 2020b). This species is also threatened by the encroachment of vegetation at nesting sites, bioaccumulation of pesticides and other contaminants, and climate change effects such as sea level rise and fluctuations in prey availability due to changes in ENSO, although there is insufficient data to determine the extent of this connection at this time (Gergis and Fowler 2009; Thompson *et al.* 2020; USFWS 2020b).

Given their federal- and state-listed status, no lethal WDM of this species is expected to occur under the Proposed Project, and only limited non-lethal WDM would occur for the protection of human safety at airports. The Proposed Project would provide beneficial effects for this species through non-lethal and lethal WDM of nest predators. The Proposed Project would also benefit the species by preventing collisions with aircraft which generally result in the death of the bird. Given that only non-lethal WDM will be conducted for this species, the Proposed Project has no potential to contribute to cumulative effects on California least tern populations.

3.4.11 American Badger

The American badger, a CDFW Species of Special Concern and fur-bearing mammal (CFGC Section 4000), is a carnivorous species that occurs throughout most of California within dry open shrub, forest, and herbaceous areas containing friable soils (CWHR 2022). American badgers have a widely varied diet consisting of rodents, especially ground squirrels and pocket gophers, as well as reptiles, insects, earthworms, eggs, birds, and carrion (CWHR 2022). This species' diet shifts seasonally in response to availability of prey (CWHR 2022). They are considered a species of "least concern" by IUCN, though their global population is reported to be declining (IUCN 2022). Based on the CDFW habitat modeling for American badger provided in Appendix C1, the estimated low population size for California is 74,683 individuals. Also included in Appendix C1 are the population estimates of American badgers within each county.

Boddicker (1980) has suggested that the long-term sustainable harvest threshold for American badger is above 30-40%; however, this author supplied no empirical data for this assessment. Banci and Proulx (1999) reported the sustainable harvest rate to be between 10% and 25% in Canada, including areas of recent badger range expansion (where sustainable harvest rates would be expected to be lower). They considered the badger to have "low-intermediate" resilience due to their low reproductive rate compared to other furbearing mammals. Warner and Ver Steeg (1995) report a 4.5% harvest rate was sustainable with normal reproductive output based on modeling in a population in Illinois with much lower density than in the western United States. These authors did not attempt to determine the maximum sustainable harvest rate; they only reported that 4.5% was sustainable. The 4.5% reported by these authors is also limited to trapping only. As such, this number is appropriate for comparing WDM take, but not for comparing cumulative anthropogenic mortality, which includes roadkill. These other sources of mortality were included in different input parameters in the model by Warner and Ver Steeg (1995). No other published sustainable harvest rates for American badgers were found, despite an exhaustive literature search. Badgers in western states like California have higher densities, smaller home ranges, and more abundant food sources (Warner and Ver Steeg 1995); the higher sustainable harvest estimate of 10-25% from Banci and Proulx (1999) is thus more likely to be applicable to badgers in California. And because we aim to compare cumulative anthropogenic mortality (referred to herein simply as "cumulative take"), the estimates from Banci and Proulx (1999) are more appropriate. For this analysis we will use 10%, the lowest estimate in the range published by Banci and Proulx (1999), as a conservative threshold for potential impacts to American badger populations in California.

3.4.11.1 Previous Wildlife Damage Management

During the 10-year WS-California MIS baseline period (CY 2010-2019), WDM for American badger was comprised of lethal activities (i.e., individuals killed) and non-lethal activities (i.e., individuals freed). An average of 27.1 American badgers were killed and 0.8 individuals were freed per year. Therefore, approximately 27.9 individuals per year were affected by WS-California WDM.[116] WS-California WDM targeting American badger occurred within 11 counties throughout the state with averages ranging from 0.1 to 22.8 individuals per year. The majority of WS-California average lethal take of American badger occurred within Siskiyou County (84% of WS-California take, or 22.8 individuals per year). WS-California average lethal take of American badger accounts for 49% (27.1 individuals) of total annual WDM take (55 individuals taken by WS-California and non-WS California WDM annually) of American badger, with WS-California WDM in Siskiyou County accounting for 42% (22.8 individuals) of that total.

Estimates for lethal WDM conducted by individuals or entities other than WS-California were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-42) according to the methods outlined in Section 2.4. The potential for occasional lethal take was also included in counties with no apparent lethal take from this method, but with badger populations higher than 100 (Table 3-42). WS-California provided subjective and qualitative determinations of occasional lethal WDM take (by non-WS-California entities) whenever there was a moderate population of the target species (more than 100) and resources with the potential for damage by the target species (T. Felix, pers. comm. 2022a). During the 10-year baseline period, lethal take of American badger is estimated at an average of 68.9 individuals annually. This total is comprised of the WS-California lethal take of 27.1 individuals per year and the non-WS-California estimates for lethal take of 41.8 individuals per year (Table 3-42). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data.

To account for interannual variation in take, we calculated the standard deviation of the WS-California statewide American badger take through the 10-year analysis period and used it to estimate the 99% confidence interval of WS-California lethal take (average ± 2.58 standard deviations). The highest value, rounded up to the next integer, was used to represent the 99% confidence high estimate for WS-California lethal take. The relationship of this number to the average lethal take was calculated by dividing the 99% confidence high estimate by the average. This factor, named the 99% Confidence Factor for the analyses in this BTR, was calculated for each species with WS-California lethal take. All known and estimated previous take averages were multiplied by the 99% Confidence Factor to estimate the Proposed Project Maximum Lethal Take Estimate. For American badger, the average WS-California lethal take is 24.6,[117] the standard deviation is 15.98, and the 99% confidence high estimate is 65.83, which we rounded up to 66 individuals. The 99% Confidence Factor was 66/24.6 = 2.68. Average WDM take within each county were multiplied by the 99% Confidence Factor to generate the Proposed Project Maximum Lethal Take Estimate for each county (Table 3-42).

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[116] Average includes activities that both intentionally and unintentionally affect American badger and all potential methods used by WS-California.

[117] Data for calculating the 99% Confidence Factor includes 10-year averages for all counties, regardless of the number of years those counties had CSAs with WS-California. These averages are not as accurate as the numbers in Table 3-42. This small amount of error was accepted for this calculation.

3.4.11.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of American badger under the Proposed Project is likely to be similar to the total take estimated above on average; however, due to annual variations in WDM, some years might have higher take than others. The total Proposed Project Maximum Lethal Take Estimate is 148 badgers taken annually, which represents 0.2% of the population. The statewide modeled low population estimate for this species is approximately 74,683 individuals (Appendix C1). The population estimate for each county is provided in Table 3-42. The Proposed Project Maximum Lethal Take Estimate by county ranges from 0% (0 individuals of 2 estimated county population; San Francisco County) to 3.5%[118] (62 individuals of 1,755 estimated county population; Siskiyou County). These numbers, which are all well below the sustainable harvest threshold of 10% of the estimated county populations. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to this total annual average of lethal take of 101. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 101 individuals. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Badgers are considered mesopredators (Prugh *et al.* 2009) that are highly specialized burrowing, carnivorous mammals that help control small mammal populations (CWHR 2022). Mesopredators can fulfill an important role in ecosystem function, structure, and dynamics (Roemer *et al.* 2009). Indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to American badger, are not anticipated because to the percentage of American badgers killed under the Project in a maximum take scenario would be below the sustainable harvest threshold of 10% regionally (ranging from <0.01% to 3.5% of estimated county populations, statewide (0.25% of the estimated statewide population), and cumulatively (4.1% of the estimated statewide population).

3.4.11.3 Potential Beneficial Effects of Wildlife Damage Management to Natural Resources

The WS-California MIS baseline data (2010–2019) have documented American badger predation on the federally listed desert tortoise in San Bernardino County. Evidence of predation on desert tortoise by American badger has been suggested by observations of desert tortoise mortality within the Western Mojave Desert and Joshua Tree National Park (Smith *et al.* 2016; Emblidge *et al.* 2015). Badger has also been documented as predating on sage grouse nests in Oregon (Batterson and Morse 1948), and it likely that badgers in sagebrush habitats of California also predate on this species. Removal of this species under WDM activities could result in a net benefit to native prey species populations (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.4.11.4 Cumulative Effects to the Species

Cumulative (i.e., total) anthropogenic mortality was estimated from all potential causes, including vehicle collisions (roadkill), legal hunting and trapping, and various other sources (e.g., illegal harvest, accidental poisoning). These

[118] Based on 2012-2019 data only for Siskiyou County.

are analyzed below. Cumulative anthropogenic mortality was calculated by adding all of these other sources to maximum lethal WDM under the Proposed Project and rounding this number up to the next integer (Table 3-42).

American badger cannot be commercially or recreationally trapped for fur in most or all cases (California AB 273, 09/04/2019). No hunter harvest data were found for badger, but we analyzed trapping harvest of badgers during the analysis period (2010 through 2019; excluding 2020 and 2021 data which are potentially confounded by behavioral changes due to COVID-19). Badger trapping harvest appears to be decreasing among these years, especially after the fur trapping ban (AB 273) took effect in 2019. However, to be conservative we will use the average from the 2010-2019 baseline period to estimate future trapping harvest. The 10-year average statewide was 8.1 badgers per year, and averages varied by county from zero (numerous counties) to 2.2 per year (Butte County) (CDFW 2020). As a percentage of the estimated badger population in Butte County, this equates to 0.5%. These averages statewide and by county were added to all other known and estimated anthropogenic mortality to estimate cumulative anthropogenic mortality.

Collisions with vehicles (roadkill) might be a large anthropogenic mortality factor for badger, with estimates of up to 25% annual mortality reported from some badger populations near major highways (Klafki 2014). This level of mortality exceeds the sustainable harvest threshold (10%), but did not impact the population, which was reported to be “stable to increasing” (Klafki 2014). Roadkill mortality is not likely to occur at this level statewide in California, and even this level appears to be sustainable. The number of badgers killed by vehicle collisions in California is unknown; we found no quantitative data on this source of mortality. The California Roadkill Observation System (CROS 2023) contains these data but the entity that owns the data asserts that they are proprietary. Therefore, we estimated badger mortality from vehicle collisions. Roadkill data from the California Department of Transportation (Caltrans) were not available but data from the Colorado Department of Transportation are readily available, so we analyzed those data. Badger roadkill mortality during Calendar Year 2015-2019 averaged 23 per year (CDOT 2022), which is 0.045% of the estimated American badger population in Colorado (USDA 2019). These data are limited to roadkills known by the Colorado Department of Transportation, which might not be inclusive of all badgers killed by vehicle collisions. As such, this number might underestimate badger mortality from this source. However, the only other source we are aware of is the “up to 25%” roadkill mortality for badgers at the northern end of their range in Canada (Klafki 2014). These estimates vary by a factor of more than 500, and the badger roadkill mortality in California likely like somewhere in between these extremes. The geometric mean[119] of these two extremes is 1.06%. The highest roadkill estimates for which we found reliable data were for mule deer (CDOT 2016, 2017, 2018, 2019, and 2020) (Section 3.2.23) and mountain lion (Section 3.2.24), and both are approximately 1% of the respective population. To be the most conservative, we used the highest percentage we calculated among all species and methods: 1.2% of the population (see Section 3.2.24).

The final source of anthropogenic mortality we estimated was more general: other anthropogenic mortality, which includes illegal harvest (poaching), accidental poisoning, and other unknown sources of intentional and unintentional mortality. Because there are so many unknowns in this category, we used the highest estimate of this “other” mortality, which was 2.6% for mountain lion (Section 3.2.24) as a conservative estimate.

Cumulative anthropogenic mortality is estimated at 2,995 individuals statewide (4.0% of the statewide population). Maximum lethal WDM under the Proposed Project would contribute 4.9% of that cumulative mortality (148 of 2,995 individuals; Table 3-42). At the county level, cumulative mortality ranged from 3.8% to 7.4% of the county populations.

[119] The geometric mean of two numbers is the square root of their product. Geometric mean is often used with numbers which differ by orders of magnitude instead of using the arithmetic mean (i.e., the average), which is more appropriate for numbers which do not differ by orders of magnitude.

The lowest cumulative mortality estimates are equal to the estimated roadkill and “other” mortality estimates, equaling 3.8% of the population. The highest cumulative mortality under the Proposed Project is in San Bernardino County, which includes up to 525 badgers or 4.0% of the population. Maximum lethal WDM under the Proposed Project would contribute only 5.0% of that cumulative mortality (26 of 525 individuals; Table 3-42). The highest cumulative mortality as a percentage of the population is in Siskiyou County: 129 individuals or 7.4% of the population. This county also has the highest estimate of maximum lethal WDM under the Proposed Project, which would contribute 48% of that cumulative mortality (62 of 129 individuals; Table 3-42). All of these numbers are well below the conservative cumulative threshold of 10% (Banci and Proulx 1999).

Future WDM activities under the Proposed Project might expand to include WDM by USDA and/or counties in counties without a current county-led WDM program, depending on the Alternative chosen. However, we estimated the likely WDM take in these counties, and any future expansion of federal, state, or county involvement in WDM under the Proposed Project is not expected to exceed the estimates provided in this Report. Future WDM activities are expected to provide the same services as those occurring under baseline conditions; no changes are proposed that would significantly increase the number of American badger individuals lethally taken at any level. Future WDM under the Proposed Project would not affect badger habitat, restrict badger range, or add to any mortality in American badger populations beyond sustainable levels statewide or within any county.

Table 3-42. Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide for American Badger.

County	County-Based		T&E Species Protection		Airports		Total Lethal WDM				Maximum Cumulative Anthropogenic Mortality Estimate	Low Population Estimate[2]	Proposed Project Max Lethal Take Estimate of Population (%)	Proposed Project Max Cumulative Lethal Take Estimate of Population (%)
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Average Lethal Take Total	Proposed Project Max Lethal Take Estimate1				
ALAMEDA	0	0.2	0	0	0	0	0	0.2	0.2	1	10	213	0.5%	4.7%
ALPINE	0	0.2	0	0	0	0	0	0.2	0.2	1	13	307	0.3%	4.2%
AMADOR	0	0.2	0	0	0	0	0	0.2	0.2	1	10	213	0.5%	4.7%
BUTTE	0	0.3	0	0	0	0	0	0.3	0.3	1	21	459	0.2%	4.6%
CALAVERAS	0	0.3	0	0	0	0	0	0.3	0.3	1	15	361	0.3%	4.2%
COLUSA	0	0.3	0	0	0	0	0	0.3	0.3	1	19	468	0.2%	4.1%
CONTRA COSTA	0	0.2	0	0	0	0	0	0.2	0.2	1	11	254	0.4%	4.3%
DEL NORTE	0	0.2	0	0	0	0	0	0.2	0.2	1	4	59	1.7%	6.8%
EL DORADO	0	0.3	0	0	0	0	0	0.3	0.3	1	15	361	0.3%	4.2%
FRESNO	0	2.2	0	0	0	0	0	2.2	2.2	6	122	3,035	0.2%	4.0%
GLENN	0	0.5	0	0	0	0	0	0.5	0.5	2	27	632	0.3%	4.3%
HUMBOLDT	0	0.3	0	0	0	0	0	0.3	0.3	1	18	430	0.2%	4.2%
IMPERIAL	0.2	0	0	0	0	0	0.2	0	0.2	1	107	2,765	<0.1%	3.9%
INYO	0	5.0	0	0	0	0	0	5.0	5.0	14	276	6,876	0.2%	4.0%
KERN	0.2	0	0	0	0	0	0.2	0	0.2	1	186	4,846	<0.1%	3.8%
KINGS	0	0.7	0	0	0	0	0	0.7	0.7	2	36	887	0.2%	4.1%
LAKE	0	0.4	0	0	0	0	0	0.4	0.4	1	20	487	0.2%	4.1%
LASSEN	2.1	0	0	0	0	0	2.1	0	2.1	6	101	2,478	0.2%	4.1%
LOS ANGELES	0	1.3	0	0	0	0	0	1.3	1.3	4	71	1,753	0.2%	4.1%
MADERA	0.2	0	0	0	0	0	0.2	0	0.2	1	40	1,023	0.1%	3.9%
MARIN	0	0.1	0	0	0	0	0	0.1	0.1	1	9	197	0.5%	4.6%
MARIPOSA	0	0.4	0	0	0	0	0	0.4	0.4	2	23	535	0.4%	4.3%
MENDOCINO	0	0.4	0	0	0	0	0	0.4	0.4	2	24	555	0.4%	4.3%
MERCED	0	0.9	0	0	0	0	0	0.9	0.9	3	48	1,162	0.3%	4.1%
MODOC	0.2	0	0	0	0	0	0.2	0	0.2	1	90	2,272	<0.1%	4.0%
MONO	0	1.4	0	0	0	0	0	1.4	1.4	4	76	1,865	0.2%	4.1%
MONTEREY	0	1.3	0	0	0	0	0	1.3	1.3	4	70	1,724	0.2%	4.1%
NAPA	0.4	0	0	0	0	0	0.4	0	0.4	2	13	284	0.7%	4.6%
NEVADA	0	0.1	0	0	0	0	0	0.1	0.1	1	9	193	0.5%	4.7%
ORANGE	0	0.2	0	0	0	0	0	0.2	0.2	1	10	216	0.5%	4.6%
PLACER[3]	0	0.2	0	0	0	0	0	0.2	0.2	1	12	283	0.4%	4.2%
PLUMAS	0.5	0	0	0	0	0	0.5	0	0.5	2	23	535	0.4%	4.3%
RIVERSIDE	0	3.2	0	0	0	0	0	3.2	3.2	9	175	4,343	0.2%	4.0%
SACRAMENTO	0	0.3	0	0	0	0	0	0.3	0.3	1	16	394	0.3%	4.1%
SAN BENITO[4]	0	0.6	0	0	0	0	0	0.6	0.6	2	33	800	0.3%	4.1%
SAN BERNARDINO	0.1	9.6	0	0	0	0	0.1	9.6	9.7	26	525	13,066	0.2%	4.0%
SAN DIEGO	0	1.7	0	0	0	0	0	1.7	1.7	5	92	2,278	0.2%	4.0%

Table 3-42. Annual Average Lethal Wildlife Damage Management under the Proposed Project and Cumulative Mortality Estimates by County and Statewide for American Badger.

County	County-Based		T&E Species Protection		Airports		Total Lethal WDM				Maximum Cumulative Anthropogenic Mortality Estimate	Low Population Estimate[2]	Proposed Project Max Lethal Take Estimate of Population (%)	Proposed Project Max Cumulative Lethal Take Estimate of Population (%)
	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	WS Lethal Take	Non-WS Lethal Take Estimate	Average Lethal Take Total	Proposed Project Max Lethal Take Estimate1				
SAN FRANCISCO[7]	0	0	0	0	0	0	0	0	0	0	0	2	0%	3.8%
SAN JOAQUIN	0	0.6	0	0	0	0	0	0.6	0.6	2	33	808	0.3%	4.1%
SAN LUIS OBISPO	0.1	0	0	0	0	0	0.1	0	0.1	1	76	1,958	<0.1%	3.9%
SAN MATEO	0	0.1	0	0	0	0	0	0.1	0.1	1	6	113	0.9%	5.3%
SANTA BARBARA	0	1.1	0	0	0	0	0	1.1	1.1	3	64	1,556	0.3%	4.1%
SANTA CLARA	0	0.3	0	0	0	0	0	0.3	0.3	1	16	372	0.3%	4.3%
SANTA CRUZ	0	0.1	0	0	0	0	0	0.1	0.1	1	4	73	1.4%	5.5%
SHASTA	0	0.7	0	0	0	0	0	0.7	0.7	2	39	967	0.2%	4.0%
SIERRA	0	0.2	0	0	0	0	0	0.2	0.2	1	10	235	0.4%	4.3%
SISKIYOU[5]	22.8	0	0	0	0	0	22.8	0	22.8	62	129	1,755	3.5%	7.4%
SOLANO	0	0.3	0	0	0	0	0	0.3	0.3	1	17	404	0.3%	4.2%
SONOMA[6]	0.3	0	0	0	0	0	0.3	0	0.3	1	19	466	0.2%	4.1%
STANISLAUS	0	0.6	0	0	0	0	0	0.6	0.6	2	35	867	0.2%	4.0%
SUTTER	0	0.2	0	0	0	0	0	0.2	0.2	1	10	227	0.4%	4.4%
TEHAMA	0	0.9	0	0	0	0	0	0.9	0.9	3	50	1,219	0.3%	4.1%
TRINITY	0	0.3	0	0	0	0	0	0.3	0.3	1	17	402	0.3%	4.2%
TULARE	0	1.6	0	0	0	0	0	1.6	1.6	5	89	2,198	0.2%	4.0%
TUOLUMNE	0	0.5	0	0	0	0	0	0.5	0.5	2	29	695	0.3%	4.2%
VENTURA	0	0.7	0	0	0	0	0	0.7	0.7	2	41	1,013	0.2%	4.0%
YOLO	0	0.4	0	0	0	0	0	0.4	0.4	2	23	536	0.4%	4.3%
YUBA	0	0.2	0	0	0	0	0	0.2	0.2	1	10	211	0.5%	4.7%
Total	**27.1**	**41.8**	**0**	**0**	**0**	**0**	**27.1**	**41.8**	**68.9**	**184**	**3,031**	**74,683**	**0.3%**	**4.1%**

Notes: USDA = United States Department of Agriculture; T&E = threatened and endangered; MIS = Management Information System; 0 = no MIS management occurred during the 10-year baseline period.
Totals may not sum due to rounding.
1 Refer to Section 3.4.12.1 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C1. The lower population estimate described in Appendix C1 is used here to provide the most conservative impact analysis.
3 Placer County averages includes calendar years 2010 through 2015 only (six years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
4 San Benito County averages includes calendar years 2010 through 2012 only (three years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
5 Siskiyou County averages includes calendar years 2010 through 2018 only (nine years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
6 Sonoma County averages includes calendar years 2010 through 2013 only (four years of the 10-year analysis period) because these were the only years during the analysis period for which WS-California had a CSA with this county for wildlife damage management.
7 Estimated cumulative take in San Francisco County was 0.03 individuals. Due to the low population estimate in this county and the resulting low cumulative take estimate, we rounded this number down rather than up for the maximum cumulative mortality estimate.

3.4.12 Mountain Lion

Mountain lion is a widespread uncommon permanent resident of California, ranging from sea level to alpine meadows, that is found in all habitats except some xeric regions of the Mojave and Colorado deserts that do not support mule deer populations. Mountain lion is a specially protected carnivorous mammal under the California Wildlife Protection Act of 1990 and a state candidate species. The California Wildlife Protection Act of 1990 (Proposition 117) classified the mountain lion as a "specially protected mammal." The act prohibited CDFW from developing hunting seasons or take limits for the species and only provides three exemptions to take prohibitions: (1) if a depredation permit is issued due to lion-caused livestock or pet mortality, (2) for public safety, or (3) to protect ESA-listed bighorn sheep. All mountain lion WDM take under the Proposed Project is consistent with the California Wildlife Protection Act of 1990 (Proposition 117) and the exemptions provided therein.

In April 2020, the California Fish and Game Commission found that the Center for Biological Diversity and the Mountain Lion Foundation (2019) Petition to List the Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions as Threatened under the California Endangered Species Act (CESA) (referred to in this Report as the Petition) warranted additional study. Therefore, mountain lion is currently a candidate species for listing in the following counties: Alameda, Contra Costa, Imperial, Los Angeles, Monterey, Orange, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, and Ventura. It should be noted that boundary for the Southern California/Central Coast Evolutionarily Significant Unit also includes small, western portions of inland counties or the southern portions of northern coastal counties (i.e., Fresno, Kern, Kings, Marin, Merced, Sacramento, San Francisco, San Joaquin, Solano, Stanislaus, and Yolo), which according to Figure ES-1 in the Petition are mainly comprised of lower probability areas. The higher probability areas shown on Figure ES-1 of the Petition are located within the south and central coastal areas. Therefore, only mountain lions occurring in the south and central coastal counties listed above are considered candidate species locations for the purpose of this analysis. The precise boundaries will be determined by the State of California if the species becomes listed under CESA.

Under the CESA, a candidate species receives the same protections as a state threatened species. Lethal take of mountain lions in these candidate counties during the analysis period (CY 2010-2019) occurred before April 2020 when the California Fish and Game Commission granted candidate status there. Future lethal take of mountain lion in these candidate counties is dependent on the outcome of the additional study and determination by the State of California regarding the listing of mountain lion under CESA.

Because the scope of future WDM for mountain lion in candidate counties depends on this listing decision, we provide estimated maximum take of mountain lion under the Proposed Project in these counties under two scenarios: (1) the species becomes listed under CESA, and (2) the species does not become listed under CESA. In scenario 2, future WDM for mountain lion under the Proposed Project would continue based on the information presented in Section 3.2.24. In scenario 1, lethal take of mountain lion under the Proposed Project would not be conducted by the CDFA or the counties; however, WS-California might occasionally lethally take a mountain lion if they determine it to be a threat to federally listed species or human health and safety. Lethal take under the Proposed Project under both scenarios is presented in Table 3-43 and Table 3-44. Refer to Section 3.2.24 for the statewide analysis of mountain lion WDM.

CDFW considers most mountain lion populations to be relatively stable in California (CDFW 2023d). However, in 2014, CDFW began implementing a statewide mountain lion study to determine the status, relative abundance, and population densities across California (CDFW 2023d). Ongoing monitoring of localized trends, data collection and analysis is being conducted statewide to derive a baseline population estimate (CDFW 2023d). The population estimate for this species in these candidate counties is approximately 1,454 individuals based on the CDFW habitat modeling for mountain lion provided in Appendix C27, and the population estimate for each county is also provided in Table 3-43 and Table 3-44.

3.4.12.1 Previous Wildlife Damage Management

Previous WDM for mountain lion was analyzed in Section 3.2.24 which includes WDM in candidate counties. Under previous WS-California efforts, lethal WDM activities affected on average approximately 9.0 individuals per year within candidate counties based on the WS-California MIS data from Calendar Years 2010 to 2019.[120]

Lethal WDM estimates for mountain lion (i.e., non-MIS estimates) for each county, including non-candidate counties are provided in Table 3-25 (Section 3.2.24). An estimate for each Project component (county-based, T&E species protection, and airport WHM) is provided for each county based on the methods described in Section 2.4. The non-MIS estimates for lethal WDM of mountain lions in candidate counties totals 12.5 individuals per year during 2010-2019 (i.e., before candidate status was provided in these counties (Table 3-43).

The population estimate for this species in candidate counties is approximately 1,454 individuals based on the CDFW habitat modeling for mountain lion provided in Appendix C27. The population estimate for each county is provided in Table 3-25, and the estimates specifically for candidate counties are also provided in Table 3-43. Approximately 1.91% (13.0 individuals) of the special-status population was affected by lethal WDM activities annually. Refer to Chapter 6 of this Report for a discussion of substantial effects for this species.

Estimates for lethal WDM conducted by individuals or entities other than WS-California (non-WS lethal take) were calculated for each Proposed Project component (county-based, T&E species protection, and airport WHM) and by county (Table 3-25) according to the methods outlined in Section 2.4. During the 10-year baseline period, lethal take of mountain lion in candidate counties is estimated at 21.5 individuals annually. This total is comprised of the WS-California lethal take of 9.0 individuals per year and the non-WS-California estimates for lethal take of 12.5 individuals per year (Table 3-25 and Table 3-43). These estimates of WDM take were used to estimate cumulative take as well as county-level WDM take for counties without WS-California MIS data. The statewide modeled low population estimate for this species in candidate counties is approximately 1,454 individuals. The population estimates for each county are provided in Table 3-25, and the estimates for each candidate county are also provided in Table 3-43 and Table 3-44. Approximately 1.48% of the population in candidate counties was affected by lethal WDM activities annually.

These data pre-date the candidate status of the species in these counties. Lethal take after the species received candidate status in these counties would have been much lower, but the analysis period we used pre-dated candidate status. After candidate status, non-WS-California take would be estimated at zero in these counties (rather than 12.5 as above), and WS-California lethal take would be estimated at a maximum of half of the take analyzed above (T. Felix, pers. comm. 2022e): 4.5 individuals. As such, our analysis of previous lethal WDM for mountain lion in these candidate counties is not indicative of likely future mountain lion WDM. This analysis of previous WDM is provided for consistency and transparency.

3.4.12.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM take of mountain lion in candidate counties under the Proposed Project is likely to be much lower than the total take estimated above on average, and the estimates depend on whether the State of California decides to list the species under CESA. The estimates below consider the two likely scenarios: (1) mountain lions become state listed under CESA, and (2) mountain lions do not become state listed under CESA. Due to annual variations in WDM, some years might have higher take than others, but due to changes in mountain lion management by

[120] Average includes activities that both intentionally and unintentionally affect mountain lion and all potential methods used during WDM activities.

CDFW, future take is likely to be at most half of previous take regardless of which scenario occurs (T. Felix, pers. comm. 2022e).

Scenario 1: Mountain Lion is listed under CESA:

Under this scenario mountain lions would not be lethally taken for WDM by the CDFA or the several counties where mountain lion becomes listed. WS-California might occasionally lethally take a mountain lion in these counties for federal T&E species protection or human health and safety. The total Proposed Project Maximum Lethal Take Estimate for the 16 candidate counties is 1.6 mountain lions (0.11% of the population) and consists of 0.1 mountain lion per county (i.e., one mountain lion in 10 years; 0.05% to 0.67% of the county populations). These numbers are provided by county in Table 3-43.

Table 3-43. Lethal Take of Mountain Lion under the Proposed Project in Candidate Counties if the Species Becomes State Listed

County	Proposed Project Maximum Lethal Take Estimate[1]	Proposed Project Maximum Cumulative Anthropogenic Mortality	Population Estimate[2]	Proposed Project Maximum Lethal Take % of Population	Proposed Project Maximum Cumulative Anthropogenic Mortality % of Population
ALAMEDA	0.1	1.1	31	0.3%	3.6%
CONTRA COSTA	0.1	0.9	27	0.4%	3.3%
IMPERIAL	0.1	0.6	18	0.6%	3.2%
LOS ANGELES	0.1	3.7	113	0.1%	3.3%
MONTEREY	0.1	6.2	190	0.1%	3.3%
ORANGE	0.1	0.8	21	0.5%	3.6%
RIVERSIDE	0.1	4.6	142	0.1%	3.3%
SAN BENITO	0.1	2.9	88	0.1%	3.3%
SAN BERNARDINO	0.1	3.3	99	0.1%	3.3%
SAN DIEGO	0.1	5.9	180	0.1%	3.3%
SAN LUIS OBISPO	0.1	6.5	199	0.1%	3.3%
SAN MATEO	0.1	0.6	15	0.7%	3.9%
SANTA BARBARA	0.1	5.0	154	0.1%	3.3%
SANTA CLARA	0.1	2.1	63	0.2%	3.4%
SANTA CRUZ	0.1	0.6	17	0.6%	3.8%
VENTURA	0.1	3.2	97	0.1%	3.3%
Total	**1.6**	**48**	**1,454**	**0.1%**	**3.3%**

Note: Totals may not equal sum of county numbers due to rounding.
1 Refer to Section 3.4.13.2 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C27. The lower population estimate described in Appendix C27 is used here to provide the most conservative effects analysis.

Scenario 2: Mountain Lion is *not* listed under CESA:

Under this scenario mountain lions would continue to be lethally taken for WDM in the several counties where mountain lion was previously a candidate species. Lethal take under the Proposed Project would be as analyzed in

Section 3.2.24. The total Proposed Project Maximum Lethal Take Estimate for the 16 candidate counties is 11.4 mountain lions (0.77% of the population), and ranges from zero to 1.6 by county (zero to 1.43% of the county populations). These numbers are provided by county in Table 3-44. These numbers represent the highest take expected under the Proposed Project in any year. The Proposed Project is not expected to reach this level of take in most years.

WS-California take might increase as a percentage of this take due to increases in the number of CSA Counties (i.e., those with contracts with WS-California to conduct WDM), up to the Proposed Project Maximum Lethal Take Estimate for the 16 candidate counties of 11.4 individuals. The proportion of take associated with county- and CDFA-directed programs also might increase, up to a maximum annual average of the total lethal take of 11.4 individuals. These changes depend upon the Alternative chosen by the Agencies, which is outside the scope of this Report. These potential differences will be discussed in the EIR/EIS.

Table 3-44. Lethal Take of Mountain Lion under the Proposed Project in Candidate Counties if the Species Does Not Become State Listed

County	Proposed Project Maximum Lethal Take Estimate[1]	Proposed Project Maximum Cumulative Anthropogenic Mortality	Population Estimate[2]	Proposed Project Maximum Lethal Take % of Population	Proposed Project Maximum Cumulative Anthropogenic Mortality % of Population
ALAMEDA	0.4	1.4	31	1.3%	4.5%
CONTRA COSTA	0.1	0.9	27	0%	3.2%
IMPERIAL	0.1	0.6	18	0%	3.2%
LOS ANGELES	1.3	4.9	113	1.2%	4.3%
MONTEREY	0.7	6.7	190	0.4%	3.5%
ORANGE	0.3	0.9	21	1.4%	4.3%
RIVERSIDE	1.6	6.1	142	1.1%	4.3%
SAN BENITO	0.4	3.2	88	0.5%	3.6%
SAN BERNARDINO	1.1	4.3	99	1.1%	4.3%
SAN DIEGO	1.2	6.9	180	0.7%	3.8%
SAN LUIS OBISPO	1.6	7.9	199	0.8%	4.0%
SAN MATEO	0.2	0.6	15	1.3%	4.0%
SANTA BARBARA	0.4	5.3	154	0.3%	3.4%
SANTA CLARA	0.7	2.7	63	1.1%	4.3%
SANTA CRUZ	0.2	0.7	17	1.2%	4.1%
VENTURA	1.1	4.2	97	1.1%	4.3%
Total	**11.4**	**57.3**	**1,454**	**0.8%**	**3.9%**

Note: Totals may not equal sum of county numbers due to rounding.
1 Refer to Section 3.4.13.2 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.
2 A population estimate is provided for each county based on the methods described in detail in Appendix C27. The lower population estimate described in Appendix C27 is used here to provide the most conservative effects analysis.

Mountain lion is considered to be an apex predator and a keystone species (Prugh *et al.* 2009). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes *et al.* 2011). Large-scale or complete removal of apex predators from an ecosystem has the potential to result in trophic cascade and mesopredator release (Ritchie and Johnson 2009; Estes *et al.* 2011; Miller *et al.* 2012; Wallach *et al.* 2015). Mountain lions compete with other California predators, bobcats, coyotes, black bears, and wolverines, though they prey primarily on mule deer, which limits competition with most small and medium-sized predators (CWHR 2022). They are also considered to be subordinate competitors to wolves and black bears (Elbroch and Kulster 2018) but can predate on coyotes (CWHR 2022). They have the ability to affect populations of some ungulates like bighorn sheep (CDFW 2022c; USFWS 2000). High species diversity of apex predators, mesopredators, and prey species in an ecosystem can make the mesopredator release less likely to occur (Brashares *et al.* 2010).

The complex social system of mountain lions responds differently to large-scale removal of individuals depending on the amount of habitat available, seasonal timing of removal, and the sex and age of the population that is removed (Logan 2019). Therefore, indirect impacts to ecosystem function, structure, or dynamics, resulting from the Project's lethal impacts to mountain lion, are not anticipated due to the percentage of mountain lions impacted by the Project regionally and statewide is less than 1.5%, and cumulative mortality is less than 4% statewide for the candidate mountain lion populations.

3.4.12.3 Potential Adverse Effects of Wildlife Damage Management

<u>Scenario 1: Mountain Lion is listed under CESA:</u>

In this scenario, lethal mountain lion take under the Proposed Project is expected to be extremely low compared to the population statewide and in each county, based on the analysis above: 0.11% statewide with a maximum of 0.67% in any county. These numbers represent maximum take; most years would be lower. All anticipated take would be for the protection of human safety. All anticipated WDM mountain lion take under the Proposed Project is well below the 11% harvest threshold for mountain lion. If CDFW finds cause to list mountain lion under CESA in these counties it is likely that almost any level of take has the potential to impact the population.

<u>Scenario 2: Mountain Lion is *not* listed under CESA:</u>

In this scenario, lethal mountain lion take under the Proposed Project is expected to be very low compared to the population statewide and in each county, based on the analysis above: 0.77% statewide with a maximum of 1.43% in any county. All anticipated WDM mountain lion take under the Proposed Project is well below the 11% harvest threshold for mountain lion.

3.4.12.4 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) have documented mountain lion predation to the federally listed species Sierra Nevada bighorn sheep. According to the Sierra Nevada Bighorn Sheep Recovery Program – Predator Monitoring and Management (CDFW 2022c), predation by mountain lions can have a substantial effect on isolated populations of Sierra Nevada bighorn sheep. They also are known to have substantial effects on other populations of desert bighorn sheep, including the endangered peninsular (USFWS 2000). Therefore, removal of mountain lions under for WDM could result in a net benefit to threatened and endangered species populations (e.g., increased survival rates) regardless of whether they were the intended beneficiary.

3.4.12.5 Potential Cumulative Effects to the Species

Refer to Section 3.2.24.4 for a general discussion of cumulative effects to mountain lions throughout California. The Proposed Project would not affect habitat, so it would not contribute to habitat loss. However, there is a potential for lethal WDM to add to other losses and threats. Other anthropogenic mortality for mountain lion consists of illegal harvest, secondary poisoning, and vehicle collisions. These were evaluated in Section 3.2.24 to represent losses of approximately 3.2% of the mountain lion population annually. Cumulative anthropogenic mortality includes these losses as well as lethal WDM.

<u>Scenario 1: Mountain Lion is listed under CESA:</u>

Cumulative mortality under the Proposed Project is estimated at 3.30% of the population in this scenario. Lethal WDM would be responsible for 0.1% (3%) of that 3.30% mortality (Table 3-43). In other words, lethal WDM under the Proposed Project would add a small amount (3%) to the low cumulative mortality of mountain lions, whose population would generally be expected to be increasing due to the low level of harvest (i.e., well below the threshold of 11%). However, if mountain lions become state-listed in this area, the decision to list this population is a likely indication that these other mortality factors and threats to survival are higher in this population than in other more stable mountain lion populations, and that the population might be declining. Small incremental additional losses like those from lethal WDM might have a higher potential for impacting such populations. The specific determinations regarding the mountain lion population in southern California (i.e., population growth status, annual mortality, annual fecundity, available habitat, and carrying capacity) would be useful in assessing the likelihood of such an impact.

<u>Scenario 2: Mountain Lion is *not* listed under CESA:</u>

Cumulative mortality under the Proposed Project is estimated at 3.9% of the population in this scenario. Lethal WDM would be responsible for 0.77% (19.7%) of that 3.9% mortality (Table 3-44). In other words, lethal WDM under the Proposed Project would add a moderate amount (19.7%) to the low cumulative mortality of mountain lions, whose population would be expected to be increasing due to the low level of harvest (i.e., well below the threshold of 11%). If the State of California decides not to list mountain lions in this area, that decision is a likely indication that the mountain lion population in southern California is either stable or increasing, and not likely in jeopardy from these other mortality factors and threats to survival. Even moderate incremental additional losses like those from lethal WDM might would be expected to have a low potential for impacting such populations as long as cumulative harvest does not exceed the 11% threshold. In this scenario cumulative mortality would be well below that threshold.

3.4.13 Ringtail

Ringtail is a CDFW Fully Protected, primarily carnivorous mammal that occurs in various riparian habitats and in brush stands of most forest and shrub habitats, at low to mid elevations (CDFW 2022a; CWHR 2022). Its diet consists mainly of woodrats, mice, rabbits, birds and eggs, reptiles, invertebrates, some carrion, fruits, and nuts. This widely distributed, common to uncommon permanent resident is usually not found more than 1 kilometer from permanent water (CWHR 2022). Ringtail is considered a species of “Least Concern” by IUCN, though their global population trend is unknown (IUCN 2022). The statewide modeled population estimate for this species is approximately 389,236 individuals, based on the distribution and occurrence modeling for ringtail provided in Appendix C28.

3.4.13.1 Previous Wildlife Damage Management

WDM for ringtail includes only non-lethal activities (i.e., individuals freed and relocated, and transfer of custody). During the 10-year MIS baseline, an average of 0.6 ringtails were freed, 0.5 individuals were relocated, and 0.1 individual underwent a transfer of custody per year. No lethal WDM of ringtail was recorded in the WS-California MIS data from 2010 to 2019. Therefore, under the current WS-California efforts, non-lethal WDM affected on average approximately 1.2 individuals per year based on the WS-California MIS data from 2010 to 2019.[121]

Because no lethal WDM of ringtail occurred during the analysis period, no lethal WDM estimates (i.e., non-MIS estimates) are provided and county-level analyses are not provided.

The statewide modeled population estimate for this species is approximately 389,236 individuals, based on the distribution and occurrence modeling for ringtail provided in Appendix C28. Therefore, <0.01% of the statewide population was affected by non-lethal WDM activities annually.

3.4.13.2 Estimated Future Wildlife Damage Management under the Proposed Project

Future WDM for ringtail under the Proposed Project is likely to be similar to that analyzed above during the 10-year analysis period: no lethal take is expected and nonlethal WDM is expected to be only occasional. Because no lethal take of ringtail is expected, 0% of the population would be affected. The 99% confidence high WS-California lethal take (average plus 2.58 standard deviations) was not calculated because there was no lethal take during the analysis period.

Ringtail take was not analyzed by county because no lethal take is anticipated under the Proposed Project. Due to the lack of lethal WDM, we did not determine a sustainable harvest threshold for ringtail. Less than 0.01% of the statewide population is expected to be subjected to non-lethal WDM activities annually under the Proposed Project.

3.4.13.3 Potential Beneficial Effects of Wildlife Damage Management

The WS-California MIS baseline data (2010–2019) documented no damage to federal-listed, state-listed, or state Fully Protected species caused by ringtail. Non-lethal WDM for ringtail is not expected to provide beneficial effects for any protected species.

3.4.13.4 Potential Cumulative Effects to the Species

Given their Fully Protected status and the lack of previous lethal WDM, no lethal WDM of ringtail is expected to occur under the Proposed Project, and only limited non-lethal WDM would occur. Therefore, the Proposed Project has no potential to add to any cumulative negative impact on the species.

[121] Average includes activities that both intentionally and unintentionally affect ringtail and all potential methods used during non-lethal WDM activities.

3.5 Statewide Summary of Target Species Take

Table 3-45 includes a statewide summary of the percent of the target mammal species population taken by lethal WDM activities. Table 3-46 includes a statewide summary of the percent of the target bird species population taken by lethal WDM.

Table 3-45. Target Wildlife Species Project Lethal WDM Take Summary

Target Species	State Population (estimate)[1]	Lethal Take (% of State Population)		Cumulative Mortality Estimate (% of State Population)
		Annual Average	Proposed Project Max Take Estimate[2]	
Black bear	20,446	0.7%	1.5%	11.6%
Bobcat	51,088	0.1%	0.4%	4.8%
Coyote	227,394	3.6%	5.6%	24.4%
Gray Fox	240,202	0.1%	0.2%	6.0%
Sacramento Valley Red Fox[2]	228	2.4%	4.0%	12.7%
Long-Tailed Weasel	95,685	<0.1%	<0.1%	3.9%
American Mink	2,383	<0.1%	1.6%	5.0%
Raccoon	2,557,065	0.1%	0.2%	4.0%
River Otter	896	0.4%	1.7%	5.5%
Western Spotted Skunk	497,414	<0.1%	<0.1%	3.8%
Striped Skunk	1,830,939	0.3%	0.4%	4.2%
North American beaver	556,612	0.2%	0.3%	4.1%
North American Porcupine	314,017	<0.1%	<0.1%	3.8%
Yellow-bellied marmot	348,034	<0.1%	<0.1%	5.1%
Big-eared woodrat	44,017,269	<0.1%	<0.1%	3.8%
Dusky-footed woodrat	80,987,432	<0.1%	<0.1%	3.8%
Black-tailed jackrabbit	7,236,205	<0.1%	<0.1%	5.0%
Desert Cottontail Rabbit	25,644,085	0.1%	0.3%	4.3%
Brush rabbit	11,508,386	0.1%	0.3%	4.1%
California ground squirrel	138,496,766	<0.1%	<0.1%	3.8%
Western gray squirrel	6,335,022	<0.1%	0.4%	4.8%
Deer mouse	819,674,844	<0.1%	<0.1%	3.8%
Mule deer	562,237	<0.1%	<0.1%	23.9%
Mountain lion (statewide)	5,062	2.2%	1.1%	4.9%
American badger	74,683	0.1%	0.3%	4.1%
Mountain lion (Candidate counties, if listed)	1,454	1.5%	0.1%	3.3%
Mountain lion (Candidate counties, if not listed)	1,454	1.5%	0.8%	3.9%
Ringtail	389,236	0%	0%	0%

Notes:
1 A population estimate is provided for each species based on the methods described in detail in Appendices C1–C29.
2 Refer to Section 3.2 and 3.4 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.

Table 3-46. Target Bird Species Project Lethal WDM Take Summary

Target Species	State Population1 (est.)	Lethal Take (individuals)		Cumulative Mortality Estimate (% of State Population)
		Annual Average	Proposed Project Max Take Estimate[2]	
American crow	480,000	722.6	1,418	0.3%
Common raven	330,000	494.2	742	0.2%
California scrub jay	1,200,000	112.8	113	<0.01%
Red-tailed hawk	230,000	296.7	594	0.3%
Ferruginous hawk	220	3.6	10	4.5%
Barn owl	24,000	15.2	35	0.2%
Red-winged blackbird	14,000,000	12,891.3	37,127	0.3%
Brewer’s blackbird	4,200,000	6,920.5	22,146	0.5%
Yellow-headed blackbird	530,000	355.9	1,762	0.3%
Canada goose	51,148	433.8	781	0.5%
California gull	112,601	277.2	610	0.5%
Black-crowned night heron	15,740	29.0	70	0.4%
Acorn woodpecker	1,900,000	491.1	492	0.03%
Northern flicker	430,000	581.4	582	0.1%
Tricolored blackbird	210,042	0	0	0%
Sandhill crane	41,788	0	0	0%
Bald eagle	10,953	0	0	0%
Golden eagle	3,801	0	0	0%
Northern harrier	24,000	0	0	0%
Swainson’s hawk	44,000	0	0	0%
White-tailed kite	9,700	0	0	0%
California brown pelican	6,481	0	0	0%
Western snowy plover	1,738	0	0	0%
California least tern	8,190	0	0	0%

Notes:

1 Statewide population estimates from Appendices C1–C29.

2 Refer to Section 3.3 and 3.4 for how the Proposed Project Max Annual Lethal Take Estimate was calculated.

4 Non-Target Species Impact Analyses

4.1 Non-Target Capture

WS-California captured 65 different non-target species during WDM during the analysis period (CY 2010-2019), with an average of 257.4 individuals unintentionally captured per year. Most of these species (51 of 65 species were also target species during other WDM activities. Most non-target capture was non-lethal, resulting in the release of the captured animal, or the transfer to another custody . An average of 249.9 individuals,(97.1% of annual average non-target capture) were associated with this unintentional non-lethal capture annually (Table 4-1). Non-lethal capture of non-target species does not have the potential to impact the populations of these species and was not considered in this Report.

Unintentional lethal non-target take was infrequent, accounting for a total of 7.5 individuals per year, all of which were also target species during other WDM activities. Unintentional lethal non-target take was low, the highest being 1.1 raccoons unintentional lethally taken per year (Table 4-1). This amount of unintentional lethal take was included in total lethal take for these target species in Chapter 3 of this Report. No additional analysis is provided in this Chapter for non-target species because all non-target lethal take was included in the analyses in Chapter 3.

Table 4-1. Average Annual Non-Target Individuals Captured by Wildlife Services in California during Wildlife Damage Management (CY 2010-2019)

Species	Average Non-Target Non-Lethal Capture	Average Non-Target Lethal Take
Amphibians		
American bullfrog	0.3	0
Birds		
Corvids		
Western scrub jay	0.1	0
Common raven	0.2	0
Raptors		
Golden Eagle	0.1	0
Merlin	0.1	0
Cooper's hawk	0.1	0
Peregrine falcon	0	0
Turkey vulture	1.0	0
Granivores		
Red-winged blackbird	0.3	0
Rusty blackbird	0.2	0
Tri-colored blackbird	38.5	0
House finch	0.3	0.2
House sparrow	0.1	0
Savannah sparrow	0.1	0
Song sparrow	0.8	0

Table 4-1. Average Annual Non-Target Individuals Captured by Wildlife Services in California during Wildlife Damage Management (CY 2010-2019)

Species	Average Non-Target Non-Lethal Capture	Average Non-Target Lethal Take
California towhee	0.1	0
Spotted towhee	0.1	0
Insectivores		
Western kingbird	0.1	0
Horned lark	0	0.4
Northern mockingbird	0.2	0
Marsh wren	0.1	0
Upland Game Birds		
Eurasian collared dove (Non-Native)	0.6	0.2
Mourning dove	0.5	0
Wild turkey	0.1	0
Waterfowl		
American coot	0.1	0
Mallard	0.5	0.1
Ring-necked duck	0.4	0
Wood duck	0.2	0
Canada geese	0	0.1
Waterbirds		
American bittern	0.3	0
Western gull	0.1	0
Black-crowned night heron	0.1	0
Killdeer	0.1	0
Invertebrates		
Red swamp crawfish	0.2	0
Mammals		
Badger	0.3	0
Black bear	0.1	0.1
North American beaver	2.4	0
Bobcat	1.8	0
Feral cat	0.8	0
Coyote	1.2	0
Mule deer	0.2	1.0
Feral dog	0.3	0
Domestic animal	0.2	0
Elk	0	0.1
Gray fox	15.1	0.6
Kit fox	0.1	0
Black-tailed jackrabbit	0.2	0.1
Deer mouse	0.9	0.3

Table 4-1. Average Annual Non-Target Individuals Captured by Wildlife Services in California during Wildlife Damage Management (CY 2010-2019)

Species	Average Non-Target Non-Lethal Capture	Average Non-Target Lethal Take
American mink	3.6	0
Muskrat	136.2	1.0
Virginia opossum (Non-Native)	13.4	0.1
River otter	1.9	0.4
Porcupine	0	0.3
Cottontail rabbit	0.2	0.2
Raccoon	16.9	1.1
Black (roof) rat	0	0.1
Norway (brown) rat	0	0.1
Striped skunk	0.3	0.4
California ground squirrel	6.3	0.7
Western gray squirrel	0.4	0
Feral swine (Non-Native)	0	0.1
Voles	0.1	0
Long-tailed weasels	0.1	0
Dusky-footed woodrat	0.7	0
Reptile		
Western diamondback rattlesnake	0.1	0
Slider turtle	0.1	0
Total of Species Listed	**249.9**	**7.5**

5 Summary of Wildlife Damage Management by County

This section summarizes WDM conducted within each California county. All lethal WDM was analyzed in Chapter 3 (target take) and Chapter 4 (non-target take) by species. As described in Section 2.4, all WDM in California has been organized into three categories: Airport WHM, T&E Species Protection, and County-Based WDM. Airport WHM and T&E species protection are conducted by WS-California and to some extent by private industry. These categories are outside of the auspices of the various counties, which, through their association with the CDFA, are charged with protecting California agriculture, including WDM. That WDM conducted at the county level is called County-Based WDM in this Report. As described in Section 1.2, the various counties currently take one of three different approaches to implementing a WDM program: CSAs with WS-California, county-directed programs, and no county-directed program. This Chapter is organized by those approaches. Refer to Section 1.2 for the definitions and descriptions of each.

5.1 Counties with Cooperative Service Agreements (CSAs)

This Chapter focuses on County-Based WDM; that is, the WDM conducted or directed at the county level. This includes current (or recent) WDM and potential future WDM under the Proposed Project. Because of this focus, airport WDM and T&E species protection are both considered "other" WDM and are included under potential cumulative impacts.

5.1.1 Alameda

Baseline WS-California lethal WDM activities for the Alameda County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and 12 mammal species:

> *Birds:* American coot, Canada goose, rock pigeon, and wild turkey
>
> *Mammals:* coyote, gray fox, red fox, mountain lion, deer mouse, Virginia opossum, cottontail, raccoon, black rat, striped skunk, fox squirrel, and feral swine

Several of these species were non-natives and take of those species is not described in this analysis. Others are non-special-status species taken in such low numbers on a statewide and county basis that they are not analyzed further in this document (Table 3-1). County-program take of native species, including some estimates for additional County-level take that is not recorded in the MIS baseline data (e.g., 200 California ground squirrel), are included in Table 5-1. The most common methods used in Alameda County during the baseline period were firearms. Lethal WDM under County programs represent <0.1-4.4% of the estimated populations within the county (or statewide for bird species). Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-1 and 5-2. These take estimates were derived using the methods described for each species in Chapter 3.

In addition to County-Based WDM, other WDM was also conducted in Alameda County by other entities, mostly by WS-California. For purposes of County-level analysis, this other WDM is considered cumulative. During the baseline period, 91% of all WDM activities in Alameda County were non-lethal dispersals occurring at airports. Such non-lethal WDM is not included in Table 5-1 or Table 5-2 because it has no potential to negatively impact the populations of target or non-target species. Protection of threatened and endangered wildlife species (e.g., California least tern and snowy plover) from predation by both mammal and bird species accounted for 2% of all WDM activities occurring within Alameda County. Any non-County-based lethal WDM at airports or for threatened and endangered species protection is included as part of the Proposed Project Max Cumulative Lethal Take Estimate in Table 5-1 and Table 5-2. Other cumulative mortality was quantified as feasible for each target species as described in Chapter 3.

Table 5-1. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Alameda County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	213	0.5%	10	4.7%	10%
Bobcat	0	1	294	0.3%	13	4.4%	17%
Coyote	1.2	2	952	0.2%	184	19.3%	50%
Gray Fox	9.3	19	436	4.4%	43	9.9%	20%
Long-Tailed Weasel	0	1	612	0.2%	24	3.9%	10%
Raccoon	101.8	182	39,342	0.5%	1,832	4.7%	49%
Striped Skunk	87.4	142	12,250	1.2%	1,039	8.5%	10%
Western Spotted Skunk	<0.1	1	3,395	<0.1%	130	3.8%	10%
Dusky-Footed Woodrat	<0.1	10	490,166	<0.1%	18,637	3.8%	60%
Black-Tailed Jackrabbit	312.9	680	35,473	1.9%	2,449	6.9%	20%
Desert Cottontail Rabbit	182.6	470	181,416	0.3%	7,828	4.3%	40%
Brush Rabbit	153	498	152,938	0.3%	6,310	4.1%	40%
California Ground Squirrel	200	302	942,915	<0.1%	37,231	3.9%	40%
Deer Mouse	1,002.2	3,578	4,109,434	0.1%	159,737	3.9%	40%
Mountain Lion	0.8	0.4	31	1.3%	1.6	5.2%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

Table 5-2. County-Program Lethal Take and Cumulative WDM Lethal Take of Target Bird Species Under the Proposed Project in Alameda County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Max Lethal Take Proportion of Statewide WDM Lethal Take	Cumulative WDM Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	103
Common Raven	0	0	330,000	0%	0%	46
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	112
Barn Owl	0	0	24,000	0%	0%	6
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	670
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	390
California Gull	0.1	1	112,601	<0.1%	<0.1%	268
Black-crowned Night Heron	0	0	15,740	0%	0%	34
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: 0 = no County Program WDM occurred during the 10-year baseline period. Totals may not sum due to rounding.
Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.2 Alpine

Baseline WS-California lethal WDM activities for the Alpine County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved seven mammal species:

> *Mammals*: black bear, North American beaver, coyote, mountain lion, yellow-bellied marmot, raccoon, and woodchuck (*Marmota monax*).

Of those, only woodchuck is not analyzed further as noted in Table 3-1. County-program take of native species, including some estimates for additional County-level take that is not recorded in the MIS baseline data (e.g., 1,000 deer mouse, 100 California ground squirrel), are included in Table 5-1 based on USDA expert opinion.

Of all the WDM activities conducted in Alpine County, 73% involved lethal WDM of coyote in response to predation of cattle. The most common method of WDM used in Alpine County during the baseline period was firearms used for lethal WDM of coyotes. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-3 and 5-4. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-3. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Alpine County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	307	0.3%	13	4.2%	10%
Black Bear	1.8	4	201	2.0%	21	10.4%	14.2%
Bobcat	0	1	239	0.4%	10	4.2%	17%
Coyote	24.1	38	1,023	3.7%	230	22.5%	50%
Long-Tailed Weasel	0	1	581	0.2%	23	4.0%	10%
American Mink	<0.01	1	41	2.4%	2	4.9%	25%
Raccoon	0.2	1	9,340	<0.1%	358	3.8%	49%
Striped Skunk	0	1	8,111	<0.1%	313	3.9%	10%
Western spotted Skunk	<0.1	1	2,274	<0.1%	87	3.8%	10%
North American Beaver	3.7	6	6,380	0.1%	248	3.9%	20%
North American Porcupine	0.016	1	3,308	<0.1%	126	3.8%	20%
Yellow-Bellied Marmot	2.4	12	11,967	0.1%	618	5.2%	20%
Black-Tailed Jackrabbit	<0.1	1	3,778	<0.1%	236	6.2%	20%
California Ground Squirrel	100	152	114,130	0.1%	4,492	3.9%	40%
Western Gray Squirrel	50	326	15,590	2.1%	1,026	6.6%	40%
Deer Mouse	1,000	3,570	3,861,530	0.1%	150,309	3.9%	40%
Mountain Lion (not CSA listed)	0.1	0.1	38	0.3%	1.5	3.9%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

Table 5-4. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Alpine County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	0
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	16	4,200,000	<0.1%	0.1%	16
Yellow-headed Blackbird	5	60	530,000	<0.1%	3.4%	60
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	0
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall

2 Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.3 Amador

Baseline WS-California lethal WDM activities for the Amador County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species and 15 mammal species:

Birds: rock pigeon

Mammals: black bear, North American beaver, bobcat, coyote, gray fox, mountain lion, muskrat, Virginia opossum, raccoon, striped skunk, California ground squirrel, and feral swine.

Of those, rock pigeon, muskrat, and feral swine are not analyzed further as noted in Table 3-1. County-program take of native species, including some estimates for additional County-level take that is not recorded in the MIS baseline data (e.g., 1,000 deer mouse), are included in Table 5-5 and 5-6 based on USDA expert opinion.

Of all the WDM activities conducted in Amador County, 72% involved lethal WDM of coyote in response to predation of cattle and lethal WDM of striped skunk in response to damage to structures and predation. The most common methods of WDM used in Amador County during the baseline period were cage traps used for lethal WDM of striped skunks and neck snares used for lethal WDM of coyotes. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-5 and 5-6. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-5. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Amador County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	213	0.5%	10	4.7%	10%
Black Bear	0.7	2	98	2.0%	12	NA	14.2%
Bobcat	0.1	1	204	0.5%	12	5.9%	17%
Coyote	40.6	64	879	7.3%	229	26.1%	50%
Long-tailed Weasel	0	1	502	0.2%	20	4.0%	10%
American Mink	0	1	12	8.3%	1	8.3%	25%
Gray Fox	1.6	4	825	0.5%	50	6.1%	20%
Raccoon	9.1	17	9,280	0.2%	371	4.0%	49%
Striped Skunk	36.4	59	9,150	0.6%	411	4.5%	10%
Western Spotted Skunk	<0.1	1	2,558	0.04%	98	3.8%	10%
North American Beaver	0.3	1	158	0.6%	7	4.4%	20%
North American Porcupine	<0.1	1	2,655	<0.1%	101	3.8%	20%
Yellow-Bellied Marmot	0.2	1	1,790	<0.1%	92	5.1%	20%
Big-Eared Woodrat	<0.1	10	779,427	<0.1%	29,629	3.8%	60%
Black Tailed Jackrabbit	<0.1	1	21,527	<0.1%	6,600	30.7%	20%
Desert Cottontail Rabbit	81.2	209	81,189	0.3%	3,626	4.5%	40%
Brush Rabbit	65.8	214	65,845	0.3%	2,779	4.2%	40%
California Ground Squirrel	204.4	309	724,779	<0.1%	27,855	3.8%	40%
Western Gray Squirrel	50	326	47,936	0.7%	2,476	5.2%	40%
Deer Mouse	1,000	3,570	3,117,150	0.1%	122,022	3.9%	40%
Mountain Lion	1.5	0.8	32	2.3%	2.0	6.1%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–29 are used here to provide the most conservative effects analysis.

Table 5-6. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Amador County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.4 Butte

Baseline WS-California lethal WDM activities for the Butte County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved 9 bird species and 16 mammal species:

Birds: Brewer's blackbird, red-winged blackbird, brown-headed cowbird, American crow, Canada goose, rock pigeon, house sparrow, European starling, and wild turkey.

Mammals: Black bear, North American beaver, bobcat, feral cat, coyote, mule deer/black-tailed deer, gray fox, red fox, mountain lion, muskrat, Virginia opossum, river otter, raccoon, striped skunk, California ground squirrel, and feral swine.

During the baseline period, 46% of the activities conducted within Butte County were for dispersals. The most common methods of WDM used in Butte County during the baseline period were firearms used for dispersal and lethal WDM of birds and cage traps used for both lethal and non-lethal WDM of bird and mammal species. The majority of WDM activities involved the following species: rock pigeons (*Columba livia*), European starlings, brown-headed cowbirds (*Molothrus ater*), striped skunk, and North American beaver. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-7 and 5-8. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-7. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Butte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	459	0.2%	21	4.6%	10%
Black Bear	5.7	12	241	5.0%	60	24.9%	14.2%
Bobcat	0.3	1	564	0.2%	26	4.6%	17%
Coyote	10.8	17	2,381	0.7%	466	19.6%	50%
Long-Tailed Weasel	<0.1	1	1,114	0.1%	43	3.9%	10%
American Mink	<0.1	1	156	0.6%	7	4.5%	25%
Gray Fox	2.3	5	1,941	0.3%	116	6.0%	20%
Red Fox	0.3	1	29	3.4%	3	10.3%	25%
Raccoon	63.7	114	34,759	0.3%	1,438	4.1%	49%
River Otter	1.2	5	92	5.4%	8	8.9%	20%
Striped Skunk	205	333	27,739	1.2%	1,393	5.0%	10%
Western Spotted Skunk	<0.1	1	6,233	<0.1%	237	3.8%	10%
North American beaver	76.5	112	14,894	0.8%	723	4.9%	20%
North American Porcupine	<0.1	1	6,263	<0.1%	239	3.8%	20%
Yellow-Bellied Marmot	0.1	1	1,172	0.1%	60	5.1%	60%
Dusky-Footed Woodrat	<0.1	10	1,753,428	<0.1%	66,641	3.8%	60%
Black-Tailed Jackrabbit	0.26	1	67,237	<0.1%	5,887	8.8%	20%
Desert Cottontail Rabbit	254.8	655	254,803	0.3%	11,848	4.6%	40%
Brush Rabbit	132.5	431	132,494	0.3%	5,895	4.4%	40%
California Ground Squirrel	226.8	343	2,129,101	<0.1%	81,253	3.8%	40%
Western Gray Squirrel	100	652	141,481	0.5%	6,998	4.9%	40%
Deer Mouse	1,000	3,570	8,600,693	<0.1%	330,397	3.8%	40%
Mule Deer	0.3	1	6,913	<0.1%	1,652	23.9%	ND

Table 5-7. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Butte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
Mountain Lion	3.7	1.9	64	3.0%	4.3	6.7%	11%

Notes:

Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-8. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Butte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.7	2	480,000	<0.1%	0.1%	6
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	122.1	352	14,000,000	<0.1%	0.9%	353
Brewer's Blackbird	109.1	327	4,200,000	<0.1%	1.5%	327
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30

Table 5-8. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Butte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
Canada Goose	0.9	2	51,148	<0.1%	0.2%	3
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.5 Calaveras

Baseline WS-California lethal WDM activities for the Calaveras County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species and 12 mammal species:

> *Birds:* Canada goose.
>
> *Mammals:* Black bear, North American beaver, bobcat, coyote, gray fox, mountain lion, Virginia opossum, desert cottontail, raccoon, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Calaveras County, 55% involved lethal WDM of coyote in response to predation of livestock and lethal WDM of raccoon in response to damage to agriculture and property. The most common method of WDM used in Calaveras County during the baseline period was cage traps used for lethal WDM of raccoons and other mammal species. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-9 and 5-10. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-9. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Calaveras County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0	1	361	0.3%	15	4.2%	10%
Black Bear	3.5	8	186	4.3%	37	NA	14.2%
Bobcat	1.7	6	367	1.6%	27	7.4%	17%
Coyote	56.4	88	1,550	5.7%	379	24.5%	50%
Gray Fox	21.6	42	1,710	2.5%	139	8.1%	20%
Long Tailed Weasel	0	1	883	0.1%	34	3.9%	10%
American Mink	<0.01	1	12	8.3%	1	8.3%	25%
Raccoon	66.6	119	17,043	0.7%	769	4.5%	49%
Western spotted skunk	<0.1	1	4,718	<0.1%	180	3.8%	10%
Striped Skunk	36.9	60	16,928	0.4%	708	4.2%	10%
North American beaver	0.1	1	1,856	0.1%	71	3.8%	20%
North American Porcupine	<0.1	1	5,076	0.0%	193	3.8%	20%
Yellow Bellied Marmot	0.2	1	1,424	0.1%	73	5.1%	60%
Big Eared Woodrat	<0.1	10	1,805,540	0.0%	68,621	3.8%	60%
Black Tailed Jackrabbit	0.16	1	41,902	0.0%	2,394	5.7%	20%
Desert Cottontail Rabbit	141.4	364	141,035	0.3%	6,417	4.5%	40%
Brush Rabbit	141	458	140,769	0.3%	5,974	4.2%	40%
California Ground Squirrel	221.5	335	1,348,065	0.0%	51,566	3.8%	40%
Western Gray Squirrel	100	652	100,744	0.6%	5,171	5.1%	40%
Deer Mouse	1,000	3,570	5,300,209	0.1%	204,978	3.9%	40%
Mountain Lion	4.2	2.1	62	3.4%	4.5	7.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-10. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Calaveras County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0.8	2	51,148	<0.1%	0.2%	3
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

5.1.6 Colusa

Baseline WS-California lethal WDM activities for the Colusa County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species and 14 mammal species:

Birds: rock pigeon

Mammals: North American beaver, feral cat, coyote, feral dog, gray fox, red fox, mountain lion, muskrat, Virginia opossum, raccoon, brown rat, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Colusa County, 60% involved lethal WDM of coyote in response to predation of livestock and lethal WDM of North American beavers in response to damage to agriculture and property. The most common methods of WDM used in Colusa County during the baseline period were manual (hand, blown) calling devices and firearms used for lethal WDM of coyotes. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-11 and 5-12. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-11. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Colusa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	468	0.2%	19	4.1%	10%
Bobcat	0	1	224	0.4%	10	4.5%	17%
Coyote	276.9	432	1,700	25.4%	752	44.2%	50%
Gray Fox	0.1	1	1,504	0.0%	89	5.9%	20%
Red Fox	3.2	5	37	13.1%	8	21.6%	25%
Long Tailed Weasel	0	1	667	0.1%	27	4.0%	10%
American Mink	<0.1	1	145	0.7%	6	4.1%	25%
Raccoon	30.6	55	10,437	0.5%	507	4.9%	49%
Western spotted skunk	0.04	1	4,581	0.0%	175	3.8%	10%
Striped Skunk	22.4	37	19,793	0.2%	831	4.2%	10%
North American beaver	64	94	2,870	3.3%	208	7.2%	20%
North American Porcupine	<0.1	1	858	0.1%	33	3.8%	20%
Dusky Footed Woodrat	<0.1	10	1,051,971	0.0%	39,985	3.8%	60%
Black Tailed Jackrabbit	0.24	1	61,817	0.0%	3,502	5.7%	20%
Desert Cottontail Rabbit	250.6	645	250,635	0.3%	11,849	4.7%	40%
Brush Rabbit	107	347	106,618	0.3%	4,918	4.6%	40%
California Ground Squirrel	204.7	310	1,490,638	0.0%	56,958	3.8%	40%
Western Gray Squirrel	50	326	43,373	0.8%	2,272	5.2%	40%
Deer Mouse	1,000	3,570	6,024,910	0.1%	232,517	3.9%	40%
Mountain Lion	0.3	0.2	30	0.7%	1.3	4.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-12. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Colusa County

Species	Average County-Program Lethal WDM Take	County Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.7 Contra Costa

Baseline WS-California lethal WDM activities for the Contra Costa County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved 5 bird species and 9 mammal species:

Birds: feral duck, feral pea fowl, Canada goose, common raven, wild turkey

Mammals: North American beaver, coyote, mule deer/black-tailed deer, gray fox, red fox, Virginia opossum, raccoon, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Contra Costa County, 89% involved lethal WDM of California ground squirrel. The most common method of WDM used in Contra Costa County during the baseline period were firearms used for lethal WDM of California ground squirrel. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-13 and 5-14. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-13. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Contra Costa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	254	0.4%	11	4.3%	10%
Bobcat	0	1	445	0.2%	19	4.3%	17%
Coyote	1.9	3	904	0.3%	178	19.7%	50%
Gray Fox	0.4	1	373	0.2%	26	7.0%	20%
Long Tailed Weasel	0	1	610	0.2%	24	3.9%	10%
American Mink	<0.01	1	23	4.3%	1	4.3%	25%
Raccoon	2.8	5	44,959	<0.1%	1,830	4.1%	49%
River Otter	0.4	2	31	5.2%	2.8	9.0%	20%
Western Spotted Skunk	0.03	1	3,342	0.0%	128	3.8%	10%
Striped Skunk	1.3	3	12,377	0.0%	540	4.4%	10%
North American beaver	7.2	11	1,998	0.5%	91	4.6%	20%
Big Eared Woodrat	0.007	10	2,558	<0.1%	99	3.9%	60%
Dusky Footed Woodrat	0.004	10	375,833	<0.1%	14,292	3.8%	60%
Black Tailed Jackrabbit	0.15	1	37,704	<0.1%	1,912	5.1%	20%
Desert Cottontail Rabbit	187.7	483	187,687	<0.1%	8,096	4.3%	40%
Brush Rabbit	129	418	128,576	0.3%	5,304	4.1%	40%
California Ground Squirrel	2,035	3,073	947,980	0.3%	39,101	4.1%	40%
Deer Mouse	1,000	3,570	4,002,932	0.1%	155,682	3.9%	40%
Mule Deer	0.2	1	2,775	<0.1%	663	23.9	ND

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-14. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Contra Costa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0.1	1	330,000	<0.1%	<0.1%	3
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	357
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.8 El Dorado

Baseline WS-California lethal WDM activities for the El Dorado County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and 14 mammal species:

Birds: Canada goose, rock pigeon

Mammals: black bear, North American beaver, bobcat, coyote, mule deer/black-tailed deer, gray fox, mountain lion, yellow-bellied marmot, Virginia opossum, raccoon, striped skunk, fox squirrel, feral swine and woodchuck.

Of all the WDM activities conducted in El Dorado County, 86% involved lethal WDM of coyote in response to predation of livestock and lethal WDM of raccoon and striped skunk in response to property and agriculture damage. The most common method of WDM used in El Dorado County during the baseline period was cage traps used for lethal WDM of raccoon and striped skunk. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-15 and 5-16. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-15. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in El Dorado County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	361	0.3%	15	4.2%	10%
Black Bear	11.6	24	493	4.9%	103	20.9%	14.2%
Bobcat	0.8	3	662	0.5%	35	5.3%	17%
Coyote	101.7	159	2,501	6.4%	628	25.1%	50%
Gray Fox	9.7	19	2,739	0.7%	174	6.4%	20%
Long Tailed Weasel	0	1	1,446	0.1%	56	3.9%	10%
American Mink	<0.1	1	24	4.2%	1	4.2%	25%
Raccoon	190	339	40,354	0.8%	1,875	4.6%	49%
Western Spotted Skunk	<0.1	1	6,895	0.0%	263	3.8%	10%
Striped Skunk	199.4	324	25,343	1.3%	1,294	5.1%	10%
North American Beaver	10	15	7,959	0.2%	318	4.0%	20%
North American Porcupine	<0.1	1	9,452	0.0%	360	3.8%	20%
Yellow Bellied Marmot	0.2	1	8,737	0.0%	444	5.1%	20%
Big Eared Woodrat	<0.1	10	2,716,708	0.0%	103,245	3.8%	60%
Dusky Footed Woodrat	<0.1	10	964,330	0.0%	36,655	3.8%	60%
Black Tailed Jackrabbit	0.14	1	36,903	0.0%	2,166	5.9%	20%
Desert Cottontail Rabbit	95.3	245	95,283	0.3%	4,388	4.6%	40%
Brush Rabbit	127	412	126,563	0.3%	5,361	4.2%	40%
California Ground Squirrel	200	302	2,072,169	0.0%	79,049	3.8%	40%
Western Gray Squirrel	100	652	188,106	0.3%	9,089	4.8%	40%
Deer Mouse	1,000	3,570	8,957,167	0.0%	203,758	2.3%	40%
Mule Deer	1.5	4	11,092	0.0%	2,651	23.9%	ND
Mountain Lion	11.1	5.6	108	5.2%	9.7	9.0%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-16. County-Program Lethal Take of Target Bird Species Under the Proposed Project in El Dorado County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	290
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.9 Humboldt

Baseline WS-California lethal WDM activities for the Humboldt County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species and nine mammal species:

Birds: European starling

Mammals: black bear, North American beaver, coyote, gray fox, mountain lion, Virginia opossum, raccoon, spotted skunk, striped skunk.

Of all the WDM activities conducted in Humboldt County, 99% involved dispersal of Aleutian cackling geese (*Branta hutchinsii leucopareia*) in response to field crop damage. The most common methods of WDM used in Humboldt County during the baseline period were 12-gauge cracker shells and vehicles used for dispersal of Aleutian cackling geese. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-17 and 5-18. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-17. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Humboldt County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	430	0.23%	18	4.2%	10%
Black Bear	5.2	11	1,371	0.8%	149	10.8%	14.2%
Bobcat	0	1	1,141	0.1%	52	4.6%	17%
Coyote	17.7	28	5,416	0.5%	1,050	19.4%	50%
Gray Fox	1.3	3	3,173	0.1%	182	5.7%	20%
Long Tailed Weasel	0	1	3,095	<0.1%	118	3.8%	10%
American Mink	<0.1	1	144	0.7%	6	4.2%	25%
Raccoon	45	81	67,184	0.1%	2,637	3.9%	49%
Western Spotted Skunk	0.2	1	15,479	0.01%	589	3.8%	10%
Striped Skunk	96.3	157	44,892	0.36%	1,870	4.2%	10%
North American beaver	0.2	1	7,097	0.01%	270	3.8%	20%
North American Porcupine	<0.1	1	16,246	0.01%	618	3.8%	20%
Dusky Footed Woodrat	<0.1	10	6,907591	<0.01%	262,499	3.8%	60%
Black Tailed Jackrabbit	0.22	1	56,339	<0.01%	3,028	5.4%	20%
Brush Rabbit	224	728	223,865	0.33%	9,328	4.2%	40%
California Ground Squirrel	200	300	3,882,009	0.01%	147,823	3.8%	40%
Western Gray Squirrel	100	652	494,783	0.13%	22,844	4.6%	40%
Deer Mouse	1,000	3,570	18,650,414	0.02%	712,286	3.8%	40%
Mountain Lion	2.3	1.2	146	0.8%	6.7	4.6%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-18. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Humboldt County.

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	0	0	530,000	0%	0%	0
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.10 Imperial

Baseline WS-California lethal WDM activities for the Imperial County program (not including airport WDM or WDM for T&E species protection) as recorded in the MIS data involved three bird species and six mammal species:

Birds: Red-winged blackbird, red-tailed hawk, European starling

Mammals: American badger, North American beaver, coyote, feral dog, cottontail, and raccoon.

Of all the WDM activities conducted in Imperial County, 87% involved dispersal of red-winged blackbirds in response to agriculture damage. The most common methods of WDM used in Imperial County during the baseline period were firearms and gas exploders used for dispersal of red-winged blackbirds and European starlings. Lethal WDM of coyotes was conducted in response to predation of livestock. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-19 and 5-20. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-19. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Imperial County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	2,765	<0.1%	107	3.9%	10%
Bobcat	0	1	1,024	0.1%	44	4.3%	17%
Coyote	121.1	189	5,695	3.3%	1,260	22.1%	50%
Long Tailed Weasel	0	1	105	1.0%	5	4.8%	10%
Raccoon	2.2	4	16,469	<0.1%	634	3.8%	49%
Western Spotted Skunk	0.04	1	3,939	<0.1%	150	3.8%	10%
Striped Skunk	0	0	16,318	<0.1%	627	3.8%	10%
North American beaver	0.2	1	818	0.1%	32	3.9%	20%
Big-eared Woodrat	0	10	17,376	0.1%	671	3.9%	60%
Black Tailed Jackrabbit	0.88	2	228,406	<0.1%	11,984	5.2%	20%
Desert Cottontail Rabbit	1,014.6	2,608	1,013,872	0.3%	50,822	5.0%	40%
Brush Rabbit	2.7	10	2,106	0.5%	91	4.3%	40%
California Ground Squirrel	100	151	114,130	0.1%	4,492	3.9%	40%
Deer Mouse	1,000	3,570	21,962,230	<0.1%	838,135	3.8%	40%
Mountain Lion (not CESA candidate)	0	0	18	<0.1%	0.7	3.9%	11%
Mountain Lion (CESA candidate)	0	0.1	18	0.6%	0.6	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-20. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Imperial County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.2	1	230,000	<0.1%	0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	119.2	344	14,000,000	<0.1%	0.9%	345
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.11 Kern

Baseline WS-California lethal WDM activities for the Kern County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved nine bird species and fifteen mammal species:

> *Birds:* American coot, American crow, common barn owl, great horned owl, rock pigeon, common raven, house sparrow, European starling, and acorn woodpecker.
>
> *Mammals:* Black bear, American badger, North American beaver, bobcat, coyote, feral dog, gray fox, red fox, black-tailed jackrabbit, mountain lion, Virginia opossum, raccoon, striped skunk, California ground squirrel, and feral swine.

During the baseline period, 38% of the activities conducted within Kern County were for dispersals of birds and 40% of the activities conducted were for lethal WDM of coyotes. The most common methods of WDM used in Kern County during the baseline period were vehicles used for dispersal of birds and firearms used for lethal WDM coyote. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-21 and 5-22. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-21. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Kern County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	4846	<0.1%	186	3.8%	10%
Black Bear	2.1	5	651	0.8%	68	10.4%	14.2%
Bobcat	1.8	6	2,432	0.2%	133	5.5%	17%
Coyote	914.5	1,427	12,080	11.8%	3,698	30.6%	50%
Gray Fox	0.3	1	12015	<0.1%	711	5.9%	20%
Long Tailed Weasel	0	1	4,788	<0.1%	183	3.8%	10%
Raccoon	29.1	52	79,452	0.1%	3,087	3.9%	49%
Western Spotted Skunk	0.25	1	26,388	<0.1%	1,002	3.8%	10%
Striped Skunk	29.9	49	99,261	<0.1%	3,843	3.9%	10%
North American beaver	7.9	12	2,463	0.5%	106	4.3%	20%
North American Porcupine	0	1	9,455	<0.1%	360	3.8%	20%
Yellow Bellied Marmot	0	1	1,594	<0.1%	82	5.1%	20%
Big-Eared Woodrat	0	10	3,011,535	<0.1%	114,449	3.8%	60%
Dusky Footed Woodrat	<0.1	10	169,780	<0.1%	6,462	3.8%	60%
Black-Tailed Jackrabbit	11.3	90	464,255	<0.1%	26,256	5.7%	20%
Desert Cottontail Rabbit	2,012.7	5,173	2,012,653	0.3%	101,662	5.1%	40%
Brush Rabbit	441	1,433	440,725	0.3%	25,610	5.8%	40%
California Ground Squirrel	208	315	7,744,137	<0.1%	294,596	3.8%	40%
Western Gray Squirrel	100	652	128,644	0.5%	6,422	5.0%	40%
Deer Mouse	1,000	3,570	42,595,850	<0.1%	1,622,213	3.8%	40%
Mountain Lion	1.7	0.9	166	0.5%	7.2	4.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-22. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Kern County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	5.1	10	480,000	<0.1%	0.7%	14
Common Raven	15.3	23	330,000	<0.1%	3.1%	28
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.8	2	24,000		5.3%	2
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10.1	65	1,900,000	<0.1%	13.1%	65
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.12 Lake

Baseline WS-California lethal WDM activities for the Lake County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and fifteen mammal species:

Birds: Common pea fowl, feral goose, common raven, wild turkey.

Mammals: Black bear, North American beaver, bobcat, coyote, mule/black-tailed deer, feral dog, gray fox, mountain lion, Virginia opossum, river otter, raccoon, striped skunk, western gray squirrel, feral swine, and long-tailed weasel.

Of all the WDM activities conducted in Lake County, 83% involved lethal WDM of coyote in response to livestock predation (31%) and lethal WDM of feral swine (21%), raccoon (12%), and striped skunk (19%) in response to agriculture and property damage. The most common methods of WDM used in Lake County during the baseline period were cage traps used for lethal WDM of raccoon and striped skunk and firearms used for lethal WDM of coyotes and feral swine. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-23 and 5-24. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-23. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Lake County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0	1	487	0.2%	20	4.1%	10%
Black Bear	2.4	5	398	1.3%	30	NA	14.2%
Bobcat	1	3	434	0.7%	27	6.2%	17%
Coyote	62.8	98	1,918	5.1%	460	24.0%	50%
Gray Fox	2.7	6	2,230	0.3%	156	7.0%	20%
Long-Tailed Weasel	0.1	1	1,095	<0.1%	42	3.8%	10%
American Mink	<0.1	1	8	12.4%	1	12.4%	25%
Raccoon	23.3	42	24,250	0.2%	971	4.0%	49%
River Otter	0.1	0.4	3	13.3%	0.5	16.7%	20%
Striped Skunk	37.5	61	20,846	0.3%	857	4.1%	10%
North American Beaver	0.4	1	1,174	0.1%	46	3.9%	20%
North American Porcupine	<0.1	1	5,779	<0.1%	220	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	2,783,818	<0.1%	105,796	3.8%	60%
Black-Tailed Jackrabbit	0.2	1	53,838	<0.1%	3,272	6.1%	20%
Desert Cottontail	8.9	23	8,926	0.3%	386	4.3%	40%
Brush Rabbit	222	722	222,107	0.3%	9,163	4.1%	40%
California Ground Squirrel	200	302	1,656,971	<0.1%	63,271	3.8%	40%
Western Gray Squirrel	101.2	660	101,979	0.6%	5,234	5.1%	40%
Deer Mouse	1,000	3,570	6,577,431	0.1%	253,513	3.9%	40%
Mule Deer	0.2	1	8,225	<0.1%	1,966	23.9%	ND
Mountain Lion	1.1	0.6	75	0.8%	3.4	4.5%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-24. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Lake County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0.9	2	330,000	<0.1%	0.2%	4
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.13 Lassen

Baseline WS-California lethal WDM activities for the Lassen County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved six bird species and 17 mammal species:

> *Birds:* Brewer's blackbird, red-winged blackbird, brown-headed cowbird, rock pigeon, common raven, and European starling.
>
> *Mammals:* American badger, black bear, North American beaver, bobcat, feral cat, coyote, feral dog, gray fox, mountain lion, yellow-bellied marmot, raccoon, spotted skunk, striped skunk, California ground squirrel, western gray squirrel, woodchuck, and dusky-footed woodrat.

Of all the WDM activities conducted in Lassen County, 92% involved dispersal of lesser snow geese *(Chen caerulescens caerulescens*) in response to field crop consumption. The most common methods of WDM used in Lassen County during the baseline period were whistlers/screamers used for dispersal of lesser snow geese and firearms for the lethal WDM of coyote and other mammal species. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-25 and 5-26. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-25. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Lassen County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	2.1	6	2,478	0.2%	101	4.1%	10%
Black Bear	2.4	5	482	1.0%	37	NA	14.2%
Bobcat	0.4	2	1,553	0.1%	72	4.6%	17%
Coyote	350.4	547	6,951	7.9%	1,859	26.7%	50%
Gray Fox	0.2	1	2,744	<0.1%	163	5.9%	20%
Long-Tailed Weasel	0	1	3,957	<0.1%	151	3.8%	10%
American Mink	<0.1	1	35	2.8%	2	5.7%	25%
Raccoon	5.6	10	36,685	<0.1%	1,408	3.8%	49%
Western Spotted Skunk	0.6	2	21,378	<0.1%	814	3.8%	10%
Striped Skunk	66.5	108	76,546	0.1%	3,029	4.0%	10%
North American Beaver	17.5	26	44,115	0.1%	1,703	3.9%	20%
North American Porcupine	<0.1	1	10,409	<0.1%	396	3.8%	20%
Yellow-Bellied Marmot	24.4	115	61,813	0.2%	3,243	5.2%	20%
Dusky-Footed Woodrat	0.7	10	4,025,847	<0.1%	152,993	3.8%	60%
Black-Tailed Jackrabbit	0	2	233,271	<0.1%	21,698	9.3%	20%
California Ground Squirrel	204.7	310	6,108,614	<0.1%	232,441	3.8%	40%
Western Gray Squirrel	100.1	653	198,702	0.3%	1,026	0.5%	40%
Deer Mouse	1,000	3,570	23,775,639	<0.1%	907,045	3.8%	40%
Mountain Lion	3.6	1.8	135	1.3%	6.9	5.1%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-26. County-Program Lethal Take of Target Bird Species Under the Proposed Project in Lassen County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	2.8	2	330,000	<0.1%	0.2%	4
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.14 Madera

Baseline WS-California lethal WDM activities for the Madera County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and 15 mammal species:

> *Birds:* American crow, wild turkey.
>
> *Mammals:* American badger, black bear, North American beaver, bobcat, coyote, feral dog, gray fox, red fox, mountain lion, Virginia opossum, feral rabbit, raccoon, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Madera County, 43% involved lethal WDM of coyote in response to predation of livestock. The most common methods of WDM used in Madera County during the baseline period were neck snares used for lethal WDM of coyote and body grip traps for the lethal WDM of California ground squirrel. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-27 and 5-28. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-27. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Madera County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	1,023	0.1%	40	3.9%	10%
Black Bear	2.5	6	275	2.2%	46	NA	14.2%
Bobcat	0.2	1	502	0.2%	29	5.8%	17%
Coyote	96.9	152	3,109	4.9%	734	23.6%	50%
Gray Fox	4.0	8	2,723	0.3%	162	5.9%	20%
Long-Tailed Weasel	0	1	1,567	<0.1%	60	3.8%	10%
American Mink	<0.1	1	20	5.0%	1	5.0%	25%
Raccoon	9	17	32,113	0.1%	1,239	3.9%	49%
Western Spotted Skunk	0.07	1	7,224	<0.1%	275	3.8%	10%
Striped Skunk	15.2	25	31,536	0.1%	1,228	3.9%	10%
North American Beaver	8.1	12	3,778	0.3%	156	4.1%	20%
North American Porcupine	<0.1	1	6,701	<0.1%	255	3.8%	20%
Yellow-Bellied Marmot	0	4	7,431	<0.1%	380	5.1%	20%
Big-Eared Woodrat	0	10	1,465,192	<0.1%	55,688	3.8%	60%
Black-Tailed Jackrabbit	0	1	86,999	<0.1%	4,892	5.6%	20%
Desert Cottontail Rabbit	0	854	331,929	0.3%	15,577	4.7%	40%
Brush Rabbit	133	433	132,999	0.3%	6,117	4.6%	40%
California Ground Squirrel	233.3	353	2,078,559	<0.1%	79,342	3.8%	40%
Western Gray Squirrel	100	652	114,080	0.6%	5,769	5.1%	40%
Deer Mouse	1,000	3,570	11,195,461	<0.1%	428,998	3.8%	40%
Mountain Lion	1.1	0.6	84	0.7%	3.8	4.5%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-28. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Madera County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.2	1	480,000	<0.1%	<0.1%	5
Common Raven	0	0	330,000	0%	0%	2
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Goose	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.15 Mariposa

Baseline WS-California lethal WDM activities for the Mariposa County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved three bird species and 13 mammal species:

Birds: common raven, wild turkey and acorn woodpecker.

Mammals: black bear, North American beaver, bobcat, coyote, feral dog, gray fox, mountain lion, Virginia opossum, raccoon, black rat, striped skunk, western gray squirrel, and feral swine.

Of all the WDM activities conducted in Mariposa County, 34% involved lethal WDM of coyote and feral swine in response to predation of livestock and agriculture and property damage, respectively. The most common method of WDM used in Mariposa County during the baseline period were firearms used for lethal WDM of coyote and feral swine. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-29 and 5-30. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-29. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Mariposa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0	2	535	0.4%	23	4.3%	10%
Black Bear	5.9	12	311	3.9%	39	NA	14.2%
Bobcat	5.3	16	510	3.1%	41	8.0%	17%
Coyote	106.9	167	2,187	7.6%	578	26.4%	50%
Gray Fox	4.4	9	2,177	0.4%	133	6.1%	20%
Long Tailed Weasel	0	1	1,243	<0.1%	48	3.9%	10%
American Mink	<0.1	1	17	5.8%	1	5.8%	25%
Raccoon	43.4	78	22,422	0.3%	933	4.2%	49%
Striped Skunk	47.1	77	22,637	0.3%	941	4.2%	10%
North American Beaver	1.1	2	3,914	0.1%	151	3.9%	20%
North American Porcupine	<0.1	1	7,242	<0.1%	276	3.8%	20%
Yellow Bellied Marmot	0	2	3,129	<0.1%	160	5.1%	20%
Big Eared Woodrat	0	10	2,299,289	<0.1%	87,383	3.8%	60%
Black Tailed Jackrabbit	0	1	50,846	<0.1%	2,537	5.0%	20%
Desert Cottontail Rabbit	155.9	401	155,946	0.2%	6,726	4.3%	40%
Brush Rabbit	202	657	201,818	0.3%	8,326	4.1%	40%
California Ground Squirrel	200	302	1,526,740	<0.1%	58,323	3.8%	40%
Western Gray Squirrel	50.2	328	128,533	0.3%	6,093	4.7%	40%
Deer Mouse	1,000	3,570	7,592,334	<0.1%	292,079	3.8%	40%
Mountain Lion	3.3	1.7	97	1.8%	1.7	1.8%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-30. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Mariposa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0.9	2	330,000	<0.1%	0.2%	4
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Acorn Woodpecker	0.5	4	1,900,000	<0.1%	0.6%	4
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.16 Mendocino

Baseline WS-California lethal WDM activities for the Mendocino County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved three bird species and 12 mammal species:

Birds: common raven and European starling.

Mammals: black bear, bobcat, coyote, feral dog, gray fox, mountain lion, Virginia opossum, raccoon, spotted skunk, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Mendocino County, 42% involved lethal WDM of coyote in response to predation of livestock and property damage. The most common method of WDM used in Mendocino County during the baseline period was neck snares used for lethal WDM of coyote. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-31 and 5-32. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-31. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Mendocino County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.4	2	555	0.37	23	4.3%	10%
Black Bear	11.5	24	1,336	1.8%	154	NA	14.2%
Bobcat	3.9	12	104	11.5%	63	60.6%	17%
Coyote	151.4	237	5,368	4.4%	1,242	23.1%	50%
Gray Fox	11.8	23	3,797	0.6%	243	6.4%	20%
Long-Tailed Weasel	0	1	3,061	<0.1%	117	3.8%	10%
American Mink	<0.1	1	21	4.7%	1	4.7%	25%
Raccoon	41.3	74	64,098	0.1%	2,521	3.9%	49%
Western Spotted Skunk	1.7	5	15,318	<0.1%	587	3.8%	10%
Striped Skunk	57.2	93	49,727	0.2%	1,990	4.0%	10%
North American Porcupine	0.3	2	15,364	<0.1%	585	3.8%	20%
Dusky-Footed Woodrat	<0.1	1	7,583,993	<0.1%	288,202	3.8%	60%
Black-Tailed Jackrabbit	0.29	1	74,283	<0.1%	5,641	7.6%	20%
Brush Rabbit	261	849	261,387	0.3%	10,876	4.2%	40%
California Ground Squirrel	202	306	3,797,564	<0.1%	144,617	3.8%	40%
Western Gray Squirrel	100	652	484,841	0.1%	22,398	4.6%	40%
Deer Mouse	1,000	3,570	18,391,509	<0.1%	702,448	3.8%	40%
Mule Deer	1	3	22,613	<0.1%	5,405	23.9%	ND
Mountain Lion	5	1.7	38	4.5%	2.5	6.6%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-32. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Mendocino County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	0.4	1	330,000	<0.1%	0.1%	3
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.17 Merced

Baseline WS-California lethal WDM activities for the Merced County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and 12 mammal species:

Birds: brown-headed cowbird, cattle egret, black-crowned night heron, common raven and European starling.

Mammals: North American beaver, bobcat, coyote, gray fox, red fox, mountain lion, nutria, Virginia opossum, raccoon, striped skunk, California ground squirrel, and feral swine.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: California gulls (94.0 average individuals affected per year), rock pigeons (103.5 individuals affected per year), and European starlings (2,319.9 individuals affected per year). The most common method of WDM used in Merced County during the baseline period were cracker shells used for dispersal of birds at airports and body grip traps for North American beavers in response to agriculture damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-33 and 5-34. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-33. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Merced County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.9	3	1,162	0.3%	48	4.1%	10%
Bobcat	0.4	2	336	0.6%	19	5.7%	17%
Coyote	28.6	45	2,759	1.6%	574	20.8%	50%
Gray Fox	5.9	12	2,302	0.5%	142	6.2%	20%
Long Tailed Weasel	0	1	1,355	<0.1%	52	3.8%	10%
American Mink	<0.1	1	336	0.3%	14	4.2%	25%
Raccoon	12.8	23	18,314	0.1%	724	4.0%	49%
River Otter	0.1	0.4	14	2.9%	1.4	10.0%	20%
Striped Skunk	12.6	21	33,371	0.1%	1,294	3.9%	10%
North American beaver	45.7	67	6,479	1.0%	314	4.8%	20%
Big Eared Woodrat	0	10	13,304	<0.1%	516	3.9%	60%
Dusky Footed Woodrat	<0.1	10	279,877	<0.1%	10,646	3.8%	60%
Black Tailed Jackrabbit	0.4	1	110,617	<0.1%	6,014	5.4%	20%
Desert Cottontail Rabbit	491.6	1,264	491,553	0.3%	21,881	4.5%	40%
Brush Rabbit	104	338	103,957	0.4%	4,676	4.5%	40%
California Ground Squirrel	200.4	303	2,471,916	<0.1%	94,275	3.8%	40%
Deer Mouse	1,000	3,570	10,188,975	<0.1%	390,752	3.8%	40%
Mountain Lion	0.1	0.1	29	0.3%	1.2	4.1%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-34. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Merced County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	10
Common Raven	1.8	3	330,000	<0.1%	0.4%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	21
Black-crowned Night Heron	0.4	1	15,740	<0.1%	1.4%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.18 Modoc

Baseline WS-California lethal WDM activities for the Modoc County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and 15 mammal species:

Birds: common raven and rock pigeon.

Mammals: American badger, black bear, North American beaver, bobcat, coyote, red fox, mountain lion, muskrat, raccoon, black rat, brown rat, spotted skunk, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Modoc County, 72% involved lethal WDM of coyote in response to predation of livestock. The most common method of WDM used in Modoc County during the baseline period was firearms used for lethal WDM of coyote. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-35 and 5-36. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-35. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Modoc County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	2,272	<0.1%	90	4.0%	10%
Black Bear	0.3	1	320	0.3%	14	NA	14.2%
Bobcat	0.6	2	1,263	0.2%	57	4.5%	17%
Coyote	253.6	396	5,963	6.6%	1,522	25.5%	50%
Long Tailed Weasel	0	1	3,393	<0.1%	130	3.8%	10%
American Mink	<0.1	1	24	4.1%	2	8.3%	25%
Raccoon	5.4	10	35,127	<0.1%	1,348	3.8%	49%
Western Spotted Skunk	0.1	1	18,025	<0.1%	686	3.8%	10%
Striped Skunk	46.1	75	66,456	0.1%	2,623	3.9%	10%
North American Beaver	5.6	9	32,471	<0.1%	1,243	3.8%	20%
North American Porcupine	<0.1	1	7,327	<0.1%	279	3.8%	20%
Yellow Bellied Marmot	5.1	24	47,139	<0.1%	2,410	5.1%	20%
Dusky Footed Woodrat	<0.1	10	2,285,165	<0.1%	86,847	3.8%	60%
Black Tailed Jackrabbit	0.8	2	203,961	<0.1%	14,122	6.9%	20%
California Ground Squirrel	200	302	5,360,334	<0.1%	203,999	3.8%	40%
Western Gray Squirrel	100	652	141,182	0.5%	6,985	4.9%	40%
Deer Mouse	1,000	3,570	20,843,386	<0.1%	795,619	3.8%	40%
Mountain Lion	3.9	2	143	1.4%	7.4	5.2%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-36. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Modoc County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	2.8	5	330,000	<0.1%	0.6%	7
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	0	0	1,900,000	0%	0%	0
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.19 Monterey

Baseline WS-California lethal WDM activities for the Monterey County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved eight bird species and 12 mammal species:

Birds: Brewer's blackbird, American coot, American crow, feral duck, Canada goose, California gull, cliff swallow, and wild turkey.

Mammals: North American beaver, bobcat, coyote, red fox, black-tailed jackrabbit, mountain lion, Virginia opossum, cottontail rabbit, raccoon, striped skunk, California ground squirrel, and feral swine.

The majority of WDM activities for bird species involved the following species: American coot (179.4 average individuals affected per year), American crow (25.4 individuals affected per year), and common raven (12.7 individuals affected per year). Lethal WDM of American coot occurred in response to property damage to golf courses. Protection of threatened and endangered wildlife species (i.e., snowy plover) from predation by common raven accounted for 2% of all WDM activities occurring within Monterey County. Lethal WDM of coyote occurred in response to predation of livestock. The most common methods of WDM used in Monterey County during the baseline period were A/C powder used for lethal WDM of birds and gas cartridges for ground squirrel in response to agriculture and property damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-37 and 5-38. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-37. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Monterey County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.3	4	1,724	0.2%	70	4.1%	10%
Bobcat	1.5	5	1,120	0.4%	54	4.8%	17%
Coyote	142.2	222	4,997	4.4%	1,162	23.3%	50%
Long Tailed Weasel	0	1	2,870	<0.1%	110	3.8%	10%
Raccoon	0.8	2	55,049	<0.1%	2,097	3.8%	49%
Western Spotted Skunk	0	1	15,199	<0.1%	578	3.8%	10%
Striped Skunk	0.8	2	56,619	<0.1%	2,179	3.8%	10%
North American Beaver	1	2	3,974	0.1%	153	3.9%	20%
North American Porcupine	<0.1	1	3,233	<0.1%	123	3.8%	20%
Big Eared Woodrat	<0.1	10	2,717,289	<0.1%	103,267	3.8%	60%
Dusky Footed Woodrat	<0.1	10	2,183,977	<0.1%	83,002	3.8%	60%
Black Tailed Jackrabbit	0.9	2	175,452	<0.1%	9,527	5.4%	20%
Desert Cottontail Rabbit	856.2	2,201	854,997	0.3%	42,171	4.9%	40%
Brush Rabbit	784.2	2,549	782,984	0.3%	34,949	4.5%	40%
California Ground Squirrel	202.3	306	4,452,809	<0.1%	169,931	3.8%	40%
Western Gray Squirrel	100	652	105,629	0.6%	5,390	5.1%	40%
Deer Mouse	1,000	3,570	17,351,620	<0.1%	662,932	3.8%	40%
Mountain Lion (not CSA listed)	1.3	0.7	190	0.4%	7.9	4.2%	11%
Mountain Lion (CSA listed)	1.3	0.1	190	0.1%	6	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-38. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Monterey County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	3.8	8	480,000	<0.1%	0.5%	47
Common Raven	0	0	330,000	0%	0%	21
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	290
Brewer's Blackbird	100.2	321	4,200,000	<0.1%	1.4%	322
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0.1	1	51,148	<0.1%	<0.1%	2
California Gull	1.9	5	112,601	<0.1%	0.7%	7
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Note: Only species with county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.20 Napa

Baseline WS-California lethal WDM activities for the Napa County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved three bird species and 12 mammal species:

Birds: common pea fowl, rock pigeon, and wild turkey.

*Mammals: A*merican badger, black bear, North American beaver, bobcat, coyote, mule/black-tailed deer, gray fox, mountain lion, muskrat, Virginia opossum, river otter, raccoon, striped skunk, western gray squirrel, and feral swine.

Of all the WDM activities conducted in Napa County, 82% involved lethal WDM of coyote (16%), raccoon (20%), striped skunk (22%), and feral swine (24%) in response to predation of livestock and agriculture and property damage. The most common method of WDM used in Napa County during the baseline period was cage traps used for lethal WDM of raccoons and striped skunks. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-39 and 5-40. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-39. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Napa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.4	2	284	0.7%	13	4.6%	10%
Black Bear	0.6	2	93	2.2%	6	NA	14.2%
Bobcat	2	6	229	2.6%	18	7.9%	17%
Coyote	56.5	89	1,114	8.0%	298	26.8%	50%
Gray Fox	21.4	42	1,159	3.6%	107	9.2%	20%
Long-Tailed Weasel	0	1	602	<0.1%	24	4.0%	10%
American Mink	<0.1	1	42	2.4%	2	4.7%	25%
Raccoon	70.6	126	16,623	0.8%	760	4.6%	49%
River Otter	0.7	2.7	0	ND[3]	2.8	ND[3]	20%
Striped Skunk	76.8	125	12,621	1.0%	608	4.8%	10%
North American Beaver	1.5	3	679	0.4%	29	4.3%	20%
North American Porcupine	<0.1	1	1,210	<0.1%	46	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	1,340,609	<0.1%	50,954	3.8%	60%
Black-Tailed Jackrabbit	0.1	1	34,478	<0.1%	2,274	6.6%	20%
Desert Cottontail Rabbit	31.6	82	31,591	0.3%	1,696	5.4%	40%
Brush Rabbit	144.6	470	144,615	0.3	6,132	4.2%	40%
California Ground Squirrel	200	302	977,569	<0.1%	37,454	3.8%	40%
Western Gray Squirrel	50.1	327	66,468	0.5%	3,309	5.0%	40%
Deer Mouse	1,000	3,570	3,902,727	0.1%	151,874	3.9%	40%
Mule Deer	2.2	6	4,023	0.1%	961	24.0%	ND
Mountain Lion	0.7	0.4	37	1.1%	1.7	4.6%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

[2] A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

[3] Population estimates for Napa County did not include any populations of river otter based on CDFW habitat suitability models. Therefore, the percentage of the county population taken under the Project could not be calculated.

Table 5-40. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Napa County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.21 Nevada

Baseline WS-California lethal WDM activities for the Nevada County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and 11 mammal species:

Birds: Brewer's blackbird, red-winged blackbird, brown-headed cowbird, Canada goose, and European starling.

Mammals: black bear, North American beaver, bobcat, coyote, gray fox, mountain lion, muskrat, Virginia opossum, raccoon, striped skunk, and feral swine.

Of all the WDM activities conducted in Nevada County, 78% involved lethal WDM of feral swine (17%), coyote (21%), raccoon (19%), and striped skunk (24%) in response to predation of livestock and agriculture damage. The most common method of WDM used in Nevada County during the baseline period was firearms used for lethal WDM of mammal species. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-41 and 5-42. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-41. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Nevada County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.1	1	193	0.5%	9	4.7%	10%
Black Bear	1.8	4	281	1.3%	35	NA	14.2%
Bobcat	0.4	2	407	0.3%	21	5.2%	17%
Coyote	25.4	40	1,383	2.9%	300	21.7%	50%
Gray Fox	1.8	4	1,391	0.3%	85	6.1%	20%
Long Tailed Weasel	0	1	808	<0.1%	31	3.8%	10%
American Mink	<0.1	1	17	5.8%	1	5.8%	25%
Raccoon	22.2	40	26,154	0.2%	1,040	4.0%	49%
Striped Skunk	25.9	42	13,829	0.3%	572	4.1%	10%
North American Beaver	5.7	9	6,772	0.1%	266	3.9%	20%
North American Porcupine	<0.1	1	5,491	<0.1%	209	3.8%	20%
Yellow Bellied Marmot	0.5	3	4,448	<0.1%	228	5.1%	20%
Dusky Footed Woodrat	<0.1	10	1,276,537	<0.1%	48,519	3.8%	60%
Black Tailed Jackrabbit	<0.1	1	18,604	<0.1%	1,099	5.9%	20%
Desert Cottontail Rabbit	44.7	115	44,700	0.3%	2,238	5.0%	40%
Brush Rabbit	61.9	202	61,898	0.3%	2,710	4.4%	40%
California Ground Squirrel	200	302	1,199,992	<0.1%	45,906	3.8%	40%
Western Gray Squirrel	50	326	88,060	0.4%	4,276	4.9%	40%
Deer Mouse	1,000	3,570	5,024,662	0.1%	194,508	3.9%	40%
Mountain Lion	3.2	1.6	55	2.9%	3.7	6.7%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-42. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Nevada County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Canada Geese	5	30	51,148	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	0	0	1,900,000	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.22 Plumas

Baseline WS-California lethal WDM activities for the Plumas County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved 10 mammal species:

Mammals: black bear, North American beaver, coyote, gray fox, mountain lion, muskrat, raccoon, striped skunk, California ground squirrel and feral swine.

Of all the WDM activities conducted in Plumas County, 42% involved lethal WDM of coyote in response to predation of livestock and 27% involved lethal WDM of muskrat in response to property damage. The most common methods of WDM used in Plumas County during the baseline period were rodent bait used for lethal WDM of muskrat and neck snares used for lethal WDM of coyotes. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-43 and 5-44. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-43. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Plumas County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.5	2	535	0.4%	23	4.3%	10%
Black Bear	5.8	12	923	1.3%	107	11.6%	14.2%
Bobcat	0	1	882	0.1%	39	4.4%	17%
Coyote	130.5	204	3,893	5.2%	934	24.0%	50%
Gray Fox	0.9	2	5,607	<0.1%	324	5.8%	20%
Long Tailed Weasel	0	1	2,215	<0.1%	85	3.8%	10%
American Mink	<0.1	1	64	1.6%	3	4.7%	25%
Raccoon	18.9	34	43,728	0.1%	1,700	3.9%	49%
Western Spotted Skunk	0	1	11,088	<0.1%	422	3.8%	10%
Striped Skunk	49.1	80	42,365	0.2%	1,701	4.0%	10%
North American Beaver	19	28	67,926	<0.1%	2,613	3.8%	20%
North American Porcupine	<0.1	1	14,836	<0.1%	564	3.8%	20%
Yellow Bellied Marmot	3.2	16	29,859	<0.1%	1,527	5.1%	20%
Dusky Footed Woodrat	<0.1	10	615,884	<0.1%	23,414	3.8%	60%
Brush Rabbit	11	37	11,187	0.3%	525	4.7%	40%
Black Tailed Jackrabbit	0.2	1	54,314	<0.1%	2,710	5.0%	20%
California Ground Squirrel	201.5	305	3,417,084	<0.1%	130,158	3.8%	40%
Western Gray Squirrel	100	652	320,057	0.2%	15,007	4.7%	40%
Deer Mouse	1,000	3,570	13,393,763	<0.1%	512,533	3.8%	40%
Mountain Lion	1	0.5	158	0.3%	6.5	4.1%	11%

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-44. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Plumas County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer’s Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.23 Sacramento

Baseline WS-California lethal WDM activities for the Sacramento County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved six bird species and 12 mammal species:

> *Birds:* feral chicken, common pea fowl, rock pigeon, wild turkey, cliff swallow, and Canada goose.
>
> *Mammals:* black bear, North American beaver, coyote, mule deer, feral dog, muskrat, Virginia opossum, river otter, raccoon, striped skunk, fox squirrel, and feral swine.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: red-winged blackbird (8,653.7 average individuals affected per year), mixed-flock blackbird (10,393.0 individuals affected per year), rock pigeon (10,923.4 individuals affected per year), and cliff swallows (*Petrochelidon pyrrhonota*) (8,616.6 individuals affected per year). The most common methods of WDM used in Sacramento County during the baseline period were firearms used for dispersal of birds at airports and for lethal WDM of North American beaver, coyote, black-tailed jackrabbit, and striped skunk in response to agriculture and property damage and livestock predation. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-45 and 5-46. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-45. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Sacramento County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0	1	394	0.46%	16	4.1%	10%
Black Bear	0.1	1	0	NA	0	NA	14.2%
Bobcat	0	1	230	0.4%	13	5.7%	17%
Coyote	75.7	119	1,301	9.1%	427	32.8%	50%
Gray Fox	0	1	869	0.1%	51	5.9%	20%
Long-Tailed Weasel	0	1	813	<0.1%	32	3.9%	10%
American Mink	<0.1	1	55	1.8%	3	5.5%	25%
Raccoon	68.8	123	52,445	0.2%	2,136	4.1%	49%
River Otter	0.2	0.8	34	2.4%	2.1	6.2%	20%
Striped Skunk	424	687	16,680	4.1%	1,397	8.4%	10%
North American Beaver	169.4	248	4,836	5.1%	436	9.0%	20%
North American Porcupine	<0.1	1	190	0.5%	8	4.2%	20%
Big-Eared Woodrat	0	10	22,123	<0.1%	851	3.8%	60%
Brush Rabbit	12.8	42	12,821	0.3%	930	7.3%	40%
Black-Tailed Jackrabbit	0.2	1	58,344	<0.1%	3,878	6.6%	20%
Desert Cottontail Rabbit	258.3	664	258,278	0.3%	11,944	4.6%	40%
California Ground Squirrel	200	302	1,291,298	<0.1%	49,869	3.9%	40%
Deer Mouse	1,000	3,570	5,061,637	0.1%	195,913	3.9%	40%
Mule Deer	0.6	2	2,944	0.1%	704	24.0%	ND

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-46. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Sacramento County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	27
Common Raven	0	0	330,000	0%	0%	4
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	14
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	814
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	673
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	5.2	10	51,148	<0.1%	1.2%	40
California Gull	0	0	112,601	0%	0%	2
Black-crowned Night Heron	0	0	15,740	0%	0%	5
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.24 San Diego

Baseline WS-California lethal WDM activities for the San Diego County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species, one reptile, and 11 mammal species:

Birds: American coot, mallard duck, black-crowned night heron, wild turkey, and western gull.

Reptiles: American alligator

Mammals: bobcat, feral cat, coyote, feral dog, mountain lion, Virginia opossum, desert cottontail, raccoon, striped skunk, California ground squirrel, and feral swine.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: Heermann's gull (561.1 individuals affected per year), western gull (426.5 individuals affected per year), great blue heron (338.8 individuals affected per year), and brown pelican (255.0 individuals affected per year). The most common methods of WDM used in San Diego County during the baseline period were dogs used for dispersal of birds at airports and cage traps used for lethal WDM of California ground squirrel in response to property damage and for T&E species protection. Species in San Diego County removed for protection of threatened and endangered species (i.e., snowy plover and California least tern) included feral swine, feral cats (*Felis catus*), coyotes, feral dogs (*Canis familiaris*), black-tailed jackrabbits, Virginia opossum, raccoons, rats (black [*Rattus rattus*] and Norway [*R. norvegicus*]), striped skunks, and California ground squirrel. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-47 and 5-48. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-47. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Diego County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.7	5	2,278	0.2%	92	4.0%	10%
Bobcat	1.7	6	1,850	0.3%	94	5.1%	17%
Coyote	68.4	107	5,917	1.8%	1,255	21.2%	50%
Gray Fox	0	4	7,230	0.1%	418	5.8%	20%
Raccoon	20.6	37	170,768	<0.1%	6,606	3.9%	49%
Western Spotted Skunk	0	1	16,374	<0.1%	623	3.8%	10%
Striped Skunk	9	15	58,001	<0.1%	2,306	4.0%	10%
North American Beaver	0	1	1,783	0.1%	72	4.0%	20%
Big Eared Woodrat	<0.1	30	5,835,939	<0.1%	221,796	3.8%	60%
Black Tailed Jackrabbit	1	3	246,020	<0.1%	12,855	5.2%	20%
Desert Cottontail Rabbit	1,097.5	2,821	1,095,637	0.3%	56,246	5.1%	40%
Brush Rabbit	841.1	2,735	839,511	0.3%	39,130	4.7%	40%
California Ground Squirrel	267.4	404	4,538,840	<0.1%	173,599	3.8%	40%
Western Gray Squirrel	50	326	42,259	0.8%	2,222	5.3%	40%
Deer Mouse	1,000	3,570	22,131,981	<0.1%	844,608	3.8%	40%
Mule Deer	0	1	21,519	<0.1%	5,143	23.9%	ND
Mountain Lion (not CSA listed)	2.3	1.2	180	0.7%	8.0	4.4%	11%
Mountain Lion (CSA listed)	2.3	0.1	180	0.1%	5.9	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-48. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Diego County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	504
Common Raven	0	0	330,000	0%	0%	155
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	13
Barn Owl	0	0	24,000	0%	0%	8
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Canada Geese	0	0	51,148	0%	0%	0
California Gull	0	0	112,601	0%	0%	6
Black-crowned Night Heron	0.9	3	15,740	<0.1%	3.1%	6
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.25 San Joaquin

Baseline WS-California lethal WDM activities for the San Joaquin County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and 14 mammal species:

> *Birds:* Eurasian collared dove, common pea fowl, rock pigeon, European starling, and Canada goose.
>
> *Mammals:* North American beaver, feral cat, coyote, mule deer, gray fox, red fox, muskrat, nutria, Virginia opossum, river otter, raccoon, striped skunk, fox squirrel, and California ground squirrel.

The majority of WDM activities for bird species included the following: sandhill crane dispersal (350.0 average individuals affected per year) and lethal WDM of rock pigeon (480.4 individuals affected per year) and European starling (161.8 individuals affected per year). The most common methods of WDM used in San Joaquin County during the baseline period were firearms used for lethal WDM of birds and cage traps used for non-lethal WDM of muskrats. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-49 and 5-50. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-49. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Joaquin County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.6	2	808	0.3%	33	4.1%	10%
Bobcat	0	1	113	0.9%	5	4.4%	17%
Coyote	26.9	42	2,056	2.0%	428	20.8%	50%
Gray Fox	0.3	1	1,835	0.1%	418	5.8%	20%
Long Tailed Weasel	0	1	991	<0.1%	38	3.8%	10%
American Mink	<0.1	1	51	2.0%	2	4.0%	25%
Raccoon	4.4	8	31,269	<0.1%	1,199	3.8%	49%
River Otter	0.1	0.4	22	1.8%	1.3	5.9%	20%
Striped Skunk	1.2	2	24,074	<0.1%	921	3.8%	10%
North American beaver	13.8	21	2,919	0.7%	132	4.5%	20%
Big Eared Woodrat	0	10	12,158	<0.1%	472	3.9%	60%
Dusky Footed Woodrat	<0.1	10	104,338	<0.1%	3,975	3.8%	60%
Black Tailed Jackrabbit	0.3	1	84,375	<0.1%	5,295	6.3%	20%
Desert Cottontail Rabbit	375.8	966	375,750	0.3%	20,946	5.6%	40%
Brush Rabbit	27.5	90	27,508	0.3%	3,506	12.7%	40%
California Ground Squirrel	238.9	361	1,877,305	<0.1%	71,703	3.8%	40%
Deer Mouse	1,000	3,570	7,316,301	<0.1%	281,590	3.8%	40%
Mule Deer	0.1	1	2,017	<0.1%	482	23.9%	ND

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-50. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Joaquin County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	290
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0.4	1	51,148	<0.1%	0.1%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.26 San Luis Obispo

Baseline WS-California lethal WDM activities for the San Luis Obispo County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and 15 mammal species:

Birds: Heermann's gull, common raven, wild turkey, and red-tailed hawk.

Mammals: American badger, black bear, North American beaver, bobcat, coyote, mule deer, gray fox, red fox, mountain lion, Virginia opossum, desert cottontail rabbit, raccoon, striped skunk, California ground squirrel and feral swine.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: mourning dove (828.6 average individuals affected per year), cliff swallow (695.0 individuals affected per year), and whimbrel (583.8 individuals affected per year). The most common methods of WDM used in San Luis Obispo County during the baseline period were vehicles used for dispersal of birds at airports and cage traps used for lethal WDM of raccoon and striped skunk in response to property damage and for T&E species protection. Species in San Luis Obispo County removed for protection of threatened and endangered species (i.e., snowy plover), wetlands, and restoration included feral swine, coyotes, raccoons, and striped skunks. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-51 and 5-52. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-51. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Luis Obispo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.1	1	1,958	<0.1%	76	3.9%	10%
Black Bear	1.8	4	594	0.7%	23	NA	14.2%
Bobcat	0.3	1	1,062	0.1%	50	4.7%	17%
Coyote	141.5	221	4,987	4.4%	1,198	24.0%	50%
Gray Fox	0.1	1	4,396	<0.1%	249	5.7%	20%
Long Tailed Weasel	0	1	2,845	<0.1%	109	3.8%	10%
Raccoon	333.1	593	43,252	1.4%	2,251	5.2%	49%
Western Spotted Skunk	0	1	15,239	<0.1%	580	3.8%	10%
Striped Skunk	226.7	368	55,232	0.7%	2,483	4.5%	10%
North American Beaver	0.2	1	2,055	<0.1%	79	3.8%	20%
North American Porcupine	<0.1	1	4,368	<0.1%	166	3.8%	20%
Big Eared Woodrat	<0.1	10	1,274,482	<0.1%	48,441	3.8%	60%
Dusky Footed Woodrat	<0.1	10	2,573,683	<0.1%	97,810	3.8%	60%
Black Tailed Jackrabbit	0.7	2	191,694	<0.1%	10,853	5.7%	20%
Desert Cottontail Rabbit	886.3	2,278	885,899	0.3%	40,565	4.6%	40%
Brush Rabbit	813.7	2,645	813,657	0.3%	34,645	4.3%	40%
California Ground Squirrel	245.2	371	4,367,048	<0.1%	166,369	3.8%	40%
Western Gray Squirrel	103.2	673	126,716	0.5%	6,357	5.0%	40%
Deer Mouse	1,000	3,570	17,319,086	<0.1%	661,696	3.8%	40%
Mule Deer	2.9	8	11,857	0.1%	2,834	24.0%	ND
Mountain Lion (not CSA listed)	3.1	1.6	199	0.8%	9.1	4.6%	11%
Mountain Lion (CSA listed)	3.1	0.1	199	0.1%	6.5	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-52. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Luis Obispo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	20
Common Raven	5.5	9	330,000	<0.1%	1.1%	18
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	70
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	304
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	32
Canada Geese	0	0	51,148	0%	0%	11
California Gull	0	0	112,601	0%	0%	4
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.27 Santa Barbara

Baseline WS-California lethal WDM activities for the Santa Barbara County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and 10 mammal species:

> *Birds:* common raven and cliff swallow.
>
> *Mammals:* bobcat, coyote, gray fox, red fox, mountain lion, Virginia opossum, raccoon, striped skunk, California ground squirrel and feral swine.

Of all the WDM activities conducted in Santa Barbara County, 64% involved lethal WDM of coyote (37%) in response to predation of livestock and lethal WDM of striped skunk (27%) in response agriculture and property damage, as well as for the protection of threatened and endangered species (i.e., snowy plover). The most common method of WDM used in Santa Barbara County during the baseline period was cage traps used for lethal WDM of striped skunks. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-53 and 5-54. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-53. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Santa Barbara County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.1	3	1,556	0.2%	64	4.1%	10%
Bobcat	1.2	4	894	0.4%	41	4.6%	17%
Coyote	125	195	3,809	5.1%	909	23.9%	50%
Gray Fox	0.4	1	4,992	<0.1%	286	5.7%	20%
Long Tailed Weasel	0	1	2,343	<0.1%	90	3.8%	10%
Raccoon	30.7	55	58,884	0.1%	2,303	3.9%	49%
Western Spotted Skunk	0	1	12,674	<0.1%	482	3.8%	10%
Striped Skunk	82.7	134	46,743	0.3%	1,929	4.1%	10%
North American Porcupine	<0.1	1	5,876	<0.1%	224	3.8%	20%
Big Eared Woodrat	<0.1	10	2,000,616	<0.1%	76,034	3.8%	60%
Dusky Footed Woodrat	<0.1	10	2,748,050	<0.1%	104,436	3.8%	60%
Black Tailed Jackrabbit	0.6	2	143,283	<0.1%	8,197	5.7%	20%
Desert Cottontail Rabbit	663.6	1,706	663,648	0.3%	31,073	4.7%	40%
Brush Rabbit	618.9	2,012	618,933	0.3%	26,757	4.3%	40%
California Ground Squirrel	200.1	303	3,444,148	<0.1%	131,184	3.8%	40%
Western Gray Squirrel	50	326	58,286	0.6%	2,941	5.0%	40%
Deer Mouse	1,000	3,570	14,365,209	<0.1%	549,448	3.8%	40%
Mountain Lion (not CSA listed)	0.8	0.4	154	0.3%	6.3	4.1%	11%
Mountain Lion (CSA listed)	0.8	0.1	154	0.1%	5	3.2%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-54. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Santa Barbara County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	10
Common Raven	0.4	1	330,000	<0.1%	0.1%	4
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.28 Shasta

Baseline WS-California lethal WDM activities for the Shasta County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved seven bird species and 15 mammal species:

Birds: Brewer's blackbird, red-winged blackbird, yellow-headed blackbird, American coot, brown-headed cowbird, house sparrow, and European starling.

Mammals: black bear, North American beaver, bobcat, coyote, mule deer, feral dog, gray fox, mountain lion, muskrat, Virginia opossum, river otter, raccoon, striped skunk, California ground squirrel and feral swine.

The majority of WDM activities for bird species, most of which were non-lethal, involved the following species: red-winged blackbird (347,459.3 average individuals affected per year), yellow-headed blackbird (1,030.6 individuals affected per year), mixed-flock blackbirds (7,500.0 individuals affected per year), and American coot (1,870.8 individuals affected per year). The most common method of WDM used in Shasta County during the baseline period was firearms used for dispersal of birds and lethal WDM of muskrat in response to agriculture, property, and natural resource damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-55 and 5-56. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-55. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Shasta County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.7	2	967	0.2%	39	4.0%	10%
Black Bear	16.1	33	1,145	2.9%	212	NA	14.2%
Bobcat	0.9	3	1,394	0.2%	70	5.0%	17%
Coyote	49.5	78	5,694	1.4%	1,150	20.2%	50%
Gray Fox	1	2	6,248	<0.1%	375	6.0%	20%
Long Tailed Weasel	0	1	3,266	<0.1%	125	3.8%	10%
American Mink	<0.1	1	45	2.2%	5	11.0%	25%
Raccoon	2.7	5	77,187	<0.1%	2,949	3.8%	49%
River Otter	0.1	0.4	28	1.4%	1.5	5.4%	20%
Western Spotted Skunk	0	1	16,619	<0.1%	632	3.8%	10%
Striped Skunk	7.6	13	61,427	<0.1%	2,357	3.8%	10%
North American Beaver	9.4	14	73,857	<0.1%	2,824	3.8%	20%
North American Porcupine	<0.1	1	19,488	<0.1%	741	3.8%	20%
Yellow Bellied Marmot	1.7	8	15,466	<0.1%	791	5.1%	20%
Dusky Footed Woodrat	<0.1	10	4,975,164	<0.1%	189,067	3.8%	60%
Black Tailed Jackrabbit	0.5	2	122,179	<0.1%	6,965	5.7%	20%
Desert Cottontail Rabbit	175.5	452	175,521	0.3%	8,239	4.7%	40%
Brush Rabbit	320.2	1,041	320,164	0.3%	13,542	4.2%	40%
California Ground Squirrel	202.2	306	5,079,201	<0.1%	193,319	3.8%	40%
Western Gray Squirrel	100	652	448,139	0.1%	20,752	4.6%	40%
Deer Mouse	1,000	3,570	19,843,616	<0.1%	757,628	3.8%	40%
Mule Deer	0.1	1	25,453	<0.1%	6,083	23.9%	ND
Mountain Lion	7.4	3.7	230	1.6%	12.4	5.4%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-56. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Shasta County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	4,419.3	12,728	14,000,000	<0.1%	34.3%	12,729
Brewer's Blackbird	130.2	417	4,200,000	<0.1%	1.9%	418
Yellow-headed Blackbird	90.6	539	530,000	<0.1%	30.5%	539
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.29 Sierra

Baseline WS-California lethal WDM activities for the Sierra County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved eight mammal species:

> *Mammals:* black bear, North American beaver, coyote, mountain lion, muskrat, raccoon, spotted skunk, and striped skunk.

Of all the WDM activities conducted in Sierra County, 89% involved lethal WDM of coyote (56%) in response to predation of livestock and lethal WDM of muskrat (33%) in response to property damage. The most common methods of WDM used in Sierra County during the baseline period were rodent bait used for lethal WDM of muskrat and firearms used for lethal WDM of coyotes. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-57 and 5-58. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-57. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Sierra County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	235	0.4%	10	4.3%	10%
Black Bear	1.3	3	322	0.9%	41	NA	14.2%
Bobcat	0	1	323	0.3%	14	4.3%	17%
Coyote	74.4	117	1,456	8.0%	390	26.8%	50%
Long Tailed Weasel	0	1	828	<0.1%	32	3.9%	10%
American Mink	<0.1	1	18	5.5%	1	5.5%	25%
Raccoon	2.3	5	15,662	<0.1%	602	3.8%	49%
Western Spotted Skunk	0.1	1	3,455	<0.1%	132	3.8%	10%
Striped Skunk	4.5	8	14,854	0.1%	576	3.9%	10%
North American beaver	6.5	10	9,269	0.1%	363	3.9%	20%
North American Porcupine	<0.1	1	5,290	<0.1%	202	3.8%	20%
Yellow Bellied Marmot	0.9	5	8,205	<0.1%	420	5.1%	20%
Dusky Footed Woodrat	<0.1	10	698,128	<0.1%	26,539	3.8%	60%
Brush Rabbit	11	36	10,798	0.3%	462	4.3%	40%
Black Tailed Jackrabbit	0.05	1	12,690	<0.1%	649	5.1%	20%
California Ground Squirrel	200	302	1,250,022	<0.1%	47,807	3.8%	40%
Western Gray Squirrel	50	326	46,445	0.7%	2,410	5.2%	40%
Deer Mouse	1,000	3,570	5,004,735	0.1%	193,750	3.9%	40%
Mountain Lion (not CSA listed)	0.2	0.1	56	0.2%	2.2	3.9%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-58. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Sierra County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.1	1	24,000	<0.1%	0.7%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.30 Siskiyou

Baseline WS-California lethal WDM activities for the Siskiyou County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and 14 mammal species:

> *Birds:* Brewer's blackbird, brown-headed cowbird, common raven, and European starling.
>
> *Mammals:* American badger, black bear, North American beaver, bobcat, feral cat, coyote, gray fox, mountain lion, Virginia opossum, North American porcupine, raccoon, spotted skunk, striped skunk, and feral swine.

The majority of WDM activities conducted in Siskiyou County involved lethal WDM of European starling and Brewer's blackbird in response to field crop damage and lethal WDM of coyote in response to predation of livestock and property damage. The most common methods of WDM used in Siskiyou County during the baseline period were DRC-1339-feedlots used for lethal WDM of bird species and firearms used for the lethal WDM of coyote. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-59 and 5-60. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-59. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Siskiyou County

Species	Average County-Program Lethal WDM Take[3]	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	22.8	62	1,755	3.5%	129	7.4%	10%
Black Bear	18.4	38	2,062	1.8%	221	NA	14.2%
Bobcat	0.9	3	2,188	0.1%	98	4.5%	17%
Coyote	177.9	278	9,494	2.9%	2,103	22.2%	50%
Gray Fox	9.2	18	9,427	0.2%	654	6.9%	20%
Long Tailed Weasel	0	1	5,406	<0.1%	206	3.8%	10%
American Mink	<0.1	1	38	2.6%	3	7.8%	25%
Raccoon	53.2	95	104,492	0.1%	4,080	3.9%	49%
Western Spotted Skunk	0.4	1	25,942	<0.1%	989	3.8%	10%
Striped Skunk	102	166	94,556	0.2%	3,778	4.0%	10%
North American Beaver	6.7	10	106,206	<0.1%	4,050	3.8%	20%
North American Porcupine	0.9	5	31,207	<0.1%	1,187	3.8%	20%
Yellow Bellied Marmot	2.6	13	24,130	<0.1%	1,234	5.1%	20%
Dusky Footed Woodrat	<0.1	10	8,818,148	<0.1%	335,100	3.8%	60%
Black Tailed Jackrabbit	0.8	2	193,997	<0.1%	12,821	6.6%	20%
Brush Rabbit	234	761	233,993	0.3%	9,708	4.1%	40%
California Ground Squirrel	400	604	8,207,839	<0.1%	312,506	3.8%	40%
Western Gray Squirrel	100	652	621,527	0.1%	28,529	4.6%	40%
Deer Mouse	1,000	3,570	32,998,899	<0.1%	1,257,529	3.8%	40%
Mountain Lion	4.4	2.2	339	0.6%	15.1	4.5%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

3 Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.

Table 5-60. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Siskiyou County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	6.2	10	330,000	<0.1%	1.3%	12
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	622.2	1992	4,200,000	<0.1%	9.0%	1992
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	51,148	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included. Siskiyou County had a CSA with WS-California during 2010 through 2018, so the take analysis is limited to these nine years.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.31 Solano

Baseline WS-California lethal WDM activities for the Solano County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and nine mammal species:

Birds: American crow, Canada goose, common raven, wild turkey, and feral pigeon.

Mammals: North American beaver, feral cat, coyote, red fox, black-tailed jackrabbit, Virginia opossum, raccoon, striped skunk, and feral swine.

The majority of WDM activities for bird species were non-lethal and occurred at airports, mainly involving the following species: red-winged blackbird (11,798.1 average individuals affected per year) and European starlings (30,170.5 individuals affected per year). The most common methods of WDM used in Solano County during the baseline period were 12-gauge cracker shells and vehicles used for dispersal of birds at airports and firearms used for lethal WDM of coyote, black-tailed jackrabbit, and ground squirrels in response to livestock predation and agriculture and property damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-61 and 5-62. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-61. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Solano County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	404	0.3%	17	4.2%	10%
Bobcat	0	1	143	0.7%	7	4.9%	17%
Coyote	80.3	126	1,063	11.9%	336	31.6%	50%
Gray Fox	0	1	1,059	0.1%	89	8.4%	20%
Red Fox	0.1	1	18	5.6%	3	16.7%	25%
Long Tailed Weasel	0	1	619	<0.1%	24	3.9%	10%
American Mink	<0.1	1	195	0.5%	9	4.6%	25%
Raccoon	3.9	7	18,854	<0.1%	790	4.2%	49%
Striped Skunk	0.4	1	13,933	<0.1%	585	4.2%	10%
North American beaver	7.8	12	6,606	0.2%	265	4.0%	20%
Dusky Footed Woodrat	<0.1	10	175,415	<0.1%	6,676	3.8%	60%
Desert Cottontail Rabbit	188.2	484	188,199	0.3%	8,428	4.5%	40%
Black Tailed Jackrabbit	0.3	1	43,403	<0.1%	3,824	8.8%	20%
Brush Rabbit	58.9	192	58,947	0.3%	2,588	4.4%	40%
California Ground Squirrel	200	302	1,919,196	<0.1%	73,236	3.8%	40%
Deer Mouse	1,000	3,570	4,571,599	0.1%	177,319	3.9%	40%

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

[2] A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-62. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Solano County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.4	1	480,000	<0.1%	0.1%	11
Common Raven	5.3	8	330,000	<0.1%	1.1%	14
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	22
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	350
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	341
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0.4	1	51,148	<0.1%	0.1%	11
California Gull	0	0	112,601	0%	0%	7
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.32 Sonoma

Baseline WS-California lethal WDM activities for the Sonoma County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and 12 mammal species:

Birds: red-winged blackbird and rock pigeon.

Mammals: American badger, black bear, North American beaver, bobcat, coyote, gray fox, red fox, mule deer, mountain lion, raccoon, striped skunk, and feral swine.

Because Sonoma County did not renew their contract with WS-California for 2013, the data provided are limited to only the years 2010–2012. The majority of WDM activities conducted in Sonoma County involved lethal WDM of coyote and feral swine in response to predation of livestock and agriculture damage. The most common method of WDM used in Sonoma County during the baseline period was firearms used for lethal WDM of coyote and feral swine. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-63 and 5-64. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-63. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Sonoma County

Species	Average County-Program Lethal WDM Take[3]	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	466	0.2%	19	4.1%	10%
Black Bear	0.3	1	493	0.2%	16	NA	14.2%
Bobcat	7.5	23	482	4.8%	43	8.9%	17%
Coyote	173.8	272	2,322	11.7%	707	30.4%	50%
Gray Fox	2.5	7	1,685	0.4%	103	6.1%	20%
Long Tailed Weasel	0	1	1,361	<0.1%	52	3.8%	10%
American Mink	<0.1	1	42	2.4%	2	4.7%	25%
Raccoon	4.3	8	37,403	<0.1%	1,433	3.8%	49%
Striped Skunk	1.3	3	24,714	<0.1%	946	3.8%	10%
North American Beaver	1.8	3	0	0.31%[4]	3	4.1%[4]	20%
North American Porcupine	<0.1	1	3,861	<0.1%	147	3.8%	20%
Dusky Footed Woodrat	<0.1	10	2,291,995	<0.1%	87,106	3.8%	60%
Black Tailed Jackrabbit	0.2	1	56,675	<0.1%	7,653	13.5%	20%
Brush Rabbit	227.8	741	227,844	0.3%	9,557	4.4%	40%
California Ground Squirrel	200	302	1,919,196	<0.1%	73,236	3.8%	40%
Western Gray Squirrel	100	652	156,920	0.4%	7,691	4.9%	40%
Deer Mouse	1000	3,570	8,332,018	<0.1%	320,187	3.8%	40%
Mule Deer	0.5	1.3	8,470	<0.1%	2,024	23.9%	ND
Mountain Lion	2.5	1.3	71	1.8%	3.9	5.5%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

3 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

4 A regional analysis was conducted for these counties (Lake, Mendocino, Napa, and Sonoma; Marin would have been included but the estimated population is zero) to determine mortality as a percentage of the regional population, which is 0.31% under the Proposed Project and 4.1% cumulative mortality. These percentages were applied to all counties in this region (except Marin where the estimated population is zero and there is no estimated cumulative mortality).

Table 5-64. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Sonoma County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	6
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	3
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	216.6	624	14,000,000	<0.1%	1.7%	627
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	366
Canada Geese	0.3	1	51,148	<0.1%	0.1%	3
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 Sonoma County had a CSA with WS-California during 2010 through 2013, so the take analysis is limited to these four years.

5.1.33 Stanislaus

Baseline WS-California lethal WDM activities for the Stanislaus County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and 14 mammal species:

> *Birds:* northern flicker, California scrub jay, rock pigeon, European starling, and cliff swallow.
>
> *Mammals:* North American beaver, bobcat, feral cat, coyote, mule deer, gray fox, red fox, mountain lion, muskrat, Virginia opossum, raccoon, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted in Stanislaus County, 57% involved lethal WDM of coyote and raccoon in response to predation of livestock and agriculture and property damage, respectively. The most common method of WDM used in Stanislaus County during the baseline period was cage traps used for lethal WDM of raccoon. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-65 and 5-66. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-65. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Stanislaus County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.6	2	867	0.2%	35	4.0%	10%
Bobcat	0.4	2	360	0.6%	17	4.7%	17%
Coyote	60.7	95	2,229	4.3%	513	23.0%	50%
Gray Fox	6.8	14	1,555	0.9%	101	6.5%	20%
Long Tailed Weasel	0	1	1,026	<0.1%	40	3.9%	10%
American Mink	<0.1	1	39	2.5%	2	5.1%	25%
Raccoon	61.8	111	22,844	0.5%	981	4.3%	49%
Striped Skunk	9.2	15	25,762	0.1%	998	3.9%	10%
North American beaver	31	46	1,947	2.4%	120	6.2%	20%
Big Eared Woodrat	0	10	37,732	<0.1%	1,444	3.8%	60%
Dusky Footed Woodrat	<0.1	10	712,338	<0.1%	27,079	3.8%	60%
Black Tailed Jackrabbit	0.3	1	88,878	<0.1%	7,882	8.9%	20%
Desert Cottontail Rabbit	404	1,039	404,023	0.3%	18,164	4.5%	40%
Brush Rabbit	111.3	362	111,346	0.3%	4,963	4.5%	40%
California Ground Squirrel	203.4	308	2,012,198	<0.1%	76,775	3.8%	40%
Deer Mouse	1,000	3,570	7,812,062	<0.1%	300,429	3.8%	40%
Mule Deer	0.1	1	2,649	<0.1%	633	23.9%	ND
Mountain Lion	0.2	0.1	32	0.3%	1.3	4.1%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-66. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Stanislaus County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,00	0%	0%	2
California Scrub-Jay	2.2	3	1,200,000	<0.1%	1.9%	3
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	11.1	75	430,000	<0.1%	12.7%	75

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.34 Sutter

Baseline WS-California lethal WDM activities for the Stanislaus County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species and 11 mammal species:

Birds: rock pigeon

Mammals: North American beaver, coyote, mule deer, gray fox, red fox, black-tailed jackrabbit, muskrat, Virginia opossum, raccoon, striped skunk, and feral swine.

Of all the WDM activities conducted in Sutter County, 89% involved dispersal of greater white-fronted geese (*Anser albifrons*) in response to field crop and range/pasture damage. The largest portion of non-avian WDM involved lethal WDM of North American beaver in response to agriculture and property damage. The most common methods of WDM used in Sutter County during the baseline period were bombs/bangers, firearms, and whistlers/screamers used for dispersal of greater white-fronted geese and firearms used for lethal WDM of North American beaver. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-67 and 5-68. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-67. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Sutter County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	227	0.4%	10	4.4%	10%
Bobcat	0	1	45	2.2%	4	8.9%	17%
Coyote	55.2	87	880	9.9%	252	28.6%	50%
Gray Fox	0.6	2	631	0.3%	37	5.9%	20%
Red Fox	0.6	1	32	3.1%	3	9.4%	25%
Long Tailed Weasel	0	1	273	<0.1%	11	4.0%	10%
American Mink	<0.1	1	92	1.1%	5	5.4%	25%
Raccoon	13.6	25	5,590	0.4%	250	4.5%	49%
Striped Skunk	71.2	116	10,420	1.1%	516	5.0%	10%
North American Beaver	128.7	188	3,954	4.8%	339	8.6%	20%
Black Tailed Jackrabbit	1.2	3	35,361	<0.1%	1,931	5.5%	20%
Desert Cottontail Rabbit	156.4	403	156,434	0.3%	22,912	4.3%	40%
California Ground Squirrel	200	302	784,426	<0.1%	30,115	3.8%	40%
Deer Mouse	1,000	3,570	3,154,769	0.1%	123,452	3.9%	40%
Mule Deer	0.2	1	406	0.2%	97	24.1%	ND

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-68. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Sutter County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	288
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	0
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.35 Trinity

Baseline WS-California lethal WDM activities for the Trinity County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved 11 mammal species:

Mammals: black bear, North American beaver, bobcat, coyote, gray fox, mountain lion, raccoon and striped skunk.

Of all the WDM activities conducted in Trinity County, 58% involved lethal WDM of black bear and striped skunk in response to livestock predation and agriculture damage. The most common methods of WDM used in Trinity County during the baseline period were cage traps used for the lethal WDM of striped skunk and culvert traps used for lethal WDM of lethal WDM of black bear. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-69 and 5-70. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-69. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Trinity County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	402	0.3%	17	4.2%	10%
Black Bear	3.3	7	1,251	0.6%	176	14.1%	14.2%
Bobcat	0.2	1	1,124	0.1%	47	4.2%	17%
Coyote	1	3	4,802	<0.1%	904	18.8%	50%
Gray Fox	0.3	1	3,334	<0.1%	217	6.5%	20%
Long Tailed Weasel	0	1	2,732	<0.1%	104	3.8%	10%
American Mink	<0.1	1	14	7.1%	1	7.1%	25%
Raccoon	1.6	3	59,560	<0.1%	2,272	3.8%	49%
Western Spotted Skunk	0	1	13,564	<0.1%	516	3.8%	10%
Striped Skunk	4.5	8	41,298	<0.1%	1,583	3.8%	10%
North American beaver	0.3	1	28,875	<0.1%	1,098	3.8%	20%
North American Porcupine	<0.1	1	19,973	<0.1%	760	3.8%	20%
Dusky Footed Woodrat	<0.1	10	5,875,475	<0.1%	223,279	3.8%	60%
Black Tailed Jackrabbit	0.2	1	54,596	<0.1%	4,061	7.4%	20%
Brush Rabbit	165	537	165,045	0.3%	7,583	4.6%	40%
California Ground Squirrel	200	302	4,241,781	<0.1%	161,494	3.8%	40%
Western Gray Squirrel	100	652	451,427	0.1%	20,900	4.6%	40%
Deer Mouse	1,000	3,570	16,673,176	<0.1%	637,151	3.8%	40%
Mountain Lion	1.8	0.9	148	0.6%	6.5	4.4%	11%

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-70. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Trinity County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.36 Tuolumne

Baseline WS-California lethal WDM activities for the Tuolumne County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species, one reptile species, and 15 mammal species:

Birds: Canada goose and rock pigeon.

Reptiles: western diamond rattlesnake.

Mammals: black bear, North American beaver, bobcat, coyote, mule deer, gray fox, feral goat, mountain lion, Virginia opossum, raccoon, striped skunk, California ground squirrel, western gray squirrel, dusky-footed woodrat, and feral swine.

Of all the WDM activities conducted in Tuolumne County, 70% of activities involved lethal WDM of coyote, striped skunk, and raccoon in response to predation of livestock and agriculture and property damage. The most common methods of WDM used in Tuolumne County during the baseline period were firearms used for lethal WDM of coyote and cage traps for lethal WDM of raccoon and striped skunk. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-71 and 5-72. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-71. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Tuolumne County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.5	2	695	0.2%	28	4.0%	10%
Black Bear	1.9	4	658	0.6%	81	12.3%	14.2%
Bobcat	1.9	6	760	0.8%	40	5.3%	17%
Coyote	83.3	130	3,068	4.2%	711	23.2%	50%
Gray Fox	4.6	9	3,167	0.3%	189	6.0%	20%
Long Tailed Weasel	0	1	1,756	<0.1%	67	3.8%	10%
American Mink	<0.1	1	39	2.5%	2	5.1%	25%
Raccoon	0	1	39,021	<0.1%	1,487	3.8%	49%
Striped Skunk	153.4	249	27,002	0.9%	1,281	4.7%	10%
North American Beaver	0.3	1	7,332	<0.1%	280	3.8%	20%
North American Porcupine	<0.1	1	11,664	<0.1%	444	3.8%	20%
Yellow Bellied Marmot	1.7	8	15,696	0.1%	803	5.1%	20%
Big Eared Woodrat	0.1	10	2,527,837	<0.1%	96,068	3.8%	60%
Black Tailed Jackrabbit	0.2	1	41,042	<0.1%	2,218	5.4%	20%
Desert Cottontail Rabbit	87.6	226	87,589	0.3%	3,779	4.3%	40%
Brush Rabbit	121.6	396	121,551	0.3%	5,015	4.6%	40%
California Ground Squirrel	211.7	320	1,636,664	<0.1%	62,518	3.8%	40%
Western Gray Squirrel	100.2	654	147,394	0.4%	7,265	4.9%	40%
Deer Mouse	1,000	3,570	11,674,839	<0.1%	447,214	3.8%	40%
Mule Deer	1.4	4	13,256	<0.1%	3,168	23.9%	ND
Mountain Lion	4.1	2.1	136	1.5%	7.2	5.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-72. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Tuolumne County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	2
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	289
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	320
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	3.1	6	51,148	<0.1%	0.7%	7
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.37 Yolo

Baseline WS-California lethal WDM activities for the Yolo County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and 12 mammal species:

Birds: feral chicken, common pea fowl, rock pigeon, and wild turkey.

Mammals: North American beaver, bobcat, coyote, mule deer, gray fox, Virginia opossum, river otter, raccoon, striped skunk, California ground squirrel, western gray squirrel, and feral swine.

Of all the WDM activities conducted in Yolo County, 65% involved lethal WDM of coyote and North American beaver in response to predation of livestock and agriculture and property damage. The most common method of WDM used in Yolo County during the baseline period was firearms used for lethal WDM of coyote and North American beaver. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-73 and 5-74. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-73. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Yolo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.4	2	536	0.4%	23	4.3%	10%
Bobcat	0.1	1	151	0.7%	8	5.3%	17%
Coyote	110.2	172	1,491	11.5%	452	30.3%	50%
Gray Fox	0.3	1	1,677	0.1%	96	5.7%	20%
Long Tailed Weasel	0	1	760	0.1%	30	3.9%	10%
American Mink	<0.1	1	45	1.0%	5	5.2%	25%
Raccoon	35.5	64	16,165	0.4%	683	4.2%	49%
River Otter	0.1	1	25	4.0%	1.4	5.6%	20%
Striped Skunk	35	57	17,420	0.3%	727	4.2%	10%
North American Beaver	162.5	238	2,284	10.4%	326	14.3%	20%
Dusky Footed Woodrat	<0.1	10	510,784	<0.1%	19,420	3.8%	60%
Black Tailed Jackrabbit	0.2	1	57,540	<0.1%	3,774	6.6%	20%
Desert Cottontail Rabbit	258.6	665	258,556	0.3%	15,424	6.0%	40%
Brush Rabbit	47.3	154	47,277	0.3%	4,087	8.6%	40%
California Ground Squirrel	202.6	306	1,329,189	<0.1%	50,820	3.8%	40%
Western Gray Squirrel	51.9	339	28,489	1.2%	1,617	5.7%	40%
Deer Mouse	1,000	3,570	5,287,807	0.1%	204,507	3.9%	40%
Mule Deer	0.1	1	1,549	0.1%	370	24.0%	ND

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-74. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Yolo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	4
Common Raven	0	0	330,000	0%	0%	3
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	3
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	290
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	321
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	3.1	6	51,148	<0.1%	0.0%	1
California Gull	0	0	112,601	0%	0%	1
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Northern Flicker	10	67	430,000	<0.1%	12.9%	64

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.1.38 Yuba

Baseline WS-California lethal WDM activities for the Yuba County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species and 14 mammal species:

Birds: Brewer's blackbird, red-winged blackbird, American coot, rock pigeon, and European starling.

Mammals: black bear, North American beaver, feral cat, coyote, gray fox, mountain lion, muskrat, Virginia opossum, river otter, feral rabbit, raccoon, striped skunk, California ground squirrel, and feral swine.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: mixed-flock blackbird (14,836.0 individuals affected per year), lesser snow geese (10,078.1 individuals affected per year), and greater white-fronted geese (14,157.9 individuals affected per year). The most common methods of WDM used in Yuba County during the baseline period were 12-gauge cracker shells used for dispersal of birds at airports and cage traps for lethal WDM of mammal species in response to agriculture and property damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-75 and 5-76. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-75. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Yuba County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	211	0.47%	10	4.7%	10%
Black Bear	2	5	63	7.9%	20	31.7%	14.2%
Bobcat	0	1	159	0.6%	11	6.9%	17%
Coyote	5.8	10	941	1.1%	201	21.4%	50%
Gray Fox	2.4	5	750	0.7%	47	6.3%	20%
Long Tailed Weasel	0	1	451	0.2%	18	4.0%	10%
American Mink	<0.1	1	45	2.2%	2	4.4%	25%
Raccoon	19.6	35	9,196	0.4%	388	4.2%	49%
River Otter	0.4	1.6	17	9.4%	2.3	13.5%	20%
Western Spotted Skunk	0.2	1	15,479	0.1%	589	3.8%	10%
Striped Skunk	69	112	10,274	1.1%	507	4.9%	10%
North American beaver	68.6	101	6,029	1.7%	330	5.5%	20%
North American Porcupine	<0.1	1	2,028	<0.1%	78	3.8%	20%
Dusky Footed Woodrat	<0.1	10	694,379	<0.1%	26,397	3.8%	60%
Black Tailed Jackrabbit	0.1	1	28,445	<0.1%	1,869	6.6%	20%
Desert Cottontail Rabbit	120.2	309	120,208	0.4%	5,617	4.7%	40%
Brush Rabbit	55	179	54,552	0.3%	2,561	4.7%	40%
California Ground Squirrel	201	303.51	826,976	<0.1%	31,810	3.8%	40%
Western Gray Squirrel	50	326	49,485	0.7%	2,546	5.1%	40%
Deer Mouse	1000	3570	3,292,487	0.1%	128,685	3.9%	40%
Mountain Lion	1.6	0.8	21	3.8%	1.6	7.6%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-76. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Yuba County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	5
Common Raven	0	0	330,000	0%	0%	9
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	22
Red-winged Blackbird	103.8	299	14,000,000	<0.1%	0.8%	300
Brewer's Blackbird	101.9	327	4,200,000	<0.1%	1.5%	358
Yellow-headed Blackbird	5	30	530,000	<0.1%	1.7%	30
Canada Geese	0	0	51,148	0%	0%	22
California Gull	0	0	112,601	0%	0%	6
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.2 County-Directed Programs

5.2.1 Fresno

Baseline lethal WDM activities for the county-directed Fresno County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved only American coot. WDM methods used by USDA-WS in Fresno County consisted of A/C powder for lethal WDM of American coot and non-lethal WDM of mallard, as well as dogs and drug delivery devices related to non-lethal WDM of mountain lion. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-77 and 5-78. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-77. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Fresno County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	2.2	6	3,035	0.2%	122	4.0%	10%
Black Bear	4.6	10	648	1.5%	90	13.9%	14.2%
Bobcat	1.5	5	1,339	0.4%	52	3.9%	17%
Coyote	293.6	459	8,416	5.5%	2,036	24.2%	50%
Gray Fox	8.2	8	7,343	0.1%	429	5.8%	20%
Long Tailed Weasel	<0.1	1	4,204	<0.1%	160	3.8%	10%
Raccoon	105.9	189	93,235	0.2%	3,735	4.0%	49%
River Otter	0.1	0.4	11	3.6%	0.9	8.2%	20%
Western Spotted Skunk	0.18	1	19,259	<0.1%	733	3.8%	10%
Striped Skunk	190.3	309	883,731	<0.1%	3,495	0.4%	10%
North American beaver	4.6	7	2,070	0.3%	86	4.2%	20%
North American Porcupine	<0.1	1	13,083	<0.1%	498	3.8%	20%
Yellow Bellied Marmot	2.5	12	23,477	0.1%	1,201	5.1%	20%
Big Eared Woodrat	<0.1	10	2,039,552	<0.1%	77,513	3.8%	60%
Dusky Footed Woodrat	<0.1	10	752,962	<0.1%	28,623	3.8%	60%
Black-Tailed Jackrabbit	0.9	3	244,587	<0.1%	13,141	5.4%	20%
Desert Cottontail Rabbit	1,022.6	2,629	1,022,606	0.3%	49,269	4.8%	40%
Brush Rabbit	330	1,074	330,271	0.3%	16,207	4.9%	40%

Table 5-77. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Fresno County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
California Ground Squirrel	321.2	486	5,883,673	<0.1%	222,169	3.8%	40%
Western Gray Squirrel	100.6	656	170,375	0.4%	8,298	4.9%	40%
Deer Mouse	1,000	3,571	31,191,294	<0.1%	1,188,841	3.8%	40%
Mule Deer	0.5	2	16,722	<0.1%	3,997	23.9%	ND
Mountain Lion	4.5	2.3	207	1.1%	10.1	4.9%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-78. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Fresno County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	6
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	3
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	322	14,000,000	<0.1%	1.7%	325
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	366
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	3
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.2.2 Kings

Baseline lethal WDM activities for the county-directed Kings County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved five bird species:

Birds: American coot, feral duck, mallard duck, common gallinule, and European starling.

The majority of WDM activities for bird species occurred at airports and mainly involved the following species: mourning dove (6,956.0 individuals affected per year), horned lark (*Eremophila alpestris*) (14,054.5 individuals affected per year), and western meadowlark (*Sternula neglecta*) (2,042.2 individuals affected per year). The most common methods of WDM used in Kings County by USDA-WS during the baseline period were firearms used for dispersal of birds at airports and firearms for lethal WDM of mammal species. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-79 and 5-80. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-79. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Kings County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.7	2	887	0.2%	36	4.1%	10%
Black Bear	2.9	6	398	1.5%	19	NA	14.2%
Bobcat	0.2	1	132	0.8%	6	4.5%	17%
Coyote	71.7	112	2,055	5.5%	512	24.9%	50%
Gray Fox	2.4	3	2,172	0.1%	125	5.8%	20%
Long Tailed Weasel	0	1	1,067	<0.1%	41	3.8%	10%
Raccoon	22.7	41	20,024	0.2%	804	4.0%	49%
Western Spotted Skunk	0	1	5,773	0.02%	220	3.8%	10%
Striped Skunk	53.4	87	23,505	0.4%	984	4.2%	10%
North American Beaver	0.1	1	59	1.7%	3	5.1%	20%
Dusky Footed Woodrat	<0.1	10	69,636	<0.1%	2,657	3.8%	60%
Black Tailed Jackrabbit	0.3	1	83,799	<0.1%	4,837	5.8%	20%
Desert Cottontail Rabbit	370.8	953	370,786	0.4%	21,113	5.7%	40%
Brush Rabbit	26	85	26,379	0.3%	1,298	4.9%	40%
California Ground Squirrel	238.2	360	1,840,909	<0.1%	72,511	3.9%	40%
Deer Mouse	1,000	3,570	7,138,078	0.1%	274,817	3.9%	40%
Mountain Lion (not CSA listed)	0.2	0.1	7	1.4%	0.4	5.7%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-80. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Kings County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	25
Common Raven	1.6	3	330,000	<0.1%	0.3%	8
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	83
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	725
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	365
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	49
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	1
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	180
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.2.3 Los Angeles

Baseline lethal WDM activities for the county-directed Los Angeles County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and three mammal species.

Birds: American coot, feral duck and mallard duck

Mammals: coyote, mule deer, and gray fox

The majority of WDM activities by USDA-WS for bird species occurred at airports and mainly involved the following species: mourning dove (1,517.6 individuals affected per year), house finch (*Haemorhous mexicanus*) (1,528.5 individuals affected per year), horned lark (1,561.5 individuals affected per year), and European starling (1,663.2 individuals affected per year). The most common methods of WDM used in Los Angeles County by USDA-WS during the baseline period were firearms used for dispersal of birds at airports and cage traps for lethal WDM of California ground squirrels in response to property damage. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-81 and 5-82. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-81. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Los Angeles County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.3	4	1,753	0.23%	71	4.1%	10%
Black Bear	3.8	8	530	1.5%	35	NA	14.2%
Bobcat	2.1	7	1,563	0.4%	77	4.9%	17%
Coyote	189.1	295	5,302	5.6%	1,316	24.8%	50%
Gray Fox	6.2	13	5,442	0.2%	435	8.0%	20%
Long-Tailed Weasel	0	1	2,662	<0.1%	102	3.8%	10%
Raccoon	262	467	230,727	0.2%	9,266	4.0%	49%
Western Spotted Skunk	0	1	17,741	<0.1%	675	3.8%	10%
Striped Skunk	118.2	192	51,997	0.4%	2,223	4.3%	10%
North American Porcupine	<0.1	1	7,338	<0.1%	279	3.8%	20%
Big-Eared Woodrat	0.02	10	4,153,802	<0.1%	157,855	3.8%	60%
Black-Tailed Jackrabbit	0.89	2	230,847	<0.1%	13,737	6.0%	20%
Desert Cottontail Rabbit	998.8	2,567	999,822	0.3%	46,138	4.6%	40%
Brush Rabbit	675	2,194	674,737	0.3%	29,106	4.3%	40%
California Ground Squirrel	284	429	4,044,465	<0.1%	155,417	3.8%	40%
Western Gray Squirrel	100.2	654	43,841	1.5%	2,621	6.0%	40%
Deer Mouse	1,000.1	3,571	21,301,455	<0.1%	813,027	3.8%	40%
Mule Deer	1.1	3	13,581	<0.1%	3,246	23.9%	ND
Mountain Lion (not CSA listed)	2.5	1.3	113	1.2%	5.6	5.0%	11%
Mountain Lion (CSA listed)	2.5	0.1	113	0.1%	3.7	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-82. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Los Angeles County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	249
Common Raven	1.6	3	330,000	<0.1%	0.3%	51
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	3
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	144
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	669
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	372
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	83
Canada Geese	0.3	1	51,148	<0.1%	0.1%	12
California Gull	0.1	1	112,601	<0.1%	<0.1%	31
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	69

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.2.4 Marin

Baseline lethal WDM activities for the county-directed Marin County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and four mammal species.

Birds: rock pigeon and Canada goose

Mammals: coyote, Virginia opossum, raccoon, and striped skunk.

The majority of WDM activities conducted by USDA-WS in Marin County involved dispersal of Canada geese. Non-lethal and lethal WDM of common raven within Marin County occurred for the protection of threatened and endangered species (i.e., snowy plover). The most common methods of WDM used in Marin County by USDA-WS during the baseline period were dogs used for dispersal of Canada geese and cage traps for lethal WDM of raccoon and striped skunk. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-83 and 5-84. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-83. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Marin County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.1	1	197	0.5%	9	4.6%	10%
Black Bear	0.8	2	113	1.8%	5	4.4%	14.2%
Bobcat	0.3	1	229	0.4%	12	5.2%	17%
Coyote	25.7	41	732	5.6%	178	24.3%	50%
Gray Fox	0.7	1	588	0.2%	34	5.8%	20%
Long-Tailed Weasel	0	1	441	0.2%	17	3.9%	10%
American Mink	<0.1	1	22	4.5%	1	4.5%	25%
Raccoon	23.3	42	16,398	0.3%	667	4.1%	49%
Striped Skunk	24.3	40	8,239	0.5%	357	4.3%	10%
North American Porcupine	<0.1	1	1,190	<0.1%	46	3.9%	20%
Dusky Footed Woodrat	<0.1	10	613,452	<0.1%	23,322	3.8%	60%
Black-Tailed Jackrabbit	<0.1	1	21,785	<0.1%	1,088	5.0%	20%
Brush Rabbit	98.3	320	98,345	0.3%	4,058	4.1%	40%
California Ground Squirrel	213.9	323	66,787	0.5%	25,665	38.4%	40%
Western Gray Squirrel	50.1	327	32,015	1.0%	1,763	5.5%	40%
Deer Mouse	1,000	3,570	3,063,622	0.1%	119,988	3.9%	40%
Mule Deer	0.1	1	2,765	<0.1%	661	23.9%	ND
Mountain Lion	0.5	0.3	23	1.3%	1.1	4.8%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-84. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Marin County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	28
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	365
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.2.5 Placer

Baseline lethal WDM activities for the county-directed Placer County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species and four mammal species.

Birds: rock pigeon

Mammals: black bear, North American beaver, bobcat, coyote, mule deer, feral dog, gray fox, red fox, mountain lion, American mink, Virginia opossum, raccoon, brown rat, striped skunk, fox squirrel, western gray squirrel, and feral swine.

The majority of WDM activities conducted by USDA-WS in Placer County involved lethal WDM of North American beaver, raccoon, and striped skunk in response to agriculture and property damage. The most common methods of WDM used in Placer County by USDA-WS during the baseline period were cage traps used for lethal WDM of raccoon and striped skunk and neck snares used for the lethal WDM of North American beaver and coyote. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-85 and 5-86. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-85. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Placer County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	283	0.4%	12	4.2%	10%
Black Bear	5.5	12	375	3.2%	64	17.1%	14.2%
Bobcat	1.3	4	538	0.7%	28	5.2%	17%
Coyote	120.8	189	2,044	9.2%	572	28.0%	50%
Gray Fox	8.3	19	2,131	0.9%	144	6.8%	20%
Long-Tailed Weasel	<0.1	1	1,184	<0.1%	46	3.9%	10%
American Mink	0.2	2	48	4.1%	5	10.3%	25%
Raccoon	292.8	522	40,876	1.3%	2,089	5.1%	49%
Striped Skunk	553	896	22,022	4.1%	1,741	7.9%	10%
North American Beaver	218.7	320	15,522	2.1%	912	5.9%	20%
North American Porcupine	<0.1	1	6,928	<0.1%	264	3.8%	20%
Yellow-Bellied Marmot	0.7	4	6,467	<0.1%	331	5.1%	20%
Dusky Footed Woodrat	<0.1	10	1,549,423	<0.1%	58,889	3.8%	60%
Black-Tailed Jackrabbit	0.1	1	37,135	<0.1%	1,946	5.2%	20%
Desert Cottontail Rabbit	111.9	288	111,902	0.3%	5,075	4.5%	40%
Brush Rabbit	76.4	249	76,411	0.3%	3,277	4.3%	40%
California Ground Squirrel	200	302	1,861,691	<0.1%	71,051	3.8%	40%
Western Gray Squirrel	61.5	401	99,932	0.4%	4,884	4.9%	40%
Deer Mouse	1,000	3,570	7,373,700	<0.1%	283,771	3.8%	40%
Mule Deer	0.2	1	8,204	<0.1%	1,961	23.9%	ND
Mountain Lion	1.3	0.7	73	1.0%	3.4	4.7%	11%

Notes: Only species with projected county-level lethal take are included. Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-86. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Placer County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	6
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	624
Brewer’s Blackbird	113.7	364	4,200,000	<0.1%	1.6%	366
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 Placer County had a CSA with WS-California during 2010 through 2015, so the take analysis is limited to these six years.

5.2.6 San Bernardino

Baseline lethal WDM activities for the county-directed San Bernardino County program (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species and seven mammal species.

Birds: American coot, mallard duck, black-crowned night heron, common raven

Mammals: American badger, feral cat, coyote, Virginia opossum, desert cottontail rabbit, striped skunk, and California ground squirrel

Most WDM activities for bird species by USDA-WS occurred at airports and mainly involved the following species: mourning dove (514.9 individuals affected per year), brown-headed cowbird (709.4 individuals affected per year), and European starling (1,880.4 individuals affected per year). A portion of the lethal WDM of common raven and coyote and non-lethal WDM of badger, bobcat, and kit fox within San Bernardino County occurred for the protection of threatened and endangered species (i.e., desert tortoise). The most common methods of WDM used in San Bernardino County by USDA-WS during the baseline period were firearms used for dispersal of birds at airports and hand tools for lethal WDM of California ground squirrels in response to property damage. The average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-87 and 5-88. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-87. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Bernardino County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	9.7	26	13,066	0.2%	525	4.0%	10%
Black Bear	2	5	286	1.7%	28	9.8%	14.2%
Bobcat	10.8	33	8,083	0.4%	365	4.5%	17%
Coyote	1,038.2	1,620	29,755	5.4%	7,208	24.2%	50%
Gray Fox	49.5	44	44,225	0.1%	2,566	5.8%	20%
Long-Tailed Weasel	0	1	1,421	<0.1%	55	3.9%	10%
Raccoon	87	155	76,610	0.2%	3,069	4.0%	49%
Western Spotted Skunk	0	1	9,398	<0.1%	358	3.8%	10%
Striped Skunk	57.1	93	24,805	0.4%	1,055	4.3%	10%
North American Beaver	11.9	18	5,323	0.3%	220	4.1%	20%
North American Porcupine	<0.1	1	3,608	<0.1%	138	3.8%	20%
Big Eared Woodrat	<0.1	10	1,980,065	<0.1%	75,253	3.8%	60%
Black Tailed Jackrabbit	4.6	11	1,194,824	<0.1%	66,533	5.6%	20%
Desert Cottontail Rabbit	5,281	13,573	5,279,987	0.3%	237,696	4.5%	40%
Brush Rabbit	210.1	683	209,112	0.3%	13,374	6.4%	40%
California Ground Squirrel	246.3	372	1,963,531	<0.1%	75,827	3.9%	40%
Western Gray Squirrel	50.2	358	54,128	0.7%	2,756	5.1%	40%
Deer Mouse	1,000.5	3,572	105,510,245	<0.1%	4,012,964	3.8%	40%
Mule Deer	0.3	1	11,291	<0.1%	2,699	23.9%	ND
Mountain Lion (not CSA listed)	2.2	1.1	99	1.1%	4.9	4.9%	11%
Mountain Lion (CSA listed)	2.2	0.1	99	0.1%	3.3	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-88. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Bernardino County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	76
Common Raven	1.6	3	330,000	<0.1%	0.3%	86
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	86
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	622
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	394
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Black -crowned Night Heron	0.2	1	15,740	<0.1%	0.7%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3 Counties with No Known Government Provided WDM Program

5.3.1 Del Norte

Baseline WS-California lethal WDM activities for Del Norte County as recorded in the MIS data are minimal, as the County had no CSA and no official county-directed program. MIS for Del Norte County involved just European starling and black bear. The most common method of WDM reported in MIS for Del Norte County during the baseline period was DRC-1339-feedlots used for lethal WDM of European starlings. WDM methods for black bear consisted of firearms and culvert traps. Although the MIS data include reported costs for livestock predation by mountain lion in Del Norte County, no WDM of mountain lion is recorded in Del Norte County in the MIS data. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-89 and 5-90. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-89. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Del Norte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	59	1.7%	4	6.8%	10%
Black Bear	3	7	393	1.8%	38	NA	14.2%
Bobcat	0.5	2	359	0.6%	16	4.5%	17%
Coyote	53.4	84	1,531	5.5%	371	24.2%	50%
Gray Fox	1.2	3	1,034	0.3%	60	5.8%	20%
Long-Tailed Weasel	<0.1	1	875	0.1%	34	3.9%	10%
American Mink	<0.1	1	93	1.1%	4	4.3%	25%
Raccoon	23.9	43	21,015	0.2%	844	4.0%	49%
River Otter	0.2	0.8	53	1.5%	3	5.5%	20%
Western Spotted Skunk	<0.1	1	4,429	<0.1%	169	3.8%	10%
Striped Skunk	30.2	49	13,285	0.4%	558	4.2%	10%
North American Beaver	31	46	13,825	0.3%	571	4.1%	20%
North American Porcupine	<0.1	1	5,645	<0.1%	215	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	2,067,689	<0.1%	78,583	3.8%	60%
Black-Tailed Jackrabbit	<0.1	1	15,439	<0.1%	771	5.0%	20%
Brush Rabbit	56	181	55,609	0.3%	2,295	4.1%	40%
California Ground Squirrel	224	339	1,154,858	<0.1%	44,227	3.8%	40%
Western Gray Squirrel	100.5	656	140,192	0.5%	6,944	5.0%	40%
Deer Mouse	1,000	3,570	5,268,100	0.1%	203,758	3.9%	40%
Mule Deer	0.2	1	7,306	<0.1%	1,746	23.9%	ND
Mountain Lion	0.9	0.5	42	1.2%	2.1	5.0%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-90. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Del Norte County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	364
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.2 Glenn

Baseline WS-California lethal WDM activities for Del Norte County as recorded in the MIS data are minimal, as the County had no CSA and no official county-directed program. MIS data for Glenn County included only North American beaver, which was taken through lethal methods using body grip traps. Although the MIS data reported costs includes livestock predation by coyotes in Glenn County, no WDM of coyote is recorded in Glenn County MIS data. A Glenn County representative responded to a questionnaire during preparation of this report indicating wildlife damage WDM activities, if any, are handled by the sheriff, animal control, or by the general public without county involvement. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-91 and 5-92. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-91. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Glenn County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.5	2	632	0.3%	27	4.3%	10%
Black Bear	1	3	143	2.1%	28	19.6%	14.2%
Bobcat	0.4	2	307	0.7%	17	5.5%	17%
Coyote	69.2	108	1,984	5.4%	481	24.2%	50%
Gray Fox	1.7	2	1,550	0.1%	115	7.4%	20%
Red Fox	0.8	2	34	5.9%	4	11.8%	25%
Long Tailed Weasel	<0.1	1	885	0.1%	34	3.8%	10%
American Mink	<0.1	1	85	1.2%	4	4.7%	25%
Raccoon	14.4	26	12,686	0.2%	510	4.0%	49%
River Otter	0.1	0.4	20	2.0%	1.2	6.0%	20%
Western Spotted Skunk	<0.1	1	5,093	<0.1%	194	3.8%	10%
Striped Skunk	50.7	83	22,304	0.4%	935	4.2%	10%
North American beaver	9.7	15	4,082	0.4%	170	4.2%	20%
North American Porcupine	<0.1	1	1,925	0.1%	74	3.8%	20%
Dusky Footed Woodrat	<0.1	10	1,290,177	<0.1%	49,037	3.8%	60%
Black Tailed Jackrabbit	0.3	1	71,093	<0.1%	4,008	5.6%	20%
Desert Cottontail Rabbit	251.3	646	251,273	0.3%	11,178	4.4%	40%
Brush Rabbit	241	782	240,613	0.3%	10,096	4.2%	40%
California Ground Squirrel	236.3	357	1,746,534	<0.1%	66,730	3.8%	40%
Western Gray Squirrel	50.2	328	54,490	0.6%	2,772	5.1%	40%
Deer Mouse	1,000	3,570	6,906,024	0.1%	265,999	3.9%	40%
Mule Deer	0.1	1	3,703	<0.1%	885	23.9%	ND
Mountain Lion	1	0.5	44	1.1%	2.2	5.0%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-92. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Glenn County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	365
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.3 Inyo

Baseline WS-California lethal WDM activities for Inyo County as recorded in the MIS data are minimal, as the County had no CSA and no official county-directed program. MIS for Glenn County involved two mammal species: bobcat and mountain lion; mountain lion was the only species reported as being lethally taken during the baseline period (1 individual). Most WDM was non-lethal and involved radio collaring of bobcats and mountain lions, with yearly averages of 0.1 bobcat individuals and 2.3 mountain lion individuals. Most WDM methods consisted of drug delivery devices, jabstick, and firearms. An Inyo County representative responded to a questionnaire during preparation of this report indicating wildlife damage WDM activities, if any, have been handled by USDA. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-93 and 5-94. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-93. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Inyo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	5	14	6,876	0.2%	276	4.0%	10%
Black Bear	0.7	2	92	2.2%	9	9.8%	14.2%
Bobcat	4.6	14	3,460	0.4%	157	4.5%	17%
Coyote	514.6	803	14,751	5.4%	3,570	24.2%	50%
Gray Fox	25.4	50	22,725	0.2%	1,318	5.8%	20%
Long-Tailed Weasel	<0.1	1	1,477	0.1%	57	3.9%	10%
American Mink	<0.1	1	25	4.0%	2	8.0%	25%
Raccoon	4.5	9	4,004	0.2%	165	4.1%	49%
Western Spotted Skunk	0.1	1	9,507	<0.1%	362	3.8%	10%
Striped Skunk	38.9	64	17,123	0.4%	719	4.2%	10%
North American beaver	5.8	9	2,580	0.3%	107	4.1%	20%
North American Porcupine	<0.1	1	2,291	<0.1%	88	3.8%	20%
Yellow Bellied Marmot	1.5	7	13,583	0.1%	696	5.1%	20%
Big-Eared Woodrat	0	10	5,939	0.2%	228	3.8%	60%
Black-Tailed Jackrabbit	2.2	5	562,454	<0.1%	31,138	5.5%	20%
Desert Cottontail Rabbit	2,267.1	5,827	2,267,145	0.3%	101,449	4.5%	40%
California Ground Squirrel	214	324	673,331	<0.1%	25,914	3.8%	40%
Deer Mouse	1,000	3,572	53,673,191	<0.1%	2,043,154	3.8%	40%
Mule Deer	0.3	1	10,153	<0.1%	2,427	23.9%	ND
Mountain Lion (not CSA-listed)	1.7	1.4	71	2.0%	4.1	5.8%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-94. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Inyo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	364
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.4 Mono

Baseline WS-California lethal WDM activities for Inyo County as recorded in the MIS data are minimal, as the County had no CSA and no official county-directed program. Baseline WDM activities for Mono County, as recorded in the MIS data, involved two mammal species: black bear and mountain lion. Only black bear were subject to lethal WDM as reported in MIS. Most WDM was non-lethal and involved radio collaring of mountain lions, with a yearly average of 1.5 individuals. Most WDM methods consisted of drug delivery devices related to non-lethal WDM. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-95 and 5-96. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-95. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Mono County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.4	4	1,865	0.2%	76	4.1%	10%
Black Bear	2.1	5	240	2.1%	25	10.4%	14.2%
Bobcat	1.3	4	999	0.4%	45	4.5%	17%
Coyote	147.8	231	4,238	5.5%	1,026	24.2%	50%
Gray Fox	6.6	6	5,875	0.1%	342	5.8%	20%
Long-Tailed Weasel	0	1	2,379	<0.1%	91	3.8%	10%
American Mink	<0.1	1	118	0.8%	5	4.2%	25%
Raccoon	16.9	31	14,859	0.2%	598	4.0%	49%
Western Spotted Skunk	0	1	11,002	<0.1%	419	3.8%	10%
Striped Skunk	90.1	146	39,641	0.4%	1,657	4.2%	10%
North American Beaver	24.4	36	10,874	0.3%	450	4.1%	20%
North American Porcupine	<0.1	1	4,213	<0.1%	161	3.8%	20%
Yellow-Bellied Marmot	3.1	15	28,421	<0.1%	1,453	5.1%	20%
Desert Cottontail Rabbit	41.7	108	41,698	0.3%	2,870	6.9%	40%
Black-Tailed Jackrabbit	0.5	2	132,339	<0.1%	7,176	5.4%	20%
Deer Mouse	1,000	3,570	15,917,911	<0.1%	608,452	3.8%	40%
Mule Deer	0.5	2	17,079	<0.1%	4,082	23.9%	ND
Mountain Lion (not CSA listed)	1.9	1	85	1.2%	4.2	4.9%	11%

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-96. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Mono County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	365
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.5 Orange

Baseline lethal WDM activities provided by USDA-WS at the request of Orange County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species (American coot and mallard duck) and one mammal species (coyote).

Most WDM activities for bird species by USDA-WS occurred at airports and mainly involved the following species: American crow (762.2 average individuals affected per year), western meadowlark (127.9 individuals affected per year), and killdeer (80.2 individuals affected per year). The most common method of WDM used by USDA-WS in Orange County during the baseline period were deterrent lasers used for dispersal of birds at airports and traps for lethal WDM of gophers.

An Orange County representative responded to a questionnaire during preparation of this report indicating that the county does administer a limited wildlife damage WDM program, with additional support from other agencies such as Orange County Animal Control and Orange County Parks Department. They noted that Orange County controls rodent damage (i.e., California ground squirrel and pocket gophers) through rodenticides to maintain the integrity of flood control channels, inverts, and basins and Animal Control manages nuisance wildlife complaints on a case-by-case basis, such as nuisance/loitering coyotes and skunks. They also noted that ornamental nursery stock (Orange County's largest agribusiness sector) is highly affected by foraging from rodents and crows but did not specify whether wildlife damage WDM was used to avoid and minimize those damages. Quantitative data for these county-level activities were not available. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-97 and 5-98. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-97. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Orange County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.2	1	216	0.5%	10	4.6%	10%
Bobcat	0.5	2	396	0.5%	17	4.3%	17%
Coyote	35.7	56	934	6.0%	232	24.8%	50%
Gray Fox	0.4	2	388	0.5%	24	6.2%	20%
Long-Tailed Weasel	0	1	682	0.2%	27	4.0%	10%
Raccoon	99.2	177	87,354	0.2%	3,500	4.0%	49%
Striped Skunk	30.8	50	13,568	0.4%	572	4.2%	10%
Big-Eared Woodrat	<0.1	10	689,944	<0.1%	26,228	3.8%	60%
Black-Tailed Jackrabbit	0.2	1	47,518	<0.1%	2,371	5.0%	20%
Desert Cottontail Rabbit	212.5	691	212,464	0.3%	9,176	4.3%	40%
Brush Rabbit	209	680	209,015	0.3%	8,623	4.1%	40%
California Ground Squirrel	222.2	336	1,070,343	<0.1%	41,014	3.8%	40%
Deer Mouse	1,000	3,570	4,168,523	0.1%	161,974	3.9%	40%
Mule Deer	0.1	1	2,590	<0.1%	619	23.9%	ND
Mountain Lion (not CSA listed)	0.5	0.3	21	1.4%	1	4.8%	11%
Mountain Lion (CSA listed)	0.5	0.1	21	0.5%	0.8	3.8%	11%

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

[2] A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-98. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Orange County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	34
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	5
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	622
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	364
Canada Geese	0.3	1	51,148	<0.1%	0.1%	1
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

[1] County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.6 Riverside

Baseline lethal WDM activities provided by USDA-WS at the request of Riverside County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species (feral chicken) and one mammal species (coyote). Most WDM provided by USDA-WS was for dispersal of double-crested cormorants. Most WDM methods consisted of bombs/bangers and whistlers/screamers used for the dispersal of double-crested cormorants. Lethal WDM of coyote occurred in response to livestock predation, human health and safety, and property damage. The Riverside County Agricultural Commissioner responded to a questionnaire during preparation of this report indicating that the county is not involved in wildlife damage WDM activities. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-99 and 5-100. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-99. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Riverside County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate	Low Population Estimate	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	3.2	9	4,343	0.2%	175	4.0%	10%
Black Bear	1.6	4	219	1.8%	12	5.5%	14.2%
Bobcat	3.3	10	2,462	0.4%	117	4.8%	17%
Coyote	355.7	555	10,183	5.5%	2,463	24.2%	50%
Gray Fox	15.4	15	13,718	0.1%	799	5.8%	20%
Long-Tailed Weasel	0	1	2,468	<0.1%	94	3.8%	10%
Raccoon	152.3	272	134,062	0.2%	5,368	4.0%	49%
Western Spotted Skunk	0.1	1	12,820	<0.1%	488	3.8%	10%
Striped Skunk	95.2	155	41,917	0.4%	1,753	4.2%	10%
North American beaver	1	2	432	0.5%	20	4.6%	20%
Big-Eared Woodrat	<0.1	10	3,631,328	<0.1%	138,001	3.8%	60%
Black-Tailed Jackrabbit	1.6	4	415,972	<0.1%	21,842	5.3%	20%
Desert Cottontail Rabbit	1,841.5	4,733	1,841,480	0.3%	86,933	4.7%	40%
Brush Rabbit	567.5	1,845	567,517	0.3%	27,167	4.8%	40%
California Ground Squirrel	266.6	403	3,204,566	0.3%	122,181	3.8%	40%
Western Gray Squirrel	50.1	327	31,776	1.0%	1,753	5.5%	40%
Deer Mouse	1,000	3,571	37,797,298	<0.1%	1,439,869	3.8%	40%
Mule Deer	0.5	2	16,382	<0.1%	3,915	23.9%	ND
Mountain Lion (not CSA listed)	3.1	1.6	142	1.1%	6.5	4.6%	11%
Mountain Lion (CSA listed)	3.1	0.1	142	0.1%	4.6	3.2%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-100. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Riverside County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	625
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	366
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	3
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.7 San Benito

Baseline lethal WDM activities provided by USDA-WS at the request of San Benito County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved four bird species, one reptile species, and 13 mammal species:

Birds: American coot, American crow, feral duck, cliff swallow

Reptile: western diamondback rattlesnake

Mammals: bobcat, coyote, mule deer, red fox, black-tailed jackrabbit, mountain lion, Virginia opossum, desert cottontail rabbit, raccoon, brown rat, striped skunk, California ground squirrel, and feral swine.

Of all the WDM activities conducted by USDA-WS in San Benito County, 46% involved lethal WDM of American coot and coyote in response to damage to golf courses and predation of livestock, respectively. The most common methods of WDM used by USDA-WS in San Benito County during the baseline period were A/C powder for lethal WDM of American coot and cage traps used for lethal WDM of striped skunk and Virginia opossum. The San Benito County Agricultural Commissioner responded to a questionnaire during preparation of this report indicating that the county has not been involved in wildlife damage WDM activities since 2013, when their CSA with WS-California ended. Cropland farmers typically engage in hazing of problematic bird species in consultation with CDFW and conduct lethal controls under depredation permits if hazing is not effective. The county contracts with the City of Hollister for animal control activities in unincorporated areas, primarily for domestic animal control but also some species such as skunks, opossums, and raccoons. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-101 and 5-101. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-101. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Benito County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.6	2	800	0.3%	33	4.1%	10%
Bobcat	1	3	463	0.6%	27	5.8%	17%
Coyote	146.3	229	2,121	10.8%	629	29.7%	50%
Gray Fox	1.9	2	1,721	0.1%	111	6.4%	20%
Long-Tailed Weasel	0	1	1,205	<0.1%	46	3.8%	10%
Raccoon	28.7	52	13,654	0.4%	576	4.2%	49%
Striped Skunk	65.3	106	23,834	0.4%	1,020	4.3%	10%
North American Porcupine	<0.1	1	944	0.1%	36	3.8%	20%
Big-Eared Woodrat	0	10	1,903	0.5%	83	4.4%	60%
Dusky-Footed Woodrat	<0.1	10	1,618,958	<0.1%	61,531	3.8%	60%
Black-Tailed Jackrabbit	0.7	2	78,884	<0.1%	4,077	5.2%	20%
Desert Cottontail Rabbit	367.9	946	364,204	0.3%	18,812	5.2%	40%
Brush Rabbit	350.2	1,139	346,513	0.3%	15,854	4.6%	40%
California Ground Squirrel	202	306	1,873,250	<0.1%	71,493	3.8%	40%
Deer Mouse	1,000	3,570	7,275,815	<0.1%	280,051	3.8%	40%
Mule Deer	0.3	1	4,965	<0.1%	1,187	23.9%	ND
Mountain Lion (not CSA listed)	0.7	0.4	88	0.5%	3.7	4.2%	11%
Mountain Lion (CSA listed)	0.7	0.1	88	0.1%	2.9	3.3%	11%

Notes: Only species with projected county-level lethal take are included. San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-102. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Benito County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	3.3	7	480,000	<0.1%	0.5%	11
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.8	365	4,200,000	<0.1%	1.6%	366
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included. San Benito County had a CSA with WS-California during 2010 through 2012, so the take analysis is limited to these three years.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.8 San Francisco

Baseline WDM activities for San Francisco County, as recorded in the MIS data, involved one bird species (western gull) and two mammal species (feral cat and raccoon). Only raccoon was subject to lethal WDM. Most WDM was for dispersal of western gulls using 12-gauge cracker shells in response to predation of colonial sea birds. Lethal WDM of raccoon was conducted using cage traps in response to property damage. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-103 and 5-104. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-103. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Francisco County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
Coyote	1.7	3	50	6.0%	13	26.0%	50%
Gray Fox	<0.1	0.2	6	3.3%	0.5	8.8%	20%
Long Tailed Weasel	0	1	39	2.6%	2	5.1%	10%
Raccoon	11.1	20	6,475	0.3%	268	4.1%	49%
Western Spotted Skunk	0	1	222	0.5%	9	4.1%	10%
Striped Skunk	1.8	3	775	0.4%	37	4.8%	10%
Desert Cottontail	12.2	32	12,185	0.3%	527	4.3%	40%
California Ground Squirrel	101.3	153	62,271	0.2%	2,520	4.0%	40%
Deer Mouse	1,000	3,570	514,002	0.7%	23,103	4.5%	40%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-104. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Francisco County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.1	1	24,000	<0.1%	0.7%	1
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	622
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	364
Canada Geese	0.3	1	51,148	<0.1%	0.1%	1
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.9 San Mateo

Baseline lethal WDM activities provided by USDA-WS at the request of San Mateo County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved three mammal species (red fox, raccoon, and striped skunk). Of all the WDM activities conducted in San Mateo County, 58% involved lethal WDM of raccoon and striped skunk. Most lethal WDM conducted for mammal species within San Mateo County occurred for the protection of threatened and endangered species. The most common method of WDM used in San Mateo County during the baseline period was cage traps used for lethal WDM of raccoon and striped skunk. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-105 and 5-106. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-105. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in San Mateo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.1	1	113	0.9%	6	5.3%	10%
Bobcat	0.3	1	229	0.4%	10	4.4%	17%
Coyote	20.9	33	598	5.5%	146	24.4%	50%
Gray Fox	0.5	1	441	0.2%	26	5.9%	20%
Long-Tailed Weasel	0	1	381	0.3%	15	3.9%	10%
Raccoon	34.4	62	26,998	0.2%	1,112	4.1%	49%
Striped Skunk	14.6	24	6,238	0.4%	295	4.7%	10%
North American Porcupine	<0.1	1	708	0.1%	27	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	616,140	<0.1%	23,424	3.8%	60%
Black-Tailed Jackrabbit	<0.1	1	17,949	<0.1%	896	5.0%	20%
Desert Cottontail Rabbit	85.4	220	85,363	0.3%	3,683	4.3%	40%
Brush Rabbit	77.5	252	77,530	0.3%	3,199	4.1%	40%
California Ground Squirrel	210.8	320	518,743	0.1%	20,035	3.9%	40%
Western Gray Squirrel	50.1	327	28,784	1.1%	1,619	5.6%	40%
Deer Mouse	1,000	3,570	2,836,932	0.1%	111,374	3.9%	40%
Mule Deer	0.1	1	2,582	<0.1%	617	23.9%	ND
Mountain Lion (not CSA listed)	0.3	0.2	15	1.3%	0.7	4.7%	11%
Mountain Lion (CSA listed)	0.3	0.1	15	0.7%	0.6	4.0%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-106. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in San Mateo County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0	0	480,000	0%	0%	8
Common Raven	0	0	330,000	0%	0%	15
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	3
Barn Owl	0	0	24,000	0%	0%	1
Red-winged Blackbird	100	288	14,000,000	<0.1%	0.8%	293
Brewer's Blackbird	100	320	4,200,000	<0.1%	1.4%	323
Canada Geese	0	0	51,148	0%	0%	3
California Gull	0	0	112,601	0%	0%	3
Black-crowned Night Heron	0	0	15,740	0%	0%	1
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	68

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.10 Santa Clara

Baseline lethal WDM activities provided by USDA-WS at the request of Santa Clara County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved one bird species (Canada goose) and four mammal species (feral cat, Virginia opossum, striped skunk, and feral swine). Most WDM activities by USDA-WS for bird species occurred at airports and mainly involved the following species: northern shoveler (9,388.5 average individuals affected per year) and European starling (9,192.6 individuals affected per year). A portion (18%) of the lethal WDM conducted for bird and mammal species within Santa Clara County occurred for the protection of threatened and endangered species. The most common methods of WDM used in Santa Clara County during the baseline period were 12-gauge cracker shells used for dispersal of birds at airports and firearms for lethal WDM of California ground squirrel. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-107 and 5-108. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-107. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Santa Clara County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.3	1	372	0.3%	16	4.3%	10%
Bobcat	0.6	2	447	0.4%	23	5.1%	17%
Coyote	62.6	98	1,794	5.5%	435	24.2%	50%
Gray Fox	1.7	4	1,525	0.6%	96	6.3%	20%
Long-Tailed Weasel	0	1	1,111	<0.1%	43	3.9%	10%
Raccoon	66.5	119	58,541	0.2%	2,422	4.1%	49%
Western Spotted Skunk	0	1	6,004	0.02%	6,004	3.8%	10%
Striped Skunk	49.5	81	21,746	0.4%	1,114	5.1%	10%
North American Porcupine	<0.1	1	341	0.3%	13	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	1,757,369	<0.1%	66,791	3.8%	60%
Black-Tailed Jackrabbit	0.2	1	55,393	<0.1%	3,024	5.5%	20%
Desert Cottontail Rabbit	317.8	817	317,804	0.3%	14,303	4.5%	40%
Brush Rabbit	242	787	242,017	0.3%	10,282	4.2%	40%
California Ground Squirrel	235.4	356	1,705,050	<0.1%	66,747	3.9%	40%
Western Gray Squirrel	50.1	327	29,863	1.1%	1,667	5.6%	40%
Deer Mouse	1,000	3,570	6,730,571	0.1%	259,332	3.9%	40%
Mule Deer	0.2	1	7,210	<0.1%	1,723	23.9%	ND
Mountain Lion (not CSA listed)	1.4	0.7	63	1.1%	3.1	4.9%	11%
Mountain Lion (CSA listed)	1.4	0.1	63	0.2%	2.1	3.3%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-108. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Santa Clara County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	59
Common Raven	1.6	3	330,000	<0.1%	0.3%	35
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	43
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	756
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	478
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	47
Canada Geese	0.4	1	51,148	<0.1%	0.1%	142
California Gull	0.1	1	112,601	<0.1%	<0.1%	225
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.11 Santa Cruz

Baseline lethal WDM activities provided by USDA-WS at the request of Santa Cruz County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two bird species (American coot and Canada goose). Of all the WDM activities conducted in Santa Cruz County by USDA-WS, 72% involved lethal WDM of common raven and striped skunk and non-lethal WDM of raccoon. Most lethal WDM within Santa Cruz County occurred for the protection of threatened and endangered species (i.e., snowy plover). The most common method of WDM used in Santa Cruz County during the baseline period was cage traps used for lethal and non-lethal WDM of striped skunk and raccoon. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-109 and 5-110. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-109. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Santa Cruz County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.1	1	73	1.4%	4	5.5%	10%
Bobcat	0.3	1	254	0.4%	12	4.7%	17%
Coyote	21.9	35	627	5.6%	153	24.4%	50%
Gray Fox	0.5	1	438	0.2%	27	6.2%	20%
Long-Tailed Weasel	0	1	389	0.3%	15	3.9%	10%
Raccoon	25.1	45	22,141	0.2%	893	4.0%	49%
Striped Skunk	13.9	23	6,112	0.4%	270	4.4%	10%
North American Porcupine	<0.1	1	1,047	0.1%	40	3.8%	20%
Dusky-Footed Woodrat	<0.1	10	918,054	<0.1%	34,897	3.8%	60%
Black-Tailed Jackrabbit	<0.1	1	10,063	<0.1%	503	5.0%	20%
Desert Cottontail	47.6	123	47,600	0.3%	2,332	4.9%	40%
Brush Rabbit	43.3	141	43,303	0.3%	1,926	4.4%	40%
California Ground Squirrel	209	316	433,788	0.1%	16,804	3.9%	40%
Western Gray Squirrel	50.2	328	48,580	0.7%	2,507	5.2%	40%
Deer Mouse	1,000	3,570	2,335,035	0.2%	92,302	4.0%	40%
Mule Deer	0.1	1	2,852	<0.1%	682	23.9%	ND
Mountain Lion (not CSA listed)	0.4	0.2	17	1.2%	0.8	4.7%	11%
Mountain Lion (CSA listed)	0.4	0.1	17	0.6%	0.6	3.5%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-110. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Santa Cruz County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	6
Common Raven	1.6	3	330,000	<0.1%	0.3%	10
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	365
Canada Geese	1.1	2	51,148	<0.1%	0.2%	3
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.12 Tehama

Baseline lethal WDM activities provided by USDA-WS at the request of Santa Cruz County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved two mammal species: coyote and mountain lion. Firearms were the method of WDM used in Tehama County during the baseline period for lethal WDM of coyote and mountain lion. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-111 and 5-112. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-111. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Tehama County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0.9	3	1,219	0.3%	50	4.1%	10%
Black Bear	2.7	6	372	1.6%	78	21.0%	14.2%
Bobcat	1.3	4	982	0.4%	49	5.0%	17%
Coyote	157.5	246	4,512	5.5%	1,094	24.2%	50%
Gray Fox	5.1	5	4,599	0.1%	284	6.2%	20%
Red Fox	0.5	1	21	4.8%	3	14.3%	25%
Long Tailed Weasel	0	1	2,497	<0.1%	96	3.8%	10%
American Mink	<0.1	1	81	1.2%	4	5.0%	25%
Raccoon	45.6	82	40,148	0.2%	1,612	4.0%	49%
River Otter	0.4	2	33	6.1%	1.7	5.2%	20%
Western Spotted Skunk	0	1	13,086	0.01%	498	3.8%	10%
Striped Skunk	112.5	183	49,507	0.4%	2,070	4.2%	10%
North American Beaver	43.7	64	19,502	0.3%	806	4.1%	20%
North American Porcupine	<0.1	1	8,206	<0.1%	312	3.8%	20%
Yellow Bellied Marmot	0.5	3	4,609	<0.1%	236	5.1%	20%
Dusky Footed Woodrat	<0.1	10	3,671,646	<0.1%	139,533	3.8%	60%
Black Tailed Jackrabbit	0.5	2	137,089	<0.1%	7,008	5.1%	20%
Desert Cottontail Rabbit	526.9	1,355	526,911	0.3%	1,355	4.3%	40%
Brush Rabbit	564	1,833	563,836	0.3%	23,352	4.1%	40%
California Ground Squirrel	282.2	426.122	3,956,211	<0.1%	150,767	3.8%	40%
Western Gray Squirrel	100	652	258,961	0.3%	12,267	4.7%	40%
Deer Mouse	1000.1	3570.357	15,431,135	<0.1%	589,955	3.8%	40%
Mule Deer	0.4	1.048	13,999	<0.1%	3,346	23.9%	ND

Table 5-111. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Tehama County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
Mountain Lion	4	2	164	1.2%	8.2	5.0%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-112. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Tehama County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	5
Common Raven	1.6	3	330,000	<0.1%	0.3%	5
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	1
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	623
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	364

Table 5-112. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Tehama County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.3	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	2
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	66
Northern Flicker	10	67	430,000	<0.1%	11.5%	68

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.13 Tulare

Baseline lethal WDM activities provided by USDA-WS at the request of Tulare County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data involved three bird species (American coot, Canada goose, and acorn woodpecker) and three mammal species (striped skunk, California ground squirrel, and feral swine). Of all the WDM activities conducted by USDA-WS in Tulare County, 65% involved lethal WDM of American coot in response to damage to property damage. The most common method of WDM used in Tulare County during the baseline period was A/C powder for lethal WDM of American coot and other bird species. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-113 and 5-114. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-113. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Tulare County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	1.6	5	2,198	0.2%	89	4.0%	10%
Black Bear	5.5	12	765	1.6%	112	14.6%	14.2%
Bobcat	1.5	5	1,123	0.4%	54	4.8%	17%
Coyote	241.7	378	6,928	5.5%	1,676	24.2%	50%
Gray Fox	7.1	7	6,326	0.1%	368	5.8%	20%
Long-Tailed Weasel	0	1	3,494	<0.1%	133	3.8%	10%
Raccoon	140	250	70,765	0.4%	2,941	4.2%	49%
Western Spotted Skunk	0	1	16,889	0.1%	643	3.8%	10%
Striped Skunk	156.4	254	68,513	0.4%	2,861	4.2%	10%
North American Beaver	13.9	21	6,193	0.3%	256	4.1%	20%
North American Porcupine	<0.1	1	15,963	<0.1%	607	3.8%	20%
Yellow-Bellied Marmot	3	14	27,476	<0.1%	1,405	5.1%	20%
Big-Eared Woodrat	<0.1	10	3,785,997	<0.1%	143,878	3.8%	60%
Black-Tailed Jackrabbit	0.6	2	162,256	<0.1%	9,908	6.1%	20%
Desert Cottontail Rabbit	626.5	1,611	626,506	0.3%	31,102	5.0%	40%
Brush Rabbit	243	790	242,873	0.3%	12,060	5.0%	40%
California Ground Squirrel	307.1	464	5,125,949	<0.1%	195,255	3.8%	40%
Western Gray Squirrel	100.7	657	209,752	0.3%	10,065	4.8%	40%
Deer Mouse	1,000.1	3,570	25,297,352	<0.1%	964,871	3.8%	40%
Mule Deer	0.5	2	18,330	<0.1%	4,381	23.9%	ND
Mountain Lion	4.4	2.2	200	1.1%	9.8	4.9%	11%

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-114. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Tulare County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	6
Common Raven	1.6	3	330,000	<0.1%	0.3%	6
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	2
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	624
Brewer’s Blackbird	113.7	364	4,200,000	<0.1%	1.6%	366
Yellow-headed Blackbird	7.6	46	530,000	<0.1%	2.6%	46
Canada Geese	0.4	1	51,148	<0.1%	0.1%	2
California Gull	0.1	1	112,601	<0.1%	<0.1%	3
Acorn Woodpecker	10.5	67	1,900,000	<0.1%	13.6%	67
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

5.3.14 Ventura

Baseline lethal WDM activities provided by USDA-WS at the request of Ventura County (not including airport WHM or WDM for T&E species protection) as recorded in the MIS data is limited to one lethal take of coyote. When including non-lethal activities and those conducted at airports or for T&E species protection, baseline WDM activities for Ventura County as recorded in the MIS data mostly included bird species WDM at airports and mainly involved the following species: long-billed curlew (7,722.7 average individuals per year), horned lark (8,724.9 average individuals per year), and tree swallow (*Tachycineta bicolor*) (8,572.3 individuals per year). A portion of the lethal WDM conducted for bird and mammal species (i.e., coyote and Virginia opossum) occurred within Ventura County for the protection of threatened and endangered species (i.e., snowy plover and California least tern). The most common methods of WDM used in Ventura County during the baseline period were bombs/bangers used for dispersal of birds at airports and firearms for lethal WDM of California ground squirrel. Average and maximum potential lethal WDM under the Proposed Project for each target species is included in Tables 5-115 and 5-116. These take estimates were derived using the methods described for each species in Chapter 3.

Table 5-115. County-Program Lethal Take and Cumulative Lethal Take of Target Mammal Species Under the Proposed Project in Ventura County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Low Population Estimate[2]	County-Program Proposed Project Max Lethal Take Estimate of Population	Proposed Project Max Cumulative Lethal Take Estimate	Proposed Project Max Cumulative Lethal Take Estimate of Population	Sustainable Mortality Estimate
American Badger	0	2	1,013	0.2%	41	4.0%	10%
Black Bear	2	5	274	1.8%	31	NA	14.2%
Bobcat	0.9	3	701	0.4%	32	4.6%	17%
Coyote	90.9	142	2,602	5.5%	646	24.8%	50%
Gray Fox	0	4	3,174	0.1%	187	5.9%	20%
Long-Tailed Weasel	0	3	1,501	0.2%	60	4.0%	10%
Raccoon	69	123	60,722	0.2%	2,443	4.0%	49%
Western Spotted Skunk	0	1	8,098	0.01%	308	3.8%	10%
Striped Skunk	70.4	115	30,970	0.4%	1,297	4.2%	10%
North American Porcupine	<0.1	1	5,138	<0.1%	196	3.8%	20%
Big-Eared Woodrat	<0.1	10	1,189,450	<0.1%	45,210	3.8%	60%
Dusky-Footed Woodrat	<0.1	10	1,789,305	<0.1%	68,004	3.8%	60%
Black-Tailed Jackrabbit	0.4	1	103,551	<0.1%	5,530	5.3%	20%
Desert Cottontail Rabbit	456	1,173	456,390	0.3%	23,751	5.2%	40%
Brush Rabbit	385	1,252	385,019	0.3%	17,793	4.6%	40%
California Ground Squirrel	251.1	380	2,461,518	<0.1%	95,142	3.9%	40%
Western Gray Squirrel	50.1	327	22,093	1.5%	1,318	6.0%	40%
Deer Mouse	1,000	3,570	9,684,314	<0.1%	371,574	3.8%	40%
Mule Deer	0.3	1	11,416	<0.1%	2,728	23.9%	ND
Mountain Lion (not CSA listed)	2.1	1.1	97	1.1%	4.7	4.8%	11%
Mountain Lion (CSA listed)	2.1	0.1	97	0.1%	3.2	3.3%	11%

Notes: Only species with projected county-level lethal take are included. ND = not determined.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum

Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

2 A population estimate is provided for each mammal species by county based on the methods described in detail in Appendices C1–C29. The lower population estimates described in Appendices C1–C29 for each mammal species are used here to provide the most conservative effects analysis.

Table 5-116. County-Program Lethal Take and Cumulative Lethal Take of Target Bird Species Under the Proposed Project in Ventura County

Species	Average County-Program Lethal WDM Take	County-Program Proposed Project Max Lethal Take Estimate[1]	Statewide Population Estimate	County-Program Proposed Project Max Lethal Take Estimate Proportion of Statewide Population	County-Program Proportion of Statewide WDM Lethal Take	Cumulative Lethal Take (including airport and T&E species protection WDM)
American Crow	0.3	1	480,000	<0.1%	<0.1%	69
Common Raven	1.6	3	330,000	<0.1%	0.3%	44
California Scrub-Jay	2	2	1,200,000	<0.1%	1.8%	2
Red-tailed Hawk	0.1	1	230,000	<0.1%	<0.1%	15
Barn Owl	0.1	1	24,000	<0.1%	0.7%	2
Red-winged Blackbird	215.7	622	14,000,000	<0.1%	1.7%	639
Brewer's Blackbird	113.7	364	4,200,000	<0.1%	1.6%	539
Canada Geese	0.3	1	51,148	<0.1%	0.1%	11
California Gull	0.1	1	112,601	<0.1%	<0.1%	9
Black-crowned Night Heron	0.1	1	15,740	<0.1%	0.3%	2
Acorn Woodpecker	10	64	1,900,000	<0.1%	12.9%	64
Northern Flicker	10	67	430,000	<0.1%	11.5%	67

Notes: Only species with projected county-level lethal take are included.

1 County Program Proposed Project Maximum Lethal Take Estimates for species with no County Program WDM take during the 10-year baseline period are based on overall Proposed Project Maximum Lethal Estimates for the county, which includes WDM for T&E species protection and aviation safety. County Program Proposed Project Maximum Lethal Take Estimates are a portion of the overall expected take under the Proposed Project and do not exceed or add to Proposed Project Maximum Lethal Estimates for the county. Refer to the species analyses in Sections 3.2, 3.3 and 3.4 for details on how the Proposed Project Max Lethal Take Estimate was calculated.

6 Summary of Wildlife Damage Management

6.1 Summary of Project Effects

Tables 6-1 and 6-2 summarize the Project's potential for impacts on target mammal and bird species, respectively. Target species that were not analyzed in detail due to various factors (extremely low levels of lethal WDM, non-native or feral species, etc.) are listed in Table 3-1. The Project does not propose to eradicate any species, regardless of legal status, or result in lethal take that would substantially reduce species' populations. Non-lethal WDM would not have a substantial effect on non-special status wildlife populations at a statewide and county level.

Information provided and advice given to resource managers or landowners (e.g., phone calls, field visits, presentations, development and dissemination of information) regarding recommendations for non-lethal or lethal WDM methods would not have a direct effect on wildlife populations because the actions of these resource managers and landowners are up to their individual discretion. Actions of such individuals or entities outside the control of the parties hereto (WS-California, the CDFA, and the various counties) are outside the scope of this analysis other than our attempts to estimate such take for our analysis of cumulative take.

Table 6-1. Target Mammal Species Take Summary

Target Species	Statewide/County	% Average Individuals of Total Population Taken by Project	Sustainable Mortality Threshold	Take Exceeds Threshold?
Target Mammal Species				
Black bear	Statewide	1.5%	14.2%	No
	For all counties refer to Table 3-2a, for a regional analysis by hunt zone refer to Table 3-2b	Refer to Table 3-2a for county lethal WDM percentages, range from 0% to 8%; refer to Table 3-2b for regional analysis by hunt zone of lethal WDM percentages, range from 0.6% to 2.1%	14.2%	No
Bobcat	Statewide	0.4%	17%	No
	For all counties refer to Table 3-3	Refer to Table 3-3 for county lethal WDM percentages, range from 0% to 4.8%	17%	No
Coyote	Statewide	5.6%	50%	No
	For all counties refer to Table 3-4 for lethal WDM	Refer to Table 3-4 for county lethal WDM percentages, range from 0.1% to 25.5%	50%	No
Gray Fox	Statewide	0.2%	20%	No
	For all counties refer to Table 3-5	Refer to Table 3-5 for county lethal WDM percentages, range from 0% to 4.4%	20%	No
Sacramento Valley Red Fox[2]	Statewide	4.0%	25%	No
	For all counties refer to Table 3-6 for lethal WDM	Refer to Table 3-6 for county lethal WDM percentages, range from 0% to 13.5%	25%	No
Long-Tailed Weasel	Statewide	0.7%	10%	No
	For all counties refer to Table 3-7	Refer to Table 3-7 for county lethal WDM percentages, range from <0.1% to 2.6%	10%	No
American Mink	Statewide	1.6%	25%	No
	For all counties refer to Table 3-8	Refer to Table 3-8 for county lethal WDM percentages, range from 0% to 12.4%	25%	No
Raccoon	Statewide	0.2%	49%	No
	For all counties refer to Table 3-9	Refer to Table 3-9 for county lethal WDM percentages, range from <0.1%% to 1.4%	49%	No
River Otter	Statewide	1.7%	20%	No
	For all counties refer to Table 3-10	Refer to Table 3-10 for county lethal WDM percentages, range from 0% to 9.1%	20%	No

Table 6-1. Target Mammal Species Take Summary

Target Species	Statewide/County	% Average Individuals of Total Population Taken by Project	Sustainable Mortality Threshold	Take Exceeds Threshold?
Western Spotted Skunk	Statewide	<0.1%	10%	No
	For all counties refer to Table 3-11	Refer to Table 3-11 for county lethal WDM percentages, range from <0.1% to 0.5%	10%	No
Striped Skunk	Statewide	0.4%	10%	No
	For all counties refer to Table 3-12	Refer to Table 3-12 for county lethal WDM percentages, range from <0.1%% to 4.5%	10%	No
North American beaver	Statewide	0.3%	20%	No
	For all counties refer to Table 3-13	Refer to Table 3-13 for county lethal WDM percentages, range from 0% to 10.4%	20%	No
North American Porcupine	Statewide	<0.1%	20%	No
	For all counties refer to Table 3-14	Refer to Table 3-14 for county lethal WDM percentages, range from 0% to 1.4%	20%	No
Yellow-bellied marmot	Statewide	<0.1%	20%	No
	For all counties refer to Table 3-15	Refer to Table 3-15 for county lethal WDM percentages, range from 0% to 0.2%	20%	No
Big-eared woodrat	Statewide	<0.1%	60%	No
	For all counties refer to Table 3-16	Refer to Table 3-16 for county lethal WDM percentages, range from 0% to 5.5%	60%	No
Dusky-footed woodrat	Statewide	<0.1%	60%	No
	For all counties refer to Table 3-17	Refer to Table 3-17 for county lethal WDM percentages, range from 0% to 0.2%	60%	No
Black-tailed jackrabbit	Statewide	<0.1%	20%	No
	For all counties refer to Table 3-18	Refer to Table 3-18 for county lethal WDM percentages, range from 0% to 1.9%	20%	No
Desert cottontail rabbit	Statewide	0.3%	40%	No
	For all counties refer to Table 3-19	Refer to Table 3-19 for county lethal WDM percentages, range from 0% to 0.4%	40%	No
Brush rabbit	Statewide	0.3%	40%	No
	For all counties refer to Table 3-20	Refer to Table 3-20 for county lethal WDM percentages, range from 0% to 1.1%	40%	No

Table 6-1. Target Mammal Species Take Summary

Target Species	Statewide/County	% Average Individuals of Total Population Taken by Project	Sustainable Mortality Threshold	Take Exceeds Threshold?
California ground squirrel	Statewide	<0.1%	40%	No
	For all counties refer to Table 3-21	Refer to Table 3-21 for county lethal WDM percentages, range from 0% to 0.3%	40%	No
Western gray squirrel	Statewide	0.4%	40%	No
	For all counties refer to Table 3-22	Refer to Table 3-22 for county lethal WDM percentages, range from 0% to 2.1%	40%	No
Deer mouse	Statewide	<0.1%	40%	No
	For all counties refer to Table 3-23	Refer to Table 3-23 for county lethal WDM percentages, range from <0.1%to 0.7%	40%	No
Mule deer	Statewide	<0.1%	None[3]	No
	For all counties refer to Table 3-24	Refer to Table 3-24 for county lethal WDM percentages, range from 0% to <0.1%	None[3]	No
Mountain lion	Statewide	1.1%	11%	No
	For all counties refer to Table 3-25	Refer to Table 3-25 for other county lethal WDM percentages, range from 0% to 5.1%	11%	No
	Candidate counties if species becomes listed[4]	0.1% Refer to Table 3-43 for other county lethal WDM percentages, range from <0.1%% to 0.7%	11%	No
	Candidate counties if species does not become listed	0.8% Refer to Table 3-44 for other county lethal WDM percentages, range from 0% to 1.3%	11%	No
American Badger	Statewide	0. 3 %	10%	No
	For all counties refer to Table 3-42	Refer to Table 3-42 for county lethal WDM percentages, range from 0% to 3.5%	10%	No
Ringtail	Statewide[5]	0%	None[5]	No

Source: USDA 2022b

Notes: 0% = no MIS lethal WDM occurred during the 10-year baseline period. Refer to Section 3.1 for species with lethal WDM during the analysis period that are not included in this table.

1 Refer to species analyses in Sections 3.2 and 3.4 for the basis of the thresholds for each species.

2 The substantial effect threshold for red fox only applies to the counties where the Sacramento Valley red fox could occur (i.e., the estimated current range, according to Figure 4 in Sacks *et al.* 2010) which includes portions of Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Solano, and Yolo Counties. All other counties within the state are not evaluated according to thresholds as it would be the non-native species and the California Fish and Game Commission allows for this species to be killed at any time of year and in any

number. Note that no WDM activities occurred within the range of the Sierra Nevada red fox (i.e., in subalpine habitat near the Sonoran Pass within Tuolumne, Mono, Alpine, Madera, Fresno, and Inyo counties). Therefore, no lethal or non-lethal effects occurred to the Sierra Nevada red fox subspecies.

3 No threshold was assigned for this species because the mortality estimates for mule deer statewide and in each county are within the range this species can withstand without substantially affecting the population. Furthermore, CDFW will continue to ensure the stability of the mule deer population in California.

4 If CDFW finds cause to list mountain lion under CESA in these counties it is likely that almost any level of take has the potential to impact the population.

5 Because no lethal WDM of ringtail occurred during the analysis period, county-level analyses are not provided and no threshold was assigned for this species.

Table 6-2. Target Bird Species Statewide Take Summary

Target Species	Grouping	% of Statewide Population Lethally Affected by Project Annually	Take Exceeds Sustainable Harvest Threshold?
American crow	Corvids	0. 3 %	No
Common raven	Corvids	0. 2%	No
California scrub jay	Corvids	<0.1%	No
Ferruginous hawk	Raptors	4.5%	No
Red-tailed hawk	Raptors	0.3%	No
Barn owl	Raptors	0.2%	No
Red-winged blackbird	Granivores	0.3%	No
Brewer's blackbird	Granivores	0.5%	No
Yellow-headed blackbird	Granivores	0.3%	No
Acorn woodpecker	Insectivores	<0.1%	No
Northern flicker	Insectivores	0.1%	No
California gull	Water-Associated Non-Game Birds	0.5%	No
Black-crowned night heron	Water-Associated Non-Game Birds	0.4%	No
Canada goose	Waterfowl	0.5%	No
Tricolored blackbird	Special-Status Bird Species	0%	No
Sandhill crane	Special-Status Bird Species	0%	No
Bald eagle	Special-Status Bird Species	0%	No
Golden eagle	Special-Status Bird Species	0%	No
Northern harrier	Special-Status Bird Species	0.1%	ND[1]
Swainson's hawk	Special-Status Bird Species	<0.1%	ND[1]
White-tailed kite	Special-Status Bird Species	<0.1%	ND[1]
California brown pelican	Special-Status Bird Species	<0.1%	ND[1]
Western snowy plover	Special-Status Bird Species	0%	No

Table 6-2. Target Bird Species Statewide Take Summary

Target Species	Grouping	% of Statewide Population Lethally Affected by Project Annually	Take Exceeds Sustainable Harvest Threshold?
California least tern	Special-Status Bird Species	0%	No

Source: USDA 2022b
Notes: 0% = no MIS lethal WDM occurred during the 10-year baseline period, ND = Not Determined. Refer to Section 3.1 for species with lethal WDM during the analysis period that are not included in this table.
[1] Sustainable harvest thresholds were not determined (ND) for special status species due to the low Proposed Project Maximum lethal Take Estimate (<0.5% of the state population).

7 References

Anderson, D.W. and I.T. Anderson. 1976. "Distribution and Status of Brown Pelicans in the California Current." *American Birds* 30(1): 3-12. https://sora.unm.edu/node/112546

Anguiano, M.P, and J.E. Diffendorfer 2015. Effects of Fragmentation on the Spatial Ecology of the California kingsnake. (*Lampropeltis californiae*). Journal of Herpetology, 49(3), 420-427,

Banci, V., G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. In: Proulx G ed. Mammal Trapping. Sherwood Park Alberta: Alpha Wildlife Research and Management Ltd. pgs. 175 – 204.

Bartmann, R.M., G.C. White, and L.H. Carpenter. 1992. "Compensatory Mortality in a Colorado Mule Deer Population." *Wildlife Monographs*, 121, 1-39.

Batterson, W.M., and W.B. Morse. 1948. "Oregon sage-grouse." *Oregon Fauna Ser. No. 1*, Oregon State Game Commission, Portland.

Beausoleil, R. A., G. M. Koehler, B. T. Maletzke, B. N. Kertson, and R. B. Wielgus. 2013. Research to regulation: cougar social behavior as a guide for management. Wildlife Society Bulletin 37:680–688

Bechard, M.J., C.S. Houston, J.H. Sarasola, and A.S. England. 2020. "Swainson's Hawk (*Buteo swainsoni*)." Version 1.0. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.swahaw.01

Beck, D. D. 1995. Ecology and Energetics of Three Sympatric Rattlesnake Species in the Sonoran Desert. Journal of Herpetology, 29(2), 211–223. https://doi.org/10.2307/1564558.

Benmazouz, I.B., J. Jokimäki, S. Lengyel, L. Juhász, M.-L. Kaisanlahti-Jokimäki, G. Kardos, P. Paládi, and L. Kövér. 2021. "Corvids in Urban Environments: A Systematic Global Literature Review." *Animals* 11(11): 3226. https://doi.org/10.3390/ani11113226.

Beier, P. 1991. "Cougar Attacks on Humans in the United States and Canada." Wildlife Society Bulletin 19:403–412.

Bender, L.C., and O.C. Rosas-Rosas. 2016. "Compensatory Puma Predation on Adult Female Mule Deer in New Mexico." *Journal of Mammalogy*, 97, 1399-1405.

Benson, John F., 2023. The ecology of human-caused mortality for a protected large carnivore, *Proceedings of the National Academy of Sciences.* DOI: 10.1073/pnas.2220030120.

Berger, K.M., and M.M. Conner. 2008. Recolonizing wolves and mesopredator suppression of coyotes: impacts on pronghorn population dynamics. Ecological Applications 18(3):599-612

Berger, J., P.B. Stacey, L. Bellis, and M.P. Johnson. 2001. A mammalian predator-prey imbalance: grizzly bear and wolf extinction affect avian Neotropical migrants. Ecological Applications 11(4):947-960.

Bergman, E. J., P. F. Doherty, G. C. White and A. A. Holland. 2015. Density dependence in mule deer: a review of evidence. Wildlife Biology 21:18-29. https://bioone.org/journals/wildlife-biology/volume-21/issue-1/wlb.00012/Density-dependence-in-mule-deer-a-review-of-evidence/10.2981/wlb.00012.full

Bergstrom, B.J., L.C. Arias, A.D. Davidson, A.W. Ferguson, L.A. Randa, and S.R. Sheffield. 2014. License to kill: Reforming federal wildlife control to restore biodiversity and ecosystem function. Conservation Letters 7:131-142. https://www.researchgate.net/publication/249007704_License_to_Kill_Reforming_Federal_Wildlife_Control_to_Restore_Biodiversity_and_Ecosystem_Function

Beschta, R.L., D.L. Donahue, D.A. DellaSala, J.J. Rhodes, J.R. Carr, M.H. O'Brien, T.L. Fleischner, and C.D. Williams. 2013. Adapting to climate change on western public lands: addressing the ecological effects of domestic, wild, and feral ungulates. Environmental Management 51:474-491.

Beschta, R.L., and W.J. Ripple. 2018. "Can Large Carnivores Change Streams Via a Trophic Cascade?" *Ecohydrology*, 12e2048. https://trophiccascades.forestry.oregonstate.edu/sites/trophic/files/Beschta2019_Ecohyd.pdf.

Black, K., T. Batter, S. Anderson, S. Preckler-Quisquate. 2018. Occupancy, habitat, and abundance of the Sacramento Valley red fox: Sacramento Valley Red Fox Occupancy Modeling. August 2018.

Blair, R.B. 1996. "Land Use and Avian Species Diversity along an Urban Gradient." *Ecological Applications* 6(2): 506-519. https://doi.org/10.2307/2269387.

BLM (U.S. Bureau of Land Management). 1990. *The California Desert Conservation Plan*. https://eplanning.blm.gov/public_projects/lup/66949/82080/96344/CDCA_Plan.pdf.

Boal, C.W. and R.W. Mannan. 1998. "Nest-Site Selection by Cooper's Hawks in an Urban Environment." *Journal of Wildlife Management* 62(3): 864-871. http://www.jstor.com/stable/3802537.

Boarman, W. I. and B. Heinrich 2020. Common Raven (Corvus corax), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.comrav.01

Boddicker, M.L. 1980. Managing Rocky Mountain Furbearers. Colorado Trapper's Assoc. Training Manual, 181 pp.

Boves, T.J. and Belthoff, J.R. 2012. "Roadway Mortality of Barn Owls in Idaho, USA." Journal of Wildlife Management 76(7): 1381-1392. https://doi.org/10.2307/23251436.

Brashares, J.S., L.R. Prugh, C.J. Stoner, and C.W. Epps. 2010. Ecological and Conservation Implications of mesopredator release. In: Terborgh, J., and J.A. Estes, Eds. Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature. Island Press. P. 221-240

Briggs, K.T., D.B. Lewis, W.B. Tyler, G.L. Hunt, Jr. 1981. "Brown Pelicans in Southern California: Habitat Use and Environmental Fluctuations." *Condor* 83(1): 1-15. https://doi.org/10.2307/1367591

Brown, D. E., & Babb, R. D. 2009. *Status of the Porcupine (Erithizon dorsatuh) in Arizona, 2000–2007*. Journal of the Arizona-Nevada Academy of Science, 41(2), 36-41.

Brown, D. E., M.M. Altemus, R.D. Babb, J. Heffelfinger, K. Klima. 2020. Fluctuations in a Jackrabbit Population, 2009 -2020. Journal of the Arizona-Nevada Academy of Science, 49(1), 29–36. https://www.jstor.org/stable/26983733

Buechley, E.R., D. Oleyar, J.L. Watson, J. Bridgeman, S. Volker, D.A. Goldade, C.E. Swift, and B.A. Rattner. 2022. "Preliminary Evidence of Anticoagulant Rodenticide Exposure in American Kestrels (*Falco sparverius*) in the Western United States." *Journal of Raptor Research* 57(2): 1-11. https://doi.org/10.3356/JRR-22-18

Buehler, D.A. 2022. "Bald Eagle (*Haliaeetus leucocephalus*)." Version 2.0. In *Birds of the World*, edited by P.G. Rodewald and S.G. Mlodinow. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.baleag.02.

Bunnell, F.L. and D.E., Tait. 1981. Population Dynamics of Bears – Implications. https://www.researchgate.net/publication/279853599_Population_dynamics_of_bears_-_implications

Burns, C. E., Ackerman, J. T., Washburn, N. B., Bluso-Demers, J., Robinson-Nilsen, C., and Strong, C. 2018. California Gull population growth and ecological impacts in the San Francisco Bay estuary, 1980–2016, in Trends and traditions: Avifaunal change in western North America (W. D. Shuford, R. E. Gill Jr., and C. M. Handel, eds.), pp. 180–189. Studies of Western Birds 3. Western Field Ornithologists, Camarillo, CA; doi 10.21199/SWB3.9.

Burton, T., D. Koch, D. Updike, and A. Brody. 1994. Evaluation of the potential effects of sport hunting on California black bears. Int. Conf. Bear Res. and Manage. 9:231-235. https://www.bearbiology.org/wp-content/uploads/2017/10/Burton_Koch_Updike_Brody_Vol_9.pdf

Butchko, P.H., and M.A., Small. 1992.""Developing A Strategy Of Predator Control For The Protection Of The California Least Tern: A Case History"" *Proceedings of the Fifteenth Vertebrate Pest Conference,* 1992(14). https://digitalcommons.unl.edu/vpc15/14.

Cade, T.J. and Bird, D.M. 1990. "Peregrine Falcons, *Falco peregrinus*, Nesting in an Urban Environment: A Review." *Canadian Field-Naturalist* 104(2): 209-218. http://www.biodiversitylibrary.org/item/106989

Caffrey, A. 1998. *California Least Tern Breeding Survey, 1996 Season*. Bird and Mammal Conservation Program Report.

Cain, J.W., J.B. Ashling, and S.G. Liley. 2018. "Survival and cause-specific mortality of translocated female mule deer in southern New Mexico, USA," Wildlife Research 45(4), 325-335, (3 July 2018). https://doi.org/10.1071/WR17173

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, M. C. E. McNall, and G. E. J. Smith. 1997. The Birds of British Columbia. Volume 3. Passerines: Flycatchers Through Vireos. University of British Columbia Press, Vancouver, BC, Canada.

CDFG (California Department of Fish and Game). 1998. Black Bear Management Plan. California Department of Fish and Game. July 1998. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=82769&inline

CDFG. 2002. *A Summary of Predation by Corvids on Threatened and Endangered Species in California and Management Recommendations to Reduce Corvid Predation*. California Department of Fish and Game, Species Conservation and Recovery Program Rpt. 2002.

CDFG. 2004. *Draft Environment Document Regarding Furbearing and Nongame Mammal Hunting and Trapping*. California Department of Fish and Game. February 2, 2004.

CDFG. 2005. Letter from CDFG to USDA in response to recent discussions regarding the take of exotic red foxes in California for depredation purposes. June 3, 2005.

CDFG. 2011. Draft Environment Document Regarding Bear Hunting. California Department of Fish and Game. February 3, 2011.

CDFW (California Department of Fish and Wildlife). 2016a. California Wildlife Habitat Relationships, Predicted Habitat Models. California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2016b. "Title 14 Section 465.5(g)(5): Zones Prohibited to the Use of Conibear-type Traps and Snares. Conibear-type traps and snares, except those totally submerged, and dead fall traps are prohibited in the following zones (Zones 1 and 2)." July 2016.

CDFW. 2017. Human/Wildlife Interactions in California: Mountain Lion Depredation, Public Safety, and Animal Welfare – Amendment to Department Bulletin 2013-02. Department of Fish and Wildlife Departmental Bulletin 2017-07. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=153021

CDFW. 2019a. Mammal Hunting Regulations, §365 Bear. Change without regulatory effect 8/9/2019. https://fgc.ca.gov/Regulations/Current/Mammals#365

CDFW. 2019b. Bobcat Harvest Assessment 2019-2020. State of California Natural Resource Agency, Department of Fish and Wildlife, Wildlife and Fisheries Division, Wildlife Branch. Prepared by Matt Meshriy, Environmental Scientist. https://wildlife.ca.gov/Hunting/Nongame-Furbearers#22863334-bobcat-harvest

CDFW. 2019c. Deer Harvest Statistics by Year, 2010-2019. State of California Natural Resource Agency, Department of Fish and Wildlife, Wildlife and Fisheries Division, Wildlife Branch. https://wildlife.ca.gov/Hunting/Deer#5477272-harvest-statistics

CDFW. 2020. Licensed Fur Trappers' and Dealers Reports 2010-2020. State of California Natural Resource Agency, Department of Fish and Wildlife, Wildlife and Fisheries Division, Wildlife Branch. https://wildlife.ca.gov/Licensing/Trapping

CDFW. 2021a. *2021 California Waterfowl Breeding Population Survey Report*. California Department of Fish and Wildlife, Wildlife Branch/Waterfowl Program. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=146708&inline.

CDFW. 2021b. "Table 1. Annual Mountain Lion Depredation Permits Issued by CDFW and Reported Number of Mountain Lions Taken by Permittees in California by County (2001–2020)." https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=177513&inline.

CDFW. 2021c. CDFW News Release: Disease Outbreak Strikes California Deer Herds. July 13, 2021. https://wildlife.ca.gov/News/disease-outbreak-strikes-california-deer-herds-july-2021#:~:text=Since%20then%2C%20CdAdV-1%20has%20been%20identified%20as%20the,mortalities%20in%20these%20age%20groups%20occur%20as%20well.

CDFW. 2022a. "Special Animals List." California Natural Diversity Database. CDFW, Biogeographic Data Branch. April 2022. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109406&inline=1.

CDFW. 2022b. Bear Hunting, Harvest Data, Annual Black Bear Take Reports 2010-2019. https://wildlife.ca.gov/Hunting/Bear#455291133-harvest-data.

CDFW. 2022c. "Sierra Nevada Bighorn Sheep Recovery Program–- Predator Monitoring and Management." https://wildlife.ca.gov/Conservation/Mammals/Bighorn-Sheep/Sierra-Nevada/Recovery-Program/Sheep-Predators.

CDFW. 2022d. "Deer Population by Year." https://wildlife.ca.gov/Conservation/Mammals/Deer/Population#32712446-population-by-year

CDFW. 2022f. Upland Game Bird Harvest Survey 2020-2021. Wildlife and Fisheries Division.

CDFW. 2022g. California Natural Diversity Database. Version 5.2.14. Accessed September 2022. https://wildlife.ca.gov/Data/CNDDB

CDFW. 2022h. California Department of Fish and Wildlife. California's known wolves – Past and Present. April 2022. Accessed March 2023. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=201829&inline

CDFW. 2023a. CDFW Black Bear Conservation Management. Accessed March 31, 2023. https://wildlife.ca.gov/Conservation/Mammals/Black-Bear

CDFW. 2023b. CDFW Bobcat Conservation Management. Accessed March 31, 2023. https://wildlife.ca.gov/Conservation/Mammals/Bobcat

CDFW. 2023c. Regional Conservation Investments Strategies Program. https://wildlife.ca.gov/Conservation/Planning/Regional-Conservation

CDFW. 2023d. Mountain Lions in California. https://wildlife.ca.gov/Conservation/Mammals/Mountain-Lion#562331243-is-the-mountain-lion-population-increasing-or-decreasing

CDFW. 2023e. Beaver Depredation Policy. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=213134&inline

Center for Biological Diversity and the Mountain Lion Foundation. 2019. *Petition to List the Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions as Threatened under the California Endangered Species Act (CESA)*. June 25, 2019. https://www.biologicaldiversity.org/species/mammals/California-mountain-lion/pdfs/CESA-petition-for-Southern-California-Central-Coast-Mountain-Lions.pdf.

CFGC (California Fish and Game Code). Section 4000. Division 4: Birds and Mammals; Part 3: Mammals; Chapter 2: Fur-Bearing Mammals.

California Fish and Game Commission. 2020. Notice of Findings, Mountain Lion (Puma concolor). April 21. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=178623

California Roadkill Observation System (CROS). (2023, June). https://www.wildlifecrossing.net/california/

Coates, P.S., S.T. O'Neil, B.E. Brussee, M.A. Ricca, P.J. Jackson, J.B. Dinkins, K.B. Howe, A.M. Moser, L.J. Foster, and D.J. Delehanty. 2020. Broad-scale impacts of an invasive native predator on a sensitive native prey species within the shifting avian community of the North American Great Basin. Biological Conservation, 243, p.108409.

Cogswell, H.L. 1977. *Water Birds of California*. Univ. California Press, Berkeley.

CDOT (Colorado Department of Transportation). 2022. Annual Roadkill Reports. https://www.codot.gov/programs/environmental/wildlife/data/annual-roadkill-reports

Colorado Parks and Wildlife (CPW). 2016. Furbearer Management Report, 2015-2016 Harvest Year. Report by Jerry A. Apker, Furbearer Management Specialist. December 14. https://cpw.state.co.us/Documents/Hunting/SmallGame/Statistics/2015-2016_Furbearer_Report.pdf

CPW. 2018. Furbearer Management Report, 2016-2017 Harvest Year. Report by Mark Vieira, Furbearer Program Manager. April 3. https://cpw.state.co.us/documents/hunting/smallgame/statistics/2016-2017_furbearer_report.pdf

Conner, M.M, M. M. Jaeger, T.J. Weller, and D. R McCullough. 1998. Effect of coyote removal on sheep depredation in Northern California. Journal of Wildlife Management 62(2)690-699.

Conner, M.M., M.R. Ebinger, F.F. Knowlton. 2008. Evaluating coyote management strategies using a spatially explicit, individual-based, socially structured population model. Ecol. Model. 219: 234-247. https://naldc.nal.usda.gov/download/22141/PDF

Connolly, G. E., and W. M. Longhurst. 1975. The effects of control on coyote populations. University of California, Division of Agricultural Science, Davis, California, USA.

Connolly, G.E. 1995. The effects of control on coyote populations another look. Pages 23-29 In: Rollins, D., C. Richardson, T. Blankenship, K. Canon, S. Henke, Eds. Proc. Symposium on Coyotes in the Southwest: A Compendium of our Knowledge. Texas Parks and Recreation Department.

Cooley, H. S., R. B. Wielgus, G. M. Koehler, H. S. Robinson, and B. T. Maletzke. 2009. Does hunting regulate cougar populations? A test of the compensatory mortality hypothesis. Ecology 90:2913–2921.

Cornell Lab of Ornithology 2022. Birds of the World, Subscriber Account. https://birdsoftheworld.org/bow/home

Côté, Steeve D. Julien Beguin, Sonia de Bellefeuille, Emilie Champagne, Nelson Thiffault, Jean-Pierre Tremblay 2014. Structuring Effects of Deer in Boreal Forest Ecosystems, *Advances in Ecology*, vol. 2014, Article ID 917834, 10 pages. https://doi.org/10.1155/2014/917834

Cox, J., E. Pool, K. Bevis, T. Stokely, S. Barnes. 2002. Porcupines in managed woodlands: tools for family forestland owners. Woodland Fish and Wildlife 2002.

CWHR (California Wildlife Habitat Relationships). 2022. “Life History and Range.” https://wildlife.ca.gov/Data/CWHR/Life-History-and-Range.

Crooks, K.R., and M.E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563-566. http://www.elkhornsloughctp.org/uploads/files/1238046095Crooks_Soule_1999_Nature_Mesopredators.pdf

Currylow, A., B. Hanley, K. Holcomb, T. Shields, S. Boland, W. Boarman, and M. Vaughn. 2022. Identifying population management strategies for avian predators: a decision tool. In press.

Czetwertynski, S.M., M.S. Boyce, F.K. Schmiegelow. 2007. "Effects of hunting on demographic parameters of American black bears," Ursus, 18(1), 1-18.

Davidson, W.R., V.F. Nettles, L.E. Hayes, E.W. Howerth, and C.E. Couvillion. 1992. “Diseases Diagnosed in Gray Foxes (*Urocyon cinereoargenteus*) from the Southeastern United States.” *Journal of Wildlife Diseases* 28: 28–33.

Davis, D. E. 1974. Comments on rabies control. J. Wild. Dis. 10:77-82.

Delaney, K.S., S. Zafar, and R.K. Wayne. 2008. “Genetic Divergence and Differentiation within the Western Scrub-Jay (*Aphelocoma californica*).” Auk 125(4): 839-849. https://doi.org/10.1525/auk.2008.07088.

Diffendorfer, J.E., J.C. Stanton, J.A. Beston, W.E. Thogmartin, S.R. Loss, T.E. Katzner, D.H. Johnson, R.A. Erickson, M.D. Merrill, and M.D. Corum. 2021. “Demographic and potential biological removal models identify raptor species sensitive to current and future wind energy.” *Ecosphere* 12(6): e03531. https://doi.org/10.1002/ecs2.3531

Dunk, J.R. 2020. “White-tailed Kite (*Elanus leucurus*).” Version 1.0. In *Birds of the World*, edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.whtkit.01

Dunk, J.R. and R.J. Cooper. 1994. “Territory-size Regulation in Black-shouldered Kites.” *Auk* 111(3): 588-595. https://sora.unm.edu/node/25415

Egan, M.E., C.C. Day, T.E. Katzner, and P.A. Zollner. 2021. “Relative Abundance of Coyotes (Canis latrans) Influences Gray Fox (*Urocyon cinereoargenteus*) Occupancy Across the Eastern United States.” *Canadian Journal of Zoology* 99(2): 63-72. https://doi.org/10.1139/cjz-2019-0246.

Elbroch, M.L., and M. Allen. 2013.“"Prey Indices and Behaviors at a Gray Fox Den in San Mateo County, California”" *Western North American Naturalist* 73(2): 240–243.

Elbroch, L. M., M. Levy, M. Lubell, H. Quigley, and A. Caragiulo. 2017.Adaptive social strategies in a solitary carnivore. Science Advances 3:e1701218

Elbroch, L. M., and A. Kusler. 2018. Are pumas subordinate carnivores, and does it matter? https://peerj.com/articles/4293/

Emblidge, P.G., K.E. Nussear, T.C. Esque, C.M. Aiello, and A.D. Walde. 2015. “Severe Mortality of a Population of Threatened Agassiz’s Desert Tortoise: The American Badger as a Potential Predator.” *Endangered Species Research* 28(2):109–116.

England, A.S., J.A. Estep, and W.R. Holt. 1995. “Nest-site Selection and Reproductive Performance of Urban-nesting Swainson’s Hawks in the Central Valley of California.” *Journal of Raptor Research* 29(3): 179-186. https://sora.unm.edu/node/53479

Estes, J.A., J. Terborgh, J.S. Brashares, M.E. Power, J. Berger, W.J. Bond, S.R. Carpenter, T.E. Essington, R.D. Holt, J.B.C. Jackson, R.J. Marquis, L. Oksanen, T. Oksanen, R.T Paine, E.K. Pikitch, W.J. Ripple, S.A. Sandin, M. Scheffer, T.W. Schoener, HB. Shurin, A.R.E. Sinclair, ME, Soulé, R. Virtanen, and D.A. Wardle. 2011. Trophic downgrading of planet earth. Science 3333:301-306.

Farias, V., T.K. Fuller, R.K. Wayne, and R.M. Sauvajot. 2005. Survival and cause-specific mortality of gray foxes (Urocyon cinereoargenteus) in southern California. Journal of the Zoological Society of London 266: 249-254.

Fedriani, J.M., T.K. Fuller, and R.M. Sauvajot. 2001. Does availability of anthropogenic food enhance densities of omnivorous mammals? An example with coyotes in southern California. Ecography 24:325-331.

Felix, T. 2022a. Assumption to include lethal take (by non-WS or any other individual or agent) in counties with no apparent lethal take during the analysis period whenever there was an adequate population of the target species and resources that might potentially be damaged by the target species. Verbal communication between T. Felix (USDA) and M. Henry (Dudek). November 07, 2022.

Felix, T. 2022b. Existing management activities occurring in counties that overlap the known geographic range of the Sierra Nevada red fox. Verbal communication between T. Felix (USDA) and M. Henry (Dudek). August 17, 2022.

Felix, T. 2022c. WS-California states that woodrat take has increased since the analysis period (CY 2010-2019), with an approximate 10-fold increase in CY 2020 due to increased recognition of the threat of damage to nesting T&E bird species T. Felix (USDA) and M. Henry (Dudek). November 16, 2022.

Felix, T. 2022d. Revision by WS-California to MIS data for lethal impacts to dusky-footed woodrat within San Diego and Tuolumne Counties; species was misidentified and lethal impacts occurred to big-eared woodrat. Verbal communication between T. Felix (USDA) and M. Henry (Dudek). November 3, 2022.

Felix, T. 2022e. WS-California anticipates take of 50% or fewer mountain lions in future years under the Proposed Project. Verbal communication between T. Felix (USDA) and M. Henry (Dudek). October 15, 2022.

Felix, T. 2023. WS-California assumes that private citizens lethally take deer mice in their homes (i.e., rodent/pest control) without involving WS-California or another WDM entity. Verbal communication between T. Felix (USDA) and M. Henry (Dudek). February 8, 2023.

Fergus, C. 2006a. Wildlife Diversity Notebook: Eastern Cottontail. Winter 2006.

Fergus, C. 2006b. Wildlife Notes: Cottontail Rabbit. Prepared for the Pennsylvania Game Commission Bureau of Information and Education Dept. Harrisburg, PA.

Forcey, G.M. and W.E. Thogmartin. 2017. *Effects of Habitat and Climate on Blackbird Populations.* Chapter 6 in *Ecology and Management of Blackbirds (Icteridae) in North America*, edited by G.M. Linz, M.L. Avery, and R.A. Dolbeer. Boca Raton, Florida: CRC Press.

Frank, S.C., A. Ordiz, J. Gosselin, A. Hertel, J. Kindberg, M. Leclerc, F. Pelleteir, S.M.J.G. Steyaert, O Stoen, J. Van De Walle, A. Zedrosser, and J. Swensen. 2017. Indirect effects of bear hunting: a review from Scandinavia. Ursus 28(2): 150-164.

Fraser, J.D., S.K. Chandler, D.A. Buehler, J.K.D. Seegar. 1996. "The Decline, Recovery and Future of the Bald Eagle Population of the Chesapeake Bay, U.S.A." In *Eagle Studies*, edited by B.U. Meyburg and R.D. Chancellor. World Working Group for Birds of Prey, Berlin, Germany. pp. 181–187. http://www.raptors-international.org/book/eagle_studies_1996/Fraser_Sheri_1996_181-187.pdf

Frédéric, J. 2020. "The Fox and the Crow. A need to update pest control strategies." Biological conservation 248 (2020): 108693. https://www.sciencedirect.com/science/article/pii/S0006320720307515#bb0020

Garrett, K., and J. Dunn. 1981. *Birds of Southern California*. Los Angeles Audubon Society.

Gashwiler, Jay S.; Robinette, W. Leslie; Morris, Owen W. (1960). "Foods of bobcats in Utah and eastern Nevada." Journal of Wildlife Management. 24 (2): 226–228. doi:10.2307/3796754. JSTOR 3796754

Gerber, B.D., J.F. Dwyer, S.A. Nesbitt, R.C. Drewien, C.D. Littlefield, T.C. Tacha, P.A. Vohs. 2020. "Sandhill Crane (*Antigone canadensis*)." Version 1.0. In *Birds of the World*, edited by A.F Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.sancra.01.

Gergis, J.L. and A.M. Fowler. 2009. "A History of ENSO Events Since A.D. 1525: Implications for Future Climate Change." *Climatic Change* 92: 343-387. https://doi.org/ 10.1007/s10584-008-9476-z

Gese, E.M. 2005. Demographic and Spatial Responses of Coyotes to Changes in Food and Exploitation. Proceedings of the Wildlife Damage Management Conference, 11, 271-285.

Gilmer, D.S., M.R. Miller, R.D. Bauer, J.R. LeDonne. 1982. "California's Central Valley Wintering Waterfowl: Concerns and Challenges." *US Fish and Wildlife Publications*, 41. https://digitalcommons.unl.edu/usfwspubs/41

Giusti, Gregory A.; Schmidt, Robert H.; Timm, Robert M.; *et al.* (1992). "The lagomorphs: rabbits, hares, and pika." In: Silvicultural approaches to animal damage management in Pacific Northwest forests. Gen. Tech. Rep. PNW-GTR-287. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: pp. 289–307. doi:10.2737/PNW-GTR-287

Goldstein, M.I., T.E. Lacher, Jr., B. Woodbridge, M.J. Bechard, S.B. Canavelli, M.E. Zaccagnini, G.P. Cobb, E.J. Scollon, R. Tribolet, and M.J. Hooper. 1999. "Monocrotophos-Induced Mass Mortality of Swainson's Hawks in Argentina, 1995-96." *Ecotoxicology* 8(3): 201-214. https://doi.org/ 10.1023/ A:1026496331396

Gray, R.L. 1975. "Sacramento Valley Red Fox Survey." California Department of Fish and Game, Nongame Wildlife Invest. Progress report.

Griffith, G.E., J.M. Omernik, D.W. Smith, T.D. Cook, E. Tallyn, K. Moseley, and C.B. Johnson. 2016. "Ecoregions of California" [Poster]. U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000. http://dx.doi.org/10.3133/ofr20161021.

Grimm, R.L. 1939. "Northern Yellowstone Winter Range Studies." *Journal of Wildlife Management*, 8: 329–334.

Grinnell, J., and J. Dixon. 1919. Natural history of the ground squirrels of California. *Calif. State Comm. Horticulture Bull*. 7:597-708.

Grinnell, J., J.S. Dixon, and J.M. Linsdale. 1937. *Furbearing Mammals of California*. University of California Press, Berkeley.

Gunderson, L.H. 2000. Ecological Resilience—in theory and application. Ann. Rev. Ecol. Syst. 31:425-39

Hager, S.B. 2009. Human-Related Threats to Urban Raptors, Journal of Raptor Research, 43(3), 210-226, 1 September

Hagar, Jr., D. C. 1957. Nesting populations of Red-tailed Hawks and Great-horned owls in central New York State. Wilson Bulletin 69:263-272. https://www.jstor.org/stable/4158602

Hamilton, R.B. 1975. "Comparative behavior of the American avocet and the black-necked stilt (*Recurvirostridae*)." *Ornithology Monographs* No. 17.

Hanley, B., A. Currylow, K. Holcomb, T. Shields, S. Boland, W. Boarman, and M. Vaughn. 2021. StallPOPdV4 Web Interactive: Software to compute population control treatments of a subsidized predator [Software]. doi: https://doi.org/10.7298/sk2e-0c38.4

Harding, Elaine K., Daniel F. Doak, and Joy D. Albertson. "Evaluating the effectiveness of predator control: the non-native red fox as a case study." Conservation Biology 15.4 (2001): 1114-1122. https://www.doaklab.org/pdf/harding_2001_conservation_biology.pdf

Harju, S.M., P.S. Coates, S.J. Dettenmaier, J.B. Dinkins, P.J. Jackson, and M.P. Chenaille. 2021. Estimating trends of common raven populations in North America, 1966–2018. *Human-Wildlife Interactions* 15:248–269.

Harrison, R. 2013. Ringtail (Bassariscus astutus) Ecology And Behavior In Central New Mexico, USA. Western North American Naturalist. 72. 10.3398/064.072.0407.

Hebblewhite, M., White, C.A., Nietvelt, C.G., McKenzie, J.A., Hurd, T.E., Fryxell, J.M., Bayley, S.E. and Paquet, P.C., 2005. Human activity mediates a trophic cascade caused by wolves. Ecology, 86(8), pp.2135-2144.

Henderson, L.A. and L.A., Trulio. 2019. Can California Ground Squirrels Reduce Predation Risk to Burrowing Owls?. Journal of Raptor Research, 53(2): 172-179. https://bioone.org/journals/journal-of-raptor-research/volume-53/issue-2/JRR-17-73/Can-California-Ground-Squirrels-Reduce-Predation-Risk-to-Burrowing-Owls/10.3356/JRR-17-73.full

Henke, S. E. 1995. Effects of coyote control on their prey: A review. In (Proceedings) Coyotes in the Southwest: A Compendium of our Knowledge. December 1995. Tex. Agric. Ext. Serv., Tex. A&M Univ. San Angelo, TX. Pp. 35-40

Henny, C. J. and H. M. Wight 1972. Population ecology and environmental pollution: red-tailed and Cooper's hawks. Population Ecology of Migratory Birds: A Symposium. Wildlife Research Report 2: 229-278.https://www.researchgate.net/publication/243787361_Population_ecology_and_environmental_pollution_Red-tailed_and_Cooper's_Hawks

Higley, J. 2002. Hunting Deer in California. Prepared for the California Fish and Game, Wildlife Programs Branch. August 2002. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=23228&inline

Hollister, N. 1911. The Generic Name of the Muskrat. Proceedings of the Biological Society of Washington, Vol XXIV, pp. 13-14. January 28, 1911.

Hopkins J.B. III, J.M. Ferguson, D.B. Tyers, and C.M. Kurle. 2017. "Selecting the Best Stable Isotope Mixing Model to Estimate Grizzly Bear Diets in the Greater Yellowstone Ecosystem." *PLoS ONE*, 12(5): e0174903. https://doi.org/10.1371/journal. pone.017490.

Hothem, R.L., B.E. Brussee, W.E. Davis Jr., A. Martínez-Vilalta, A. Motis, and G.M. Kirwan. 2020. "Black-crowned Night-Heron (*Nycticorax nycticorax*)." Version 1.0. In *Birds of the World*, edited by S.M. Billerman. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.bcnher.01

Howard, R.P. and Wolfe, M.L. 1976. Range improvement practices and Ferruginous Hawks. Journal of Range Management. 29(1): 33-37. https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/6530/6140

Ignatiuk, J. B. and R. G. Clark. 1991. Breeding biology of American crows in Saskatchewan parkland habitat. Canadian Journal of Zoology 69:168-175.

IUCN (International Union for Conservation of Nature). 2022. The IUCN Red List of Threatened Species. https://www.iucnredlist.org/

Jehl, Jr., J.R. 1989. "Nest-site Tenacity and Patterns of Adult Mortality in Nesting California Gulls (*Larus californicus*)." *Auk* 106(1): 102-106. https://sora.unm.edu/node/24660

Johns, D., and K. Armitage. 1979. Behavioral Ecology of Alpine Yellow-Bellied Marmots. *Behavioral Ecology and Sociobiology* 5: 133–157. 10.1007/BF00293302.

Johnson, S. J. 1975. Productivity of the Red-tailed Hawk in southwestern Montana. Auk 92:732-736. https://www.jstor.org/stable/4084784

Jurek, R. 1992. *Nonnative Red Foxes in California*. Report to the California Department of Fish and Game, Nongame Bird and Mammal Section Report, 92-04.

Kamler J.F., P.S. Gipson. 2004. Survival and Cause-Specific Mortality among Furbearers in a Protected Area. American Midland Naturalist 151: 27–36.

Katzner, T.E., M.N. Kochert, K. Steenhof, C.L. McIntyre, E.H. Craig, and T.A. Miller. 2020. "Golden Eagle (*Aquila chrysaetos*)." Version 2.0. In Birds of the World, edited by P.G. Rodewald and B.K. Keeney. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.goleag.02

Keigley, R.B. 2018. "How Perceptions About Naturalness Affect Science in Yellowstone National Park." *Rangeland Ecology & Management*, 71(3):395–401.

Kelly, E.C., B.L. Cypher, and T.L. Westall. 2021. "Predation on Desert Tortoises (*Gopherus agassizii*) by Desert Canids." *Journal of Arid Environments*, 189. June 2021.

Kelly, J.P., K. Etienne, C. Strong, M. McCaustland, and M.L. Parkes. 2007. "Status, Trends, and Implications for the Conservation of Heron and Egret Nesting Colonies in the San Francisco Bay Area." Waterbirds 30(4): 455-478. https://doi.org/10.1675/1524-4695(2007)030[0455:STAIFT]2.0.CO;2

Kessler, A.C., J.W. Merchant, C.R. Allen, and S.D. Shultz. 2011. "Impacts of Invasive Plants on Sandhill Crane (*Grus canadensis*) Roosting Habitat." *Nebraska Cooperative Fish and Wildlife Research Unit – Staff Publications* 191. http://digitalcommons.unl.edu/ncfwrustaff/191

Kettel, E.F., L.K. Gentle, J.L. Quinn, and R.W. Yarnell. 2018. "The Breeding Performance of Raptors in Urban Landscapes: A Review and Meta-analysis." Journal of Ornithology 159: 1-18. https://doi.org/10.1007/s10336-017-1497-9.

Klafki, R. W. 2014. Road ecology of a northern population of badgers (Taxidea Taxus) in British Columbia, Canada. Master Thesis. Retrieved from Thompson Rivers University

Knight, R.L., A.L. Knight, and R.J. Camp. 1993. "Raven Populations and Land-Use Patterns in the Mohave Desert, California." *Wildlife Society Bulletin* 21(4): 469-471.

Knowlton, F. F., E.M. Gese, and M.M. Jaeger. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52:398-412.

Koenig, W.D., E.L. Walters, P.B. Stacey, M.T. Stanback, and R.L. Mumme. 2020. "Acorn Woodpecker (Melanerpes formicivorus)." Version 1.0. In Birds of the World, edited by P.G. Rodewald and B.K. Keeney. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.acowoo.01

Kramer, J.L. and P.T. Redig. 1997. "Sixteen Years of Lead Poisoning in Eagles, 1980-95: An Epizootiologic View." *Journal of Raptor Research* 31(4): 327-332. https://sora.unm.edu/node/53635

Kristan, W.B., W.I. Boarman, and W.C. Webb. 2005. Stage-structured matrix models of Common Ravens (*Corvus corax*) in the west Mojave Desert. Fort Collins, Colorado: National Wildlife Research Center.

La Rivers, I. (1944). "Observations on the nesting mortality of the Brewer Blackbird, *Euphagus cyanocephalus*." American Midland Naturalist 32:417-437.

Lariviere, S., and L.R. Walton 1998. "*Lontra canadensis*." *Mammalian Species* No. 587, pp. 1-8. https://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/pdf/i0076-3519-587-01-0001.pdf.

Latham, A. D. M., M. C. Latham, K. H. Knopff, M. Hebblewhite and S. Boutin. 2013. Wolves, white-tailed deer, and beaver: implications of seasonal prey switching for woodland caribou declines. Ecography 36:1276-1290

Layne, J. N. and W. H. McKeon. 1956. Some aspects of red fox and gray fox reproduction in New York. N. Y. Fish and Game J. 3:44-74.

Leblond, M., C. Dussault. J. P. Quellet, and M. H. St. Laurent. 2016. Caribou avoiding wolves face increased predation by bears – caught between Scylla and Charybdis. Journal of Applied Ecology. DOI: 10.1111/1365-2664.12658

Lehman, C. P., C. T. Rota, J. D. Raithel and J. J. Millspaugh. 2018. Pumas affect elk dynamics in absence of other large carnivores. Journal of Wildlife Management 82:344—353

Lenihan, C. 2007. The Ecological Role of the California Ground Squirrel (*Spermophilus beecheyi*). https://www.researchgate.net/publication/277248199_The_Ecological_Role_of_the_California_Ground_Squirrel_Spermophilus_beecheyi

Levi, T. and C.C. Wilmers, 2012. Wolves-coyote-foxes: A cascade among carnivores. Ecology 93:921-929.

Levi, T. G.V. Hilderbrand, M.D. Hocking, T.P. Quinn, K.S. White, M.S. Adams, J.B. Armstrong, A.P. Crupi, C.T. Darimont, W. Deacy, S.L. Gilbert, W.J. Ripple, Y.N. Shakeri, R.E. Wheat, and C.C. Wilmers. 2020. Community Ecology and Conservation of Bear-Salmon Ecosystems. Front. Ecol. Evol. 8:513304

Lewis, J.C., K.L. Sallee, and R.T. Golightly. 1993. "Introduced Red Fox in California." California Department of Fish and Game, Sacramento. Non-game Bird and Mammal Sect. Rep. 93-10. http://morro-bay.com/educational/research-reports/red-fox--california-introduced-research-93_10.pdf.

Lewis, J.C., K.L. Sallee, and R.T. Golightly. 1999. "Introduction and Range Expansion of Nonnative Red Foxes (*Vulpes vulpes*) in California." *The American Midland Naturalist,* 142(2): 372–381.

Lightbody, J.P. and P.J. Weatherhead. (1988). Female setting patterns and polygyny: tests of a neutral-mate-choice hypothesis. American Naturalist 132:20-33. https://www.jstor.org/stable/pdf/2461751.pdf

Littlefield, C.D. 2002. "Winter Foraging Habitat of Greater Sandhill Cranes in Northern California." *Western Birds* 33: 51-60. https://westernfieldornithologists.org/publications/journal/journal-volume-33-1/v33-1-littlefield-greater_sandhill_cranes/

Logan, K.A. 2019. "Puma Population Limitation and Regulation: What Matters in Puma Management?" The Journal of Wildlife Management 83(8):1652-1666.

Lokemoen, J. T. and H. F. Duebbert. (1976). Ferruginous Hawk nesting ecology and raptor populations in northern South Dakota. Condor 78:464-470. https://www.jstor.org/stable/pdf/1367095.pdf

Mace R.D. and T. Chilton-Radandt. 2011. Black Bear Harvest Research and Management in Montana. Montana Fish, Wildlife and Parks, Wildlife Division. Helena, Montana. Federal Aid in Wildlife Restoration, Project W-154-R. https://fwp.mt.gov/binaries/content/assets/fwp/conservation/wildlife-reports/bears/bearrptfinalwithcovers_4_27_11_medlow1-1.pdf

Marboutin E., Y. Bray, R. Peroux, B. Mauvy, A. Lartiges. 2003. Population dynamics in European hare: breeding parameters and sustainable harvest rates. J Appl Ecol 40:580–591. https://doi.org/10.1046/j.1365-2664.2003.00813.x

Maron, J.L., and D.E. Pearson. 2011. Vertebrate predators have minimal cascading effects on plant production or seed predation in an intact grassland ecosystem. Ecology Letters 14:661-669

Marschalek, D. 2008. California Least Tern Breeding Survey, 2008 Season. Non-Game Wildlife Program. Prepared for the California Fish and Game. 2009. https://sdmmp.com/upload/SDMMP_Repository/0/qp0rbm6k8nj23yvzx4td7wh5g9f1c.pdf

Marti, C.D., A.F. Poole, L.R. Bevier, M.D. Bruce, D.A. Christie, G.M. Kirwan, and J.S. Marks. 2020. "Barn Owl (Tyto alba)." Version 1.0. In Birds of the World, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.brnowl.01.

Martin, S.G. 2020. "Brewer's Blackbird (*Euphagus cyanocephalus*)." Version 1.0. In *Birds of the World*, edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.brebla.01

Marzluff, J. M., R. B. Boone, and G. W. Cox. 1994. "Historical Changes in Populations and Perceptions of Native Pest Bird Species in the West." *Studies in Avian Biology* 15:202-220.

Marzluff, J.M., K.J. McGowan, R. Donnelly, and R.L. Knight. 2001. "Causes and Consequences of Expanding American Crow Populations." In J.M. Marzluff, R. Bowman, and R. Donnelly (Eds.), *Avian Ecology and Conservation in an Urbanizing World*, pp 332–363. Kluwer Academic Press, Norwall MA.

Massemin, S. and Zorn, T. 1998. "Highway Mortality of Barn Owls in Northeastern France." *Journal of Raptor Research* 32(3): 229-232. https://biostor.org/reference/215946.

Mee, A., and N. Snyder. 2007. "California Condors in the 21st Century - Conservation Problems and Solutions."

Merkel & Associates Inc. 2010. *Western Snowy Plover Nesting at Bolsa Chica, California, 2010*. December 2010.

Miller, S. D. 1990. Population management of bears in North America. Int. Conf. Bear Res. Manage. 8:357-373. https://www.bearbiology.org/fileadmin/tpl/Downloads/URSUS/Vol_8/Miller_BearMgtNA_8.pdf

Miller, B.J., H.J. Harlow, T.S. Harlow, D. Biggins and W.J. Ripple. 2012. Trophic cascades linking wolves (Canis lupus), coyotes (Canis latrans) and small mammals. Canadian Journal of Zoology 90:70-78.

Mills, L.S., Soule, M.E.; Doak, D.F. 1993. "The Keystone-Species Concept in Ecology and Conservation." BioScience. 43 (4): 219-224.

Moore, G. C., and G. R. Parker. 1992. Pages 23-38 in A. H. Boer, editor. Colonization by the eastern coyote (Canis latrans). Ecology and management of the eastern coyote. Wildl. Res. Unit, Univ. New Brunswick, Fredericton

Moriarty, J.G., S.P.D. Riley, L.E. Serieys, J.A. Sikich, C.M. Schoonmaker, and R.H. Poppenga. 2012. "Exposure of Wildlife to Anticoagulant Rodenticides at Santa Monica Mountains National Recreation Area: From Mountain Lions to Rodents." *Proceedings of the Vertebrate Pest Conference*, 25. https://escholarship.org/content/qt8h35t18v/qt8h35t18v.pdf?t=pj62rk

Mowbray, T.B., C.R. Ely, J.S. Sedinger, and R.E. Trost. "Canada Goose (*Branta canadensis*)." Version 1. In Birds of the World, edited by P.G. Rodewald. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.cangoo.01

Naiman, R.J. and K.H. Rogers. 1997. Large animals and system-level characteristics in river corridors, implications for river management. BioScience 47(8):521-529.

Nasman, K., K. Bay, T. Mattson, J. Leckband, and D. Becker. 2021. "Predicting Bald Eagle Collision at Wind Energy Facilities." *The Journal of Wildlife Management* 85(3): 520–530.

Nielsen, C.K. 2016. "Modeling Population Growth and Response to Harvest for River Otters in Illinois." *Journal of Contemporary Water Research and Education* 157: 14–22.

Nixon, C. M., McClain, M. W., & Donohoe, R. W. 1975. Effects of Hunting and Mast Crops on a Squirrel Population. The Journal of Wildlife Management, 39(1), 1–25. https://doi.org/10.2307/3800460

NPS (National Park Service). 2014. "Griffith Park Mountain Lion Exposed to Poison, Suffering from Mange". April 17. https://www.nps.gov/samo/learn/news/gp-lion-exposed-to-poison.htm

NPS. 2020. "Bobcat and mountain lion found dead from anticoagulant rodenticide poisoning". August 27. https://www.nps.gov/samo/learn/news/bobcat-and-mountain-lion-found-dead-from-anticoagulant-rodenticide-poisoning.htm

NPS 2022a. "Adult female mountain lion P-54 and her four full-term fetuses were exposed to multiple anticoagulant rodenticides". September 7. https://www.nps.gov/samo/learn/news/adult-female-mountain-lion-p-54-and-her-four-full-term-fetuses-were-exposed-to-multiple-anticoagulant-rodenticides.htm

NPS. 2022b. "California Brown Pelican." Channel Islands National Park. Last updated October 27, 2022. Accessed April 26, 2023. https://www.nps.gov/chis/learn/nature/brown-pelican.htm

Nunley, G. L. 1977. The effects of coyote control operations on non-target species in Colorado. Great Plains Wildlife Damage Workshop 3:88-110. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1227&context=gpwdcwp

Olendorff, R.R. 1976. "The Food Habits of North American Golden Eagles." *American Midland Naturalist,* 231–236

Olendorff, R. R. (1993). Status, biology, and management of Ferruginous Hawks: a review. Boise, ID: U.S. Dep. Interior, Bur. Land Manage. https://digitalcommons.usu.edu/govdocs/232/

Olson, S.M. (Compiler). 2021. *Pacific Flyway Data Book, 2021*. U.S. Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Vancouver, Washington.

Orians, G. H. (1980). Some Adaptations of Marsh Nesting Blackbirds. Princeton University Press, Princeton, NJ, USA. https://books.google.com/books?hl=en&lr=&id=if3RDwAAQBAJ&oi=fnd&pg=PP1&dq=Orians,+G.+H.+(1980).+Some+Adaptations+of+Marsh+Nesting+Blackbirds.+Princeton+University+Press,+Princeton,+NJ,+USA.&ots=Q87Mon6g_P&sig=OyHfNpBXdfJW2fYRnKwKo4JtECE#v=onepage&q&f=false

Osburn, D.J., and M.J. Cramer. 2013. "Foraging response of Erethizon dorsatum and Lepus americanus to specialized and generalized predator scents." *The American Midland Naturalist*, 169(1): 66-73.

Page, G.W., L.E. Stenzel, J.S. Warriner, J.C. Warriner, and P.W. Paton. 2020. "Snowy Plover (*Charadrius nivosus*)." Version 1.0. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.snoplo5.01

Paine, T.T. 1969. "A Note on Trophic Complexity and Community Stability." *The American Naturalist* 103(929): 91–93.

Partners in Flight. 2016. *Partners in Flight Landbird Conservation Plan.* https://www.partnersinflight.org/wp-content/uploads/2016/08/pif-continental-plan-final-spread-single.pdf.

PIF (Partners in Flight). 2022. "Population Estimates for California." https://pif.birdconservancy.org/population-estimate-database-scores/.

Peebles, L.W., and J.O. Spencer. 2020. *Common Ravens. Wildlife Damage Management Technical Series.* USDA, APHIS, Wildlife Services. February 2020. https://www.aphis.usda.gov/wildlife_damage/reports/Wildlife%20Damage%20Management%20Technical%20Series/Common%20Ravens_WDM%20Technical%20Series_February%202020.pdf.

Penrod, K., P. Beier, E. Garding, and C. Cabañero. 2012. *A Linkage Network for the California Deserts. Produced for the Bureau of Land Management and The Wildlands Conservancy*. Produced by Science and Collaboration for Connected Wildlands, Fair Oaks, California, and Northern Arizona University, Flagstaff, Arizona. http://www.scwildlands.org/reports/ALinkageNetworkForTheCaliforniaDeserts.pdf.

Perrine, J.D., J.P. Pollinger, B.N. Sacks, R.H. Barrett, R.K. Wayne. 2007. Genetic evidence for the persistence of the critically endangered Sierra Nevada red fox in California. Conservation Genetics 8:1083–1095.

Pierce, B.M., C.V. Bleich, and R.T. Bowyer. 2000. "Selection of Mule Deer by Mountain Lions and Coyotes: Effects on Hunting Style, Body Size, and Reproductive Status." *Journal of Mammalogy,* 81(2): 462–472. May 2000.

Pitt, W.C., F.F. Knowlton, P.W. Box. 2001. A New Approach to Understanding Canid Populations Using an Individual-based Computer Model: Preliminary Results. U.S. Department of Agriculture: Animal and Plant Health Inspection Service. USDA National Wildlife Research Center – Staff Publications 562. https://digitalcommons.unl.edu/icwdm_usdanwrc/562?utm_source=digitalcommons.unl.edu%2Ficwdm_usdanwrc%2F562&utm_medium=PDF&utm_campaign=PDFCoverPages

Pollock, M.M., M. Heim, D. Werner. 2003. Hydrologic and Geomorphic Effects of Beaver Dams and Their Influence on Fishes. National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center.

Pollock, M.M., G.R. Pess, T.J. Beechie and D.R. Montgomery. 2004. The Importance of North American beaver Ponds to Coho Salmon Production in the Stillaguamish River Basin, Washington, USA, North American Journal of Fisheries Management, 24:3, 749-760

Pollock, M.M., T.J. Beechie, J.M. Wheaton, C.E. Jordan, N. Bouwes, N. Weber, and C. Volk. 2014. Using Beaver Dams to Restore Incised Stream Ecosystems. BioScience Vol. 64, Issue 4. April 2014, Pages 279–290. https://academic.oup.com/bioscience/article/64/4/279/2754168

Pollock, M.M., G.M. Lewallen, K. Woodruff, C.E. Jordan and J.M. Castro (Editors) 2018. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 2.01. United States Fish and Wildlife Service, Portland, Oregon. 189 pp.

Pope, K.L. and L.A. Powell. 2021. Harvest of Fish and Wildlife, New Paradigms for Sustainable Management. CRC Press 2021.

Preston, C.R. and R.D. Beane. 2020. "Red-tailed Hawk (*Buteo jamaicensis*)." Version 1.0. Commercial Subscription. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.rethaw.01

Prugh, L.R., C.J. Stoner, C.W. Epps, W.T. Bean, W. J. Ripple, A.S. Laliberte, and J.S. Brashares. 2009. The rise of the mesopredator. Bioscience, 59:779-791. https://nature.berkeley.edu/BrasharesGroup/wp-content/uploads/2015/06/Prugh-et-al.-2009-Rise-of-the-Mesopredator1.pdf

Ralls, K., and P.J. White. 1995. "Predation on San Joaquin Kit Foxes by Larger Canids." Journal of Mammalogy, 76(3): 723–729.

Ramsden, D.J. 2003. *Barn Owls and Major Roads: Results and Recommendations from a 15-Year Research Project*. The Barn Owl Trust. http://www.barnowltrust.org.uk/Forms/WebsiteReport.pdf.

Responsive Management. 2015. Harvest of Small Game, Upland Birds, and Other Wildlife in California. Conducted for the California Department of Fish and Wildlife. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=108608.

Riley, P.D., L.E.K. Serieys, J.P. Pollinger, J.A. Sikich, L. Dalbeck, R.K. Wayne, H.B. Ernest. 2014. "Individual Behaviors Dominate the Dynamics of an Urban Mountain Lion Population Isolated by Roads." Current Biology, 24(17): 1989–1994. https://www.sciencedirect.com/science/article/pii/S0960982214008550.

Riley, P. D., C. Bromley, R.H. Poppenga, F.A. Uzal, L. Whited, R.M. Sauvajot. 2007. Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. The Journal of Wildlife Management, 71(6), 1874–1884. http://www.jstor.org/stable/4496279

Ripple, W.J., A.J. Wirsing, C.C. Wilmers, and M. Letnic. 2013. "Widespread Mesopredator Effects After Wolf Extirpation." *Biological Conservation*, 160.

Ripple, W.J. and R.L. Beschta. 2006. Linking a cougar decline, trophic cascade and catastrophic regime shift in Zion National Park. Biological Conservation 138:514-519.

Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M.P. and Schmitz, O.J., 2014. Status and ecological effects of the world's largest carnivores. Science, 343(6167), p.1241484.

Ritchie, *E.G.* and C.N. Johnson. 2009. Predator interactions, mesopredator release, and biodiversity conservation. Ecology Letters 12 982-998.

Robbins, C., D. Brystrak, and P.H. Geissler. 1986. *The Breeding Bird Survey: Its First Fifteen Years, 1965–1979*. https://pubs.usgs.gov/unnumbered/5230189/report.pdf.

Robinson, W. B. 1961. Population changes of carnivores in some coyote-controlled areas. Journal of Mammalogy. 42:510-515

Robinson, J., and K. Redford. 1991. Sustainable harvest of Neotropical forest mammals. (J.G. Robinson, K.H. Redford, Eds.). pp. 415-429. Chicago: Chicago University Press. https://www.researchgate.net/publication/285386967_Sustainable_harvest_of_Neotropical_forest_mammals

Robinson, H. S., R. B. Wielgus, H. S. Cooley, and S. W. Cooley. 2008. Sink populations in carnivore management: Cougar demography and immigration in a hunted population. Ecological Applications 18: 1028–1037

Rodriguez-Robles, J. A. 2003. Home ranges of gopher snakes in central California. American Society of Ichthyologists and Herpetologists: (2003) 391-396. https://www.jstor.org/stable/pdf/1448682.pdf

Roemer, G.W., M.E. Gompper, and B. Van Valkenburgh. 2009. The ecological role of the mammalian mesocarnivore. BioScience 59:165-173. https://www.researchgate.net/publication/232688215_The_Ecological_Role_of_the_Mammalian_Mesocarnivore

Rosatte, R.C. 2000. Management of Raccoons (*Procyon lotor*) in Ontario, Canada: Do Human Intervention and Disease have Significant Impact on Raccoon Populations?. Mammalia. 64. 369-390. 10.1515/mamm.2000.64.4.369.

Rosenfield, R. N., K. K. Madden, J. Bielefeldt, and O. E. Curtis. 2020. Cooper's Hawk (*Accipiter cooperii*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.coohaw.01

Rudd, J.L, S.C. McMillin, M.W. Kenyon, D.L. Clifford, and R.H. Poppenga, 2018. Prevalence of First and Second-generation Anticoagulant Rodenticide Exposure in California Mountain Lions (*Puma concolor*). *Proceedings of the Vertebrate Pest Conference*, 28. http://dx.doi.org/10.5070/V42811046 https://escholarship.org/uc/item/5380t405

Runge, M.C. 1999. Design and Analysis of a Population Model for North American beaver (*Castor canadensis*). Cornell Biometrics Unit Technical Series BU-1462, Cornell University, Ithaca, New York. 29 p

Russell, F. L., Zippin, D. B. and N. L. Fowler. 2001. Effects of white-tailed deer (*Odocoileus virginianus*) on plants, plant populations and communities: a review. *American Midland Naturalist* 146:1-26.

Russell, R.E. and J.C. Franson. 2014. “Causes of Mortality in Eagles Submitted to the National Wildlife Healthy Center 1975-2013.” *Wildlife Society Bulletin* 38(4): 697-704. https://doi.org/10.1002/wsb.469

Sacks, B.N., K.M. Blejwas, and M.M Jaeger. 1999. Relative vulnerability of coyotes to removal methods on a northern California ranch. Journal of Wildlife Management 63(3):939-949.

Sacks BN, Statham MJ, Perrine JD, Wisely SM, Aubry KA. 2010a. North American montane red foxes: expansion, fragmentation, and the origin of the Sacramento Valley red fox. Conservation Genetics 11:1523–1539.

Sacks, B.N., H.U. Wittmer, and M.J. Statham. 2010b. *The Native Sacramento Valley Red Fox*. Report to the California Department of Fish and Game, May 30, 2010. https://mecu.ucdavis.edu/wp-content/uploads/sites/491/2017/11/The-Native-Sacramento-ValleyRedFox_2010.pdf.

Sanderson, G.C. 1999. Raccoon. In: Novak, M., J.A. Baker, M.E. Obbard, and B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada. Pp. 486-499.

Santana, E.M. and J.B. Armstrong. 2017. Food habits and anthropogenic supplementation in coyote diets along an urban-rural gradient. Human-Wildlife Interactions 11(2):156-166

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski, Jr, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2019. The North American Breeding Bird Survey, Results and Analysis 1966 - 2019. Version 2.07.2019 USGS Patuxent Wildlife Research Center, Laurel, MD. https://www.mbr-pwrc.usgs.gov/.

SFBO and USFWS (San Francisco Bay Observatory and U.S. Fish and Wildlife Service Don Edwards San Francisco Bay National Wildlife Refuge). 2007. *Western Snowy Plover Numbers, Nesting Success, and Avian Predator Surveys in the San Francisco Bay, 2006*.

Schai-Braun, S.C., T. Ruf, E. Klansek, W. Arnold, K. Hackländer. 2020. Positive effects of set-asides on European hare (Lepus europaeus) populations: leverets benefit from an enhanced survival rate. Biol Conserv 244:108518. https://doi.org/10.1016/j.biocon.2020.108518

Schreiber, R.W. and P.J. Mock. 1988. “Eastern Brown Pelicans: What Does 60 Years of Banding Tell Us?” *Journal of Field Ornithology* 59(2): 171-182. https://sora.unm.edu/node/51404

Serieys, L.E., T.C. Armenta, J.G. Moriarty, E.E. Boydston, L.M. Lyren, R.H. Poppenga, K.R. Crooks, R.K. Wayne, S.P. Riley. 2015. Anticoagulant rodenticides in urban bobcats: exposure, risk factors and potential effects based on a 16-year study. Ecotoxicology; 24(4):844-62. https://www.raptorsarethesolution.org/wp-content/uploads/2022/12/Serieys_ARs-in-urban-bobcats_Ecotoxicology_2015.pdf

Shields, M. 2020. “Brown Pelican (*Pelecanus occidentalis*).” Version 1.0. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.brnpel.01

Slabe, V. A., J. T. Anderson, B. A. Millsap, J. L. Cooper, A. R. Harmata, M. Restani, R. H. Crandall, B. Bodenstein, P. H. Bloom, T. Booms, and J. Buchweitz. 2022. “Demographic implications of lead poisoning for eagles across North America.” *Science* 375(6582):779–782. https://doi.org/10.1126/science.abj306

Smith, A., S.R. Puffer, J.E. Lovich, L.A. Tennant, T.R. Arundel, M.S. Vamstad, and K.D. Brundige. 2016. “A Potential Predator-Prey Interaction of an American Badger and an Agassiz’s Desert Tortoise with a Review of Badger Predation on Turtles.” *California Fish and Game* 102(3): 131–144.

Smith, Dwight G., and Joseph R. Murphy. "Breeding Responses of Raptors To Jackrabbit Density." *Raptor Research* 13.1 (1979): 1-14.

Smith, K.G., S.R. Wittenberg, R.B. Macwhirter, and K.L. Bildstein. 2020. “Northern Harrier (*Circus hudsonius*).” Version 1.0. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.norhar2.01.

Smith, J.G., J. Tomoleoni, M. Staedler, S. Lyon, J. Fujii, and M.T. Tinker. 2021. Behavioral Responses Across a Mosaic of Ecosystem States Restructure a Sea Otter-Urchin Trophic Cascade. Proceedings of the National Academy of Sciences (PNAS) Vol. 118, No. 11. https://www.pnas.org/doi/10.1073/pnas.2012493118

Soulé, M.E., D.T. Bolger, A.C Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed Dynamics of Rapid Extinctions of Chaparral-Requiring Birds in Urban Habitat Islands. Conservation Biology 2(1): 75-92.

Speich, S.M., and R.L. Pitman. 1984. “River Otter Occurrence and Predation on Nesting Marine Birds in the Washington Islands Wilderness.” *The Murrelet* 65: 25–27.

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. *California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California.* Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

Stevens, A. 2010. Dynamics of Predation. Nature Education Knowledge 3(10):46. https://www.nature.com/scitable/knowledge/library/dynamics-of-predation-13229468/#:~:text=Predator%20and%20prey%20populations%20cycle,allows%20prey%20populations%20to%20rebound.

Storer, T.I. 1937. "The Muskrat as Native and Alien." *Journal of Mammalogy* Vol. 18, No 4. https://www.jstor.org/stable/1374334

Stout, W.E. and R.N. Rosenfield. 2010. "Colonization, Growth, and Density of a Pioneer Cooper's Hawk Population in a Large Metropolitan Environment." *Journal of Raptor Research* 44(4): 255-267. https://doi.org/10.3356/JRR-09-26.1

Stout, W.E., S.A. Stanley, and J.R. Cary. 2006. "Landscape Features of Red-tailed Hawk Nesting Habitat in an Urban/Suburban Environment." *Journal of Raptor Research* 40(3): 181-192. https://doi.org/10.3356/0892-1016(2006)40[181:LFORHN]2.0.CO;2

Sweeney, S.J., P.T. Redig, and H.B. Tordoff. 1997. "Morbidity, Survival and Productivity of Rehabilitated Peregrine Falcons in the Upper Midwestern U.S." Journal of Raptor Research 31(4): 347-352. https://sora.unm.edu/node/53638

Sweitzer, R.A. 1998. "Conservation Implications of Feral Pigs in Island and Mainland Ecosystems, and a Case Study of Feral Pig Expansion in California." *Proceedings of the Eighteenth Vertebrate Pest Conference*, 74. http://digitalcommons.unl.edu/vpc18/74.

Sweitzer, R.A., S.H. Jenkins, and J. Berger. 1997. *Near-Extinction of Porcupines by Mountain Lions and Consequences of Ecosystem Change in the Great Basin Desert*. Conservation Biology, 11(6), 1407-1417.

Swenson, J.E., F. Sandegren, A. Soderberg, A. Bjarvall, R. Franzen, and P. Wabakken. 1997. "Infanticide Caused by Hunting of Male Bears." *Nature* 386:450–451.

Temple, D.L., M.J. Chamberlain, and L.M. Conner. 2010. Spatial Ecology, Survival and Cause-Specific Mortality of Gray Foxes (Urocyon cinereoargenteus) in a Longleaf Pine Ecosystem. The American Midland Naturalist 163(2).

Theberge, J.R. 1990. "Potentials for Misinterpreting Impacts of Wolf Predation Through Predator:Prey Ratios." *Wildlife Society Bulletin,* 18: 188–192.

Thompson, B.C., J.A. Jackson, J. Burger, L.A. Hill, E.M. Kirsch, and J.L. Atwood. 2020. "Least Tern (*Sternula antillarum*)." Version 1.0. In *Birds of the World*, edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.leater1.01

Timossi, I.C., and R.H. Barrett. 1995. *Habitat Suitability Models for use with ARC/INFO: Northern Flicker*. Calif. Dept. of Fish and Game, CWHR Program, Sacramento, CA. CWHR Tech. Report No. 12.

Tremor, S.; Stokes, D.; Spencer, W.; Diffendorfer, J.; Thomas, H.; Chivers, S.; Unitt, P. 2017. San Diego County Mammal Atlas. In San Diego Society of Natural History, 46th ed.; San Diego Natural History Museum: San Diego, CA, USA, 2017; ISBN 9780692895399.

Troyer, E.M., S.E. Cameron Devitt, M.E. Sundquist, V.R. Goswani, and M.K. Oli. 2014. Survival, Recruitment and Population Growth of an Important Mesopredator: The Northern Raccoon. PLOS One 9(6): e98535.

Twedt, D.J. and R.D. Crawford. 2020. “Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*).” Version 1.0. In *Birds of the World*, edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.yehbla.01

UC Davis Road Ecology Center. 2021. *From Wildlife-Vehicle Conflict to Solutions for California Wildlife and Drivers.* https://roadecology.ucdavis.edu/sites/g/files/dgvnsk8611/files/files/CA_Roadkill_Hotspots_2021_2.pdf.

UCD (University of California Davis). 2021. “Tricolored Blackbird Portal database.” https://tricolor.ice.ucdavis.edu/about-tricolored-blackbirds.

USDA (U.S. Department of Agriculture). 2018. “Program Data Report E, Wildlife Hazard Management at Airports.” https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/pdr/?file=PDR-E_Report&p=2018:INDEX:.

USDA. 2019. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by USDA-APHIS-Wildlife Services. Chapter VIII. The Use of Carbon Monoxide in Wildlife Damage Management. May 2017. Peer Reviewed Final. October 2019.

USDA. 2022a. Effects of Wildlife Services Integrated Wildlife Damage Management on the Sierra Nevada DPS of the Sierra Nevada Red Fox in California. Prepared by USDA, Animal and Plant Health Inspection Service, Wildlife Services. July 2022.

USDA. 2022b. Animal and Plant Health Inspection Service – California Wildlife Services Program. Management Information System Datasets for California 2010-2019.

USFS (U.S. Forest Service). 2009. Ecological Characteristics of Fishers in the Southern Oregon Cascade Range. USDA Forest Service – Pacific Northwest Research Station 2006. https://downloads.regulations.gov/FWS-R8-ES-2018-0105-0153/attachment_2.pdf.

USFWS (U.S. Fish and Wildlife Service). 2000. Recovery Plan for Bighorn Sheep in the Peninsular Ranges. USFWS Region 1. October 25, 2000. https://ecos.fws.gov/docs/recovery_plan/001025.pdf

USFWS (U.S. Fish and Wildlife Service). 2007. *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (Charadrius alexandrinus nivosus). Volume 1: Recovery Plan.* August 13, 2007. https://ecos.fws.gov/docs/recovery_plan/070924.pdf.

USFWS. 2014. Arroyo toad (*Anaxyrus californicus*) species report. U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, CA. March 24, 2014 – Final. 114 pp.

USFWS. 2015. “12-Month Finding on a Petition To List Sierra Nevada Red Fox as an Endangered or Threatened Species” Proposed Rule by the U.S. Fish and Wildlife Service on October 8, 2015. https://www.govinfo.gov/content/pkg/FR-2015-10-08/pdf/2015-25289.pdf#page=1

USFWS. 2016. *Bald and Golden Eagles: Population Demographics and Estimation of Sustainable Take in the United Sated, 2016 Update.* Division of Migratory Bird Management, Washington D.C. Accessed April 24, 2023. https://www.fws.gov/media/population-demographics-and-estimation-sustainable-take-united-states-2016-update

USFWS. 2019a. *5-Year Review Western Snowy Plover (Pacific Coast population Distinct Population Segment) (Charadrius nivosus nivosus)*. 2019. https://ecos.fws.gov/docs/tess/species_nonpublish/2806.pdf.

USFWS. 2020a. Final Species Status Assessment for the Riparian Brush Rabbit (*Sylvilagus bachmani riparius*). Version 4.0. June 2020. https://ecos.fws.gov/ServCat/DownloadFile/171805

USFWS. 2020b. *5-Year Review California Least Tern (Sternula antillarum browni)*. Carlsbad Fish and Wildlife Office. July 7, 2020. https://ecos.fws.gov/docs/tess/species_nonpublish/2806.pdf.

USFWS. 2021. "Endangered Species Status for the Sierra Nevada Distinct Population Segment of the Sierra Nevada Red Fox." Final Rule by the U.S. Fish and Wildlife Service on August 3, 2021. https://www.govinfo.gov/content/pkg/FR-2021-08-03/pdf/2021-16249.pdf.

USFWS. 2022. Informal Section 7 Consultation between USFWS and USDA regarding Red Fox.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Verbeek, N. A. and C. Caffrey (2021). American Crow (*Corvus brachyrhynchos*), version 1.1. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.amecro.01.1

Wagner, F.H. 2006. *Yellowstone's Destabilized Ecosystem*. New York, NY: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195148213.001.0001.

Wallach, A.D., C.N. Johnson, E.G. Ritchie, and A.J. O'Neill. 2010. Predator control promotes invasive dominated ecological states. Ecology Letters 13:1008-1018.

Wallach, A.D., I. Izhaki, J.D. Toms, W.J. Ripple, U. Shanas. 2015. "What is an Apex Predator?" *Oikos* 124(11): 1453–1461.

Warner, R.E. and B. Ver Steeg. 1995. Illinois Badger Studies Final Report. Prepared by the Department of Natural Resources and Environmental Sciences, University of Illinois.

Waser, N.M., M.V. Price, D.T. Blumstein, S.R. Arozqueta, B.D. Castro Escobar, R. Pickens, and A. Pistoia. 2014. Coyotes, deer, and wildflowers: diverse evidence points to a trophic cascade. Naturwissenschaften 101:427–436.

Weatherhead, P.J. 2005. "Long-term Decline in a Red-winged Blackbird Population: Ecological Causes and Sexual Selection Consequences." *Proceedings of the Royal Society B* 272: 2313-2317. https://doi.org/10.1098/rspb.2005.3211

Wendell, M.D., J.M. Sleeman, G. Kratz. 2002. "Retrospective Study of Morbidity and Mortality of Raptors Admitted to Colorado State University Veterinary Teaching Hospital During 1995 to 1998." *Journal of Wildlife Diseases* 38(1): 101-106 https://doi.org/10.7589/0090-3558-38.1.101

Weston, J.L, and I.L Brisbin Jr. 2003. Demographics of a protected population of gray foxes (*Urocyon cinereoargenteus*) in South Carolina. Journal of Mammalogy 84(3): 996-1005

Wetlands International. 2012. *Waterbird Population Estimates, Fifth Edition*. Summary Report. Wetlands International, Wageningen, The Netherlands

White, J.H., J.L. Brown, and Z.E. Ormsby. 2020a. "A Multiscale Assessment of Red-tailed Hawk Reproductive Success Relative to Urban Density and Habitat Type." *Journal of Urban Ecology* 6(1): 1-9. https://doi.org/10.1093/jue/juaa023

White, C.M., N.J. Clum, T.J. Cade, and W.G. Hunt. 2020b. "Peregrine Falcon (Falco peregrinus)." Version 1.0. In *Birds of the World*, edited by S.M. Billerman. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.perfal.01

Wiebe, K.L. 2006. "A Review of Adult Survival Rates in Woodpeckers." Proceedings of the 6th International Woodpecker Symposium, 27-30 August 2005, *Annales Zoologici Fennici* 43(2): 112-117. https://www.jstor.org/stable/23735923.

Wiebe, K.L. and W.S. Moore. 2020. "Northern Flicker (*Colaptes auratus*)." Version 1.0. In *Birds of the World*, edited by P.G. Rodewald. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.norfli.01

Wielgus, R. B., D. E. Morrison, H. S. Cooley, and B. Maletzke. 2013. Effects of male trophy hunting on female carnivore population growth and persistence. Biological Conservation 167:69–75

Wilcox, J.T., and D.H. van Vuren. 2009. "Wild Pigs as Predators in Oak Woodlands of California." *Journal of Mammalogy*, 90(1): 114–118. https://doi.org/10.1644/08-MAMM-A-0171.

Williams, SH, R. Steenweg, T. Hegel, M. Russell, D. Hervieux, and M. Hebblewhite. (2021). Habitat loss on seasonal migratory range imperils an endangered ungulate. Ecol Solut Evidence 2:e12039. https://doi.org/10.1002/2688-8319.12039

Winkler, D. W. (2020). California Gull (*Larus californicus*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.calgul.01

Wisconsin Department of Natural Resources. 2014. Wisconsin Deer Research Studies – Annual Report 2013-2014. Bureau of Sciences Services, Madison, WI. https://p.widencdn.net/ajilww/Deer_Annual_Report_2013_2014

Withey, J. 2005. "Dispersal by Juvenile American Crows Affects Population Dynamics Across a Gradient of Urbanization." *The Auk*, 122: 205–221.

Withey, J., and J. Marzluff. 2009. "Multi-Scale Use of Lands Providing Anthropogenic Resources by American Crows in an Urbanizing Landscape." *Landscape Ecology,* 24: 281–293. 10.1007/s10980-008-9305-9.

Yasukawa, K. and W.A. Searcy. 2020. "Red-winged Blackbird (*Agelaius phoeniceus*)." Version 1.0 In *Birds of the World*, edited by P.G. Rodewald. Ithaca, New York: Cornell Lab of Ornithology. https://doi.org/10.2173/bow.rewbla.01

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1990. *California's Wildlife. Vol. 2 Birds*. California Dept. of Fish and Game, Sacramento, California.

SOURCE: ESRI 2022

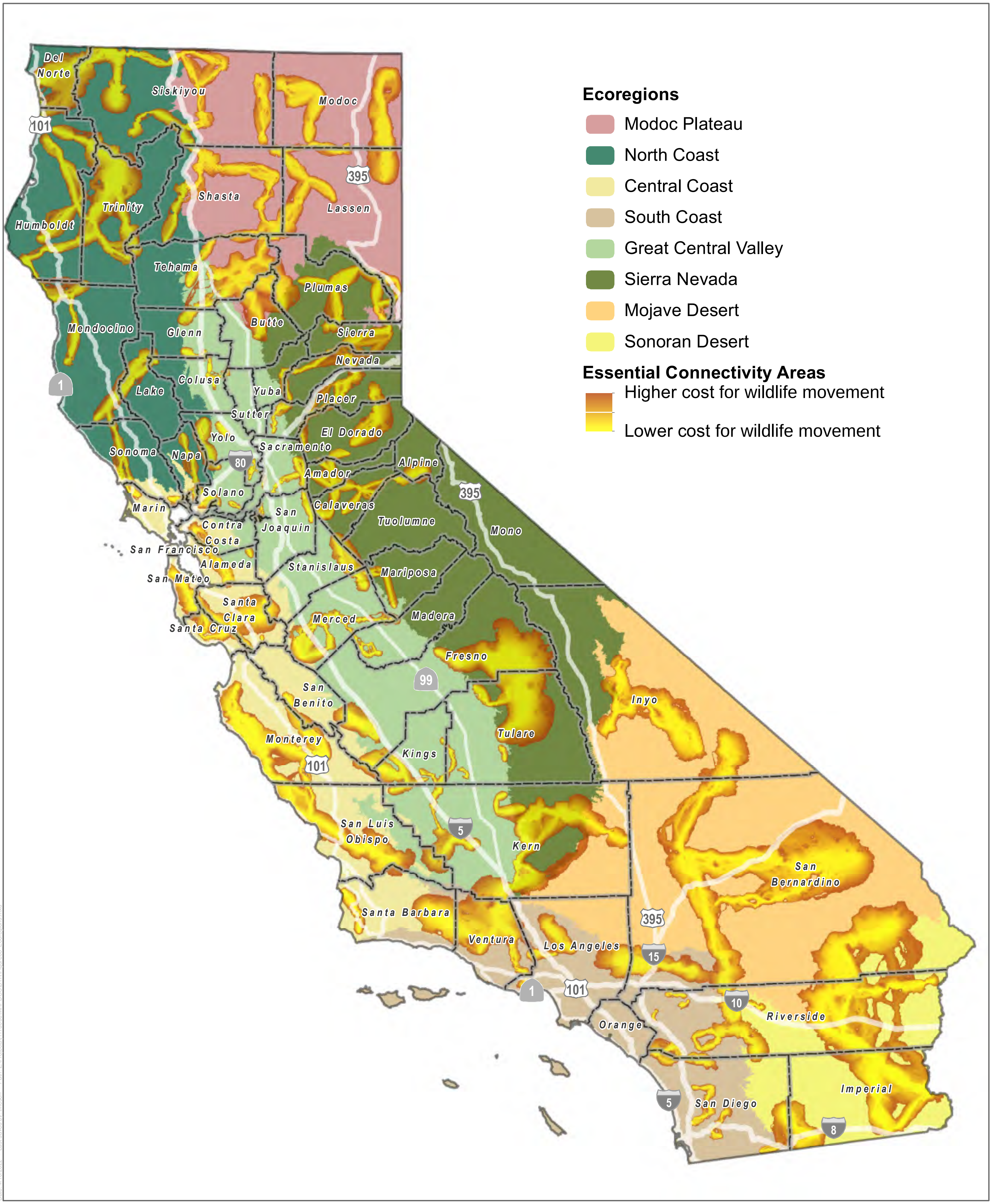
DUDEK

0 200,000 400,000 Feet

FIGURE 1

Project Overview

Biological Technical Report for the Wildlife Damage Management Project



SOURCE: ESRI 2022, Jepson 2020, CDFW 2018

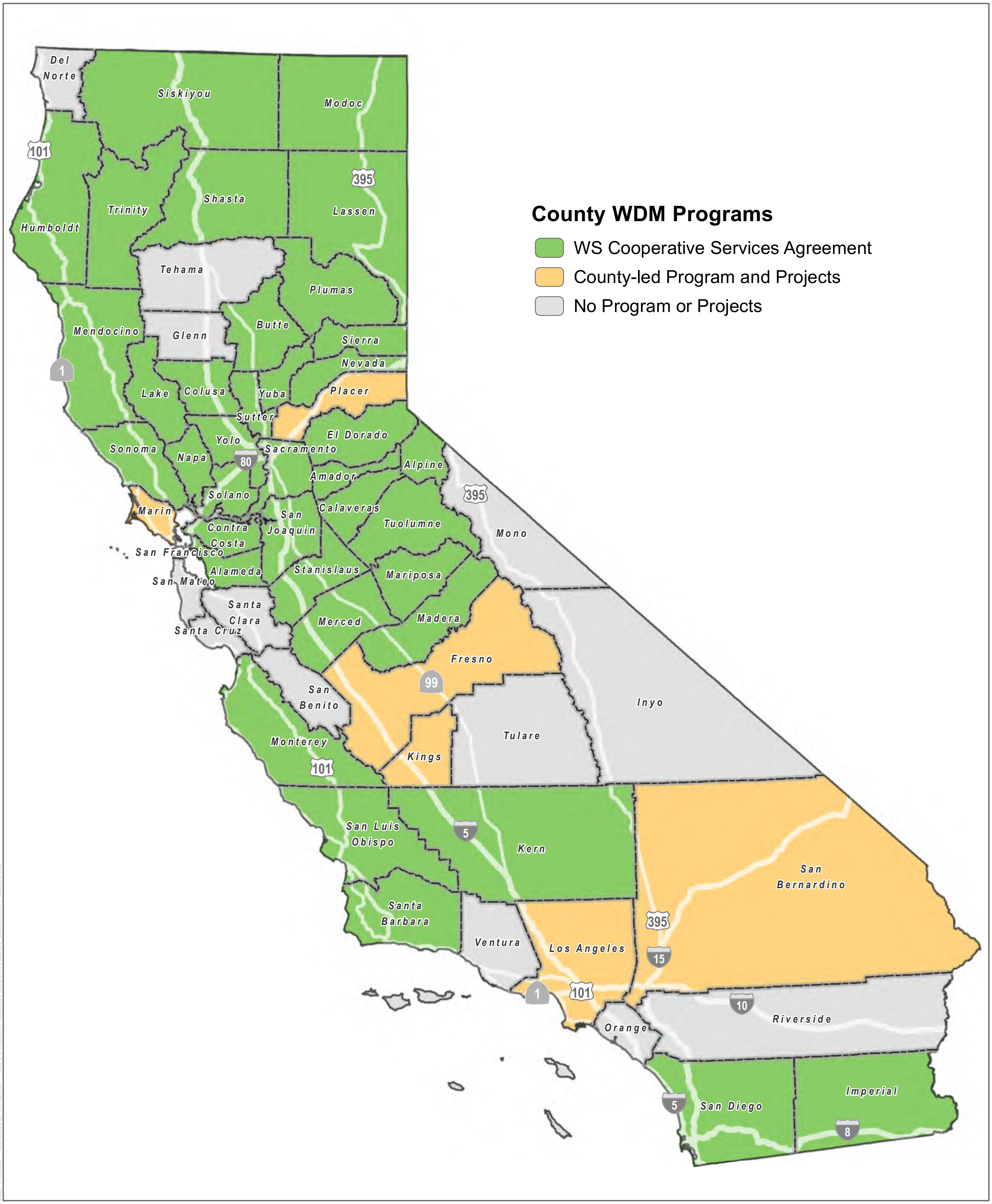
DUDEK

0 200,000 400,000 Feet

FIGURE 2

California Ecoregions

Biological Technical Report for the Wildlife Damage Management Project



SOURCE: ESRI 2022, USDA 2022

DUDEK

0 200,000 400,000 Feet

FIGURE 3

County WDM Programs

Biological Technical Report for the Wildlife Damage Management Project

Appendix A
Section 7 Consultation History

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Formal- Update	Gray wolf (including juveniles)	WDM	All mammal	5/1/2020	
Formal consult- T&E protection	California clapper rail California least tern Light-footed clapper rail Salt-marsh harvest mouse Western snowy plover Marbled murrelet	T&E Protection	All	5/11/2018	12/8/2018 08E00000-2019-F-0001
Formal consult- Part II	San Joaquin kit fox	WDM	Neck snares	9/16/2013	
Formal Consult Amendment- Part I	California least tern Light-footed clapper rail Salt-marsh harvest mouse Western snowy plover Marbled murrelet Desert tortoise Least Bell's vireo Sierra Nevada bighorn sheep	T&E Protection	Distress/alarm calls, padded leghold traps, snap traps, cage traps & euthanasia, neck & foot snares, destroy nests/eggs, Bal-chatri trap, egg oiling, scarecrows, lasers, effigies, DRC-1339, conibear traps, shooting, spotlighting, small & large gas cartridges, decoy live trap, cage trap, trailing and decoy dogs	4/6/2009 * originally submitted 7/08/2004	

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Formal Consult-Statewide	*Albatross, short-tailed *Condor, California (U.S.A. only) *Eagle, bald (lower 48 States) *Flycatcher, southwestern willow Gnatcatcher, coastal California *Murrelet, marbled (CA, OR, WA) *Owl, northern spotted *Pelican, brown *Plover, western snowy (Pacific coastal pop.) *Plover, mountain Rail, California clapper Rail, light-footed clapper (U.S.A. only) Rail, Yuma clapper (U.S.A. only) Shrike, San Clemente loggerhead Sparrow, San Clemente sage Tern, California least Towhee, Inyo California Vireo, least Bell's Fox, San Joaquin kit Kangaroo rat, Fresno Kangaroo rat, giant Kangaroo rat, Morro Bay Kangaroo rat, San Bernardino Merriam's Kangaroo rat, Stephens' Kangaroo rat, Tipton Mountain beaver, Point Arena Mouse, Pacific pocket Mouse, salt marsh harvest Otter, southern sea [experimental nonessential] Otter, southern sea (except where experimental nonessential Rabbit, riparian brush *Sea lion, Steller (eastern pop.)	Programmatic	Distress/alarm calls, padded leghold traps, snap traps, cage traps & euthanasia, neck & foot snares, destroy nests/eggs, Bal-chatri trap, egg oiling, effigies, DRC-1339, conibear traps, shooting, spotlighting, small & large gas cartridges, decoy live trap, cage trap, minnow trap, hand catch/spotlight, dip nets, frog gigs, fishing poles, trailing hounds.	7/8/2004	Split requested by USFWS 01/26/2007. Part II separated and submitted as informal consult request 2/07/2007. Multiple updated drafts submitted after discussions with USFWS.

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	Species Reviewed	Program Activity	Methods	Date Submitted	Date Completed
	Seal, Guadalupe fur Sheep, bighorn (Peninsular CA pop.) Sheep, Sierra Nevada bighorn Shrew, Buena Vista Lake Vole, Amargosa Whale, blue Whale, finback Whale, humpback Whale, right Whale, sei Whale, sperm Woodrat, riparian (San Juaquin Valley) Frog, California red-legged Frog, mountain yellow-legged - So. Calif. Pop. Salamander, California tiger (Santa Barbara and Sonoma Counties) Salamander, desert slender Salamander, Santa Cruz long-toed Toad, arroyo (= arroyo southwestern) Lizard, blunt-nosed leopard Lizard, Coachella Valley fringe-toed Lizard, Island night *Sea turtle, green (except where endangered) *Sea turtle, leatherback *Sea turtle, loggerhead *Sea turtle, olive (Pacific) ridley Snake, giant garter Snake, San Francisco garter *Tortoise, desert Whipsnake, Alameda Purple amole				

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	Species Reviewed	Program Activity	Methods	Date Submitted	Date Completed
Formal Consult-National	Morro Bay kangaroo rat - MA Salt marsh harvest mouse - MA San Joaquin kit fox - MA Aleutian Canada Goose - MA American peregrine falcon - MA Bald eagle - MA Brown pelican - MA California Clapper Rail - MA California condor - MA California least tern -MA Light-footed clapper rail - MA Desert tortoise - MA	National Programmatic	Physical barriers, Habitat modification, electronic distress calls, gas exploders, pyrotechnics, effigies/scarecrows, lights, water spray devices, guard dogs, chemical repellents, leghold traps, cage traps, snares, pole traps, quick-kill traps, shooting (ground & aerial), hunting dogs, denning, toxicants, fumigants, stressing agents	3/27/1990	1990
Informal Consult - Part II	Yellow-billed Cuckoo	WDM	Exclusion, Mist nets, decoy traps, corral traps Propane cannons, pyrotechnics, Vehicle harassment, Spotlighting, Effigies, Dog harassment, bioacoustics, Soft catch leg/foothold, cage traps, leg snares, alpha-chloralose, raptor traps, trail and decoy dogs, shooting, neck snares conibear, aerial hunting nest/egg removal, DRC-1339, gas cartridge, sodium pentobarbital, Carbon dioxide, M-44	5/29/2015	12/15/2015 08E00000-2016-I-0001

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Informal Consult-Part II	California Condor Gray Wolf Desert Tortoise	WDM	Exclusion, Pyrotechnics, Propane cannons, Vehicle harassment, Spotlighting, Effigies, Dog harassment bioacoustics, Soft catch leg/foothold, cage traps, leg snares, alpha-chloralose, raptor traps, decoy dogs, shooting, neck snares, conibear, aerial hunting, nest/egg removal, DRC-1339, gas cartridge, sodium pentobarbital, Carbon dioxide, M-44	5/15/2012	4/15/2014 08E00000-2014-I-0011
BA Amendment-Part II	San Joaquin kit fox & Condor	WDM	Shooting, Leg-hold traps & snares,	9/8/2008	Replaced in 2012 with updated program information.
Informal Consult-Part II	Short-tailed Albatross - NLAA Coastal California gnatcatcher - NE San Clemente loggerhead shrike - NE San Clemente sage sparrow - NE Peninsular bighorn sheep - NLAA Sierra Nevada bighorn sheep - NLAA Point Arena mountain beaver - NLAA San Bernardino Merriam's kangaroo rat - NLAA San Joaquin kit fox (Leg-snare) NLAA Tipton kangaroo rat - NLAA Stephen's kangaroo rat - NLAA Buena Vista Lake shrew - NE	WDM	Exclusion, Pyrotechnics, Propane cannons, Vehicle harassment, Spotlighting, Effigies, Dog harassment, bioacoustics, Soft catch leg/foothold, cage traps, leg snares, alpha-chloralose raptor traps, decoy dogs shooting, neck snares, conibear, aerial hunting, nest/egg removal, DRC-1339, gas cartridge, sodium	2/7/2007	5/8/2007 CNO-ES

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
	Fresno kangaroo rat - NLAA Giant kangaroo rat - NLAA Morro Bay kangaroo rat - NLAA Pacific pocket mouse - NLAA California red-legged frog - NLAA California Tiger salamander - NE Santa Cruz long-toed salamander - NE Alameda whipsnake - NLAA Blunt-nosed leopard lizard - NLAA Coachella Valley fringe-toed lizard - NE Giant garter snake - NLAA Amargosa vole -NE Inyo California towhee - NE Arroyo toad - NE Desert slender salamander -NE Mountain yellow-legged frog - NE Riparian (San Joaquin Valley) woodrat - NLAA Riparian brush rabbit - NLAA San Francisco garter snake - NLAA fish & inverts - NE		pentobarbital, Carbon dioxide, M-44		
Informal Consult				12/8/2003	Rescinded
Informal Consult				8/23/2002	Rescinded

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Informal Consult- Central District	Aleutian Canada goose* American peregrine falcon** Bald eagle* California Brown Pelican*** California clapper rail*** California least tern*** California condor** Least Bell's vireo Mountain plover Southwestern willow flycatcher Western snowy plover Inyo brown towhee Amargosa vole Fresno kangaroo rat*** Giant kangaroo rat*** Riparian brush rabbit Salt marsh harvest mouse*** San Joaquin Valley woodrat San Joaquin kit fox** Tipton kangaroo rat*** Alameda whipsnake Blunt-nosed leopard lizard* Desert tortoise* Giant garter snake California red-legged frog California tiger salamander fish, inverts, plants	Programmatic	Leg-hold traps, Neck snares Foot snares, Dogs Alpha-chloralose, Shooting Conibear, Aerial Hunting M-44 use, DRC-1339 1080 LPCs, Gas cartridges, Sodium pentobarbital	2/26/1997	2/27/1997 1-1-97-I-831

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Informal Consult- San Luis/South Dist	Aleutian Canada goose* American peregrine falcon** Arctic peregrine falcon*** Bald eagle* California Brown Pelican*** California clapper rail*** California least tern*** California condor** Least Bell's vireo Mountain plover Southwestern willow flycatcher Western snowy plover San Clemente loggerhead shrike San Clemente sage sparrow coastal California gnatcatcher Marbled murrelet Yuma clapper rail Giant kangaroo rat*** Morro Bay kangaroo rat*** Tipton's kangaroo rat*** Pacific pocket mouse Riparian brush rabbit Salt marsh harvest mouse*** San Joaquin Valley woodrat San Joaquin kit fox** southern sea otter Steller sea-lion Stephens kangaroo rat Guadalupe fur seal Peninsular bighorn sheep San Bernardino Merriam's kangaroo rat Blunt-nosed leopard lizard* Coachella Valley fringed-toed lizard Desert tortoise*	Programmatic	Leg-hold traps Neck snares Foot snares Dogs Alpha-chloralose Shooting Conibear Aerial Hunting M-44 use DRC-1339 1080 LPCs Gas cartridges Sodium pentobarbital	6/5/1997	6/20/1997 1-1-97-I-1579

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
	Mojave Desert population of Desert tortoise flat-tailed horned lizard Green sea turtle*** Island night lizard* Leatherback sea turtle*** Loggerhead sea turtle*** Olive ridley sea turtle*** San Francisco garter snake* arroyo southwestern toad California red-legged frog California tiger salamander desert slender salamander Santa Cruz long-toed salamander fish, inverts, plants				
Informal Consult-North District	Aleutian Canada goose American peregrine falcon Bald eagle California Brown Pelican Western snowy plover Northern Spotted Owl Marbled murrelet Point Arena mountain beaver California red-legged frog fish, inverts, plants	Programmatic	Leg-hold traps Neck snares Foot snares Dogs Alpha-chloralose Shooting Conibear Aerial Hunting M-44 use DRC-1339 1080 LPCs Gas cartridges Sodium pentobarbital	9/30/1996	10/18/1996 1-1-96-I-1795

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Informal Consult-Sacramento District	Aleutian Canada goose American peregrine falcon Bald eagle California Brown Pelican California clapper rail Western snowy plover Northern Spotted Owl Marbled murrelet Salt marsh harvest mouse Giant garter snake California red-legged frog fish, inverts, plants	Programmatic	Leg-hold traps Neck snares Foot snares Dogs Alpha-chloralose Shooting Conibear Aerial Hunting M-44 use DRC-1339 1080 LPCs Gas cartridges Sodium pentobarbital	10/3/1996	10/31/1996 1-1-97-I-98

WS-California Endangered Species Act Section 7 Consultation Requests					
Document Type	**Species Reviewed**	**Program Activity**	**Methods**	**Date Submitted**	**Date Completed**
Internal Section 7	San Joaquin kit fox -NLTJ Salt marsh harvest mouse -NLTJ Southern sea otter - NLTJ Morro Bay kangaroo rat - NLTJ Fresno kangaroo rat - NLTJ California condor -NLTJ Bald Eagle - NLTJ American peregrine falcon - NLTJ Aleutian Canada goose - NLTJ California brown pelican - NLTJ California clapper rail - NLTJ Light-footed clapper rail - NLTJ Yuma clapper rail - NLTJ Santa Barbara sparrow - NLTJ California least tern - NLTJ San Clemente loggerhead shrike - NLTJ San Clemente sage sparrow - NLTJ Blunt-nosed leopard lizard - NLTJ Desert slender salamander - NLTJ Santa Cruz long-toed lizard - NLTJ San Francisco garter snake - NLTJ Island night lizard - NLTJ Fish , inverts, plants	National Programmatic	Traps, snares, toxicants, shooting and aerial shooting, nonlethal at airports	6/5/1978	7/28/1978
Request for Confirmation of Validity	2007, 2014 & 2015 Informal consults	WDM		5/29/2014	6/14/2016 FWS/R8/AES

Appendix B
Airport WHM Weighting Factors

Different facilities were weighted based on the presumed amount of WHM occurring at each type of facility, based on professional judgment of WS-California staff and BTR preparers that facilities with more flight operations would have greater likelihood for bird-aircraft strikes and therefore increased potential to demand WHM. Part 139-certificated airports (i.e., those that accommodated commercial passenger aircraft) were weighted more highly than General Aviation airports because of FAA requirements for Part 139-certificated airports to prepare and implement Wildlife Hazard Management Plans, which invariably include some level of WHM.

For General Aviation airports, bird WHM weighting factors ranged from a minimum of 0 to a maximum of 3 based on the number of flight operations per day, based on AirNav compilations of FAA data:

- weighting of 0 for under 30 operations per day,
- weighting of 1 if 31-100 operations per day,
- weighting of 2 if 101-200 operations per day,
- weighting of 3 if 201 or more operations per day,

For Part 139 certificated airports, bird WHM weighting factors ranged from a minimum of 5 to a maximum of 10 based on the number of flight operations per day, based on AirNav compilations of FAA data:

- weighting of 5 for under 250 operations per day,
- weighting of 6 if 250-400 operations per day,
- weighting of 7 if 401-600 operations per day,
- weighting of 8 if 601-800 operations per day,
- weighting of 9 if 801-1000 operations per day, and
- weighting of 10 if 1,001 or more operations per day.

Military airfields were weighted based on professional judgment related to the level of activity at each airfield as no statistics are available on the basis of national security.

- weighting of 3 for small island airfields or single airfields within larger complexes,
- weighting of 4 for moderate sized airfields, and
- weighting of 5 or more for major airfields.

This analysis does not include public heliports or seaplane bases, or private airports. These are assumed to have negligible levels of WHM.

A summary of the weighting factor analysis and calculations are provided below.

County	WS-Served Airports and Airfields	Non WS-Served Military Airfields	Non-WS-Served Civilian Airports	Sum of Non-WS-Served Airport Weighted Values	Multiplier to Derive Non-MIS WHM (If Applicable)
Alameda	Oakland International (651 per day, weighting 8), SUM 8	N/A	Livermore Municipal Airport (397 per day, weighting 3), Hayward Executive Airport (320 per day, weighting 3)	6	0.75
Alpine	N/A	N/A	Alpine County Airport (21 per month, weighting 0)	0	0
Amador	N/A	N/A	Amador County Airport (68 per day, weighting 1)	1	N/A
Butte	Chico Municipal (93 per day, weighting 1), SUM 1	N/A	Oroville Municipal (99 per day, weighting 1)	1	1
Calaveras	N/A	N/A	Calaveras County Airport (88 per day, weighting 1)	1	N/A
Colusa	N/A	N/A	Colusa County Airport (77 per day, weighting 1)	1	N/A
Contra Costa	Buchanon Field (248 per day, Part 139 weighting 5), Byron Airport (227 per day, weighting 3), SUM 8	N/A	N/A	0	0
Del Norte	N/A	N/A	Mc Namara Field/ Del Norte Regional Airport (34 per day weighting 1)	1	N/A
El Dorado	Lake Tahoe Apt (71 per day, weighting 1) SUM 1	N/A	Placerville Airport (163 per day, weighting 2), Georgetown Airport (62 per day, weighting 1), Cameron Airpark (99 per day, weighting 1)	4	4
Fresno	Lemoore NAS (counted in Kings), SUM 0	N/A	Fresno Yosemite International Airport (253 per day, Part 139 weighting 6), Harris Ranch (27 per day, weighting 0), New Coalinga Muni (46 per week, weighting 0), Firebaugh (27 per day, weighting 0), Fresno Chandler Executive (84 per day, weighting 1), Sierra Sky Park (39 per day, weighting 1), William Robert Johnston Muni (77 per week, weighting 0), Reedley Muni (90 per day, weighting 1), Selma Airport (26 per day, weighting 0)	9	N/A
Glenn	N/A	N/A	Willow-Glenn County Airport (81 per day, weighting 1), Haigh Field Airport (55 per day, weighting 1)	2	N/A

Humboldt	Humboldt County Apt (115 per day, Part 139 weighting 5), Murray Field (152 per day, weighting 2), SUM 7	N/A	Dinsmore Airport (83 per month, weighting 0), Samoa Field (48 per week, weighting 0), Kneeland Airport (134 per week, weighting 0), Rohnerville Airport (68 per day, weighting 1), Garberville Airport (36 per day, weighting 1), Hoopa Airport (21 per month, weighting 0), Shelter Cove Airport (58 per week, weighting 0)	2	0.29
Imperial	El Centro Naval Air Facility (military weighting 3), SUM 3	N/A	Imperial County Airport (123 per week, weighting 2), Brawley Muni (44 per week, weighting 0), Calexico Intl (46 per week, weighting 0), Cliff Hatfield Apt (29 per week, weighting 0), Salton Sea Apt (29 per month, weighting 0)	2	0.67
Inyo	N/A	N/A	Bishop (Eastern Sierra Regional) Airport (32 per day, weighting 1), Furnace Creek Apt (29 per day, weighting 0), Stovepipe Wells Apt (83 per month, weighting 0), Independence Apt (57 per week, weighting 0), Lone Pine Apt (24 per day, weighting 0), Shoshone Apt (58 per month, weighting 0), Trona Apt (86 per week, weighting 0)	1	N/A
Kern	Edwards AFB (weighting 8), Bakersfield Muni (68 per day, weighting 1), China Lake NAS (weighting 4), Tehachapi Muni (30 per day, weighting 1), Mojave Air and Space Port (58 per day, weighting 1), Meadows Field (168 per day, Part 139 weighting 5), SUM 20	N/A	Elk Hills -Buttonwillow Apt (23 per week, weighting 0), California City Muni (68 per week, weighting 0), Delano Muni (52 per day, weighting 1), Poso Kern County Apt (83 per month, weighting 0), Inyokern Apt (90 per day, weighting 1), Kern Valley Apt (32 per day, weighting 1), Rosamond Skypark (29 per day, weighting 0), Shafter-Minter Field (123 per day, weighting 2), Taft-Kern County Apt (27 per day, weighting 0), Mountain Valley Apt (141 per day, weighting 2), Wasco-Kern County Apt (27 per day, weighting 0)	7	0.35
Kings	Lemoore NAS (weighting 8)	N/A	Hanford Muni (79 per day, weighting 1)	1	0.13
Lake	N/A	N/A	Lampson Field Apt (209 per day, weighting 3), Gravelley Valley Apt (83 per month, weighting 0)	3	N/A
Lassen	Herlong Apt (58 per month, weighting 0), Sierra Army Depot (no runways, weighting 1). SUM 1	N/A	Southard Field Apt (29 per week, weighting 0), Ravendale Apt (30 per month, weighting 0), Spaulding Apt (53 per week, weighting 0), Susanville Muni (34 per day, weighting 1)	1	1

Los Angeles	Long Beach Airport (768 per day, Part 139 weighting 8), LAX (1136 per day, Part 139 weighting 10), Van Nuys Airport (615 per day, weighting 3), San Clemente Island NALF, weighting 3, Palmdale AFB/Palmdale Regional Airport (same runway, 176 per day, weighting 4). SUM 28	N/A	San Gabriel Valley Airport (240 per day, weighting 3), Burbank Airport (349 per day, Part 139 weighting 6), Agua Dulce Apt (60 per month, weighting 0), Catalina Apt (37 per day, weighting 1), Compton-Woodley Apt (181 per day, weighting 2), Hawthorne Muni (220 per day, weighting 3), Brackett Field (291 per day, weighting 3), General Wm J Fox Airfield (132 per day, weighting 2), Whiteman Apt (269 per day, weighting 3), Santa Monica Muni (185 per day, weighting 2), Zamperini Field (326 per day, weighting 3)	28	1
Madera	N/A	N/A	Chowchilla Apt (128 per week, weighting 1), Madera Muni (139 per day, weighting 2)	3	N/A
Marin	N/A	N/A	Gnoss Field Apt (234 per day, weighting 3)	3	N/A
Mariposa	N/A	N/A	Mariposa Yosemite Apt (26 per day, weighting 0)	0	N/A
Mendocino	N/A	N/A	Boonville Apt (96 per week, weighting 0), Round Valley Apt (38 per week, weighting 0), Ocean Ridge Apt (29 per week, weighting 0), Little River Apt (57 per week, weighting 0), Ukiah Muni Apt (119 per day, weighting 2), Ells Field-Willits Muni Apt (105 per week, weighting 0)	2	N/A
Merced	Castle Airport (283 per day, weighting 3) SUM 3	N/A	Merced Regional Airport/Macready Field (161 per day, weighting 2), Gustine Apt (22 per day, weighting 0), Los Banos Muni (44 per day, weighting 1), Turlock Muni (31 per day, weighting 1)	4	1.3
Modoc	N/A	N/A	Adin Apt (100 per year, weighting 0), Alturas Muni Apt (54 per day, weighting 1), California Pines Apt (24 per week, weighting 0), Cedarville Apt (45 per week, weighting 0), Fort Bidwell Apt (35 per year, weighting 0), Tulelake Muni Apt (36 per day, weighting 1)	2	N/A
Mono	N/A	N/A	Mammoth Yosemite (103 per week, weighting 2), Bryant Field (61 per week, weighting 0), Lee Vining Apt (42 per week, weighting 0)	2	N/A

Monterey	Camp Roberts (weighting 3), Monterey Regional (115 per day, Part 139 weighting 5) SUM 8	N/A	Marina Muni (115 per day, weighting 2), Salinas Muni (192 per day, weighting 2)	4	0.5
Napa	Napa County Apt (123 per day, weighting 2) SUM 2	N/A	Angwin-Parrett Field (27 per day, weighting 1)	1	0.5
Nevada	N/A	N/A	Nevada County Apt (76 per day, weighting 1), Truckee-Tahoe Apt (96 per day, weighting 1)	2	N/A
Orange	John Wayne (824 per day, Part 139 weighting 9), Los Alamitos AA (weighting 5) SUM 14	N/A	Fullerton Municipal Airport (200 per day, weighting 3)	3	0.21
Placer	N/A	N/A	Lincoln Regional Airport/Karl Harder Field (204 per day, weighting 3), Auburn Muni (206 per day, weighting 3), Blue Canyon-Nyack Apt (23 per week, weighting 0)	6	N/A
Plumas	N/A	N/A	Nervino Apt (33 per day, weighting 1), Rogers Field Apt (43 per day, weighting 1), Gansner Field (25 per day, weighting 0)	2	N/A
Riverside	French Valley (246 per day, weighting 3), Hemet-Ryan (207 per day, weighting 3), Jacqueline Cochran (303 per day, weighting 3), March ARB (military weighting 8), Palm Springs Intl (157 per day, Part 139 weighting 5) SUM 22	N/A	Banning Muni (105 per week, weighting 0), Blythe Apt (37 per day, weighting 1), Chiriaco Summit Apt (115 per week, weighting 0), Corona Muni (96 per day, weighting 1), Bermuda Dunes Apt (38 per day, weighting 1), Perris Valley Apt (53 per day, weighting 1), Riverside Muni (318 per day, weighting 3), Flabob Apt (30 per day, weighting 1)	8	0.36
Sacramento	McClellan (weighting 4) SUM 4	N/A	Mather Airport (272 per day, weighting 3), Sacramento Intl (379 per day, Part 139 weighting 6) Sacramento Executive (304 per day, weighting 3), Franklin Field Airport (89 per day, weighting 1), Rancho Murieta Apt (22 per day, weighting 0), Rio Linda Apt (55 per day, weighting 1)	14	3.5
San Benito	N/A	N/A	Frazier Lake Airpark (20 per day, weighting 0), Hollister Muni (157 per day, weighting 2)	2	N/A
San Bernardino	Ontario Intl (275 per day, Part 139 weighting 6), San Bernardino Intl (155 per day, Part 139 weighting 5) SUM 11	Twentynine Palms MCAGCC (military weighting 5)	Chino Airport (451 per day, weighting 3), Big Bear City Airport (82 per day, weighting 1), Southern California Logistics Airport (46 per day, Part 139 weighting 5), Apple Valley Apt, Baker Apt (103 per day, weighting 2), Chemehuevi Valley Apt (38 per week, weighting 0), Chino Apt (451 per day, weighting 3),	28	2.55

			Barstow-Daggett Apt (100 per day, weighting 2), Hesperia Apt (115 per week, weighting 0), Needles Apt (29 per day, weighting 0), Redlands Muni Apt (183 per day, weighting 2), Twentynine Palms Apt (49 per day, weighting 1), Cable Apt (252 per day, weighting 3), Yucca Valley Apt (40 per day, weighting 1)		
San Diego	Ream Field (military weighting 4), Halsey Field (military weighting 4, Brown Field Muni (275 per day, weighting 3), Ramona Apt (397 per day, weighting 3), Gillespie Field (499 per day, weighting 3) SUM 17	Miramar-Marine Corps Air Station (military weighting 5), Camp Pendleton MCAS (military weighting 5)	San Diego International Airport (624 per day, Part 139 weighting 8), McClellan-Palomar (411 per day, weighting 3), Agua Caliente Apt (64 per week, weighting 0), Borrego Valley Apt (20 per day, weighting 0), Fallbrook Community Airpark (58 per day, weighting 1), Jacumba Apt (66 per month, weighting 0), Oceanside Muni (80 per day, weighting 1), Ocotillo Apt (60 per month, weighting 0), Montgomery Field (756 per day, weighting 3)	26	1.53
San Francisco	N/A	N/A	N/A	0	N/A
San Joaquin	Stockton Metro (151 per day, P139 weighting 5), Kingdon Apt (77 per week, weighting 0) SUM 5	N/A	Lodi Apt (119 per day, weighting 2), Lodi Airpark (100 per week, weighting 0), New Jerusalem Apt (77 per week, weighting 0), Tracy Muni (161 per day, weighting 2)	4	0.8
San Luis Obispo	McMillan Army Airfield (part of Camp Roberts), weighting 3 SUM 3	N/A	San Luis County Regional Airport (208 per day, weighting 3) Oceano County Apt (27 per day, weighting 0), Paso Robles Muni (94 per day, weighting 1)	4	1.33
San Mateo	N/A	N/A	San Francisco International Airport (1255 per day, weighting 10), Half Moon Bay Airport (137 per day, weighting 2), San Carlos Apt (318 per day, weighting 3)	15	N/A
Santa Barbara	Vandenberg AFB (weighting 8), Santa Maria Apt (92 per day, weighting 1, Santa Barbara Muni (249 per day, P139 weighting 5) SUM 14	N/A	Lompoc Apt (82 per day, weighting 1), New Cuyama Apt (42 per month, weighting 0), Santa Ynez Apt (83 per day, weighting 1)	2	0.14
Santa Clara	Moffett FA (weighting 4, San Jose Intl (568 per day, P139 weighting 7) SUM 11	N/A	Palo Alto Airport (525 per day, weighting 3), Reid-Hillview Apt (573 per day, weighting 3)	6	0.55
Santa Cruz	San Nicolas Island NOLF (weighting 3) SUM 3	N/A	Watsonville Muni (164 per day, weighting 2)	2	0.67

Shasta	Redding Muni (191 per day, weighting 2) SUM 2	N/A	Fall River Mills Apt (96 per week, weighting 1), Benton Field Apt (110 per day, weighting 2)	3	1.5
Sierra	N/A	N/A	Sierraville Dearwater Apt (23 per week, weighting 0)	0	N/A
Siskiyou	N/A	N/A	Butte Valley Apt (20 per week, weighting 0), Dunsmuir Muni (42 per week, weighting 0), Scott Valley Apt (22 per day, weighting 0), Happy Camp Apt (150 per year, weighting 0), Montague-Yreka Rohrer Field Apt (73 per week, weighting 0), Siskiyou County Apt (38 per day, weighting 1), Weed Apt (28 per day, weighting 0)	1	N/A
Solano	Travis AFB (weighting 10), Nut Tree (238 per day, weighting 3) SUM 13	N/A	Rio Vista Muni (96 per day, weighting 1)	1	0.08
Sonoma	Petaluma Muni (146 per day, weighting 2) SUM 2	N/A	Sonoma County Airport (182 per day, Part 139 weighting 5), Cloverdale Muni (30 per day, weighting 1), Healdsburg Muni (56 per day, weighting 1), Sonoma Valley Airport (44 per day, weighting 1), Sonoma Skypark (41 per day, weighting 1)	9	4.5
Stanislaus	N/A	N/A	Modesto City Apt (122 per day, weighting 2, Oakdale Apt (26 per day, weighting 0)	2	N/A
Sutter	N/A	N/A	Sutter County Apt (22 per day, weighting 0)	0	N/A
Tehama	N/A	N/A	Corning Muni Apt (24 per day, weighting 0), Red Bluff Muni (72 per day, weighting 1)	1	N/A
Trinity	N/A	N/A	Hayfork Apt (34 per day, weighting 1), Hyampom Apt (24 per week, weighting 0) Ruth Apt (38 per week, weighting 0), Trinity Center Apt (23 per day, weighting 0), Weaverville Apt (105 per week, weighting 0)	1	N/A
Tulare	N/A	N/A	Porterville Muni (119 per day, weighting 2), Eckert Field (74 per week, weighting 0), Mefford Field (69 per day, weighting 1), Sequoia Field Apt (33 per day, weighting 1), Visalia Muni (89 per day, weighting 1), Woodlake Apt (33 per day, weighting 1)	6	N/A
Tuolumne	Columbia (125 per day, weighting 2) SUM 2	N/A	Pine Mountain Lake Airport (41 per day, weighting 1)	1	0.5

Ventura	Pt Mugu NAS (weighting 4), Camarillo (297 per day, weighting 3), Oxnard (222 per day, Part 139 weighting 5) SUM 11	N/A	Santa Paula Apt (266 per day, weighting 3)	3	0.27
Yolo	N/A	N/A	University Apt (67 per day, weighting 1), Yolo County Apt (166 per day, weighting 2), Watts-Woodland Apt (63 per day, weighting 1)	5	N/A
Yuba	Beale AFB (military weighting 8), Yuba County Airport (97 per day, weighting 1) SUM 9	N/A	N/A	0	N/A
TOTAL	**241**	**15**	N/A	**249**	**1.03**

() is number of flight operations either per day or per week, per AirNav compilations of FAA data

Appendices C1–C29

Species Reports

C1 American Badger Population and Distribution

The following describes the distribution and population estimate of American badger (*Taxidea taxus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, American badger observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 320 American badger observations between 2000 and 2020.

Table 1. Observations and Modeled Distribution of American Badger Across California

Dataset	Number of Observations	Date Range
American Badger Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	105	2000–2018
CNDDB (CDFW 2022)	594/215	1893–2020/2000–2020

Note: BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database; CDFW = California Department of Fish and Wildlife.

1 Data accessed December 11, 2020.

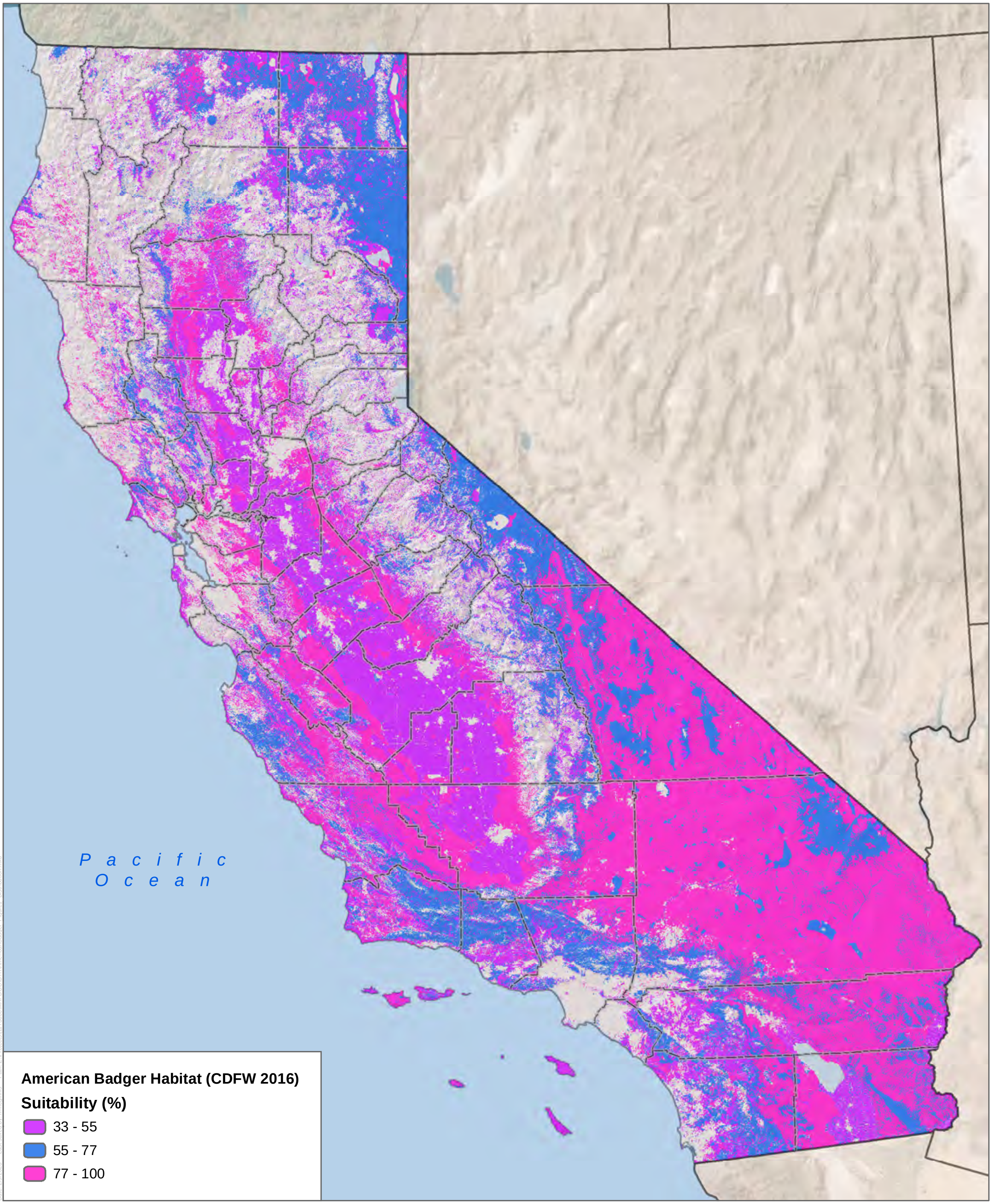
Table 2. American Badger Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	811	Orange	822
Alpine	1,168	Placer	1,077
Amador	810	Plumas	2,035
Butte	1,743	Riverside	16,505
Calaveras	1,373	Sacramento	1,497
Colusa	1,778	San Benito	3,040
Contra Costa	964	San Bernardino	49,650
Del Norte	224	San Diego	8,656
El Dorado	1,371	San Francisco	6
Fresno	11,532	San Joaquin	3,069
Glenn	2,400	San Luis Obispo	7,441

Table 2. American Badger Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Humboldt	1,634	San Mateo	431
Imperial	10,506	Santa Barbara	5,914
Inyo	26,127	Santa Clara	1,412
Kern	18,414	Santa Cruz	276
Kings	3,370	Shasta	3,674
Lake	1,849	Sierra	893
Lassen	9,415	Siskiyou	6,669
Los Angeles	6,660	Solano	1,537
Madera	3,886	Sonoma	1,772
Marin	747	Stanislaus	3,296
Mariposa	2,033	Sutter	863
Mendocino	2,110	Tehama	4,631
Merced	4,417	Trinity	1,526
Modoc	8,634	Tulare	8,353
Mono	7,086	Tuolumne	2,642
Monterey	6,552	Ventura	3,848
Napa	1,080	Yolo	2,036
Nevada	732	Yuba	801
		Total Statewide Suitable Habitat	**283,795**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of American badgers statewide (Figure 2), and modeled habitat and observations in the South Bay Area (Figure 3). The figures show that the majority of American badger observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). This is likely due to the expansive range provided by CDFW for American badger, which covers 99% (407,411 km^2) of the land area of the State of California (410,727 km^2) (CDFW 2016). These data support the accuracy of the CDFW (2016) range and habitat data for American badger.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable American Badger Habitat from CDFW Habitat Suitability Model

0 25 50 Miles

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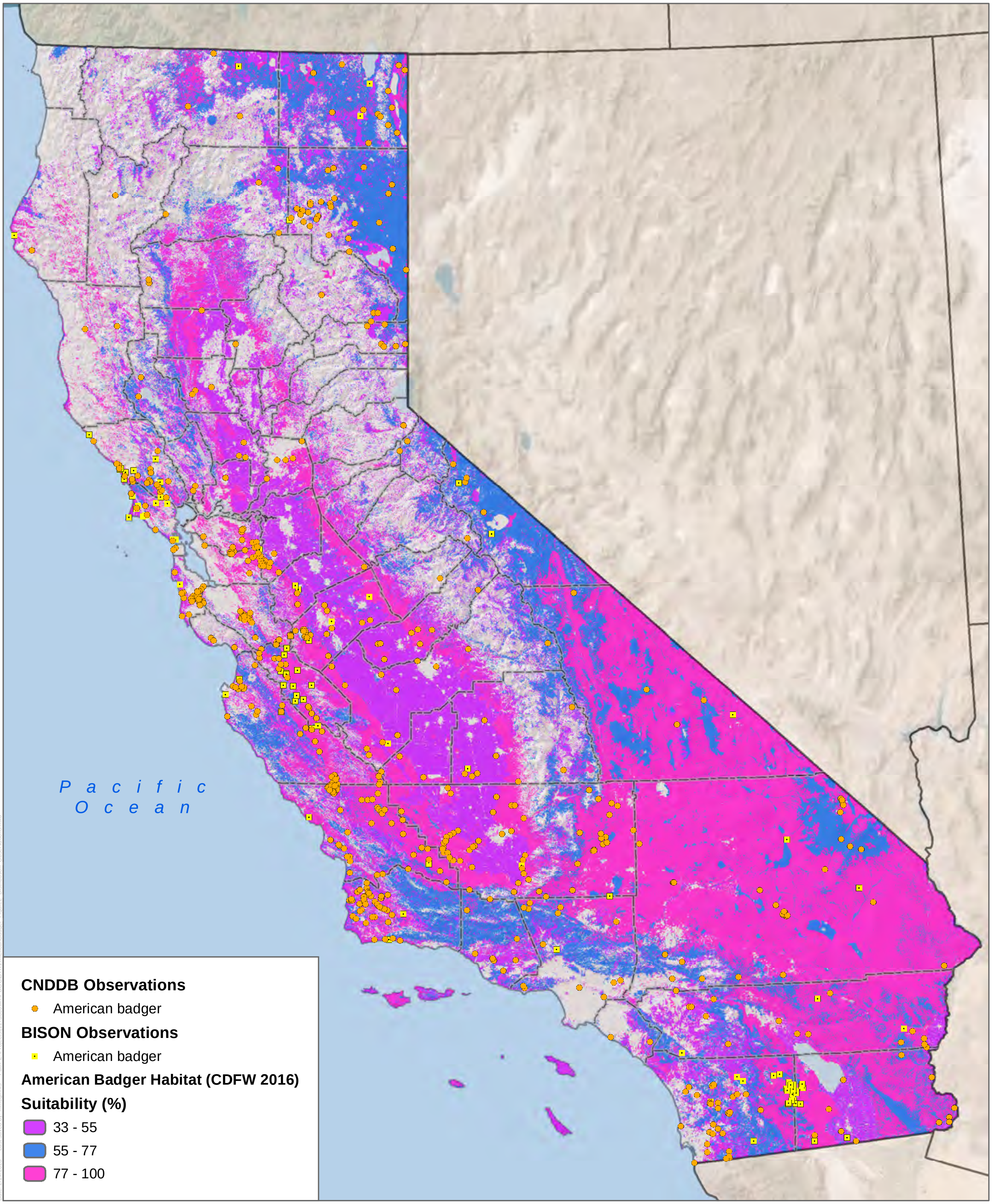

SOURCE: CDFW 2016, 2023; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of American Badger Statewide

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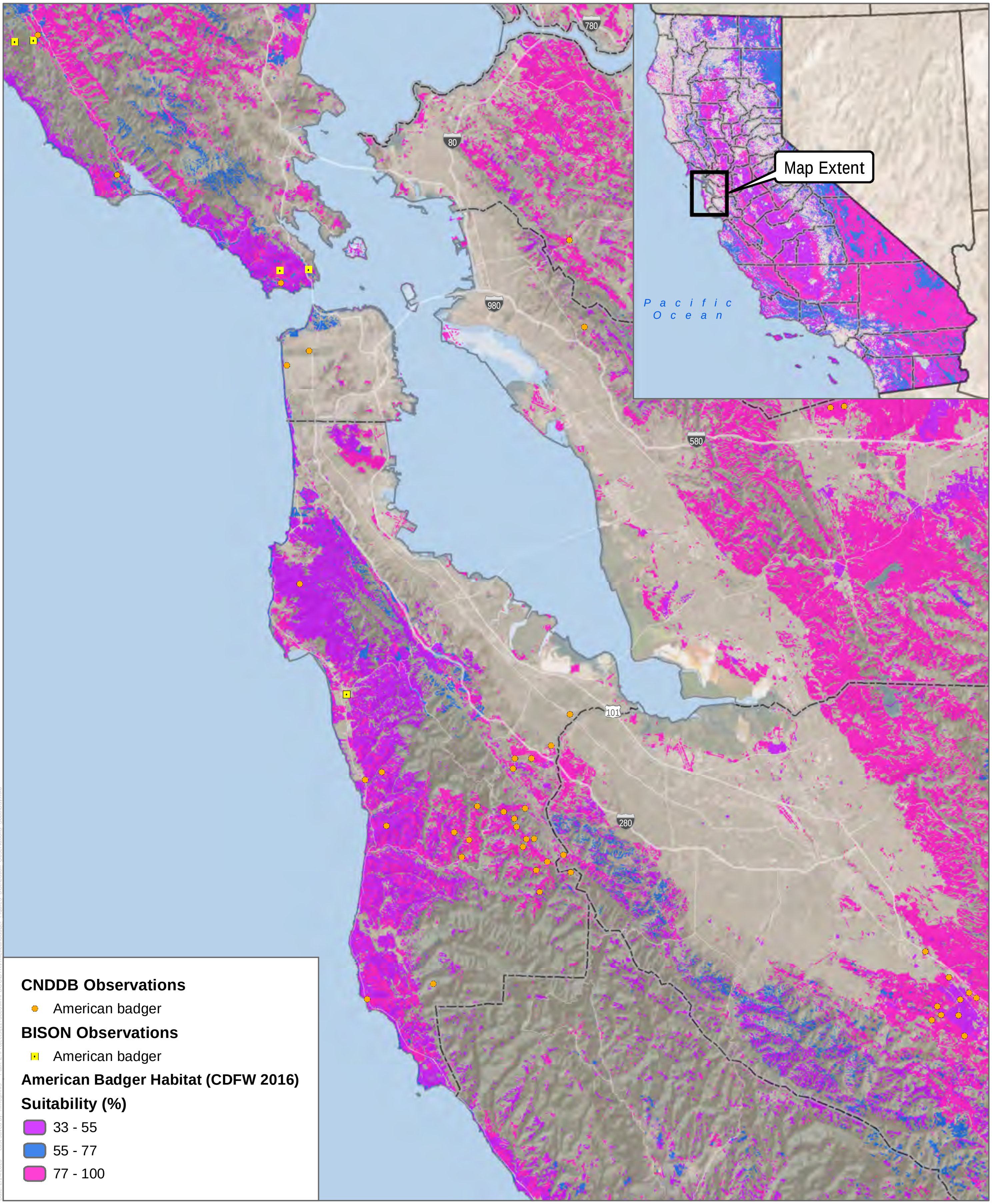

SOURCE: CDFW 2016, 2023; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of American Badger in the South Bay Area

DUDEK 0 1.5 3 Miles

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Badgers have widely varying home range sizes as described in the various research-literature sources summarized in Table 3. Badgers have a roughly 1:1 adult male to adult female ratio and most female home ranges are overlapped by one or more male and other females (Warner and Ver Steeg 1996).

Two methods were used to estimate the American badger population by county in California: (1) a population density of 0.41 individuals/km^2 (average of values in Goodrich and Buskirk 1998, Gould and Harrison 2017, and Warner and Ver Steeg 1995), which includes consideration of overlap of individual home ranges, and (2) the average published home range size for adult female badgers of 9.3 km^2, minus an average of published home range overlaps of 18%, equaling 7.6 km^2 (Table 3). To obtain a population total, adult female population estimates were multiplied by two to account for adult males in a 1:1 ratio with females (Warner and Ver Steeg 1996). These two approaches were used to estimate total adult population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average Density of 0.41 individuals/km^2 ((0.14 individuals/km^2 + 1 individual/km^2 + 0.1 individuals/km^2)/3) multiplied by the area of top two-thirds suitable habitat (km^2) in each county.

2. Home Range-Based Estimate (see Table 3 for references):

   Area of top two-thirds suitable habitat (km^2) in each county divided by 7.6 km^2 (average adult female home range value of 9.3 km^2 (7.05 km^2 + 16.35 km^2 + 3.4 km^2 + 12.3 km^2 +2.69 km^2 + 17.4 km^2 + 2.6 km^2 + 8.5 km^2 + 13.05 km^2) – 1.7 km^2 (18% average home range overlap (8% + 27.10%)/2))) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For American badger, the top two-thirds of suitable habitat represents only 70% (283,795 km^2) (Table 2) of the species' estimated range in California (407,411 km^2) (CDFW 2016). The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of badger habitat (Figures 2 and 3) (CDFW 2016). Clearly, badgers occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to underestimate the population.

The estimated American badger population in California is 116,356 individuals using the density-based estimate and 74,683 individuals using the home range-based estimate. These approaches assume the following: that there is 18% home range overlap among adult female American badgers, that no American badgers occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. American Badger Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Years	Home Range Overlap Among Females	Home Range Size (km2)	Population Density (individuals/km2)	Sample Size
Duquette 2008	Radio-collar	95% FK, annual	Ohio and Illinois (2005-2008)	ND	Ohio: 7.05 (Female); Illinois: 16.35 (Female)	ND	2 Female (Ohio), 9 Female (Illinois)
Goodrich and Buskirk (1998)	Radio-collar, mark-recapture	95% ADK (HR) and Mark-Recapture (Density)	Wyoming (1991-1993)	8%	3.4 (Female)	1.0	6 Female
Gould and Harrison (2017)	Camera traps and guzzlers	SECR	New Mexico (2012) (Chihuahuan Desert)	ND	ND	0.1	30 badgers in 301 photos
Hoodicoff (2003)	Radio-collar	95% FK	British Columbia, Canada (1999-2001)	"Some"	12.3 (Female)	ND	1 Female
Lindzey 1971	Radio-collar	MCP	Idaho and Utah (1969-1970)	ND	2.69 (Female)	ND	2 Male, 5 Female
Newhouse and Kinley (2004)	Radio-collar	95% FK	British Columbia, Canada (1996-2004)	ND	17.4	ND	31: 15 Male, 16 Female
Quinn (2008)	Radio-collar	95% FK	California Central Coast (2005-2006)	ND	2.6 (Female)	ND	5 Female
Sargeant and Warner 1972	Radio-collar	MCP	Minnesota (1963-1964)	ND	8.5	ND	1 Female
Warner and Ver Steeg (1995)	Radio-collar	95% MCP	Illinois (1990-1994)	27.10%	13.05	0.14	13: 6 Male, 7 Female

Notes: FK = fixed kernel; ND = Not Determined or not reported; ADK = adaptive kernel; HR = home range; SECR = spatially-explicit capture-recapture; MCP = minimum convex polygon.

Table 4. Statewide and County American Badger Population Estimates

County	Population Density (0.41 individuals/km^2)	Average Adult Female Home Range (7.6 km^2)	County	Population Density (0.41 individuals/km^2)	Average Adult Female Home Range (7.6 km^2)
Alameda	333	213	Orange	337	216
Alpine	479	307	Placer	442	283
Amador	332	213	Plumas	834	535
Butte	715	459	Riverside	6,767	4,343
Calaveras	563	361	Sacramento	614	394
Colusa	729	468	San Benito	1,246	800
Contra Costa	395	254	San Bernardino	20,356	13,066
Del Norte	92	59	San Diego	3,549	2,278
El Dorado	562	361	San Francisco	2	2
Fresno	4,728	3,035	San Joaquin	1,258	808
Glenn	984	632	San Luis Obispo	3,051	1,958
Humboldt	670	430	San Mateo	177	113
Imperial	4,308	2,765	Santa Barbara	2,425	1,556
Inyo	10,712	6,876	Santa Clara	579	372
Kern	7,550	4,846	Santa Cruz	113	73
Kings	1,382	887	Shasta	1,506	967
Lake	758	487	Sierra	366	235
Lassen	3,860	2,478	Siskiyou	2,734	1,755
Los Angeles	2,730	1,753	Solano	630	404
Madera	1,593	1,023	Sonoma	727	466
Marin	306	197	Stanislaus	1,351	867
Mariposa	834	535	Sutter	354	227
Mendocino	865	555	Tehama	1,899	1,219
Merced	1,811	1,162	Trinity	626	402
Modoc	3,540	2,272	Tulare	3,425	2,198
Mono	2,905	1,865	Tuolumne	1,083	695

Table 4. Statewide and County American Badger Population Estimates

County	Population Density (0.41 individuals/km^2)	Average Adult Female Home Range (7.6 km^2)	County	Population Density (0.41 individuals/km^2)	Average Adult Female Home Range (7.6 km^2)
Monterey	2,686	1,724	Ventura	1,578	1,013
Napa	443	284	Yolo	835	536
Nevada	300	193	Yuba	328	211
			Total	**116,356**	**74,683**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. American Badger Predicted Habitat (CWHR M160). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Duquette, J.F., 2008. Population ecology of badgers (Taxidea taxus) in Ohio (Doctoral dissertation, The Ohio State University).

Goodrich, J.M., and S.W. Buskirk. 1998. "Spacing and Ecology of North American Badgers (*Taxidea taxus*) in a Prairie-Dog (*Cynomys leucurus*) Complex." *Journal of Mammalogy 79*(1): 171–179.

Gould, M.J., and R.L. Harrison. 2017. "A Novel Approach to Estimating Density of American Badgers (*Taxidea taxus*) using Automatic Cameras at Water Sources in the Chihuahuan Desert." *Journal of Mammalogy 99*(1): 233–241.

Hoodicoff, C.S. 2003. "Ecology of the Badger (*Taxidea taxus jeffersonii*) in the Thompson Region of British Columbia: Implications for Conservation." Master's Thesis; University-College of the Cariboo.

Lindzey, F.G. 1971. "Ecology of Badgers in Curlew Valley, Utah and Idaho With Emphasis on Movement and Activity Patterns." All Graduate Theses and Dissertations. 3541. https://digitalcommons.usu.edu/etd/3541.

Newhouse, N.J., and T.A. Kinley. 2001. *Ecology of Badgers near a Range Limit in British Columbia*. Columbia Basin Fish and Wildlife Compensation Program, Nelson, and Parks Canada, Radium Hot Springs, BC.

Quinn, J.H. 2008. "The Ecology of the American Badger *Taxidea taxus* in California: Assessing Conservation Needs on Multiple Scales." PhD Thesis; University of California, Davis.

Sargeant, A.B. and Warner, D.W. 1972. Movements and Denning Habits of a Badger. *Journal of Mammalogy*, 53(1), pp.207-210.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Warner, R.E., and B. Ver Steeg. 1995. *Illinois Badger Studies W-103-R-1-6, July 1, 1989 through June 30, 1995*

C2 Black Bear Population and Distribution

The following describes the distribution and population estimate of black bear (*Ursus americanus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, black bear observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 426 black bear observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Black Bear across California

Dataset	Number of Observations	Date Range
Black Bear Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	426	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

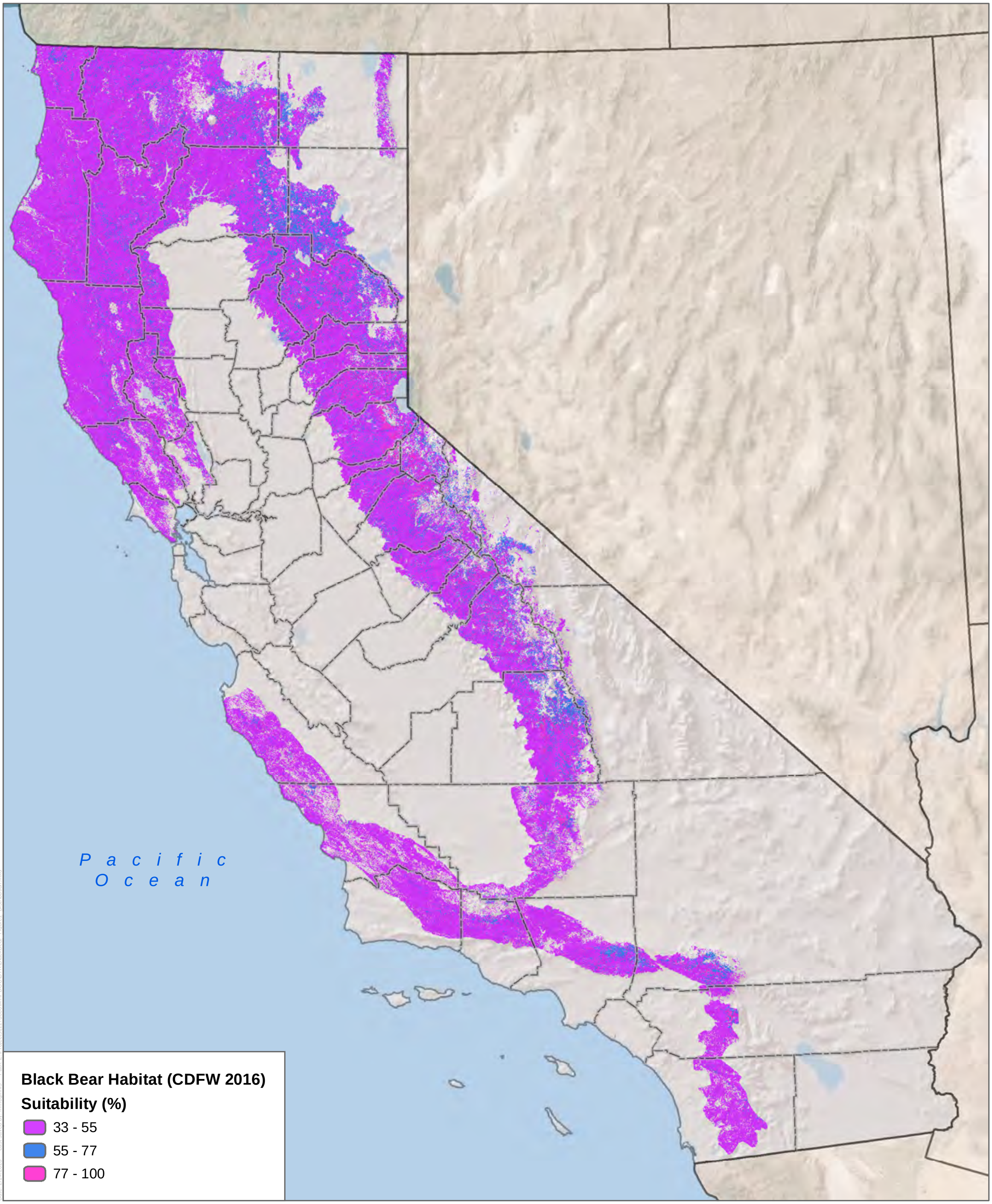
Table 2. Black Bear Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	0
Alpine	1,289	Placer	2,402
Amador	630	Plumas	5,909
Butte	1,540	Riverside	1,402
Calaveras	1,192	Sacramento	0
Colusa	400	San Benito	0
Contra Costa	0	San Bernardino	1,828
Del Norte	2,516	San Diego	2,635
El Dorado	3,157	San Francisco	0
Fresno	4,148	San Joaquin	0
Glenn	914	San Luis Obispo	3,801
Humboldt	8,777	San Mateo	0
Imperial	0	Santa Barbara	2,620
Inyo	591	Santa Clara	0
Kern	4,168	Santa Cruz	0

Table 2. Black Bear Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Kings	2,550	Shasta	7,325
Lake	2,550	Sierra	2,062
Lassen	3,087	Siskiyou	13,198
Los Angeles	3,394	Solano	7
Madera	1,761	Sonoma	3,154
Marin	721	Stanislaus	0
Mariposa	1,991	Sutter	0
Mendocino	8,549	Tehama	2,383
Merced	0	Trinity	8,008
Modoc	2,046	Tulare	4,897
Mono	1,536	Tuolumne	4,211
Monterey	2,946	Ventura	1,753
Napa	597	Yolo	5
Nevada	1,800	Yuba	402
		Total	**130,851**

The following three maps show the top two-thirds of modeled suitable habitat statewide (Figure 1), the combination of that modeled habitat with observations of black bear statewide (Figure 2), and modeled habitat and observations in the Ventura County area (Figure 3). The figures show that the majority of black bear observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). These data support the accuracy of the CDFW (2016) range and habitat data for black bear, though as discussed below, the data are likely to be somewhat conservative because black bear occur outside of the top two-thirds of habitat.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Black Bear Habitat from CDFW Habitat Suitability Model

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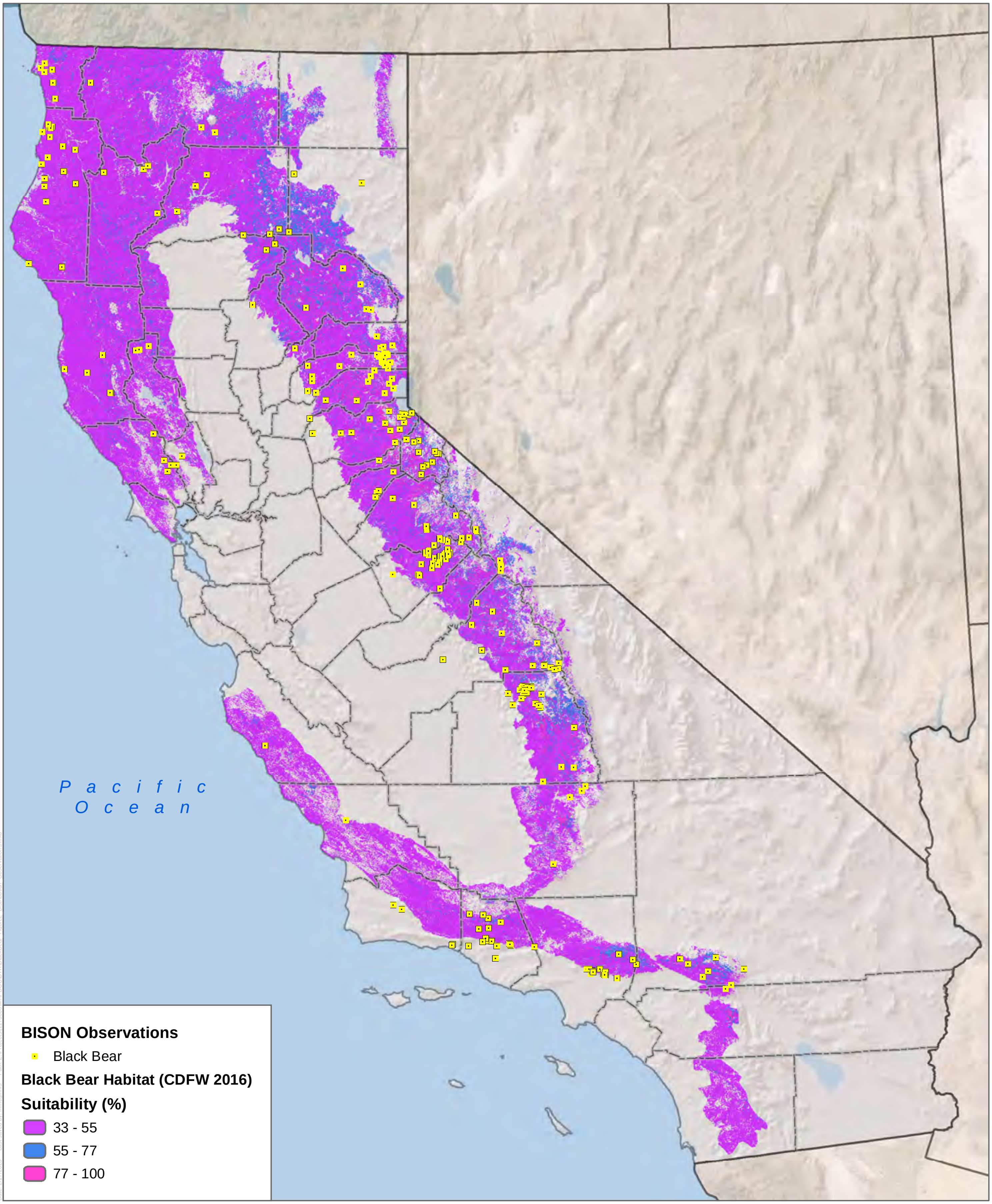

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Black Bear Statewide

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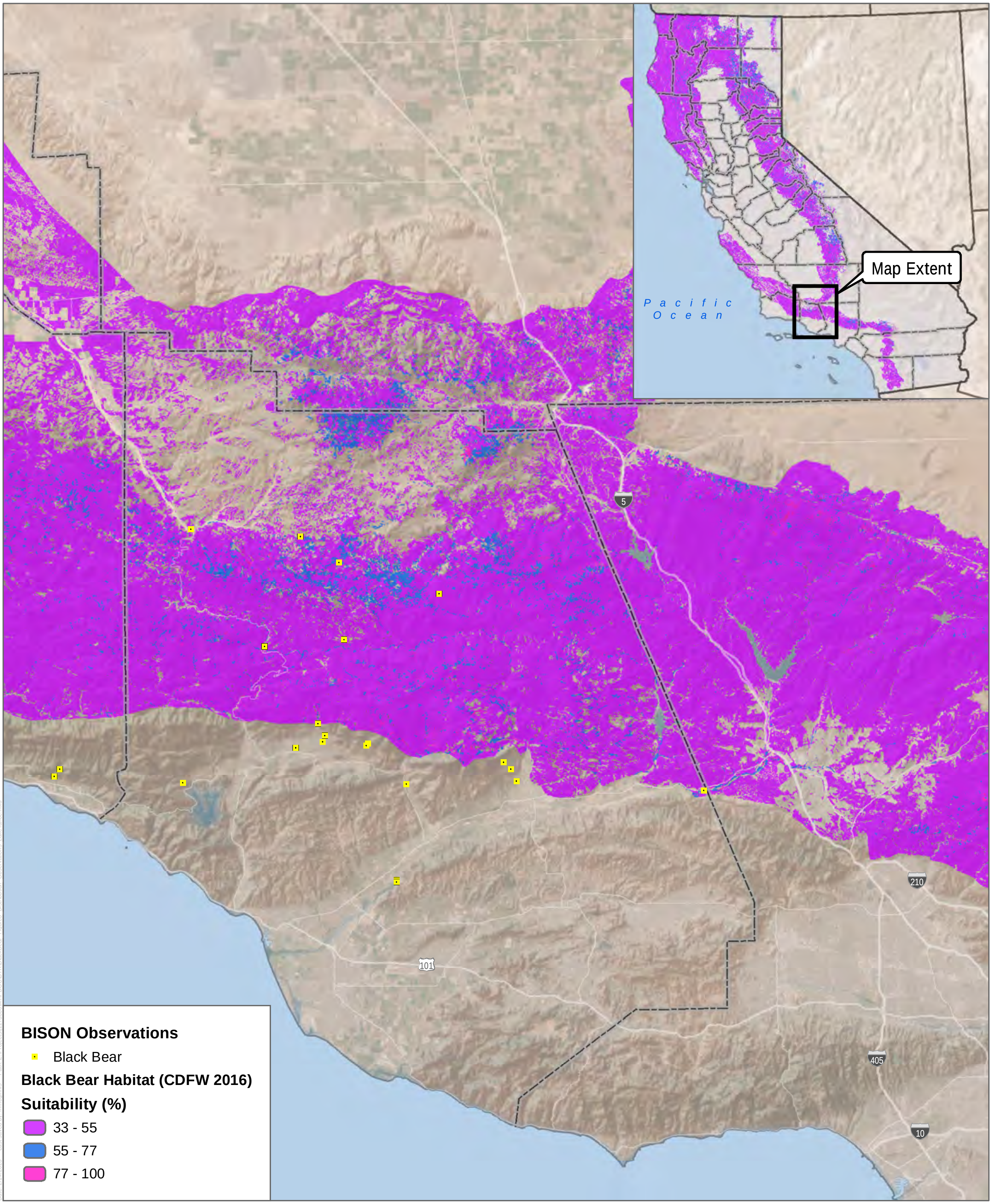

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 2 4 Miles

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Black Bear in Ventura County

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Black bears have widely varying home range sizes (7-fold) and population densities (3-fold) as described in the various research-literature sources summarized in Table 3. The two methods used to estimate the black bear population by county in California are as follows: (1) an average density of 0.22 individuals/km^2, and (2) the average adult female home range across all studies listed in Table 3 of 21.2 km^2, corrected for the average overlap among adult bears of 39.6%, resulting in a corrected home range size of 12.8 km^2. The resulting value was then multiplied by 2, equivalent to a sex ratio of 1:1 (Hellgren and Vaughan 1989; Matthews 2002). These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average density 0.22 individuals/km^2 ((0.083 individuals/km^2 + 0.35 individuals/km^2 + 0.13 individuals/km^2 + 0.051 individuals/km^2 + 0.12 individuals/km^2 + 0.158 individuals/km^2 + 0.66 individuals/km^2 + 0.33 individuals/km^2 + 0.22 individuals/km^2 + 0.08 individuals/km^2 + 0.21 individuals/km^2)/11) multiplied by the amount of Suitable Habitat Area (km^2) in each County.

2. Home Range-Based Estimate (see Table 3 for references):

   Suitable Habitat Area (km^2) in each County divided by 12.8 km^2 (average female home range value of 21.2 ((43.1 km^2 + 26.5 km^2 + 36.4 km^2 + 21.4 km^2 + 8.1 km^2 + 17.8 km^2 + 12 km^2 + 5.2 km^2 + 20.4 km^2)/9) – 8.4 (39.6% Average Home Range Overlap (38.1% + 41.0%)/2))) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For black bear, the top two-thirds of suitable habitat represent only 83% (130,851 km^2) (Table 2) of the species' estimated range in California (158,288 km^2) (CDFW 2016). The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of black bear habitat (Figures 2 and 3) (CDFW 2016). Since black bears occupy areas outside of their top two-thirds habitat, while these methods assume they do not, these methods will tend to underestimate the population.

The estimated population sizes for black bears in California are 28,787 individuals using the density-based estimate and 20,446 individuals using the home range-based estimate (Table 4). These approaches assume the following: that there is 39.6% home range overlap among adult female black bears, that no black bears occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California.

The statewide and county estimates under each method are provided in Table 4.

Table 3. Black Bear Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size/ Population Density Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km2)	Sample Size
Clark and Smith 1994	Radio-collar	Mark-Recapture (Jolly-Seber)	Arkansas (1958-1968)	ND	ND	0.075 and 0.090; Average: 0.083	108
Clark 2019	Hair-DNA	SECR	Kentucky, North Carolina, Tennessee, and South Carolina (Various years)	ND	ND	NC/TN: 0.31 (M), 0.47 (F), 0.78 (total); TN/KY: 0.07 (M), 0.09 (F), 0.16 (total); SC: 0.05 (M), 0.07 (F), 0.12 (total); Average Total: 0.35	North Carolina/Tennessee: 129; Tennessee/Kentucky: 23 Male, 18 Female; South Carolina: not reported
Dobey et al. 2005	Radio-collar, Hair DNA	95% FK, Mark-Recapture	Georgia, Florida (1995-1999)	ND	Florida: 30.3; Georgia: 55.9; Average: 43.1	0.12 and 0.14; Average: 0.13	205 (124 Male, 81 Female)
Dreher et al. 2007	Hair and tissue DNA	Mark-Recapture, Lukacs Burnham model	Michigan (2003)	ND	ND	0.051	816 DNA samples
Early 2010	Radio-collar	95% FK	Humboldt County, California (2008)	38.1%	26.5	ND	16 (8 Male, 8 Female)
Grenfell and Brody 1986	Radio-collar	Error Polygon Centers and Harmonic Mean (95%)	Tahoe National Forest, California (1979-1980)	“extensive”	36.4	ND	4 Female
Howe et al. 2022	Hair-DNA	SECR	Ontario, Canada (2017-2019)	ND	ND	0.12	~49

Table 3. Black Bear Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size/ Population Density Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km2)	Sample Size
Koehler and Pierce 2003	Radio-collar, intraperitoneal transmitter telemetry	95% FK	Cascades, Pacific coast, Washington (1994-1999)	ND	21.4	ND	31 Male, 31 Female
Loosen et al. 2019	Hair-DNA	SECR	Alberta, Canada (2013-2014)	ND	ND	0.062 (M), 0.096 (F), 0.158 (total), private lands	347 (186 Male, 161 Female)
Matthews 2002	Radio-collar	MCP	Hoopa Valley Reservation, Humboldt, CA (1998-2000)	ND	Damaged sites: 6.8; Undamaged sites: 9.4; Average: 8.1	ND	Damaged sites: 4 Female; Undamaged sites: 3 Female
Norton et al. 2018	GPS	95% FK	Michigan (2009-2014)	ND	With Cubs: 19.46; Without Cubs: 16.07; Average: 17.8	not cited	16 Female
Hellgren and Vaughan 1989	Radio-collar	Mark-Recapture (Jolly-Seber), Single Mark Recapture	Virginia and North Carolina (1984-1986)	ND	ND	0.66	71 Male, 30 Female
LeCount 1982	Radio-collar	Leslie and Peterson Method (modified)	Arizona (1973-1978)	ND	ND	0.33	55 (33 Male, 22 Female)
Powell 1987	Radio-collar	Sum of occupied 0.25 km² blocks where detected	North Carolina (1981-1984)	64.1%, 53.7%, 29.5%, 58.1%, 35.8%; Average: 41.0%	ND	ND	21
Smith 1985	Radio-collar	Convex polygon or maximum area method	Arkansas (1979-1982)	ND	12	0.22	10 Male, 9 Female

Table 3. Black Bear Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size/ Population Density Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km^2)	Population Density (individuals/km2)	Sample Size
Stetz et al. 2019	Hair-DNA	SECR	Montana (2004)	ND	ND	0.08 (minimum)	597 bears in 7,350 km^2 study area
Quigley 1982	Radio-collar	MCP	Tennessee (1978-1979)	ND	5.2	ND	6
Lombardo 1993	Capture/ re-capture, radio-collar	MCP	North Carolina (1988-1989)	"extensive for females"	20.4 (n=6)	0.21	15

Notes: FK = fixed kernel; MCP = minimum convex polygon; SECR = spatially-explicit capture-recapture; ND = not determined.

Table 4. Statewide and County Black Bear Population Estimates

County	Population Density (0.22/km^2)	Average Adult Female Home Range (12.8 km^2)	County	Population Density (0.22/km^2)	Average Adult Female Home Range (12.8 km^2)
Alameda	0	0	Orange	0	0
Alpine	283	201	Placer	528	375
Amador	139	98	Plumas	1,300	923
Butte	339	241	Riverside	308	219
Calaveras	262	186	Sacramento	0	0
Colusa	88	62	San Benito	0	0
Contra Costa	0	0	San Bernardino	402	286
Del Norte	554	393	San Diego	580	412
El Dorado	695	493	San Francisco	0	0
Fresno	913	648	San Joaquin	0	0
Glenn	201	143	San Luis Obispo	836	594
Humboldt	1,931	1,371	San Mateo	0	0
Imperial	0	0	Santa Barbara	576	409
Inyo	130	92	Santa Clara	0	0

Table 4. Statewide and County Black Bear Population Estimates

County	Population Density (0.22/km^2)	Average Adult Female Home Range (12.8 km^2)	County	Population Density (0.22/km^2)	Average Adult Female Home Range (12.8 km^2)
Kern	917	651	Santa Cruz	0	0
Kings	561	398	Shasta	1,612	1,145
Lake	561	398	Sierra	454	322
Lassen	679	482	Siskiyou	2,903	2,062
Los Angeles	747	530	Solano	1	1
Madera	387	275	Sonoma	694	493
Marin	159	113	Stanislaus	0	0
Mariposa	438	311	Sutter	0	0
Mendocino	1,881	1,336	Tehama	524	372
Merced	0	0	Trinity	1,762	1,251
Modoc	450	320	Tulare	1,077	765
Mono	338	240	Tuolumne	926	658
Monterey	648	460	Ventura	386	274
Napa	131	93	Yolo	1	1
Nevada	396	281	Yuba	88	63
			Total	**28,787**	**20,446**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Black Bear Predicted Habitat (CWHR M151). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, California.

Clark, J.D. 2019. Comparing clustered sampling designs for spatially explicit estimation of population density. Population Ecology, 61(1), pp.93-101.

Clark, J.D. and Smith, K.G., 1994. A demographic comparison of two black bear populations in the interior highlands of Arkansas. Wildlife Society Bulletin, pp.593-603.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Dobey, S., Masters, D.V., Scheick, B.K., Clark, J.D., Pelton, M.R. and Sunquist, M.E., 2005. Ecology of Florida black bears in the Okefenokee - Osceola ecosystem. Wildlife Monographs, 158(1), pp.1-41.

Dreher, B.P., Winterstein, S.R., Scribner, K.T., Lukacs, P.M., Etter, D.R., Rosa, G.J., Lopez, V.A., Libants, S. and Filcek, K.B., 2007. Noninvasive estimation of black bear abundance incorporating genotyping errors and harvested bear. The Journal of Wildlife Management, 71(8), pp.2684-2693.

Early, D. 2010. "Intraspecific Black Bear Spatial Patterns and Interactions at a Small Spatio-Temporal Scale." Master's thesis; Humboldt State University.

Grenfell, W.E., and A.J. Brody. 1986. "Black Bear Habitat Use in Tahoe National Forest, California." In *Bears: Their Biology and Management*, *Volume 6: A Selection of Papers from the Sixth International Conference on Bear Research and Management, Grand Canyon, Arizona, USA, February 1983 (1986)*, 65–72. International Association for Bear Research and Management.

Hellgren, E.C., and M.R. Vaughan. 1989. "Demographic Analysis of a Black Bear Population in the Great Dismal Swamp." *Journal of Wildlife Management* 53(4): 969–977.

Howe, E.J., Potter, D., Beauclerc, K.B., Jackson, K.E. and Northrup, J.M., 2022. Estimating animal abundance at multiple scales by spatially explicit capture–recapture. Ecological Applications, p.e2638.

Koehler, G.M., and D.J. Pierce. 2003. "Black Bear Home-Range Sizes in Washington: Climatic, Vegetative, and Social Influences." *Journal of Mammalogy* 84(1): 81–91.

LeCount, A.L. 1982. "Characteristics of an East-Central Arizona Black Bear Population." *Journal of Wildlife Management* 46(4): 861–868.

Lombardo, C.A. 1993. "Population Ecology of Black Bears on Camp Lejeune, North Carolina." Master's thesis; University of Tennessee, Knoxville. https://trace.tennessee.edu/utk_gradthes/4534.

Loosen, A.E., Morehouse, A.T. and Boyce, M.S., 2019. Land tenure shapes black bear density and abundance on a multi-use landscape. *Ecology and Evolution*, *9*(1), pp.73-89.

Matthews, S.M. 2002. "Population Attributes of Black Bear in Relation with Douglas-Fir Damage on the Hoopa Valley Reservation, California." PhD dissertation; Humboldt State University.

Norton, D.C., J.L. Belant, J.G. Bruggink, D.E. Beyer Jr., N.J. Svoboda, and T.R. Petroelje. 2018. "Female American Black Bears Do Not Alter Space Use or Movements to Reduce Infanticide Risk." *PloS ONE* 13(9): p.e0203651. https://doi.org/10.1371/journal.pone.0203651.

Powell, R.A. 1987. "Black Bear Home Range Overlap in North Carolina and the Concept of Home Range Applied to Black Bears." In *Bears: Their Biology and Management, Volume 7: A Selection of Papers for the Seventh International Conference on Bear Research and Management, Williamsburg, Virginia, USA, and Plitvice Lakes, Yugoslavia, February and March 1986,* 235–242. International Association for Bear Research and Management.

Quigley, H.B. 1982. "Activity Patterns, Movement Ecology, and Habitat Utilization of Black Bears in the Great Smoky Mountains National Park, Tennessee." Master's thesis, University of Tennessee, Knoxville. June 1982.

Smith, T.R. 1985. "Ecology of Black Bears in a Bottomland Hardwood Forest in Arkansas." PhD dissertation, University of Tennessee. August 1985. https://trace.tennessee.edu/utk_graddiss/6146.

Stetz, J.B., Mitchell, M.S. and Kendall, K.C., 2019. Using spatially ‐ explicit capture – recapture models to explain variation in seasonal density patterns of sympatric ursids. Ecography, 42(2), pp.237-248.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov.

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C3 Bobcat Population and Distribution

The following describes the distribution and population estimate of bobcat (*Lynx rufus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, bobcat observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. In the dataset, there were 842 bobcat observations between 2000 and 2020 on and off roads.

Table 1. Observations and Modeled Distribution of Bobcat Across California

Dataset	Number of Observations	Date Range
Bobcat Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	842	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

Bobcats are able to live in urban regions, adjacent to natural habitat. Within urban areas and at fine resolutions, they will tend to select against highly developed areas, while using nearby open and less-developed areas (Riley et al. 2010). This means that bobcat populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of bobcats statewide (Figure 2), and modeled habitat and observations in Los Angeles County (Figure 3). The figures show that the majority of bobcat observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). This is likely due to the expansive range provided by CDFW for bobcat, which covers 99% (408,428 km^2) of the land area of the state of California (410,727 km^2) (CDFW 2016). These data support the accuracy of the CDFW (2016) range and habitat data for bobcat and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of bobcats outside of the top two-thirds of suitable habitat.

Table 2. Bobcat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)			County	Top 2/3 Suitable Habitat (km^2)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Alameda	972	222	1,193	Orange	346	489	835
Alpine	1,708	0	1,708	Placer	2,807	204	3,010
Amador	1,390	13	1,404	Plumas	6,297	0	6,297
Butte	2,711	260	2,971	Riverside	14,017	703	14,720
Calaveras	2,517	20	2,537	Sacramento	608	204	812
Colusa	1,598	0	1,599	San Benito	3,275	7	3,281
Contra Costa	578	513	1,091	San Bernardino	46,642	2,188	48,830
Del Norte	2,390	34	2,425	San Diego	7,475	1,131	8,606
El Dorado	3,909	161	4,071	San Francisco	0	7	7
Fresno	8,062	14	8,076	San Joaquin	771	7	778
Glenn	2,185	2	2,188	San Luis Obispo	7,442	28	7,470
Humboldt	7,785	72	7,857	San Mateo	515	221	736
Imperial	7,223	18	7,241	Santa Barbara	5,516	172	5,688
Inyo	24,579	26	24,606	Santa Clara	2,151	206	2,357
Kern	14,893	489	15,381	Santa Cruz	555	248	803
Kings	801	28	829	Shasta	9,064	176	9,240
Lake	2,936	32	2,968	Sierra	2,305	0	2,305
Lassen	11,053	8	11,061	Siskiyou	14,876	148	15,024
Los Angeles	5,476	1121	6,597	Solano	799	44	843
Madera	3,516	14	3,530	Sonoma	2,796	127	2,923
Marin	812	163	975	Stanislaus	1,890	134	2,025
Mariposa	3,645	0	3,645	Sutter	284	7	291
Mendocino	7,676	42	7,718	Tehama	6,987	6	6,993
Merced	2,346	10	2,356	Trinity	8,031	0	8,031
Modoc	9,067	0	9,067	Tulare	7,989	6	7,994
Mono	7,017	24	7,041	Tuolumne	5,034	78	5,112
Monterey	7,128	172	7,300	Ventura	3,417	313	3,730

Table 2. Bobcat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Napa	1,496	27	1,523	Yolo	997	16	1,013
Nevada	2,106	158	2,264	Yuba	1,084	10	1,095
				Total Statewide Suitable Habitat	**311,547**	**10,523**	**322,070**

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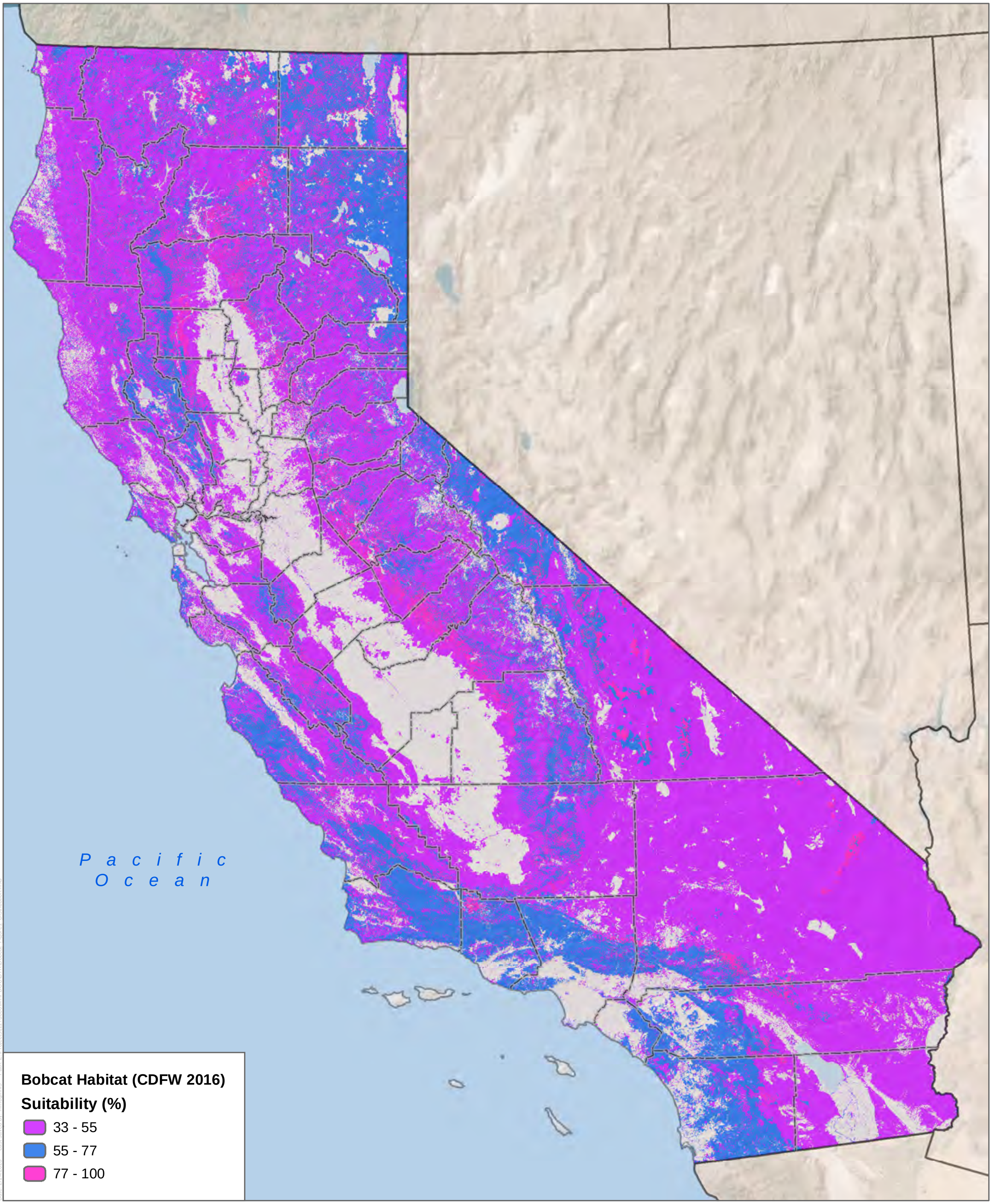

SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Bocat Habitat from CDFW Habitat Suitability Model

Biological Technical Report for the Wildlife Damage Management Project

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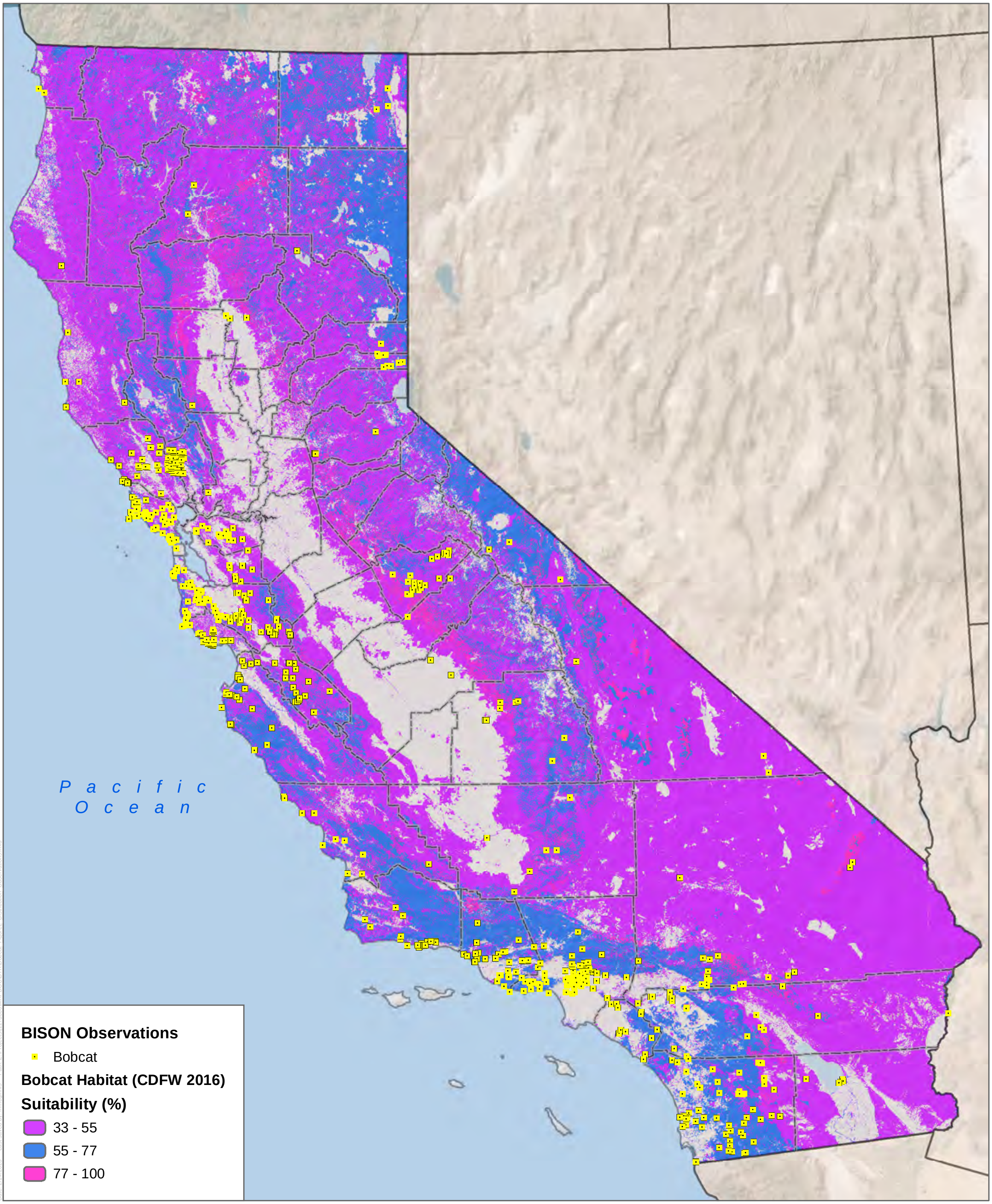

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Bobcat Statewide

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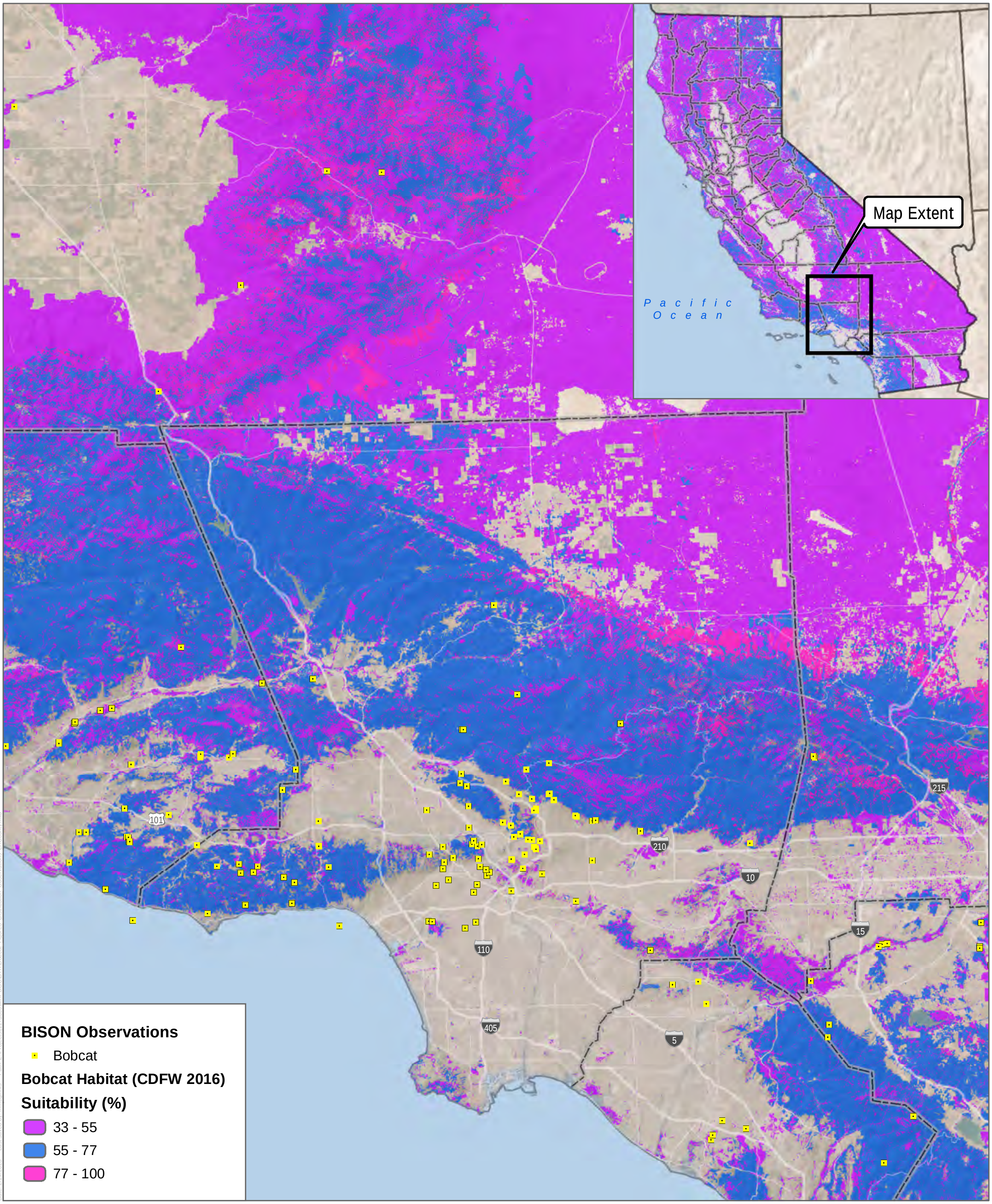

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Bobcat in Los Angeles County

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Bobcats have widely varying home range sizes as described in the various research-literature sources summarized in Table 3. Bobcats are able to live in urban regions, adjacent to natural habitat. Within urban areas and at fine resolutions, they will tend to select against highly developed areas, while using nearby open and less-developed areas (Riley et al. 2010). This means that bobcat populations can occur in urban areas and their home ranges include urban landscapes. The top two-thirds of suitable habitat was calculated for both urban and non-urban areas within counties separately and then the two areas were combined for population estimates.

Two methods were used to estimate the bobcat population by county in California: (1) the average of available published population densities of 0.164 individuals/km^2, and (2) the average of available published home range size for adult female bobcats of 16.98 km^2 (non-urban) and 3.63 km^2 (urban) minus an estimated 24% overlap per individual (average of non-zero overlap values in literature) and multiplied by 2 for a 1:1 male to female ratio. These two approaches were used to estimate maximum-likely population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):
   a. Average Non-Urban density of 0.14 individuals/km^2 ((0.097 + 0.25 + 0.173 + 0.256 + 0.177 + 0.116 + 0.125 + 0.091 + 0.1 + 0.34 + 0.03 + 0.132 individuals/km^2)/12) multiplied by the top two-thirds of Non-Urban Suitable Habitat Area (km^2) in each County.
   b. Average Urban density of 0.71 individuals/km^2 ((0.47 + 0.64 + 1.03 individuals/km^2)/3) multiplied by the top two-thirds of Urban Suitable Habitat Area (km^2) in each County.
   c. The results of method 1a for non-urban areas and 1b for urban areas are then summed together for the total population estimate.
2. Home Range-Based Estimate (see Table 3 for references):
   a. Non-Urban Suitable Habitat Area (km^2) in each County divided by 12.5 km^2 (average adult non-urban female home range value of 14.1 km^2 ((9.2 km^2 + 6.4 km^2 + 22.9 km^2 + 25.2 km^2 + 4.8 km^2 + 4.2 km^2 + 27.3 km^2 + 6.33 km^2 + 14.8 km^2 + 24.5 + 9.2 km^2)/11) – 1.58 km^2 (11.2% Average Home Range Overlap (14% + 16% + 10% + 4.9%)/4)))) and multiplied by 2 to include males.
   b. Urban Suitable Habitat Area (km^2) in each County divided by 2.8 km^2 (average adult female home range value of 3.13 km^2 ((5.91 km^2 + 3.48 + 1.6 km^2 + 1.51 km^2)/4) – 0.35 km^2 (11.2% Average Female Home Range Overlap (14% + 16% + 10% + 4.9%)/4)) and multiplied by 2 to include males.
   c. The results of method 2a for non-urban areas and 2b for urban areas are then summed together for the total population estimate.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For bobcat, the top two-thirds of suitable habitat represent only 79% (322,070 km^2) (Table 2) of the total estimated range of bobcats in California (408,428 km^2) (CDFW 2016). The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of bobcat habitat (Figures 2 and 3) (CDFW 2016). Since bobcats occupy areas outside of their top two-thirds habitat, while these methods assume they do not, these methods will tend to underestimate the population.

The estimated population sizes for bobcats in California are 51,088 individuals using the density-based estimate and 57,364 individuals using the home range-based estimate (Table 4). These approaches assume the following: that there is 11.2% home range overlap among adult female bobcats, that no bobcats occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat are fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Bobcat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Years	Home Range Overlap among Females	Female Home Range Size (km^2)	Population Density (individuals/ km^2)	Sample Size
Alonso et al. 2015*	GPS collar, camera	95% FK, mark-resight	Orange County, California (2006-2007)	ND	8.83 (Both Sexes)[1]	0.47 (Urban)	Collar: 8 Male, 6 Female; mark: 27
Benson et al. 2006	Radio-collar	95% FK; Pop density – MCP all known, n/MCP area	Michigan (1989-1997)	ND	9.2	0.097	20 Male, 31 Female
Clare et al. 2015	Camera	SECR; occupancy modeling	Wisconsin (2012-2013)	ND	ND	0.025	64
Cochrane et al. 2006	Radio-collar	95% AK	Georgia (2001-2004)	14% (F/F)	6.4	ND	17 Male, 27 Female
Donovan et al. 2011	GPS collar	100% KDE	Vermont (2005-2008)	ND	22.9	ND	10 Male, 4 Female
Dunagan et al. 2019*	GPS collar	100% MCP	Simi Hills, California (2013-2014)	ND	5.91 Urban	ND	7 Female
Golla 2017*	GPS collar, SECR	95% KDE	Dallas, Texas (2014-2015)	ND (“high”)	3.48 Urban	0.64 (Urban)	4 Male, 5 Female
Kapfer 2012	GPS collar	100% MCP	Minnesota (1977-2008)	16.0% (F/F)	25.2	ND	2 Female
Lavariega et al. 2022	Camera	Capture-recapture, Random encounter model	Oaxaca, Mexico (2013-2014)	ND	ND	0.173	28
Lawhead 1984	Radio-collar	Modified minimum area	Arizona (1976-1978)	10% (F/F)	4.8	0.256	2 Male, 5 Female
Lewis et al. 2015	Camera, GPS collar	Mark-resight	Colorado (2009-2010)	ND	ND	0.177	17
Morin et al. 2018	Fecal DNA	Spatial capture-recapture	Virginia (2011-2013)	ND	ND	0.116 (average of all sites, Table 2)	118

Table 3. Bobcat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Years	Home Range Overlap among Females	Female Home Range Size (km^2)	Population Density (individuals/ km^2)	Sample Size
Muncey 2018	GPS collar, camera	Mark-recapture; 95% MCP, 95% KDE	UT (2015-2017)	ND	95% MCP: 40.7; 95% KDE: 36.3(2)	0.125	Camera: 50; Collar: 1 Male, 1 Female
Poessel et al. 2014	GPS collar	95% MCP	Southern CA (2002-2008)	ND	4.2	ND	32 Mele, 20 Female
Popescu et al. 2021	GPS collar	95% KDE	OH (2012-2014)	ND	27.3	ND	9 Male, 11 Female
Riley et al. 2003*	Radio collar	95% MCP	Southern CA (1996-2000)	ND (but Figure 2 shows none to vast majority for F/F)	1.6 Urban	ND	16 Male, 19 Female
Riley 2006*	Radio collar	95% AK	Northern CA (Marin) (1992-1995)	Among home ranges that overlapped: 35.3% Rural (F/F), 36.3% Urban (F/F)[3]	1.51 Urban, 6.33 Rural	ND	7 Male, 12 Female
Rolley 1983	Radio-collar	Minimum Polygon	OK (1977-1981)	"little to no intrasexual overlap"	14.8	ND	9 Male, 6 Female
Rolley 1985	Radio collar; carcass exam	Minimum Polygon	OK (1977-1981)	ND	ND	0.091	Collar: 7 Male, 4 Female; carcass: 549
Rucker et al. 1989	Radio collar	MCP	AR (1982-1984)	4.90% (F/F)	24.5	0.10	1 Male, 3 Female
Ruell et al. 2009	Genotype, scat	Closed-population, heterogeneity estimation	Southern CA (2004)	ND	ND	0.34	176
Stricker et al. 2012	Hair DNA	NA	MI (2010)	ND	ND	0.03	8

Table 3. Bobcat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Years	Home Range Overlap among Females	Female Home Range Size (km^2)	Population Density (individuals/ km^2)	Sample Size
Thornton et al. 2004	Radio collar	95% FK	FL (2001-2002)	ND	9.2 (n=6)	ND	1 Male, 8 Female
Thornton and Pekins 2015	Camera	SECR	TX (2011-2012)	ND	ND	0.132	51
Young et al. 2019*	GPS collar, camera	SECR	TX (2014)	ND	ND	1.03 (Urban; lower of two estimates)	42

Notes: SECR = spatially-explicit capture-recapture; FK = fixed kernel; MCP = minimum convex polygon; AK = adaptive kernel home range; KDE = kernel density estimation; ND = Not Determined; NA = not applicable; RSPF = resource selection probability function; RSF = resource selection function; RSS = Relative Selection Strength; U = urban; R = rural.

1 This home range size was not included in the home range-based estimate because it includes both males and females.

2 This home range size was not included in the home range-based estimate due to the low sample size of one for home range determination and the marked inconsistency of this home range with other home range studies (<3 time higher than the average, and female home range was more than twice as large as the single male home range—male home ranges are considerably larger than female in most other studies).

3 These home range overlap values were not used to determine average home range overlap because they only include home ranges that overlapped; these do not represent overall home range overlap because they exclude home ranges with zero overlap.

* Study includes values for urban areas.

Table 4. Statewide and County Bobcat Population Estimates

County	Population Density (0.14 and 0.71 individuals/km^2)[1]	Adult Female Home Range (12.5 km^2 and 2.8 km^2)[2]	County	Population Density (0.14 and 0.71 individuals/km^2)[1]	Adult Female Home Range (12.5 km^2 and 2.8 km^2)[2]
Alameda	294	314	Orange	396	405
Alpine	239	273	Placer	538	595
Amador	204	232	Plumas	882	1,008
Butte	564	619	Riverside	2,462	2,745
Calaveras	367	417	Sacramento	230	243
Colusa	224	256	San Benito	463	529
Contra Costa	445	459	San Bernardino	8,083	9,026
Del Norte	359	407	San Diego	1,850	2,004
El Dorado	662	740	San Francisco	5	5
Fresno	1,139	1,300	San Joaquin	113	128

Table 4. Statewide and County Bobcat Population Estimates

County	Population Density (0.14 and 0.71 individuals/km^2)[1]	Adult Female Home Range (12.5 km^2 and 2.8 km^2)[2]	County	Population Density (0.14 and 0.71 individuals/km^2)[1]	Adult Female Home Range (12.5 km^2 and 2.8 km^2)[2]
Glenn	307	351	San Luis Obispo	1,062	1,211
Humboldt	1,141	1,297	San Mateo	229	240
Imperial	1,024	1,169	Santa Barbara	894	1,005
Inyo	3,460	3,951	Santa Clara	447	491
Kern	2,432	2,732	Santa Cruz	254	266
Kings	132	148	Shasta	1,394	1,576
Lake	434	493	Sierra	323	369
Lassen	1,553	1,774	Siskiyou	2,188	2,486
Los Angeles	1,563	1,677	Solano	143	159
Madera	502	573	Sonoma	482	538
Marin	229	246	Stanislaus	360	398
Mariposa	510	583	Sutter	45	50
Mendocino	1,104	1,258	Tehama	982	1,122
Merced	336	383	Trinity	1,124	1,285
Modoc	1,269	1,451	Tulare	1,123	1,283
Mono	999	1,140	Tuolumne	760	861
Monterey	1,120	1,263	Ventura	701	770
Napa	229	259	Yolo	151	171
Nevada	407	450	Yuba	159	181
			Total	**51,088**	**57,364**

Notes:
1 The non-urban and urban suitable habitat totals are multiplied by the respective non-urban (0.14) and urban (0.71) density values and the results are summed together for the total population estimate.
2 The non-urban and urban suitable habitat totals are divided by the respective non-urban (12.5) and urban (2.8) home range value and the results are summed together for the total population estimate.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Alonso, R.S., McClintock, B.T., Lyren, L.M., Boydston, E.E. and Crooks, K.R. 2015. Mark-recapture and mark-resight methods for estimating abundance with remote cameras: a carnivore case study. *PloS one*, *10*(3), p.e0123032.

Benson, J.F., M.J. Chamberlain, and B.D. Leopold. 2006. "Regulation of Space Use in a Solitary Felid: Population Density or Prey Availability? *Animal Behaviour* 71(3): 685–693.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Bobcat Predicted Habitat (CWHR M166). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

Clare, J.D., Anderson, E.M. and MacFarland, D.M. 2015. Predicting bobcat abundance at a landscape scale and evaluating occupancy as a density index in central Wisconsin. The Journal of Wildlife Management, 79(3), pp.469-480.

Cochrane, J.C., Kirby, J.D., Jones, I.G., Conner, L.M. and Warren, R.J. 2006. Spatial organization of adult bobcats in a longleaf pine-wiregrass ecosystem in southwestern Georgia. *Southeastern Naturalist*, *5*(4), pp.711-724.

Donovan, T.M., Freeman, M., Abouelezz, H., Royar, K., Howard, A. and Mickey, R. 2011. Quantifying home range habitat requirements for bobcats (Lynx rufus) in Vermont, USA. *Biological Conservation*, *144*(12), pp.2799-2809.

Dunagan, S.P., Karels, T.J., Moriarty, J.G., Brown, J.L. and Riley, S.P. 2019. Bobcat and rabbit habitat use in an urban landscape. Journal of Mammalogy, 100(2), pp.401-409.

Golla J.M. 2017. Urban bobcat (Lynx rufus) ecology in the Dallas-Fort Worth, Texas Metroplex. Thesis, Utah State University. 67pp.

Kapfer, P.M. 2012. Bobcat (Lynx rufus) spatial ecology and harvest in Minnesota. PhD Dissertation. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/129412.

Lavariega, M.C., Briones-Salas, M., Monroy-Gamboa, A.G. and Ramos-Méndez, D. 2022. Population density and daily activity patterns of bobcat in its southernmost continental distribution. Animal Biodiversity and Conservation, 45(2), pp.145-160.

Lawhead, D.N. 1984. “Bobcat *Lynx rufus* Home Range, Density and Habitat Preference in South-Central Arizona.” *Southwestern Naturalist* 29(1): 105–113.

Lewis, J.S., Bailey, L.L., VandeWoude, S. and Crooks, K.R. 2015. Interspecific interactions between wild felids vary across scales and levels of urbanization. *Ecology and evolution*, *5*(24), pp.5946-5961.

Morin, D.J., Waits, L.P., McNitt, D.C. and Kelly, M.J. 2018. Efficient single-survey estimation of carnivore density using fecal DNA and spatial capture-recapture: a bobcat case study. *Population Ecology*, *60*(3), pp.197-209.

Muncey, K.D. 2018. Bobcat Abundance and Habitat Selection on the Utah Test and Training Range. PhD Dissertation, Brigham University. https://scholarsarchive.byu.edu/etd/7710

Poessel, S.A., C.L. Burdett, E.E. Boydston, L.M. Lyren, R.S. Alonso, R.N. Fisher, and K.R. Crooks. 2014. “Roads Influence Movement and Home Ranges of a Fragmentation-Sensitive Carnivore, the Bobcat, in an Urban Landscape.” *Biological Conservation* 180:224–232.

Popescu, V.D., M. Kenyon, R.K. Brown, M.A. Dyck, S. Prange, W.E. Peterman, and C. Dennison. 2021. “Habitat Connectivity and Resource Selection in an Expanding Bobcat (*Lynx rufus*) Population.” *PeerJ* 9:e12460. https://doi.org/10.7717/peerj.12460.

Riley, S.P. 2006. “Spatial Ecology of Bobcats and Gray Foxes in Urban and Rural Zones of a National Park.” *Journal of Wildlife Management* 70(5): 1425–1435.

Riley, S.P., R.M. Sauvajot, T.K. Fuller, E.C. York, D.A. Kamradt, C. Bromley, and R.K. Wayne. 2003. “Effects of Urbanization and Habitat Fragmentation on Bobcats and Coyotes in Southern California.” *Conservation* Biology 17(2): 566–576.

Riley, S.P.D., Boyston, E. E., Crooks, K. R., and Lyren, L. M. 2010. Bobcats *(Lynx rufus*) Pp. 121-138 in Urban carnivores: ecology, conflict, and conservation (S. D. Gehrt, S. P. D. Riley, and B. L. Cypher, eds.). Johns Hopkins University Press, Baltimore, Maryland

Rolley, R.E. 1983. Behavior and population dynamics of bobcats in Oklahoma. Ph.D. Thesis, Oklahoma State Univ., Stillwater. 98pp.

Rolley, R.E. 1985. Dynamics of a harvested bobcat population in Oklahoma. *The Journal of Wildlife Management*, pp.283-292.

Rucker, R.A., Kennedy, M.L., Heidt, G.A. and Harvey, M.J. 1989. Population density, movements, and habitat use of bobcats in Arkansas. *The Southwestern Naturalist*, pp.101-108.

Ruell, E.W., S.P. Riley, M.R. Douglas, J.P. Pollinger, and K.R. Crooks. 2009. “Estimating Bobcat Population Sizes and Densities in a Fragmented Urban Landscape Using Noninvasive Capture–Recapture Sampling.” *Journal of Mammalogy* 90(1): 129–135.

Stricker, H.K., Belant, J.L., Beyer Jr, D.E., Kanefsky, J., Scribner, K.T., Etter, D.R. and Fierke, J. 2012. Use of modified snares to estimate bobcat abundance. *Wildlife Society Bulletin*, *36*(2), pp.257-263.

Thornton, D.H., Sunquist, M.E. and Main, M.B. 2004. Ecological separation within newly sympatric populations of coyotes and bobcats in south-central Florida. *Journal of Mammalogy*, *85*(5), pp.973-982.

Thornton, D.H. and Pekins, C.E. 2015. Spatially explicit capture–recapture analysis of bobcat (Lynx rufus) density: implications for mesocarnivore monitoring. *Wildlife Research*, *42*(5), pp.394-404.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Young, J.K., Golla, J.M., Broman, D., Blankenship, T. and Heilbrun, R. 2019. Estimating density of an elusive carnivore in urban areas: use of spatially explicit capture-recapture models for city-dwelling bobcats. Urban Ecosystems, 22(3), pp.507-512.

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C4 Coyote Population and Distribution

The following describes the distribution and population estimate of coyote (*Canis latrans*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, coyote observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. In the dataset, there were 2,222 coyote observations between 2000 and 2018 on and off roads.

Table 1. Observations and Modeled Distribution of Coyote across California

Dataset	Number of Observations	Date Range
Coyote Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	2,222	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

Coyotes are able to live in urban regions, adjacent to natural habitat. Within urban areas and at fine resolutions, they will tend to select against highly developed areas, while using nearby open and less-developed areas (Grubbs and Krausman 2009). This means that coyote populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

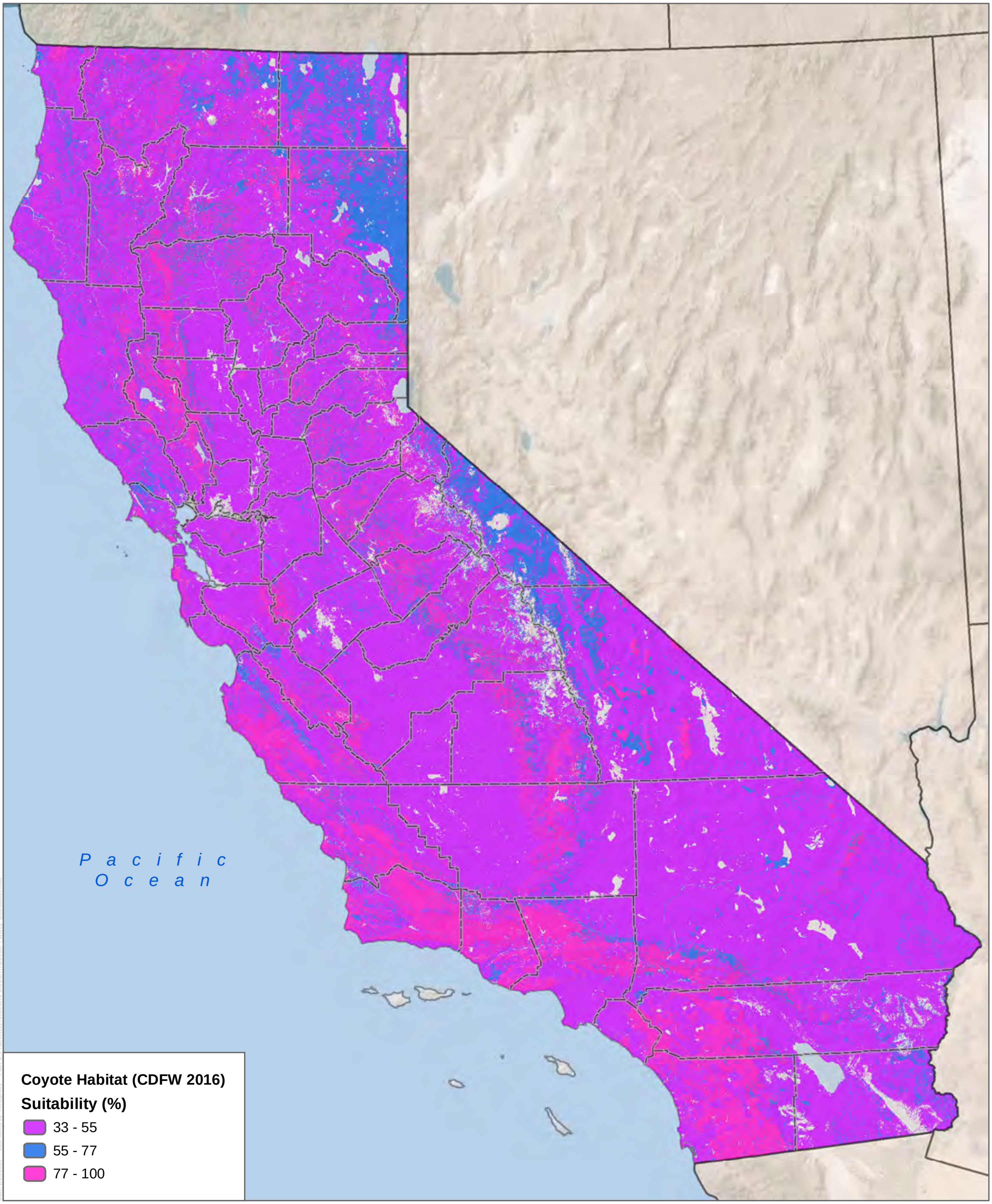
Table 2. Coyote Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Alameda	1,036	767	1,803	Orange	348	1,672	2,020
Alpine	1,713	0	1,713	Placer	3,076	476	3,552
Amador	1,453	26	1,480	Plumas	6,518	0	6,518
Butte	3,650	464	4,114	Riverside	15,263	2,458	17,721
Calaveras	2,572	31	2,602	Sacramento	1,424	1,038	2,462
Colusa	2,838	12	2,850	San Benito	3,523	40	3,562
Contra Costa	731	1,077	1,808	San Bernardino	47,271	3,507	50,777
Del Norte	2,532	43	2,575	San Diego	7,995	2,630	10,626
El Dorado	3,998	261	4,259	San Francisco	0	116	116
Fresno	13,577	709	14,286	San Joaquin	3,101	470	3,571
Glenn	3,295	37	3,333	San Luis Obispo	8,091	356	8,446
Humboldt	8,958	151	9,109	San Mateo	682	440	1,122
Imperial	9,448	120	9,568	Santa Barbara	6,035	472	6,507
Inyo	24,674	35	24,710	Santa Clara	2,286	988	3,274
Kern	19,273	1,312	20,585	Santa Cruz	794	352	1,146
Kings	3,278	225	3,503	Shasta	9,345	261	9,606
Lake	3,161	70	3,231	Sierra	2,438	0	2,438
Lassen	11,628	16	11,644	Siskiyou	15,854	60	15,913
Los Angeles	5,774	4,268	10,041	Solano	1,505	377	1,882
Madera	5,096	151	5,247	Sonoma	3,572	435	4,007
Marin	1,036	261	1,297	Stanislaus	3,466	366	3,832
Mariposa	3,662	0	3,662	Sutter	1,409	89	1,498
Mendocino	8,923	89	9,011	Tehama	7,514	57	7,572
Merced	4,457	224	4,680	Trinity	8,041	0	8,041
Modoc	9,985	0	9,985	Tulare	11,298	416	11,714
Mono	7,076	27	7,103	Tuolumne	5,070	92	5,162
Monterey	8,084	390	8,474	Ventura	3,766	812	4,578

Table 2. Coyote Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Napa	1,779	119	1,898	Yolo	2,386	153	2,540
Nevada	2,158	217	2,375	Yuba	1,529	64	1,593
				Total Statewide Suitable Habitat	359,443	29,299	388,742

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of coyotes statewide (Figure 2), and modeled habitat and observations in Inyo County (Figure 3). The figures show that the majority of coyote observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). This is likely due to the expansive range provided by CDFW for coyote which covers 99% (408,428 km^2) of the land area of the State of California (410,727 km^2) (CDFW 2016). These data support the accuracy of the CDFW (2016) range and habitat data for coyote, and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of coyotes outside of the top two-thirds of suitable habitat.



SOURCE: CDFW 2016

DUDEK

0 25 50 Miles

FIGURE 1

Top Two-thirds of Suitable Coyote Habitat from CDFW Habitat Suitability Model

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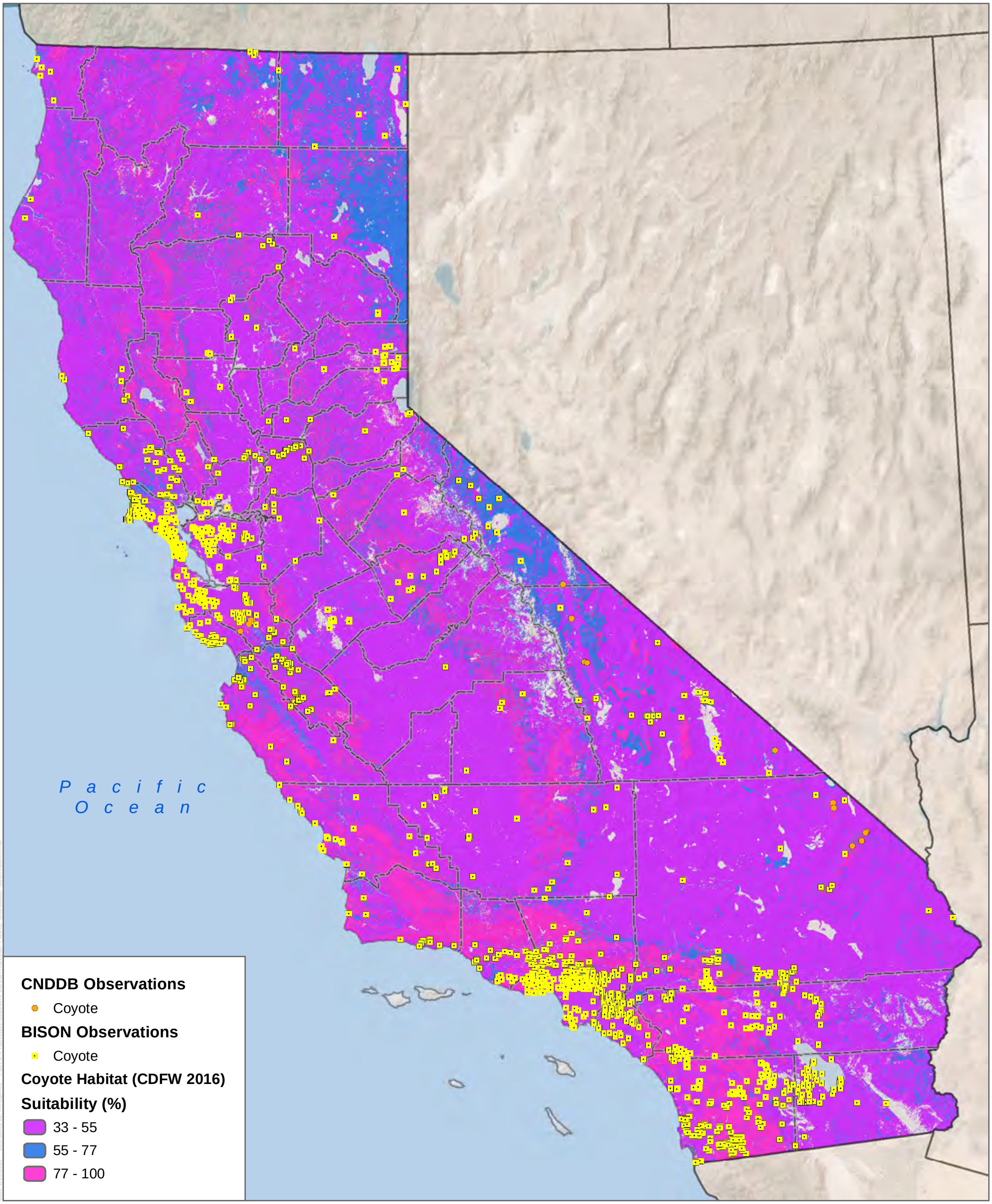

SOURCE: CDFW 2016, 2023; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Coyote Statewide

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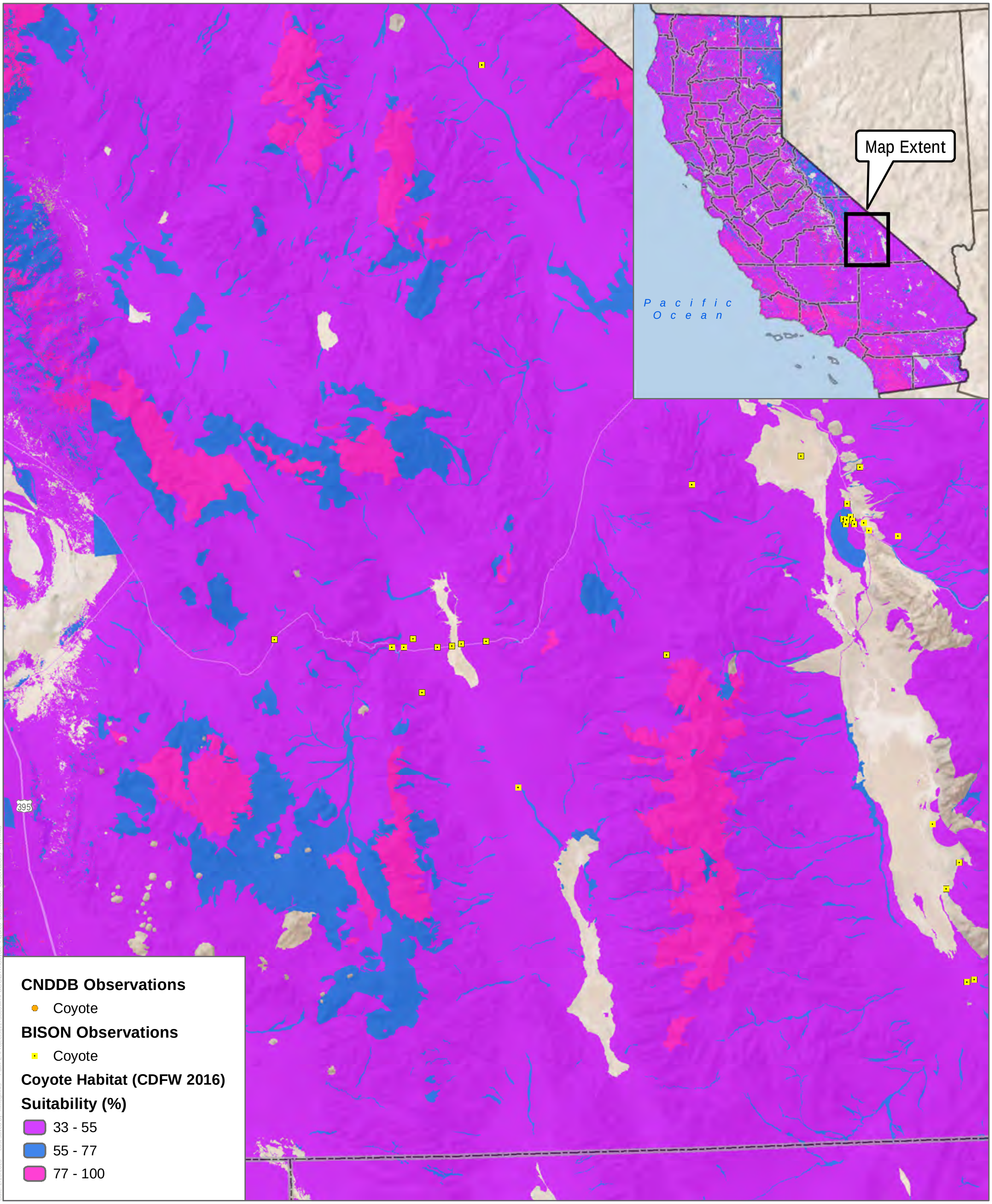

SOURCE: CDFW 2016, 2023; USGS 2020

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FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Coyote in Inyo County

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Coyotes have widely varying home range sizes and densities as described in the various research-literature sources. Because coyotes in the eastern United States have different ecology from those in the western United Sates, only home range and density data from the west were used for non-urban coyotes. For urban coyotes, data from anywhere in the United States were used, due to the paucity of data on urban coyotes in the west and because urban coyotes have similar behavior and ecology throughout the United States.

According to a review of the literature by Bekoff and Wells (1986), home range sizes can vary from approximately 1 km^2 to 100 km^2 and this variation is dependent on pack structure and membership in a pack. Social organization in coyotes is generally recognized as transients (nomads), pairs, and packs (social and territorial groups larger than two) (Camenzid 1978). Home ranges of transient coyotes have been assessed in the literature, but these animals are non-territorial and their home ranges generally completely overlap those of existing pairs and packs (e.g., see Camenzid 1978). Territorial coyotes, on the other hand, are comprised of pairs and packs. For this analysis, coyote pack size includes packs of two (pairs) as well as larger packs but excludes transients. Average pack size (including pairs but not transients) has been reported as 4.1 (Camenzid 1978), 2.5 (Gese et al. 1989), 6.9 (McClure et al. 1996), and 3.8 (Karki et al. 2007). The average across these studies is 4.3 individuals per pack: (4.1 + 2.5 + 6.9 + 3.8)/4 = 4.3. Among such packs (including pairs), home ranges of individual pack members overlap "almost completely" (Andelt 1985), so the home ranges of individuals within the pack generally reflect those of the pack (including pairs).

For the home range-based method, home range size (male, female, or both sexes) was used to represent the home range of the pack; that number is multiplied by the average pack size to estimate the adult coyote population per the calculations provided below.

There is scant information in the published literature regarding home range overlap among coyote packs (including pairs). Camenzid (1978) reported overlap among packs up to 0.75 km but did not present percentages. Andelt (1985) reported that packs "seldom" overlapped; home ranges among adult females of different packs overlapped by only 3.3%. To be conservative, no overlap was assumed among coyote packs.

Coyotes are able to live in urban environments. Within urban/suburban areas they will tend to select against highly developed (urban) areas, preferring more suburban areas (Fedriani et al. 2001, Grubbs and Krausman 2009). This means that coyote populations can occur in urban areas and their home ranges include urban landscapes. Because of this, the population size was estimated for both urban and non-urban areas within counties separately and then the two estimates were combined at the county level.

Two methods were used to estimate the coyote population by county in California: (1) the average population density from published studies (non-urban: 0.48, urban 2.2 individuals/ km^2), and (2) the average of reported home range sizes (non-urban: 7.2 km^2, urban: 9.9 km^2) multiplied by the average pack size (4.3 individuals/pack). These two approaches were used to estimate adult population sizes statewide and for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for each value reference):
   a. Average non-urban population density of 0.48 individuals/km^2 ((0.53 + 0.11 + 0.29 + 0.71 + 0.13 + 1.12 + 0.18 + 0.75 individuals/km^2)/8) multiplied by the amount of Urban and Non-Urban Suitable Habitat Area (km^2) in each county.

   b. Average urban population density of 2.2 ((1.62 + 1.38 + 3.7 individuals/(km^2)/2) multiplied by the amount of top two-thirds suitable urban habitat (km^2) in each county.
   c. The results of method 2a for non-urban areas and 2b for urban areas are then summed together for the total population estimate.
2. Home Range-Based Estimate (see Table 3 for each value reference):
   a. Non-Urban Suitable Habitat Area (km^2) in each County divided by 7.2 km^2 (average home range ((4.3 + 5.8 + 8.6 + 16.6 + 5.0 + 2.8 km^2)/6) and multiplied by 4.3 (average pack size).
   b. Urban Suitable Habitat Area (km^2) in each County divided by 9.9 km^2 (average home range ((4.95 + 9.4 + 12.6 + 10.61 + 11.9 km^2)/5) and multiplied by 4.3 (average pack size).
   c. The results of method 2a for non-urban areas and 2b for urban areas are then summed together for the total population estimate.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For coyote, the top two-thirds of suitable habitat represent 95% (388,742 km^2; CDFW 2016, Table 2) of the total estimated range of coyotes in California (408,428 km^2; CDFW 2016), so these methods are only slightly conservative for this species. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of coyote habitat (Figures 2 and 3) (CDFW 2016). Coyotes appear to occasionally occupy areas outside of their top two-thirds habitat, whereas these methods assume they do not. Therefore, these methods will tend to slightly underestimate the population.

The estimates for population size for coyote in California are 236,991 individuals using the density-based estimate and 227,394 individuals using the home range-based estimate (Table 4). These approaches assume the following: that there is no home range overlap among coyote packs, that the average pack size (including pairs) is 4.3 coyotes, that no coyotes occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available top-two-thirds suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Coyote Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap among Females	Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Andelt 1985	Radio-collar	95% MCP	South Texas (1978-1982)	3.3%	4.3 (female)	ND	19 Male, 14 Female
Camenzid 1978	Capture-recapture, direct counts	NA	Wyoming (1971-1976)	ND	5.8 (pack territory)	0.53	2 packs (home range); 55-95 (density)
Clark 1972	Den destruction and pup marking, trapping, direct counts, estimated litter size	ND	Utah and Idaho (1966-1970)	ND	ND	0.11	205
Fedriani et al. 2001*	Spatially-Explicit Capture-Recapture	NA	Santa Monica Mountains, California (1997-1998)	ND	ND	1.62	761 fecal samples
Gehrt et al. 2009*	Radio-collar	95% MCP	Chicago, Illinois (2000-2006)	ND	4.95 (resident) (no sex difference)	ND	181
Gese et al. 1989	Radio-collar	95% MCP; density extrapolated from home range size and group size	Colorado (1983-1986)	Residents did not overlap, transients did	8.6 (female)	0.29	88
Gese et al. 2012*	Radio-collar	95% FK	Illinois (2000-2002)	ND	9.4 (residents; no sex difference)	ND	41
Grinder and Krausman 2001*	Radio-collar	95% MCP	Arizona (1996-1998)	ND	12.6 (residents; no sex difference)	ND	10 Male, 6 Female

Table 3. Coyote Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap among Females	Home Range Size (km^2)	Population Density (individuals/km^2)	Sample Size
Hein and Andelt 1995	Radio-collar	Mark/re-capture, NOREMARK Immigration/ Emigration	Colorado (1990-1991)	ND	ND	0.71	5 Male, 12 Female
Henke and Bryant 1999	Removal method	NA	Texas (1990-1992)	ND	ND	0.13	354
Jantz 2011*	Radio-collar	95% AK	Alabama (2007-2009)	ND	10.61 (no sex difference)	ND	2 Male, 12 Female
Karki et al. 2007	Radio-collar	NA	Colorado (1999-2000)	ND	ND	0.22	14 Male, 10 Female
Kitchen et al. 1999	Radio-collar	95% AK	Colorado (1997-1998)	ND	16.6	ND	14 Male, 10 Female
Larrucea et al. 2006	Radio-collar and GPS collar	FK	Red Bluff, California (1999-2001)	ND	5	1.12	92
Lombardi et al. 2017*	Spatially-Explicit Capture-Recapture, Cameras	NA	Texas (2013-2014)	ND	ND	1.38	62 individuals
McClure et al. 1996*	Mark-recapture, direct counts	NA	Arizona	ND	ND	3.7	40
Poessel et al. 2016*	GPS collar	95% MCP	Colorado (2012-2014)	ND	11.9 (no sex difference)	ND	14 Male, 10 Female
Pyrah 1984	Radio-collar and aerial survey, mark-recapture	siren response, den area surveys	Montana (1976-1980)	ND	ND	0.18	12 Male, 3 Female
Riley et al. 2003	Radio-collar	95% MCP	Los Angeles County, California (1996-2000)	ND	2.8 (female)	ND	22 Male, 18 Female

Table 3. Coyote Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap among Females	Home Range Size (km^2)	Population Density (individuals/km^2)	Sample Size
Stoddart et al. 2001	Mark-recapture using scat	NA	Idaho (1979-1985)	ND	ND	0.75	Number of scat samples not reported

Notes: MCP = minimum convex polygon; AK = adaptive kernel; FK = fixed kernel; NA = not applicable; ND = Not Determined.
* = Studies used for urban area calculations.

Table 4. Statewide and County Coyote Population Estimates

County	Density-Based Population Estimate (0.48 individuals/km^2 non-urban and 2.2 individuals/km^2 urban)[1]	Home Range-Based Population Estimate (7.2 km^2 non-urban and 9.9 km^2 urban)[2]	County	Density-Based Population Estimate (0.48 individuals/km^2 non-urban and 2.2 individuals/km^2 urban)[1]	Home Range-Based Population Estimate (7.2 km^2 non-urban and 9.9 km^2 urban)[2]
Alameda	2,185	952	Orange	3,845	934
Alpine	822	1,023	Placer	2,524	2,044
Amador	755	879	Plumas	3,129	3,893
Butte	2,773	2,381	Riverside	12,734	10,183
Calaveras	1,303	1,550	Sacramento	2,967	1,301
Colusa	1,389	1,700	San Benito	1,779	2,121
Contra Costa	2,720	904	San Bernardino	30,405	29,755
Del Norte	1,310	1,531	San Diego	9,624	5,917
El Dorado	2,493	2,501	San Francisco	255	50
Fresno	8,077	8,416	San Joaquin	2,522	2,056
Glenn	1,663	1,984	San Luis Obispo	4,667	4,987
Humboldt	4,632	5,416	San Mateo	1,295	598
Imperial	4,799	5,695	Santa Barbara	3,935	3,809
Inyo	11,921	14,751	Santa Clara	3,271	1,794
Kern	12,137	12,080	Santa Cruz	1,156	627
Kings	2,068	2,055	Shasta	5,060	5,694
Lake	1,671	1,918	Sierra	1,170	1,456

Table 4. Statewide and County Coyote Population Estimates

County	Density-Based Population Estimate (0.48 individuals/km^2 non-urban and 2.2 individuals/km^2 urban)[1]	Home Range-Based Population Estimate (7.2 km^2 non-urban and 9.9 km^2 urban)[2]	County	Density-Based Population Estimate (0.48 individuals/km^2 non-urban and 2.2 individuals/km^2 urban)[1]	Home Range-Based Population Estimate (7.2 km^2 non-urban and 9.9 km^2 urban)[2]
Lassen	5,617	6,951	Siskiyou	7,742	9,494
Los Angeles	12,161	5,302	Solano	1,552	1,063
Madera	2,778	3,109	Sonoma	2,672	2,322
Marin	1,071	732	Stanislaus	2,469	2,229
Mariposa	1,758	2,187	Sutter	872	880
Mendocino	4,479	5,368	Tehama	3,732	4,512
Merced	2,632	2,759	Trinity	3,860	4,802
Modoc	4,793	5,963	Tulare	6,338	6,928
Mono	3,456	4,238	Tuolumne	2,636	3,068
Monterey	4,738	4,997	Ventura	3,594	2,602
Napa	1,116	1,114	Yolo	1,482	1,491
Nevada	1,513	1,383	Yuba	875	941
			Total	**236,991**	**227,394**

Notes:
1 The non-urban and urban suitable habitat data are multiplied by the respective non-urban and urban density averages, and the results are summed together for the total population estimate.
2 The non-urban and urban suitable habitat data are divided by the respective non-urban and urban home range averages, and the results are summed together for the total population estimate.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Andelt, W.F. 1985. Behavioral ecology of coyotes in south Texas. Wildlife Monographs, pp.3-45.

Bekoff, M. and Wells, M.C. 1986. Social ecology and behavior of coyotes. In Advances in the Study of Behavior (Vol. 16, pp. 251-338). Academic Press.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

Camenzid, F.J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson, Wyoming. Pp. 267-294 *In* Bekoff, M., Ed. 1978. Coyotes: Biology, Behavior, and Management. The Blackburn Press. Caldwell, NJ.

CDFW (California Department of Fish and Wildlife). 2016. Coyote Predicted Habitat (CWHR M146). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

Clark, F.W. 1972. Influence of jackrabbit density on coyote population change. *The Journal of Wildlife Management*, pp.343-356.Gehrt, S.D., Anchor, C. and White, L.A., 2009. Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence? Journal of mammalogy, 90(5), pp.1045-1057.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Fedriani, J.M., Fuller, T.K. and Sauvajot, R.M. 2001. Does availability of anthropogenic food enhance densities of omnivorous mammals? An example with coyotes in southern California. Ecography, 24(3), pp.325-331.

Gehrt, S.D., C. Anchor, and L.A. White. 2009. Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence? Journal of Mammalogy 90(5): 1045-1057

Gese, E.M., Rongstad, O.J. and Mytton, W.R. 1989. Population dynamics of coyotes in southeastern Colorado. The Journal of Wildlife Management, pp.174-181.

Gese, E.M., Morey, P.S. and Gehrt, S.D. 2012. Influence of the urban matrix on space use of coyotes in the Chicago metropolitan area. Journal of Ethology, 30(3), pp.413-425.

Grinder, M.I. and Krausman, P.R., 2001. Home range, habitat use, and nocturnal activity of coyotes in an urban environment. The Journal of wildlife management, pp.887-898.

Grubbs, S.E. and Krausman, P.R. 2009. Use of urban landscape by coyotes. The Southwestern Naturalist, 54(1), pp.1-12.

Hein, E.W. and Andelt, W.F. 1995. Estimating coyote density from mark-resight surveys. The Journal of wildlife management, pp.164-169.

Henke, S.E. and Bryant, F.C. 1999. Effects of Coyote Removal on the Faunal Community in Western Texas. Journal of Wildlife Management 63: 1066-1081.

Jantz, H. 2011. Home range, activity patterns, and habitat selection of the coyote (Canis latrans) along an urban-rural gradient (Doctoral dissertation).

Karki, S.M., E.M. Gese, and M.L. Klavetter. 2007. Effects of coyote population reduction on swift fox demographics in southeastern Colorado. Journal of Wildlife Management 71(8): 2707-2718

Kitchen, A.M. E.M. Gese, and E.R. Schauster. 1999. Resource partitioning between coyotes and swift foxes: space, time, and diet. Canadian Journal of Zoology 77: 1645-1656.

Larrucea, E.S., P.F. Brussard, M.M. Jaeger, and R.H. Barrett. 2006. Cameras, coyotes, and the assumption of equal detectability. Journal of Wildlife Management 71(5):1682-1689

Lombardi, J.V., C.E. Comer, D.G. Scognamillo, W.C. Conway. 2017. Coyote, fox, and bobcat response to anthropogenic and natural landscape features in a small urban area. Urban Ecosystems 20: 1239-1248.

McClure, M.F., Smith, N.S. and Shaw, W.W. 1996. Densities of coyotes at the interface of Saguaro National Monument and Tucson, Arizona. *The Southwestern Naturalist*, *41*(1), pp.83-86.

Poessel, S.A., Breck, S.W. and Gese, E.M. 2016. Spatial ecology of coyotes in the Denver metropolitan area: influence of the urban matrix. Journal of Mammalogy, 97(5), pp.1414-1427.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Montana. The Journal of wildlife management, pp.679-690.

Riley, S.P., R.M. Sauvajot, T.K. Fuller, E.C. York, D.A. Kamradt, C. Bromley, and R.K. Wayne. 2003. “Effects of Urbanization and Habitat Fragmentation on Bobcats and Coyotes in Southern California.” *Conservation Biology* 17(2): 566–576.

Stoddart, L.C., R.E. Griffiths, and F.F. Knowlton. 2001. Coyote responses to changing jackrabbit abundance affect sheep predation. Journal of Range Management 54: 15-20

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C5 Gray Fox Population and Distribution

The following describes the distribution and population estimate of gray fox (*Urocyon cinereoargenteus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, gray fox observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 488 gray fox observations between 2000 and 2018 on and off roads.

Table 1. Observations and Modeled Distribution of Gray Fox across California

Dataset	Number of Observations	Date Range
Gray Fox Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	488	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

Gray foxes are able to live in urban regions, adjacent to natural habitat. This means that gray fox populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

Table 2. Gray Fox Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Alameda	416	644	1,060	Orange	322	1,515	1,837
Alpine	1,088	0	1,088	Placer	2,178	368	2,545
Amador	849	19	868	Plumas	5,780	0	5,780
Butte	1,985	319	2,304	Riverside	14,025	2,286	16,311
Calaveras	1,761	25	1,786	Sacramento	851	873	1,724
Colusa	1,550	11	1,561	San Benito	1,772	33	1,805
Contra Costa	345	762	1,106	San Bernardino	45,432	3,118	48,549
Del Norte	1,065	22	1,087	San Diego	7,329	2,427	9,756
El Dorado	2,814	198	3,012	San Francisco	0	114	114
Fresno	7,542	557	8,099	San Joaquin	1,870	410	2,280
Glenn	1,597	27	1,624	San Luis Obispo	4,519	244	4,764
Humboldt	3,265	109	3,375	San Mateo	435	391	825
Imperial	8,338	116	8,454	Santa Barbara	5,126	392	5,518
Inyo	23,427	31	23,458	Santa Clara	1,528	849	2,377
Kern	12,333	1,027	13,360	Santa Cruz	439	243	682
Kings	2,231	165	2,396	Shasta	6,429	224	6,653
Lake	2,296	57	2,353	Sierra	1,980	0	1,980
Lassen	2,828	0	2,829	Siskiyou	9,716	42	9,758
Los Angeles	5,404	3,998	9,402	Solano	1,078	272	1,350
Madera	2,801	117	2,918	Sonoma	1,719	344	2,063
Marin	596	204	800	Stanislaus	1,589	273	1,863
Mariposa	2,245	0	2,245	Sutter	647	67	714
Mendocino	3,911	61	3,972	Tehama	4,740	37	4,777
Merced	2,364	180	2,544	Trinity	3,437	0	3,437
Modoc	830	0	830	Tulare	6,507	282	6,789
Mono	6,056	22	6,078	Tuolumne	3,261	70	3,332
Monterey	5,351	321	5,673	Ventura	3,236	705	3,941

Table 2. Gray Fox Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Napa	1,190	88	1,278	Yolo	1,722	137	1,859
Nevada	1,426	147	1,574	Yuba	771	53	823
Total Statewide Suitable Habitat					**246,343**	**24,997**	**271,340**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of gray fox statewide (Figure 2), and modeled habitat and observations in the Eastern Sierra area (Figure 3). The figures show that the majority of gray fox observations occur within or on the edge of the top two-thirds of suitable habitat. While many observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). This is likely due to the expansive range provided by CDFW for gray fox, which covers 95% (389,565 km^2) of the land area of the State of California (410,727 km^2) (CDFW 2016). These data support the accuracy of the CDFW (2016) range and habitat data for gray fox.

SOURCE: CDFW 2016

0 25 50 Miles

FIGURE 1

Top Two-thirds of Suitable Gray Fox Habitat from CDFW Habitat Suitability Model

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SOURCE: CDFW 2016; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Gray Fox Statewide

Biological Technical Report for the Wildlife Damage Management Project

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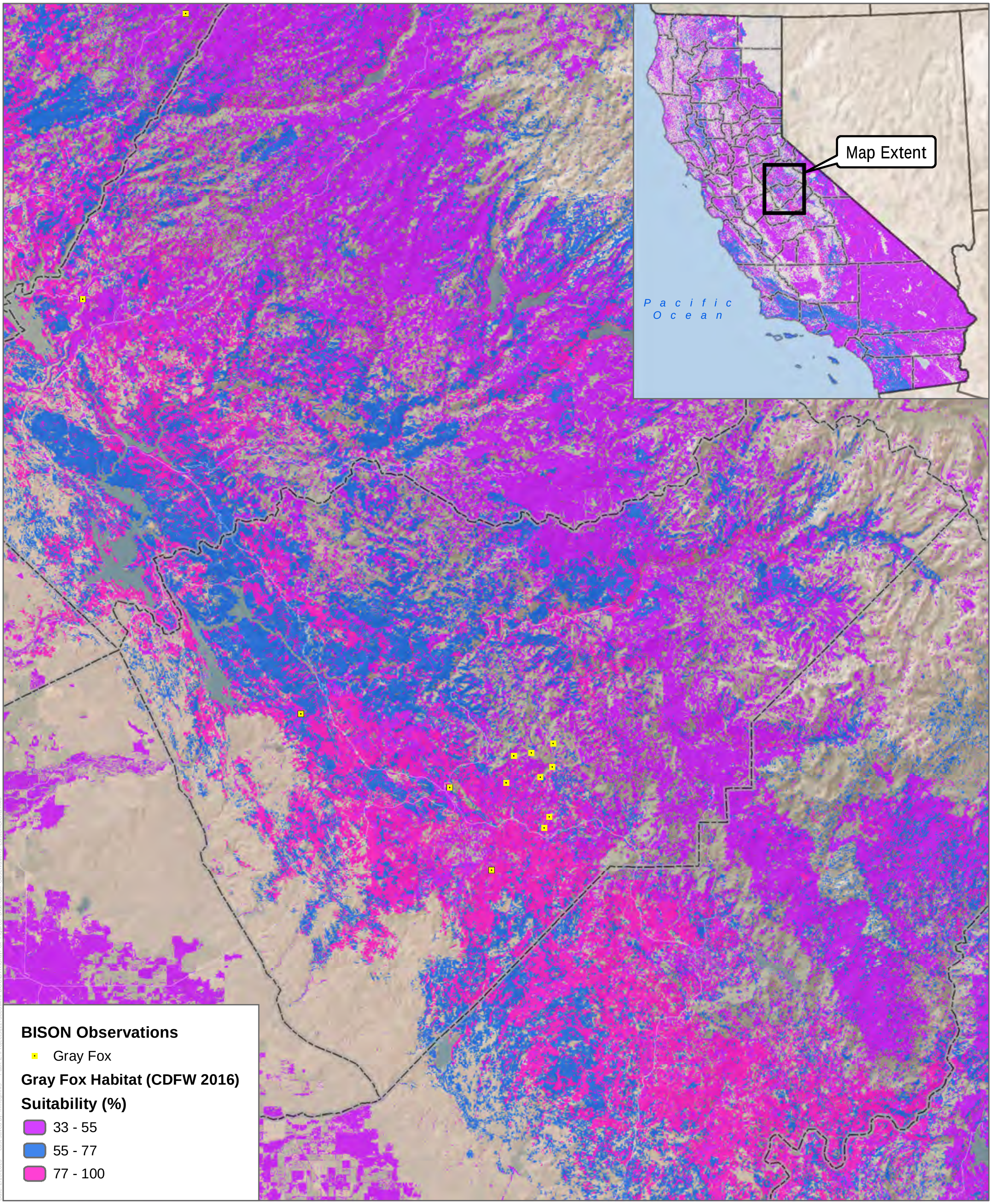

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Gray Fox in the Eastern Sierra Area

DUDEK

0 2 4 Miles

Biological Technical Report for the Wildlife Damage Management Project

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Gray foxes have widely varying home range sizes as described in the various research-literature sources summarized in Table 3. Additionally, gray foxes are able to live in natural habitat adjacent to urban regions, with higher densities of human development, but at lower densities than in rural areas. This means that gray fox populations can occur in urban areas and their home ranges include urban landscapes. Because of this, the population size was estimated for both urban and non-urban areas within counties separately and then the two estimates were combined at the county level.

Two methods were used to estimate the gray fox population by county in California: (1) the published population density of 0.97 individuals/km^2 for non-urban areas (Glenn 2009) and 0.05 individuals/km^2 for urban areas (Lombardi et al. 2017), and (2) the average of available published home range sizes for adult female gray fox of 1.96 km^2 (non-urban) and 1.67 km^2 (urban), and multiplied by 2 for a 1:1 male to female ratio. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):
   a. Density for non-urban areas (0.97 individuals/km^2) multiplied by the amount of Suitable Non-urban Habitat Area (km^2) in each county.
   b. Density for urban areas (0.05 individuals/km^2) multiplied by the amount of Suitable Urban Habitat Area (km^2) in each county.
   c. The results of method 1a for non-urban areas and 1b for urban areas are then summed together for the total population estimate.
2. Home Range-Based Estimate (see Table 3 for references):
   a. Non-Urban Areas: Top two thirds of Suitable Habitat Area (km^2) in each county divided by average adult female home range value of 1.96 km^2 (1.96 km^2 + 0.78 km^2 + 3.28 km^2 + 2.24 km^2 + 1.52 km^2)/5)) and multiplied by 2 for a 1:1 male to female ratio.
   b. Urban Areas: Suitable Habitat Area (km^2) in each county divided by average adult female home range value of 1.67 km^2 ((1.0 km^2 + 2.34 km^2)/2)) and multiplied by 2 to include males.
   c. The results of method 2a for non-urban areas and 2b for urban areas are then summed together for the total population estimate.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For gray fox, the top two-thirds of suitable habitat represent only 70% (271,340 km^2) (Table 2) of the total estimated range of gray fox in California (389,565 km^2) (CDFW 2016). The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of gray fox habitat (Figures 2 and 3) (CDFW 2016). Since gray fox occupy areas outside of their top two-thirds habitat, while these methods assume they do not, these methods will tend to underestimate the population.

The home range-based estimate assumes no home range overlap among adult females because no reliable and complete estimates were found in the published literature. However, there is sometimes considerable overlap among female home ranges (e.g., Riley 2006), and as such, the home range-based population estimate is likely to be conservative.

Conversely, previous research has shown that not all habitat available to gray foxes is occupied and that coyote presence can suppress gray fox occupancy in shared habitat (Egan et al. 2021). Therefore, the assumption of fully occupied home ranges within the top two-thirds of suitable habitat might tend to overestimate the gray fox population. The spotty distribution of this species might also result in an overestimate of the gray fox population by the density-based method because some areas within the top two-thirds of habitat might have considerably lower gray fox density. Such areas would not show up in the dataset because researchers tend not to study wildlife in areas where the density is extremely low due to the limited ability to collect data.

The estimates for population size for gray foxes in California are 240,202 individuals based on the population density-based estimate method and 281,305 individuals based on the average adult female home range size-based estimate method (Table 4). These approaches assume the following: that there is no home range overlap among adult female gray foxes, that no gray foxes occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Gray Fox Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size or Density Estimation Method	Location	Home Range Overlap among Females	Female Home Range Size (km^2)	Population Density (Individuals/km^2)	Sample Size
Deuel et al. 2017	GPS collar	95% FK	Georgia (2014-2015)	ND (but M/F pairs = 92.3% - 94.8% overlap)	1.96	ND	15 Male, 11 Female for Home Range
Glenn 2009	Trapping	NR	Georgia (1998-2000)	ND	ND	0.97	46 Male, 50 Female, 23 pups
Lombardi et al. 2017*	Trail cameras	NR	Nacogdoches, Texas (2013)	ND	ND	0.05	10
Riley 2006*	Radio-collar	95% AK	North bay area, California (1992-1995)	Rural: 19.2; Urban: 23.8% (when overlap occurred)[1]	Urban: 1.00; Rural: 0.78	ND	15 Male, 13 Female
Rountree 2004*	Radio-collar	MCP	Newport News Park, Virginia (Years NR)	ND	3.28	ND	1 Male, 3 Female
Servin et al. 2014	Radio-collar	MCP	Durango, Mexico (1991-1993)	ND	2.24	ND	4 Male, 2 Female
Temple 2007	Radio-collar	95% FK	Georgia (2002-2006)	ND	Rural: 1.52	ND	9
Veals 2018	Radio-collar	95% KDE	Arizona (2016-2017)	ND	Rural: 1.33[(2)]	ND	2 Male, 1 Female
Willingham 2008*	Radio-collar	95% MCP	Illinois (2004-2007)	ND	Urban: 2.34	ND	3 Female

Notes: MCP = minimum convex polygon; AK = adaptive kernel; FK = fixed kernel; KDE = kernel density estimate; ND = Not Determined; NR = not reported.

1 These home range overlap values were not used to determine average home range overlap because they only include home ranges that overlapped; these do not represent overall home range overlap because they exclude home ranges with zero overlap.

2 This home range was not included in the analysis due to the small sample size of one, and the fact that it is the lowest of all female home ranges found. Due to the low sample size there is no way to determine whether this is indicative of the species.

* Studies including values for urban areas

Table 4. Statewide and County Gray Fox Population Estimates

County	Population Density (0.97 rural and 0.05 urban individuals/km^2)[1]	Adult Female Home Range (1.96 rural and 1.67 urban km^2)[2]	County	Population Density (0.97 rural and 0.05 urban individuals/km^2)[1]	Adult Female Home Range (1.96 rural and 1.67 urban km^2)[2]
Alameda	436	1,196	Orange	388	2,143
Alpine	1,056	1,110	Placer	2,131	2,663
Amador	825	889	Plumas	5,607	5,898
Butte	1,941	2,408	Riverside	13,718	17,049
Calaveras	1,710	1,827	Sacramento	869	1,914
Colusa	1,504	1,595	San Benito	1,721	1,848
Contra Costa	373	1,265	San Bernardino	44,225	50,093
Del Norte	1,034	1,113	San Diego	7,230	10,385
El Dorado	2,739	3,109	San Francisco	6	137
Fresno	7,343	8,363	San Joaquin	1,835	2,399
Glenn	1,550	1,662	San Luis Obispo	4,396	4,903
Humboldt	3,173	3,462	San Mateo	441	912
Imperial	8,094	8,647	Santa Barbara	4,992	5,700
Inyo	22,725	23,942	Santa Clara	1,525	2,576
Kern	12,015	13,815	Santa Cruz	438	739
Kings	2,172	2,474	Shasta	6,248	6,828
Lake	2,230	2,411	Sierra	1,920	2,020
Lassen	2,744	2,886	Siskiyou	9,427	9,965
Los Angeles	5,442	10,302	Solano	1,059	1,426
Madera	2,723	2,998	Sonoma	1,685	2,166
Marin	588	852	Stanislaus	1,555	1,948
Mariposa	2,177	2,291	Sutter	631	740
Mendocino	3,797	4,064	Tehama	4,599	4,881
Merced	2,302	2,628	Trinity	3,334	3,507
Modoc	805	847	Tulare	6,326	6,978
Mono	5,875	6,206	Tuolumne	3,167	3,411
Monterey	5,207	5,845	Ventura	3,174	4,146

Table 4. Statewide and County Gray Fox Population Estimates

County	Population Density (0.97 rural and 0.05 urban individuals/km²)[1]	Adult Female Home Range (1.96 rural and 1.67 urban km²)[2]	County	Population Density (0.97 rural and 0.05 urban individuals/km²)[1]	Adult Female Home Range (1.96 rural and 1.67 urban km²)[2]
Napa	1,159	1,320	Yolo	1,677	1,921
Nevada	1,391	1,631	Yuba	750	850
			Total	**240,202**	**281,305**

Note:
1 The non-urban and urban suitable habitat totals are multiplied by the respective non-urban and urban population density value and the results are summed together for the total population estimate.
2 The non-urban and urban suitable habitat totals are divided by the respective non-urban and urban home range value and the results are summed together for the total population estimate.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Gray Fox Predicted Habitat (CWHR M149). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Deuel, N.R., L.M. Conner, K.V. Miller, M.J. Chamberlain, M.J. Cherry, and L.V. Tannenbaum. 2017. "Gray Fox Home Range, Spatial Overlap, Mated Pair Interactions and Extra-Territorial Forays in Southwestern Georgia, USA." *Wildlife Biology* 2017(1): wlb.00326. https//doi.org/ 10.2981/wlb.00326.

Egan, M.E., C.C. Day, T.E. Katzner, P.A. Zollner. 2021. Relative Abundance of coyotes (Canis latrans) influences gray fox (Urocyon cinereoargenteus) occupancy across the eastern United States. Can J. Zool. 99: 63-72.

Glenn, J.L.W, D.J. Civitello, and S.L. Lance. 2009. Multiple paternity and kinship in the gray fox (Urocyon cineroargenteus). Mammalian Biology 74 (2009): 394-402.

Lombardi, J.V., C.E. Comer, D.G. Scognamillo, and W.C. Conway. 2017. "Coyote, Fox, and Bobcat Response to Anthropogenic and Natural Landscape Features in a Small Urban Area." *Urban Ecosystems* 20(6): 1,239–1,248.

Riley, S.P. 2006. "Spatial Ecology of Bobcats and Gray Foxes in Urban and Rural Zones of a National Park." *The Journal of Wildlife Management* 70(5): 1,425–1,435.

Rountree, G.H. 2004. "Comparative Study of the Home Range and Habitat Usage of Red Foxes and Gray Foxes in an Urban Setting: A Preliminary Report." In *Proceedings 4th International Urban Wildlife Symposium*, edited by W.W. Shaw, L.K. Harris, and L. Van Druff, 238–244.

Servín, J., A. Bejarano, N. Alonso-Pérez, and E. Chacón. 2014. "The Home Range Size and Habitat Use of the Gray Fox (*Urocyon cinereoargenteus*) in a Temperate Forest of Durango, Mexico." *Therya* 5(1): 257–269.

Temple, D.L. 2007. *Spatial Ecology of Gray Foxes on a Longleaf Pine Forest and the Surrounding Landscape in Southwestern Georgia*. Master's Thesis, Louisiana State University. https://digitalcommons.lsu.edu/gradschool_theses/3482.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Veals, A.M. 2018. Spatial Ecology of the Gray Fox (Urocyon cinereoargenteus) in southeastern Arizona. Thesis submitted to the Faculty at the School of Natural Resources and the Environment, University of Arizona.

Willingham, A.N. 2008. *Emerging Factors Associated with the Decline of a Gray Fox Population and Multi-Scale Land Cover Associations of Mesopredators in the Chicago Metropolitan Area*. Master's Thesis, Ohio State University.

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C6 Red Fox Population and Distribution

The following describes the distribution and population estimate of the Sacramento Valley red fox (*Vulpes vulpes patwin*), which is a native subspecies native to California (Sacks et al. 2010a, 2010b). California is home to two native red fox subspecies—the Sierra Nevada red fox (*Vulpes vulpes necator*) and the Sacramento Valley red fox (CDFW 2022a)—as well as non-native red fox that have been introduced both purposely (for hunting) and inadvertently (from fur farms) over the years. The non-native red fox populations are not part of the natural fauna of California and are therefore not considered in this population and distribution analysis. The Sierra Nevada red fox is also excluded from this analysis because it is not targeted during wildlife damage management in California due to its protected status (State Threatened and Federal Endangered in the Sierra Nevada Distinct Population Segment) (86 FR 41743; CDFG 1987). In addition, limitations placed on wildlife damage management methods by the California Department of Fish and Wildlife (CDFW) and U.S. Fish and Wildlife Service render incidental take of the subspecies extremely unlikely (e.g., 14 CCR 465.5; CDFW 2005; CDFW 2016a, 2016b; USFWS 2022). Because there appears to be no potential for impact to Sierra Nevada red fox from wildlife damage management in California, the population of this subspecies is not estimated herein. There is also no estimate of the population of non-native red foxes in California because any removal of these non-native animals for wildlife damage management would have no potential to negatively impact the native fauna of California.

The Sacramento Valley red fox has been recognized as a subspecies by the U.S. Fish and Wildlife Service (80 FR 60990) but has not been assessed as a candidate under the federal Endangered Species Act. The State of California has designated the subspecies a "special animal," which is not a legal status designation but means it is tracked by the CDFW California Natural Diversity Database for conservation reasons (CDFW 2022a).

The habitat model for red fox was developed by the CDFW in 2016 and is based largely on habitat suitability within the estimated ranges of the two native red fox subspecies (i.e., Sierra Nevada red fox and Sacramento Valley red fox). The distribution model does not include all areas of suitable habitat for the non-native red fox, though the inclusion of several locations outside of the native subspecies' ranges show that it does include some. To limit this analysis to the Sacramento Valley red fox, suitable habitat was only analyzed in those counties that comprise the subspecies' range. Sacks et al. (2010) cite a range for this subspecies that includes the following 11 counties: Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba. However, all published occurrences in Placer, Sacramento, and Yuba Counties have been either non-natives or hybrids between native and non-native red fox, rather than Sacramento Valley red fox. Because one of the primary threats to the native species is hybridization with non-natives and the resulting dilution of the native genes (Sacks et al. 2010; Black et al. 2018), any lethal removal of non-native or hybrid red foxes would benefit the Sacramento Valley red fox subspecies. Therefore, these counties were not included in the analysis for Sacramento Valley red fox.

The habitat distribution model has a resolution of 30 meters statewide (CDFW 2016) (Table 1). The model was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). These estimates of suitable habitat are limited to the estimated range of the species in California, which was also prepared by CDFW. This limitation might result in underestimation of available habitat and population size calculated from that habitat for many species; however, for this subspecies of red fox, the low density more than compensates for this limitation. In this instance CDFW range and suitable habitat might tend to overestimate the amount of habitat that is actually occupied by Sacramento Valley red fox. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The medium and high habitat suitability values (i.e., top two-thirds of suitable habitat) were chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

As summarized in Table 1, red fox observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022b). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 280 red fox observations between 2000 and 2020 on and off roads. Observations include both the non-native red fox and the native red fox subspecies. The purpose of the observation data is to visually confirm the distribution model, which was the basis of the population estimate.

Table 1. Observations and Modeled Distribution of Red Fox across California

Dataset	Number of Observations	Date Range
Red Fox Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	79	2000–2018
CNDDB (CDFW 2022b)	201	1994–2014

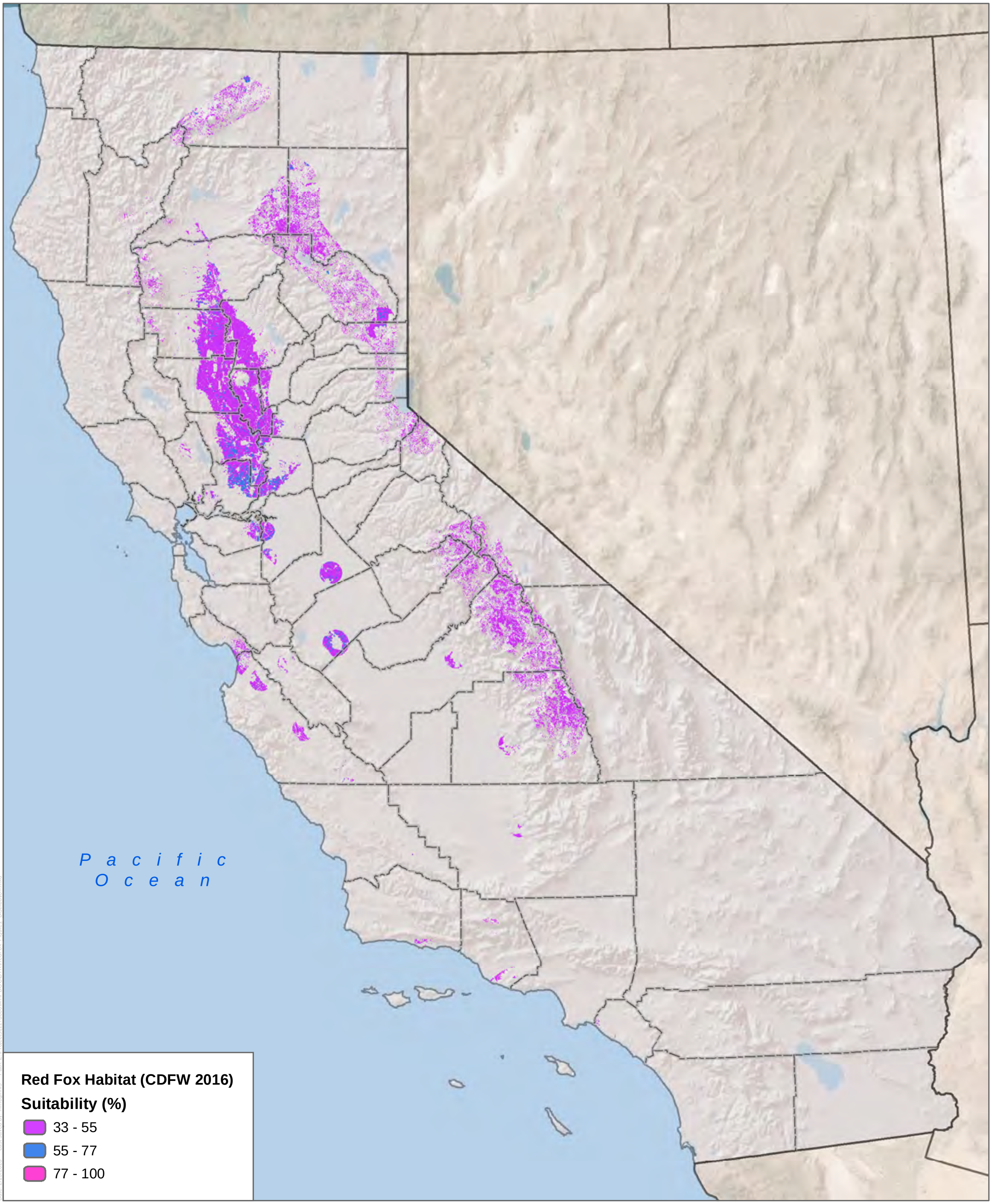
Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.

1 Data accessed December 11, 2020.

Table 2. Sacramento Valley Red Fox Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)
Butte	1,053
Colusa	1,321
Glenn	1,198
Shasta	633
Solano	645
Sutter	1,143
Tehama	734
Yolo	1,403
Total Statewide Suitable Habitat	**8,130**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat and observations of red foxes statewide (Figure 2), and modeled habitat and observations in the Sacramento Valley area (Figure 3). The distribution model in these figures is based on habitat suitability for the two native red fox subspecies (i.e., Sierra Nevada and Sacramento Valley red fox), as well as some (but not all) of the known non-native range and habitat. The observation data, which include both native and non-native red fox, often occur outside the modeled habitat as shown on Figures 2 and 3, which is an indication that not all non-native range and habitat are included. This discrepancy does not affect this analysis because it only estimates the population of the native Sacramento Valley red fox, and the range and habitat for this subspecies is adequately covered by the CDFW habitat suitability model.



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Red Fox Habitat from CDFW Habitat Suitability Model

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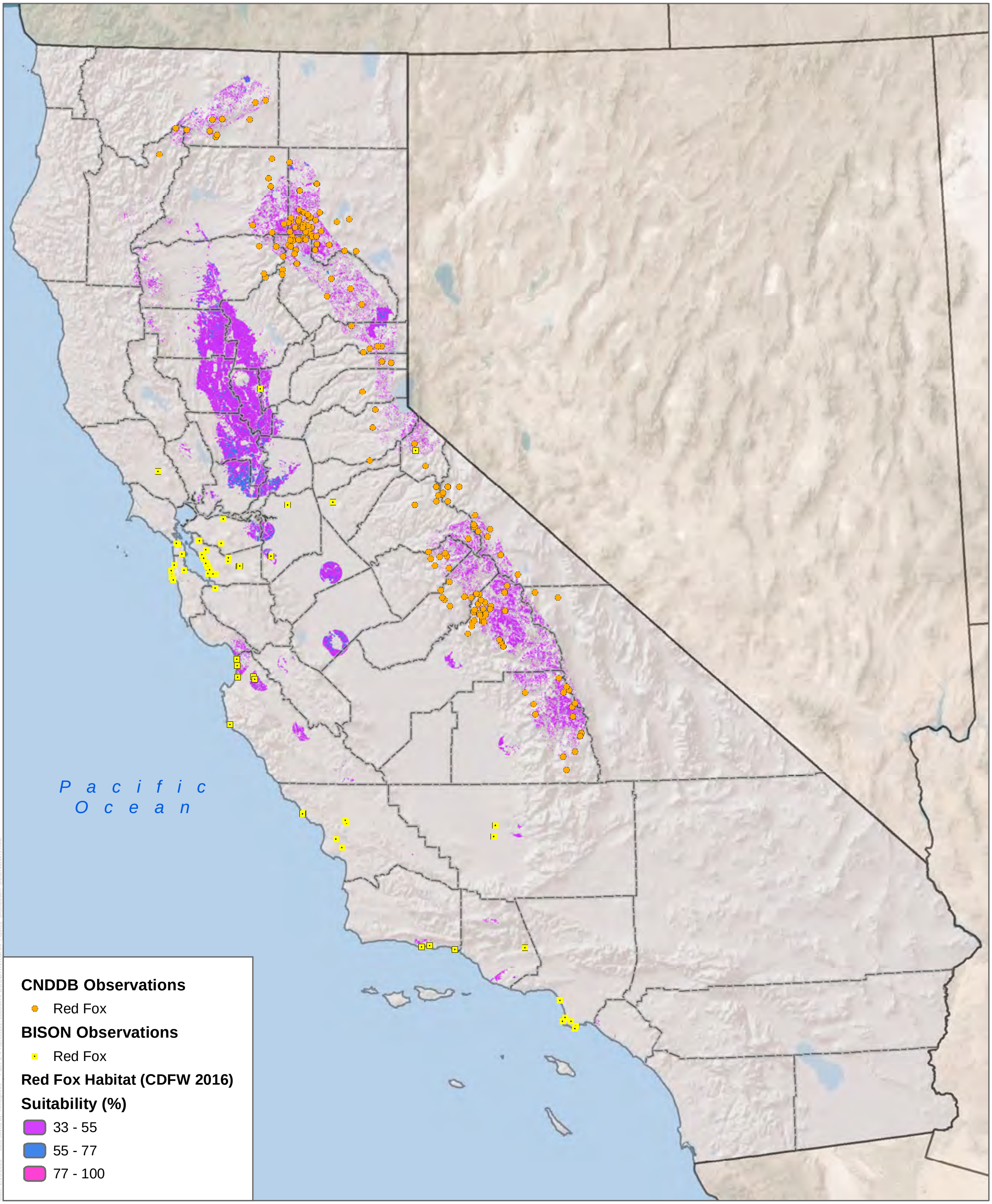

SOURCE: CDFW 2016, 2023; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Red Fox Statewide

Biological Technical Report for the Wildlife Damage Management Project

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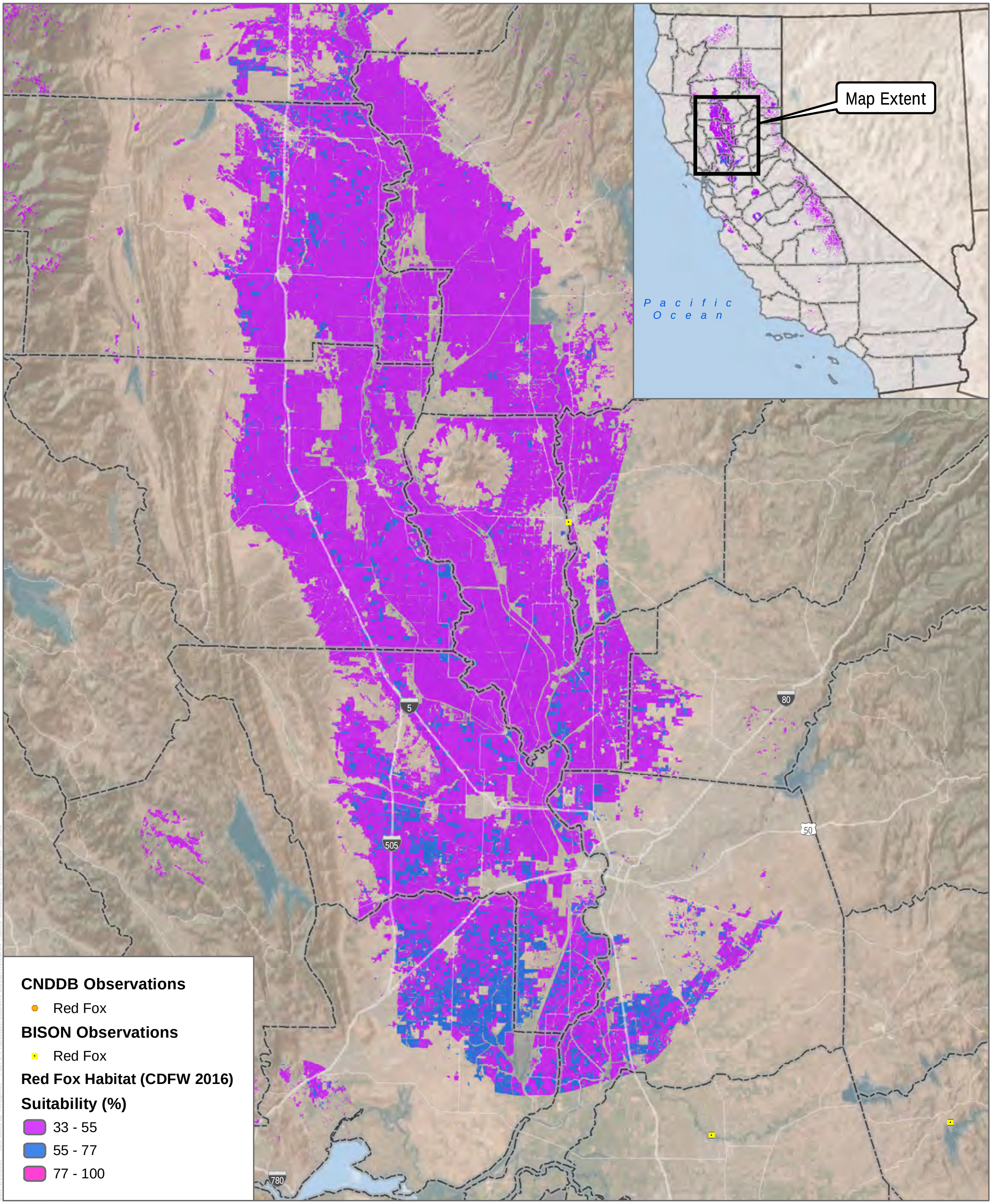

SOURCE: CDFW 2016, 2023; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Red Fox in the Sacramento Valley Area

Biological Technical Report for the Wildlife Damage Management Project

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Red foxes have widely varying home range sizes as described in the various research-literature sources from North American populations. The global median home range size has been reported to be 3.25 km^2 and varies inversely with human population density (Main et al. 2020), with the largest home range size associated with the lowest human population density. In addition, red fox home range size varies inversely with fox population density, with larger home range sizes at lower densities (Trewhella et al. 1988). For this analysis only the home range estimate for Sacramento Valley red fox was used: 2–5 km^2 (Sacks n.d. as cited in Black et al. 2018). To be conservative, the high end of the estimated range was used (5 km^2), which is slightly larger than the global median (3.25 km^2), as well as most published North American home ranges. Larger home ranges in the literature are largely limited to Sierra Nevada red fox, which is a montane species with very low density and larger home ranges (e.g., Quinn and Sacks 2014; Perrine 2015).

A wide range of density estimates have likewise been published for red fox in North American and around the world (e.g., MacDonald and Newdick 1982, Harris and Rayner 1986). However, this analysis was limited to density estimates of native California red fox subspecies because both of these subspecies are known to have very low density compared to many other red fox populations.

Two methods were used to estimate the Sacramento Valley red fox population by county in California: (1) mean population density across all published studies for native California red fox subspecies (i.e., Sierra Nevada red fox and Sacramento Valley red fox), equivalent to 0.028/km^2, and (2) the home range estimate for adult Sacramento Valley red fox of 5 km^2, multiplied by 2, equivalent to a sex ratio of 1:1. These two approaches were used to estimate population sizes for each county within the range of the Sacramento Valley red fox. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average density for native Sacramento Valley red fox: 0.028 individuals/km^2 = ((0.016 individuals/km^2 + 0.04 individuals/km^2)/2) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

2. Adult Home Range Size-Based Estimate (see Table 3 for references):

   Suitable Habitat Area (km^2) in each county divided by 5 km^2 (high home range value of B.J. Sacks (unpublished data; cited in Black et al. 2018)) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). This is especially important for carnivores with relatively large home ranges (compared to rodents, for example). For red fox, the top two-thirds of suitable habitat statewide represent only 28% (18,045 km^2) of the total estimated range of red fox in California (64,005 km^2) (CDFW 2016). The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of red fox habitat (Figures 2 and 3) (CDFW 2016) and even outside of the estimated species range (Figure 2) (CDFW 2016). Red fox occupy areas outside of their top two-thirds habitat, while these methods assume they do not. This suggests that these methods will tend to underestimate the population.

However, for red fox this analysis is more complex due to the existence of non-native red fox. Some habitat for non-native red fox is included in the CDFW data, but much is not. These data also include the Sierra Nevada red fox subspecies. Population estimates were not prepared for either the non-native red fox or the Sierra Nevada red fox. These native and non-native red fox are also included in the observation data, which limits the usefulness of these data for red fox: the range of non-native red fox is likely much more widespread than the CDFW range and habitat data would suggest. Moreover, qualitatively, the percentage of top two-thirds habitat within Sacramento Valley red fox range is much higher than the percentage in Sierra Nevada red fox range (Figure 1). As such, the top two-thirds habitat for only this subspecies would be higher than the 28% noted above. Unfortunately, these range, habitat, and observation data are not available by red fox subspecies, so a more precise analysis cannot be provided here. Qualitatively, these methods might tend to overestimate the Sacramento Valley red fox population, but there are too many unknown variables to assess this accurately.

The estimates for population size for Sacramento Valley red fox in California are 228 individuals using the density-based method and 3,252 individuals using the home range-based method (Table 4). These approaches assume the following: (1) that there is no home range overlap among adult female Sacramento Valley red foxes (home range-based method only), that no red foxes occupy any of the bottom one-third of suitable habitat, and that all available top-two-thirds suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Red Fox Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Between Sexes	Home Range Size (km^2)	Population Density (individuals/km^2)
Black et al. 2018	camera traps	NA	Sacramento Valley, California	ND	ND	0.4 (theoretical maximum)[1]
Perrine 2005	radio telemetry	95% MCP	Lassen National Park, California	ND	33.0 (n=5)[(2)]	0.016 (5 foxes in 311.5 km^2)
Sacks, B.J., unpublished data (cited in Black et al. 2018)	unknown	unknown	Sacramento Valley, California	unknown	3-5	ND
Quinn et al. 2019	spatial capture-recapture	NA	Central Sierra Nevada, California	ND	ND	0.04

Notes: NA = not applicable; ND = Not Determined; MCP = minimum convex polygon.

1 This density estimate was not used in the average because it represents a theoretical maximum, not an estimate of current density.

2 This home range estimate was not used in the average because it is for a different subspecies (Sierra Nevada red fox) which lives in very different environments. Estimates were limited to data on the Sacramento Valley red fox.

Table 4. Statewide and County Sacramento Valley Red Fox Population Estimates

County[1]	Population Density (0.028/km^2)	Female Home Range (5 km^2)
Butte	29	421
Colusa	37	528
Glenn	34	479
Shasta	18	253
Solano	18	258
Sutter	32	457
Tehama	21	294
Yolo	39	561
Total	228	3,252

Notes: Totals may not sum due to rounding.

1 Placer, Sacramento, and Yuba Counties were also included in the Sacramento Valley red fox (*Vulpes vulpes patwin*) range of Sacks et al. (2010); however, there are no published instances of a Sacramento Valley red fox in any of these counties. These counties have only been shown to contain hybrids, which are a threat to the native subspecies. Lethal removal of red fox in these counties would only help the SVRF. All California counties other than those above with Sacramento Valley red fox range are not listed. CWHR data included some range and habitat information for many of these counties, but that habitat and range is for either Sierra Nevada red fox (*Vulpes vulpes necator*) or non-native red foxes in California, which were not include in this population analysis.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Black, K.M., S. Preckler-Quisquater, T.J. Batter, S. Anderson, and B.N. Sacks. 2018. "Occupancy, Habitat, and Abundance of the Sacramento Valley Red Fox." *Journal of Wildlife Management* 83(1): 158–166.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFG (California Department of Fish and Game). 1987. Sierra Nevada red fox: Five-year status report. Sacramento: California Department of Fish and Game, Sacramento, California, USA

CDFG. 2005, Letter from John Carlson, Jr. Chief of Wildlife Programs Branch to Craig Coolahan, State Director, USDA APHIS Wildlife Services regarding take of exotic red foxes. June 3.

CDFW (California Department of Fish and Wildlife). 2016. Red Fox Predicted Habitat (CWHR M147). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2016a. Conibear/Snare Prohibition Zone 1. Map. July.

CDFW. 2016b. Conibear/Snare Prohibition Zone 2. Map. July.

CDFW. 2022a. "Special Animals List." California Natural Diversity Database. CDFW, Biogeographic Data Branch. April 2022. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109406&inline=1.

CDFW. 2022b. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Harris, S.A., & Rayner, J.M. (1986). Urban Fox (Vulpes vulpes) Population Estimates and Habitat Requirements in Several British Cities. Journal of Animal Ecology, 55, 575-591.

Macdonald DW, Newdick MT. 1982. The distribution and ecology of foxes, *Vulpes vulpes* (L.), in urban areas. Pages 123-135 in Bornkamm R, Lee JA, and Seaward MRD, editors. Urban ecology. Blackwell Scientific Publications, Oxford.

Main, M.T., Davis, R.A., Blake, D., Mills, H. and Doherty, T.S. 2020. Human impact overrides bioclimatic drivers of red fox home range size globally. *Diversity and Distributions*, *26*(9), pp.1083-1092.

Perrine, J.D. III. 2005. "Ecology of Red Fox (*Vulpes vulpes*) in the Lassen Peak Region of California, USA." PhD dissertation; University of California, Berkeley.

Quinn, C.B., and B.N. Sacks. 2014. *Ecology, Distribution, and Genetics of Sierra Nevada Red Fox*. University of California, Davis. Report to the California Department of Fish and Wildlife, Sacramento.

Sacks, B.N., M.J. Statham, J.D. Perrine, S.M. Wisely, and K.B. Aubry. 2010. "North American Montane Red Foxes: Expansion, Fragmentation, and the Origin of the Sacramento Valley Red Fox." *Conservation Genetics* 11(4): 1523–1539.

Trewhella, W.J., Harris, S. and McAllister, F.E. 1988. Dispersal distance, home-range size and population density in the red fox (Vulpes vulpes): a quantitative analysis. *Journal of Applied Ecology*, pp.423-434.

USFWS (U.S. Fish and Wildlife Service). 2022. Effects of Wildlife Services Integrated Wildlife Damage Management on the Sierra Nevada DPS of the Sierra Nevada Red Fox in California. September 12. File No. 2022-0073553.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov.

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C7 Long-Tailed Weasel Population and Distribution

The following describes the distribution and population estimate of long-tailed weasel (*Mustela frenata*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, long-tailed weasel observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 94 long-tailed weasel observations between 2000 and 2020 on and off roads.

Table 1. Observations and Modeled Distribution of Long-Tailed Weasel across California

Dataset	Number of Observations	Date Range
Long-Tailed Weasel Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	94	2001–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11,2020.

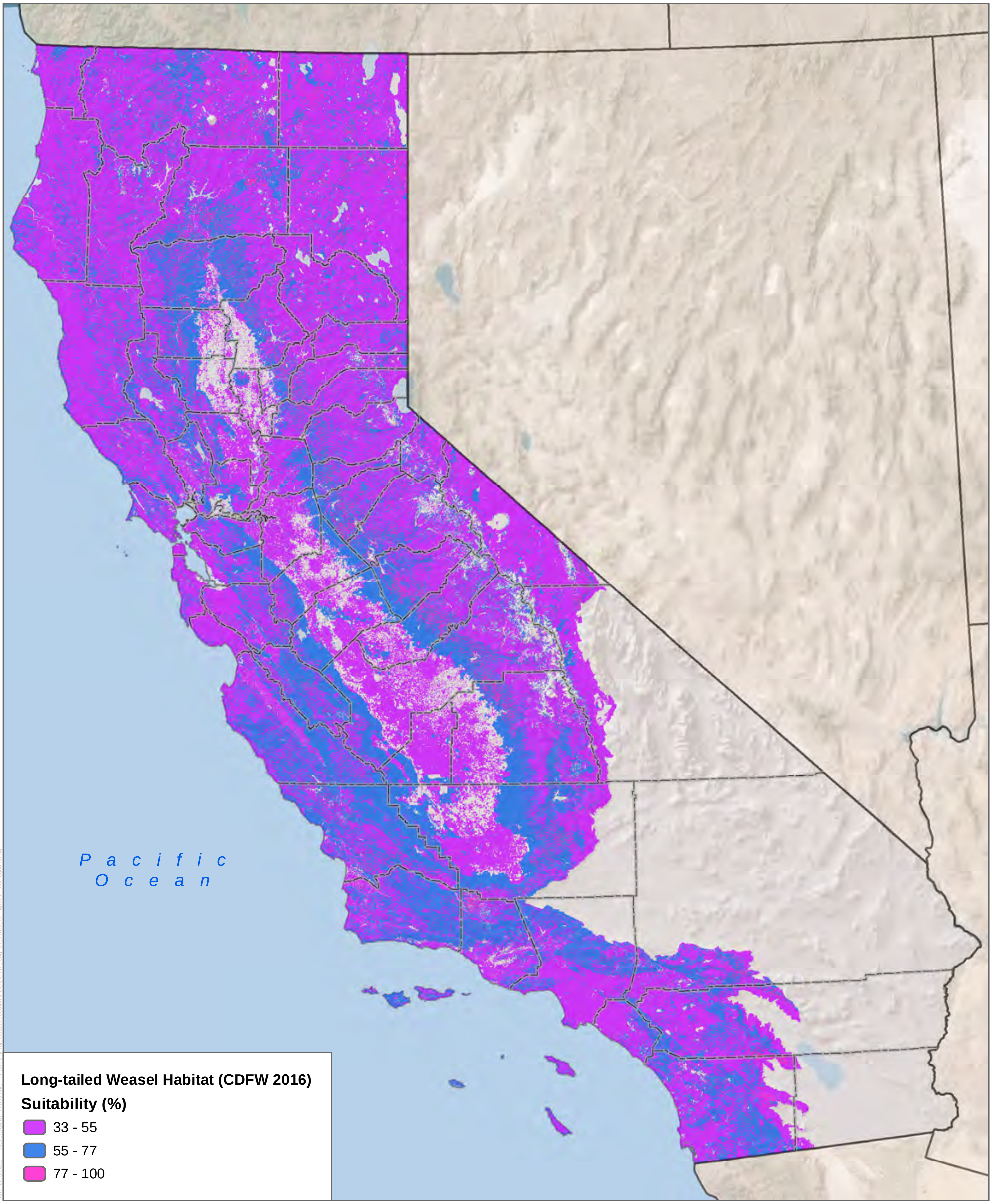
Table 2. Long-Tailed Weasel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,801	Orange	2,006
Alpine	1,708	Placer	3,483
Amador	1,476	Plumas	6,514
Butte	3,275	Riverside	7,258
Calaveras	2,596	Sacramento	2,391
Colusa	1,962	San Benito	3,544
Contra Costa	1,795	San Bernardino	4,179
Del Norte	2,574	San Diego	9,671
El Dorado	4,252	San Francisco	116
Fresno	12,363	San Joaquin	2,915
Glenn	2,602	San Luis Obispo	8,369
Humboldt	9,102	San Mateo	1,120

Table 2. Long-Tailed Weasel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Imperial	308	Santa Barbara	6,891
Inyo	4,344	Santa Clara	3,268
Kern	14,082	Santa Cruz	1,143
Kings	3,138	Shasta	9,607
Lake	3,222	Sierra	2,435
Lassen	11,637	Siskiyou	15,901
Los Angeles	7,829	Solano	1,819
Madera	4,610	Sonoma	4,002
Marin	1,297	Stanislaus	3,017
Mariposa	3,657	Sutter	803
Mendocino	9,004	Tehama	7,344
Merced	3,987	Trinity	8,034
Modoc	9,979	Tulare	10,276
Mono	6,998	Tuolumne	5,164
Monterey	8,441	Ventura	4,414
Napa	1,769	Yolo	2,235
Nevada	2,377	Yuba	1,328
		Total Statewide Suitable Habitat	**281,428**

The following three maps show the top two-thirds of modeled suitable habitat statewide (Figure 1), the combination of that modeled habitat with observations of long-tailed weasel statewide (Figure 2), and modeled habitat and observations in the San Diego area (Figure 3). The figures show that the majority of long-tailed weasel observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). These data support the accuracy of the CDFW (2016) range and habitat data for long-tailed weasel, though, as discussed below, the data are likely to be somewhat conservative because long-tailed weasels occur outside of the top two-thirds of habitat.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Long-Tailed Weasel Habitat from CDFW Habitat Suitability Model

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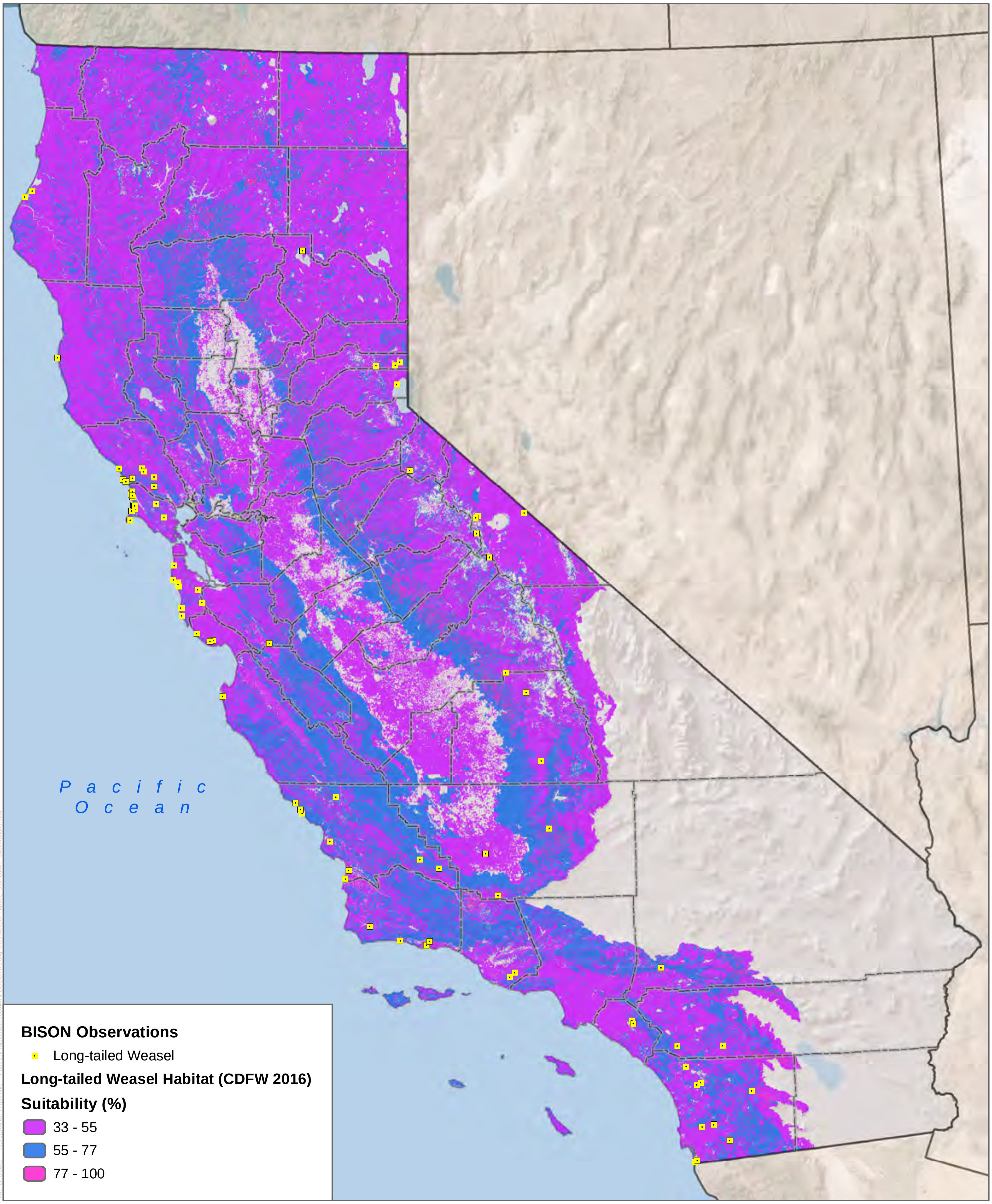

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Long-Tailed Weasel Statewide

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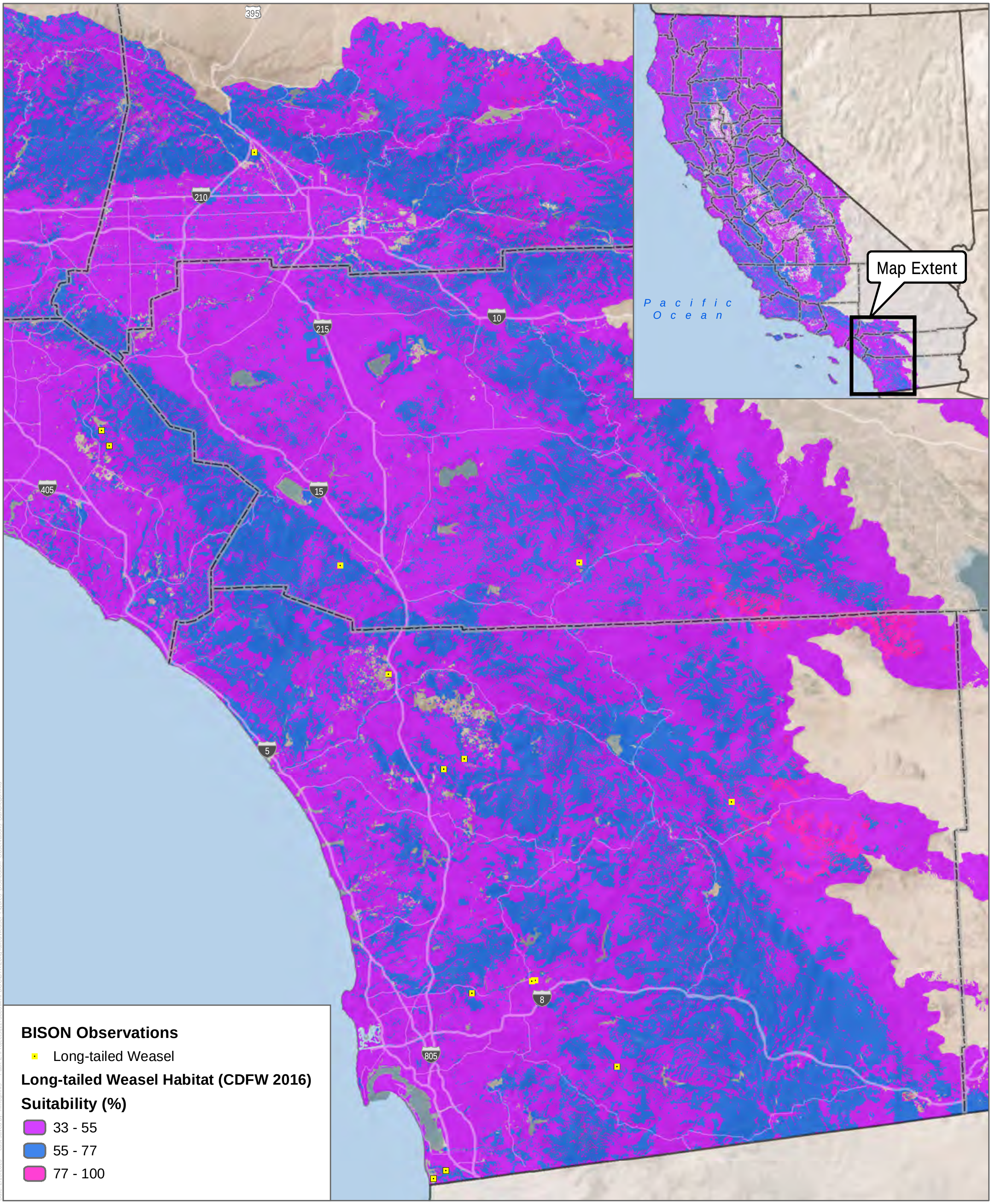

SOURCE: CDFW 2016; USGS 2020

DUDEK 0 2 4 Miles

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Long-Tailed Weasel in San Diego County

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Two methods were used to estimate the long-tailed weasel population by county in California: a low density of 0.34/km^2 and the highest reported female home range size of 1.0 km^2 (Table 3). Long-tailed weasels have widely varying home range sizes and densities as described in the various research-literature sources summarized in Table 3. Few population density values were found in the scientific literature, and those found were generally old (1940s through 1980s) and largely from eastern North America. It is not clear whether eastern population metrics represent western populations of long-tailed weasels in North America. Further, the methods used to determine density in these older studies were generally not in accordance with modern standards. Due to these limitations, and the dearth of published data, the lowest reported density value was used for long-tailed weasel (0.34/km^2) (Craighead and Craighead 1956).

It is unclear whether home range size can be appropriately used to estimate long-tailed weasel populations due to reports that they are social and gregarious, that females lack territoriality, and that female home ranges are “shared and not mutually exclusive” (Gamble 1980). However, due to the paucity of reliable density data for this species, female home range size was used to estimate the long-tailed weasel population size. Home range data were also limited in that few published estimates were found and most data were from eastern North America. Due to these limitations, the highest (i.e., most conservative) reported home range was used for long-tailed weasels, 1.0 km^2 (Quick 1951; St-Pierre et al. 2006).

These two approaches were used to estimate population sizes for each county and the results are presented in Table 4. A summary of the population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimate for Each Method

1. Density-based estimate:
   Lowest reported density of 0.34/km^2 (lowest reported density) multiplied by the top two-thirds of suitable habitat (km^2) in each county. See Table 3 for density data and references.
2. Home Range-Based Estimate:
   Top two-thirds of suitable Habitat Area (km^2) in each county divided by 1.0 km^2 (highest reported home range) and multiplied by 2 to include males. See Table 3 for references.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For long-tailed weasel, the top two-thirds of suitable habitat represent 91% (281,428 km^2) (Table 2) of the total estimated species range in California (308,203 km^2) (CDFW 2016); thus, the populations estimates are likely to be slightly conservative. However, the observation data presented herein largely or entirely occur within the top two-thirds of long-tailed weasel habitat (Figures 2 and 3) (CDFW 2016). These methods are not likely to substantially underestimate the population of this species. Because the distribution of long-tailed weasels has been shown to rely more on sociobiology than suitable habitat, and because suitable habitat might not be occupied (Gamble 1980), this last assumption likely leads to an overestimate of the population for this species. The lowest reported density estimate was used to compensate for this, so this estimate is likely to be more accurate than the home range-based estimate.

The estimates for population size for long-tailed weasels in California are 95,685 individuals (density-based estimate) and 562,855 individuals (home-range-based estimate) (Table 4). These methods assume the following: that there is no home range overlap among adult female long-tailed weasels, that no long-tailed weasels occupy any of the bottom one-third of suitable habitat, and that the top-two-thirds of available suitable habitat is fully occupied at the low density reported in the literature. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that the cited studies were for populations outside California. The statewide and county estimates are provided in Table 4.

Table 3. Long-Tailed Weasel Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	HR Overlap	Home Range Size (km²)	Population Density (no. of individuals/km²)	Sample Size
Craighead and Craighead 1956	Unknown	NA	Michigan (1942)	ND	ND	0.34	Unknown
DeVan 1982	Radio-collar, live-trapping	100% minimum polygon	Kentucky (1970-1975)	ND	0.15 (male)	11.3	29 Male, 13 Female
Gehring and Swihart 2003	NA	NA	Various (authors reviewed previous research)	ND	ND	14.0	Various
Gehring and Swihart 2004	Radio collar	95% AK	Indiana (1998–2000)	ND	0.52 (female)	ND	4 Male, 4 Female
Glover 1943	Direct observation, snow tracks	NA	Pennsylvania (1942)	ND	ND	15.8	25 (11 Male, 10 Female, 4 Unknown)
Quick 1951	Tracks in snow	NA	Colorado (1941-1946)	ND	1.0 (both sexes)	0.8	Not Reported
St-Pierre et al. 2006	Radio collar	100% MCP	Quebec, Canada (2000–2001)	ND	0.98 (female)	ND	21

Notes: AK = adaptive kernel; MCP = minimum convex polygon; NA = not applicable; ND = Not Determined.

Table 4. Statewide and County Long-Tailed Weasel Population Estimates

County	Density-Based Population Estimate (0.34 individuals/km²)	Female Home Range (1.0 km²)	County	Density-Based Population Estimate (0.34 individuals/km²	Female Home Range (1.0 km²)
Alameda	612	3,601	Orange	682	4,011
Alpine	581	3,417	Placer	1,184	6,967
Amador	502	2,951	Plumas	2,215	13,027
Butte	1,114	6,550	Riverside	2,468	14,516

Table 4. Statewide and County Long-Tailed Weasel Population Estimates

County	Density-Based Population Estimate (0.34 individuals/km^2)	Female Home Range (1.0 km^2)	County	Density-Based Population Estimate (0.34 individuals/km^2	Female Home Range (1.0 km^2)
Calaveras	883	5,192	Sacramento	813	4,782
Colusa	667	3,924	San Benito	1,205	7,088
Contra Costa	610	3,591	San Bernardino	1,421	8,358
Del Norte	875	5,148	San Diego	3,288	19,341
El Dorado	1,446	8,505	San Francisco	39	231
Fresno	4,204	24,727	San Joaquin	991	5,829
Glenn	885	5,203	San Luis Obispo	2,845	16,738
Humboldt	3,095	18,203	San Mateo	381	2,240
Imperial	105	616	Santa Barbara	2,343	13,782
Inyo	1,477	8,689	Santa Clara	1,111	6,537
Kern	4,788	28,164	Santa Cruz	389	2,287
Kings	1,067	6,276	Shasta	3,266	19,215
Lake	1,095	6,444	Sierra	828	4,869
Lassen	3,957	23,274	Siskiyou	5,406	31,802
Los Angeles	2,662	15,658	Solano	619	3,639
Madera	1,567	9,219	Sonoma	1,361	8,003
Marin	441	2,593	Stanislaus	1,026	6,033
Mariposa	1,243	7,315	Sutter	273	1,606
Mendocino	3,061	18,008	Tehama	2,497	14,687
Merced	1,355	7,973	Trinity	2,732	16,069
Modoc	3,393	19,957	Tulare	3,494	20,552
Mono	2,379	13,996	Tuolumne	1,756	10,327
Monterey	2,870	16,881	Ventura	1,501	8,828
Napa	602	3,538	Yolo	760	4,470
Nevada	808	4,753	Yuba	451	2,655
			Total	**95,685**	**562,855**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Long-tailed Weasel Predicted Habitat (CWHR M157). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Craighead, J.J., and F.C. Craighead Jr. 1956. *Hawks, Owls and Wildlife*. Harrisburg, PA: Stackpole Company.

DeVan, R. 1982. The Ecology and Life History of the Long-Tailed Weasel (Mustela frenata). PhD Dissertation. Division of Graduate Studies of the University of Cincinnati).

Gehring, T.M. and Swihart, R.K., 2003. Body size, niche breadth, and ecologically scaled responses to habitat fragmentation: mammalian predators in an agricultural landscape. Biological conservation, 109(2), pp.283-295.

Gehring, T.M., and R.K. Swihart. 2004. "Home Range and Movements of Long-Tailed Weasels in a Landscape Fragmented by Agriculture." *Journal of Mammalogy* 85(1): 79–86.

Glover, F.A. 1943. A study of the winter activities of the New York weasel. Pennsylvania Game News, September.

Quick, H.F., 1951. Notes on the ecology of weasels in Gunnison County, Colorado. Journal of Mammalogy, 32(3), pp.281-290.

St. Pierre, C., J.P. Ouellet, and M. Crête. 2006. "Do Competitive Intraguild Interactions Affect Space and Habitat Use by Small Carnivores in a Forested Landscape?" *Ecography* 29(4): 487–496.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C8 American Mink Population and Distribution

The following describes the distribution and population estimate of American mink (*Neogale vison;* also known by the older genera names, *Neovison* or *Mustela vison*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

No observation data were found to visually confirm the habitat model (Table 1), which is the basis of the population estimate. The California Roadkill Observation System (CROS 2022) contains such data, but the data were not provided after numerous requests.

Table 1. Modeled Distribution of American Mink across California

Dataset	Number of Observations	Date Range
American Mink Distribution (CDFW 2016)	30-meter cell, statewide	2016

Notes: CDFW = California Department of Fish and Wildlife.

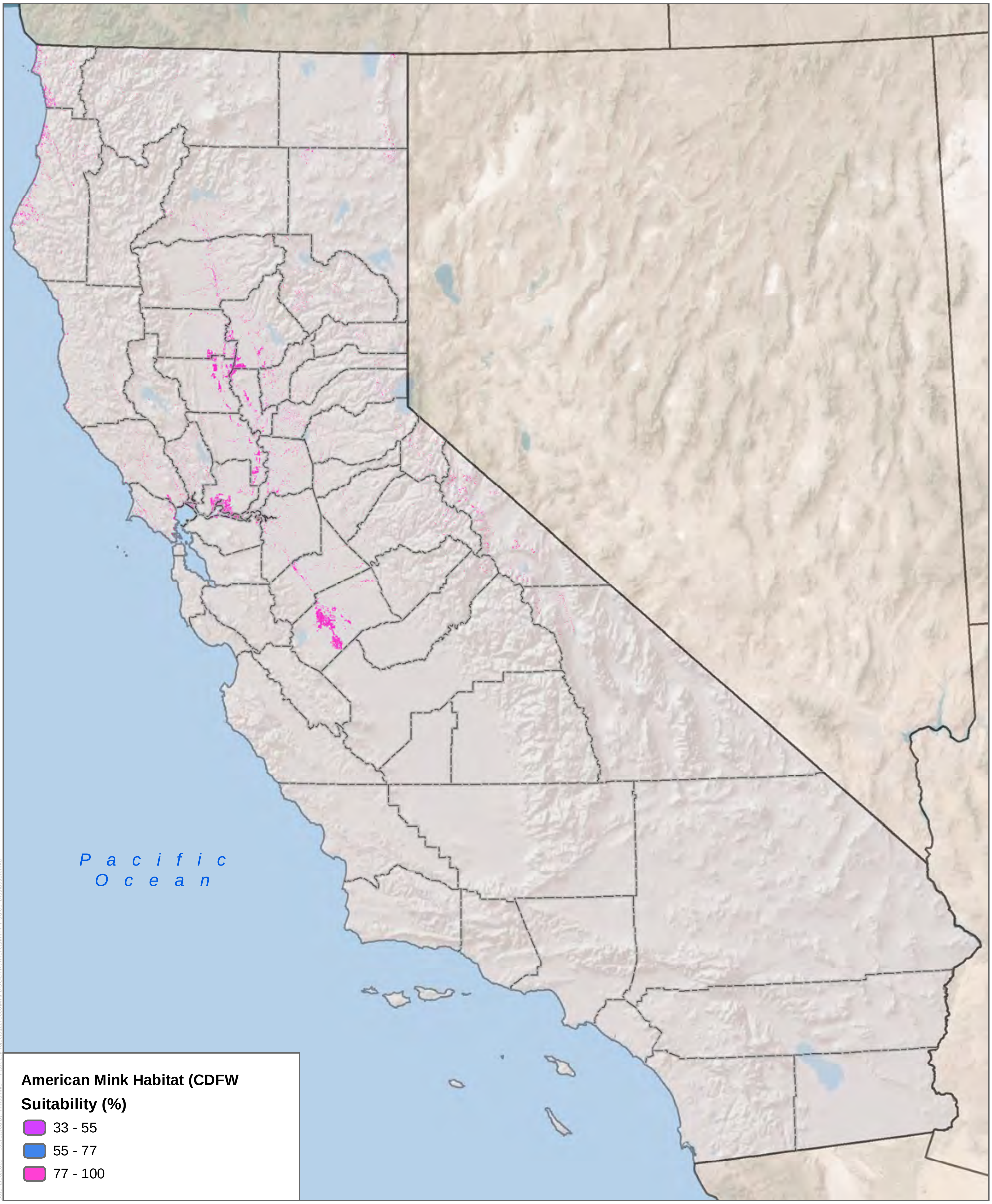
Table 2. American Mink Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	0
Alpine	41	Placer	48
Amador	12	Plumas	63
Butte	154	Riverside	0
Calaveras	12	Sacramento	54
Colusa	144	San Benito	0
Contra Costa	23	San Bernardino	0
Del Norte	92	San Diego	0
El Dorado	24	San Francisco	0
Fresno	1	San Joaquin	50
Glenn	84	San Luis Obispo	0
Humboldt	143	San Mateo	0
Imperial	0	Santa Barbara	0
Inyo	25	Santa Clara	0
Kern	0	Santa Cruz	0

Table 2. American Mink Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Kings	0	Shasta	45
Lake	8	Sierra	18
Lassen	35	Siskiyou	38
Los Angeles	0	Solano	193
Madera	20	Sonoma	42
Marin	22	Stanislaus	39
Mariposa	17	Sutter	91
Mendocino	21	Tehama	80
Merced	333	Trinity	14
Modoc	24	Tulare	0
Mono	117	Tuolumne	39
Monterey	0	Ventura	0
Napa	42	Yolo	95
Nevada	17	Yuba	45
		Total Statewide Suitable Habitat	**2,364**

The following two maps show the top two-thirds of modeled habitat statewide (Figure 1) and the top two-thirds of modeled habitat in the Sacramento–San Joaquin Delta region (Figure 2). Much of the disperse mink habitat is not apparent in Figure 1, but the disperse and narrow areas of mink habitat are more apparent in Figure 2.



SOURCE: CDFW 2016

DUDEK

0 25 50 Miles

FIGURE 1

Top Two-thirds of Suitable American Mink Habitat from CDFW Habitat Suitability Model

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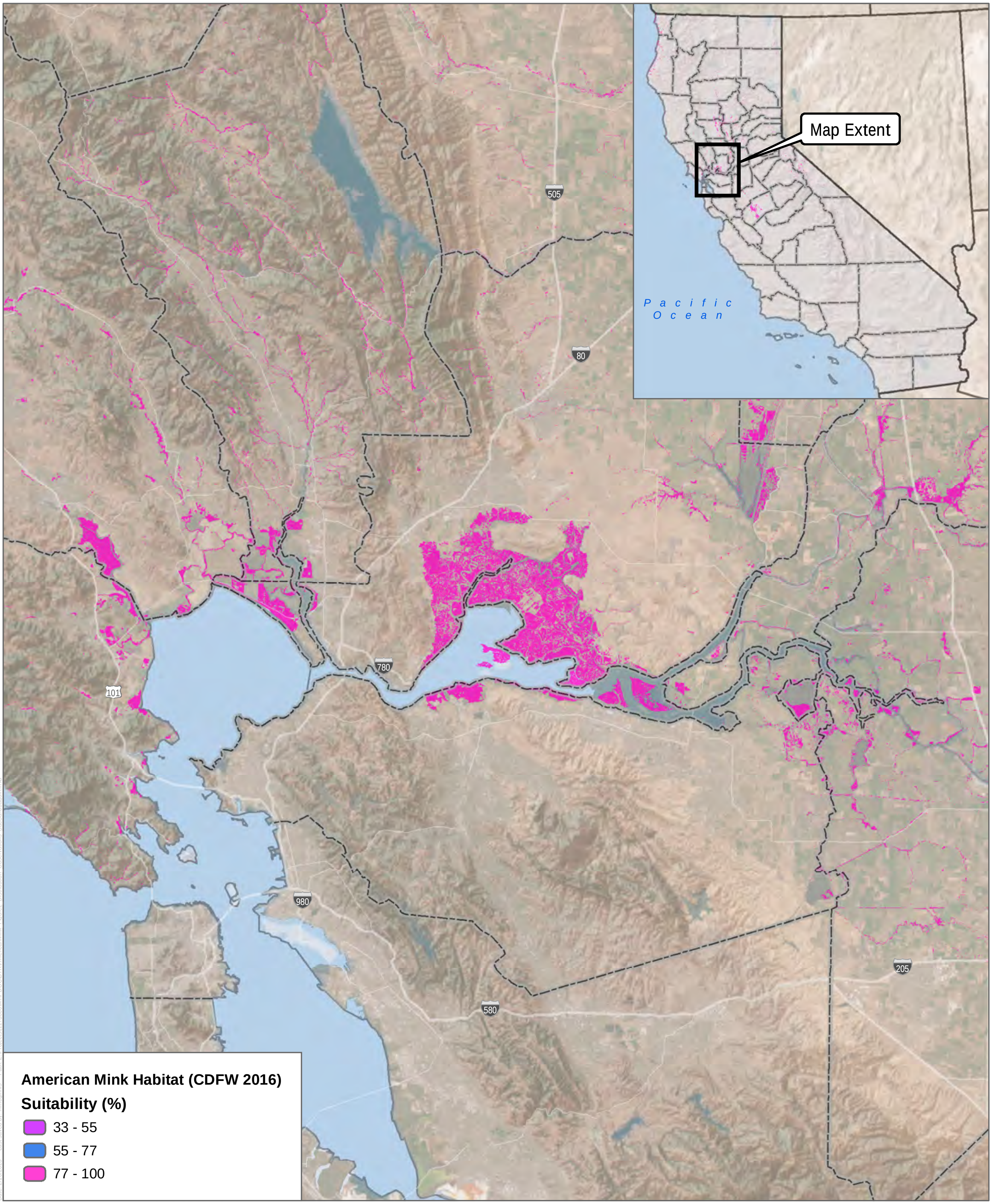

SOURCE: CDFW 2016

FIGURE 2

Top Two-thirds of Suitable Habitat of American Mink in the Sacramento-San Joaquin Delta Region

DUDEK

0 2 4 Miles

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American minks have relatively consistent home range sizes as described in the various research-literature sources summarized in Table 3. Two methods were used to estimate the American mink population by county in California: (1) the population density from Fuller et al. (2016), 2.25 individuals/km^2, and (2) the average available published home range size for adult female American minks of 1.98 km^2 and multiplied by 2 for a 1:1 male to female ratio. Based on the findings provided in Fuller et al. (2016), American mink utilizes areas occurring within 0.5 kilometers of stream networks (i.e., vegetated areas associated with water 250 meters on either side of a waterway). Therefore, published home ranges reported in kilometers of waterway (i.e., length) were converted to square kilometers (i.e., area) by multiplying by 0.5 kilometers. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Density (2.25/km^2) multiplied by the amount of Suitable Habitat Area (km^2) in each county
2. Home Range-Based Estimate (see Table 3 for references):

   Suitable Habitat Area (km^2) in each county divided by average adult female home range value of 1.98 km^2 ((2.46 + 2.12 + 1.35 km^2)/3) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For American mink, the top two-thirds of suitable habitat represent only 1.4% (2,364 km^2) (Table 2) of the total estimated species range in California (170,003 km^2) (CDFW 2016); thus, the populations estimates are likely to be extremely conservative.

The estimates for population size for American minks in California are 5,319 individuals based on the population density-based estimate and 2,389 individuals based on the adult female home range estimate (Table 4). These approaches assume the following: that there is no home range overlap among female American mink, that no American minks occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. The home range-based population estimate is expected to underestimate the population due to the assumption that there is no home range overlap among females. This assumption was made because a suitable average home range overlap was not reported in the literature. However, based on the home range overlap data presented by Yamaguchi and Macdonald (2003), female home ranges do sometimes overlap: when overlap occurs it averages 66%. Because this average did not include female home ranges that did not overlap, it does not represent the true average home range overlap for the species. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. American Mink Home Range Sizes and Population Densities from the Literature

Literature Source[1]	Tracking Method	Home Range Size Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km^2)[1]	Population Density (individuals/km^2)	Sample Size
Zabala et al. 2007[1]	Radio-collar	Linear home range (100% of fixes)	Spain (2004-2005)	ND	4.9 km ~ 2.46 km^2	ND	7 (3 Male, 4 Female)
Fuller et al. 2016[2]	Scat collection; DNA analysis	Spatial capture-recapture model	New York (2012)	ND	ND	2.25	116 samples = 34 individuals
Gorga 2012	Abdominal transmitter	95% FK	South Carolina (2010-2011)	ND	2.12 (lactating)	ND	7 Female
Yamaguchi and MacDonald 2003[1]	Radio-collar	Mapping of extreme location points; general linear models (GLM)	United Kingdom (1995-1997)	66.3% when overlap occurred[3]	2.7 km ~ 1.35 km^2	ND	27 Male, 24 Female

Notes: FK = fixed kernel; ND = not determined.

1 When home range was reported in kilometers of waterway, the value was multiplied by 0.5 kilometers to get square kilometers.

2 In Fuller et al. 2016, population density for American mink was based on the model averaged predicted density surface, which determined the expected American mink density of 2.25 individuals per km^2.

3 This reported home range overlap was not used as the average home range overlap because it only includes data when overlap occurred. Female home ranges that did not overlap were not included in this dataset, so it is not an indication of average home range overlap among all females in a population.

Table 4. Statewide and County American Mink Population Estimates

County	Population Density (2.25/km^2)	Adult Female Home Range (1.98 km^2)	County	Population Density (2.25/km^2)	Adult Female Home Range (1.98 km^2)
Alameda	0	0	Orange	0	0
Alpine	93	41	Placer	109	48
Amador	27	12	Plumas	142	64
Butte	346	156	Riverside	0	0
Calaveras	27	12	Sacramento	122	55
Colusa	324	145	San Benito	0	0
Contra Costa	52	23	San Bernardino	0	0

Table 4. Statewide and County American Mink Population Estimates

County	Population Density (2.25/km^2)	Adult Female Home Range (1.98 km^2)	County	Population Density (2.25/km^2)	Adult Female Home Range (1.98 km^2)
Del Norte	207	93	San Diego	0	0
El Dorado	54	24	San Francisco	0	0
Fresno	3	1	San Joaquin	112	51
Glenn	190	85	San Luis Obispo	0	0
Humboldt	321	144	San Mateo	0	0
Imperial	0	0	Santa Barbara	0	0
Inyo	57	25	Santa Clara	0	0
Kern	0	0	Santa Cruz	0	0
Kings	0	0	Shasta	101	45
Lake	18	8	Sierra	40	18
Lassen	79	35	Siskiyou	85	38
Los Angeles	0	0	Solano	434	195
Madera	45	20	Sonoma	94	42
Marin	50	22	Stanislaus	87	39
Mariposa	38	17	Sutter	204	92
Mendocino	48	21	Tehama	181	81
Merced	749	336	Trinity	30	14
Modoc	54	24	Tulare	0	0
Mono	263	118	Tuolumne	87	39
Monterey	0	0	Ventura	0	0
Napa	95	42	Yolo	214	96
Nevada	39	17	Yuba	101	45
			Total	**5,319**	**2,389**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. American mink Predicted Habitat (CWHR M158). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Fuller, A.K., C.S. Sutherland, J.A. Royle, and M.P. Hare. 2016. “Estimating Population Density and Connectivity of American Mink Using Spatial Capture–Recapture.” *Ecological Applications* 26(4): 1125–1135.

Gorga, C.E., 2012. Ecology of the American mink & the potential impact on species of concern in Cape Romain National Wildlife Refuge, South Carolina (Doctoral dissertation, Clemson University).

Yamaguchi, N., and D.W. Macdonald. 2003. “The Burden of Co-Occupancy: Intraspecific Resource Competition and Spacing Patterns in American Mink, *Mustela vison*.” *Journal of Mammalogy* 84(4): 1341–1355.

Zabala, J., I. Zuberogoitia, and J.A. Martínez-Climent. 2007. “Spacing Pattern, Intersexual Competition and Niche Segregation in American Mink.” *Annales Zoologici Fennici* 44(4): 249–258. Finnish Zoological and Botanical Publishing Board.

C9 Raccoon Population and Distribution

The following describes the distribution and population estimate of raccoon (*Procyon lotor*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, raccoon observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). There were 94 raccoon observations between 2001 and 2018. The California Roadkill Observation System (CROS 2022) contains such data, but the data were not provided after numerous requests.

Table 1. Observations and Modeled Distribution of Raccoon across California

Dataset	Number of Observations	Date Range
Raccoon Distribution (CDFW)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	94	2001–2018

Notes: CDFW = California Department of Fish and Wildlife.
[1] Data accessed December 11, 2020.

Raccoons are able to live in urban regions, adjacent to natural habitat. This means that raccoon populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

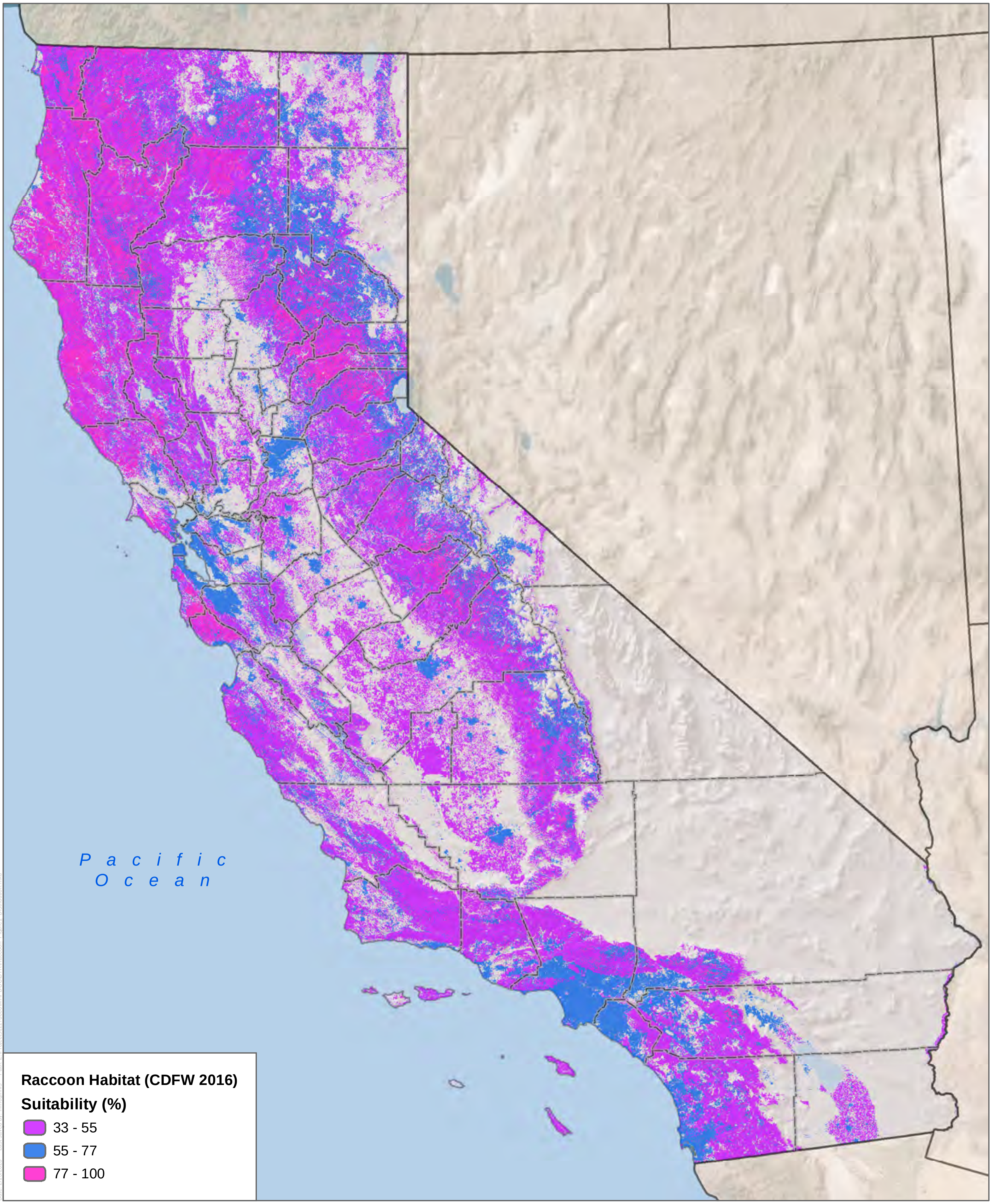
Table 2. Raccoon Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Alameda	440	633	1,073	Orange	324	1494	1,819
Alpine	1,213	0	1,213	Placer	2,653	360	3,013
Amador	1,065	19	1,084	Plumas	5,679	0	5,679
Butte	2,220	311	2,531	Riverside	3,963	1823	5,786
Calaveras	2,029	25	2,054	Sacramento	622	839	1,461
Colusa	1,289	9	1,299	San Benito	1,611	22	1,633
Contra Costa	299	751	1,050	San Bernardino	2,167	1055	3,222
Del Norte	2,471	35	2,506	San Diego	5,418	2272	7,691
El Dorado	3,640	217	3,858	San Francisco	0	114	114
Fresno	8,221	527	8,748	San Joaquin	1,361	366	1,728
Glenn	1,500	20	1,520	San Luis Obispo	3,950	226	4,177
Humboldt	7,958	104	8,061	San Mateo	563	399	962
Imperial	1,497	87	1,584	Santa Barbara	4,940	367	5,307
Inyo	520	0	520	Santa Clara	1,635	809	2,444
Kern	5,981	588	6,569	Santa Cruz	692	296	989
Kings	1,612	134	1,746	Shasta	8,490	208	8,698
Lake	2,810	46	2,856	Sierra	2,034	0	2,034
Lassen	4,720	6	4,727	Siskiyou	13,268	41	13,308
Los Angeles	3,807	3,546	7,353	Solano	656	243	899
Madera	3,337	113	3,451	Sonoma	2,497	320	2,816
Marin	551	214	765	Stanislaus	1,189	241	1,430
Mariposa	2,912	0	2,912	Sutter	335	53	389
Mendocino	7,808	70	7,878	Tehama	4,978	32	5,010
Merced	1,331	142	1,473	Trinity	7,735	0	7,735
Modoc	4,562	0	4,562	Tulare	7,265	261	7,526
Mono	1,797	18	1,815	Tuolumne	4,448	84	4,532
Monterey	5,010	290	5,300	Ventura	3,128	645	3,774

Table 2. Raccoon Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)			County	Top 2/3 Suitable Habitat (km²)		
	Non-Urban	Urban	Total		Non-Urban	Urban	Total
Napa	1,458	95	1,553	Yolo	1,251	115	1,366
Nevada	1,995	190	2,185	Yuba	855	46	901
Total Statewide Suitable Habitat					**177,766**	**20,923**	**198,690**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of raccoons statewide (Figure 2), and modeled habitat and observations in the Sacramento Valley area (Figure 3). The figures show that the majority of raccoon observations occur within or on the edge of the top two-thirds of suitable habitat. While some observations occur outside of this habitat, most observation data occur within the species' range (CDFW 2016, data not shown). These data support the accuracy of the CDFW (2016) range and habitat data for raccoon and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of raccoons outside of the top two-thirds of suitable habitat.



SOURCE: CDFW 2016

0 25 50 Miles

FIGURE 1

Top Two-thirds of Suitable Raccoon Habitat from CDFW Habitat Suitability Model

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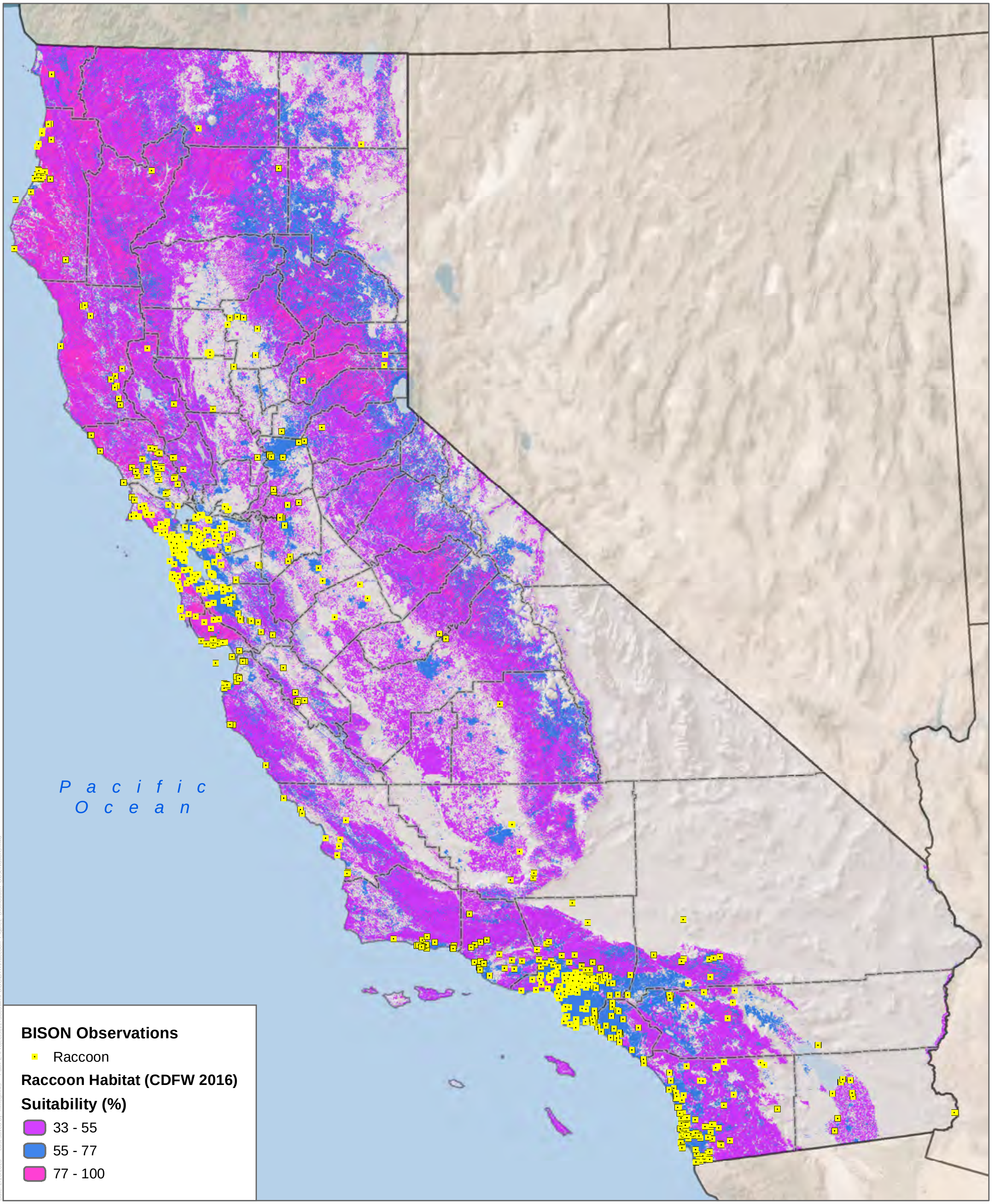

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Raccoon Statewide

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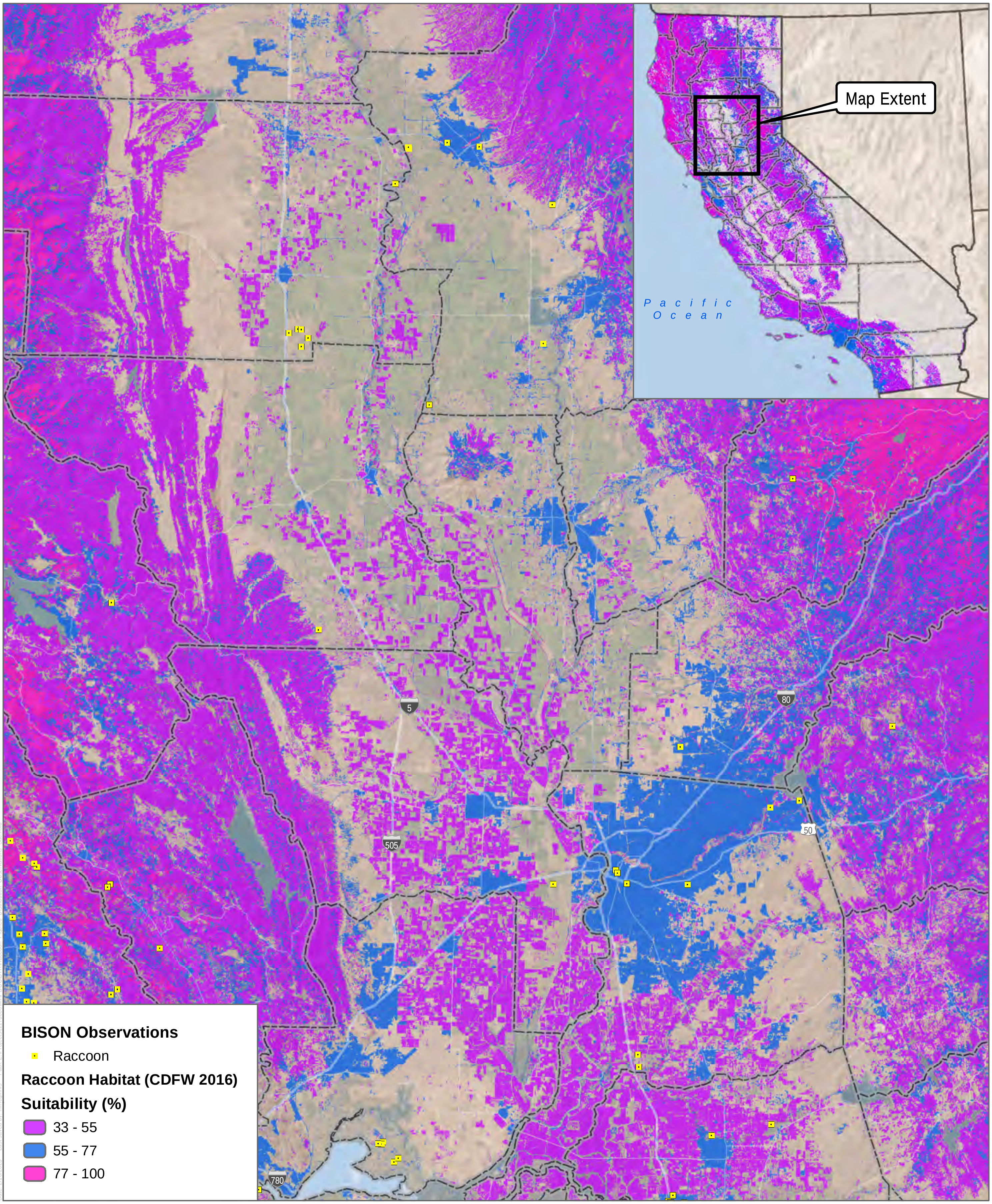

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 3.5 7 Miles

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Raccoon in the Sacramento Valley Area

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Raccoons have widely varying home range sizes as described in the various research-literature sources as summarized in Table 3. However, raccoons incorporate a variety of social structures that vary by density and location. The social structures of raccoons often result in coalition groups (e.g., Gehrt and Fritzell 1998; Pitt et al. 2008); female family units that include adults and juveniles; den-sharing (e.g., Gehrt et al. 1990; Endres and Smith 1993; Gehrt and Fritzell 1998; Prange et al. 2011); home ranges that sometimes overlap extensively (e.g., Fritzell 1978; Chamberlain and Leopold 2002; Prange et al. 2011); gregarious and socially tolerant females (e.g., Gehrt and Fritzell 1998; Kamler and Gipson 2003); and frequent social interactions among males, among females, and between sexes (e.g., Prange et al. 2011; Melville 2012; Hirsch et al. 2013). While some authors reported raccoons to be territorial (e.g., Fritzell 1978), the social constructs listed previously prohibit the use of home range to accurately estimate raccoon population size without including the potential impacts of these social constructs on raccoon population structure. As such, female home range size was not used to estimate raccoon population size in California.

Raccoons frequently inhabit urban and non-urban habitats and raccoon density appears to be higher in urban and especially suburban habitats (see Table 3). Because of this, the population size was estimated for both urban and non-urban habitats within counties separately and then the two estimates were combined at the county level.

To estimate the raccoon population by county in California, this analysis used the average of available published population densities for raccoons of 7.7 individuals/km^2 (non-urban) and 56.8 individuals/km^2 (urban) (Table 3). A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for each value reference):
   a. Non-Urban Areas: 7.7 individuals/km^2 ((13.93 + 0.5 + 11.0 + 15.5 + 1.89 + 6.325 + 4.5 individuals/km^2)/7) multiplied by the amount of Suitable Habitat Area (km^2) in each county.
   b. Urban Areas: 56.8 individuals/km^2 ((24.5 + 40.3 + 9.9 + 50 + 91 + 125 individuals/km^2)/6) multiplied by the amount of Suitable Habitat Area (km^2) in each county.
   c. The results of method 1a for non-urban areas and 1b for urban areas were then summed together for the total population estimate.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat, whereas most density publications report the entire study area, which is more comparable to the range of the species (as opposed to the top two-thirds of suitable habitat) because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For raccoon, the top two-thirds of suitable habitat represent only 64% (198,690 km^2) (Table 2) of the total estimated species range in California (309,532 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of raccoon habitat (Figures 2 and 3) (CDFW 2016). Raccoons appear to occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to underestimate the population.

The estimated raccoon population size in California is 2,5257,065 individuals using the density-based method (Table 4). This approach assumes the following: that no raccoons occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates are provided in Table 4.

Table 3. Raccoon Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Beasley et al. 2007	Radio-collar	KDE	Indiana (2003-2005)	ND	0.58 (F)	ND	33 Male, 27 Female
Beasley et al. 2011	Capture/recapture	NA	Indiana (2004-2009)	ND	ND	13.93	852
Berentsen et al. 2013*	GPS collar	95% FK	Ohio (2009-2010)	ND	0.059 (F)	ND	4 Male, 5 Female
Blackwell et al. 2004*	Transect surveys	ND	Ohio (2002)	ND	ND	24.5 (semi-urban)	391 sightings
Boydston 2005*	Radio-collar	100% MCP	San Francisco, California (2003)	ND	0.22 (F)	ND	2 Male, 5 Female
Bozek et al. 2007*	Radio-collar	KDE	Indiana (1996-2000)	ND	Rural = 2.16 (F); suburban = 0.68 (F); urban = 1.27 (F); average of suburban and urban = 0.98 (F)	ND	52 Male, 68 Female
Chamberlain and Leopold 2002	Radio-collar	95% AK	Mississippi (1991-1997)	Breeding = 49%; young-rearing = 43%; average = 46% (F/F)	Breeding season = 1.60 (F); young-rearing = 1.29 (F); winter = 1.85 (F); average = 1.58 (F)	ND	99 Male, 32 Female
Frey and Conover 2007	Radio-collar	90% KDE	Utah (1999-2000)	Pre-removal predator 7%	ND	ND	8
Fritzell 1978	Radio-collar	MCP	North Dakota (1973-1975)	M/M mean 23%[2]	adult = 0.81, juvenile = 0.66; average = 0.74	0.5	36 Male, 17 Female
Gehrt and Fritzell 1997	Radio-collar	MCP	Texas (1990-1992)	ND	1.28	ND	30 Male, 60 Female

Table 3. Raccoon Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Gehrt and Fritzell 1998	Radio-collar	MCP	Texas (1990-1992)	F/F: 7%	ND	ND	41 Male, 33 Female
Gehrt 2002*	Capture (live-trapping)	NA (CAPTURE program for population density)	Illinois (1995-2001)	ND	ND	Urban = 40.3; Semi-urban = 37.3; Rural = 11.0[1]	108-244 per year over 7 years
Glueck et al. 1988	Radio-collar	MCP	Iowa (1983)	ND	0.35	ND	10 Male, 18 Female
Graser et al. 2012*	Capture/recapture	NA (CAPTURE program for population density)	Illinois (2005-2006)	ND	ND	Urban = 4.96 and 14.84 (urban average = 9.9), rural = 15.50	530
Gross et al. 2012*	Radio-collar	Density from M(h) in Mark, 95% FK	Maryland (2006-2007)	ND	0.26	Two urban sites = 66 and 34; average = 50	18 Male, 16 Female
Kamler and Gipson 2003	Radio-collar	MCP	Kansas (1995-1997)	ND	1.22	ND	5 Male, 9 Female
Kirby et al. 2016	Radio-collar	95% MCP	Georgia (1999-2000, 2014)	ND	1.09	ND	38 Male, 26 Female
Kukielka et al. 2021	Capture/recapture and radio-collar	Spatial Mark-Resight model	Yosemite Valley, California (2017)	ND	ND	1.89	2 Male, 5 Female
McClain 2017	GPS collar, camera traps	95% Dynamic Brownian Bridge Movement Models: spatial mark-recapture	Missouri (2016)	ND	1.22	6.325	5 Male, 4 Female
Melville 2012	Radio-collar	95% FK	Texas (2009-2011)	3.8% (F/F) (average from Appendix C3)	3.28 (average from Table 2.3)	ND	11 Male, 9 Female

Table 3. Raccoon Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Nixon et al. 2009	Trap-mark-recapture,radio-collar	75% OCP	Illinois (1989-1993)	ND	0.284	4.5	208 Male, 138 Female
Owen et al. 2015	Radio-collar	95% FK	West Virginia (2001-2002)	ND	2.44	ND	17 Male, 13 Female
Prange et al. 2004*	Radio-collar	95% FK	Illinois (1996-1997)	ND	Urban: 0.38; Rural: 1.365 (calculated from Table 2)	ND	Urban: 101 Female; Rural: 84 Female
Prange et al. 2011	GPS collar	Proximity alert	Illinois (2004)	Within groups: 58%, Between groups: 13%[3]	ND	ND	20 Male, 22 Female
Ramey et al. 2008*	Radio-collar and capture/ recapture	ND	Ohio (2003-2004)	ND	ND	91 (average of 2003 and 2004) (urban)	30 Male, 31 Female
Riley et al. 1998*	Capture-recapture	ND	Maryland (1983-1984)	ND	ND	125 (urban)	386

Notes: ND = Not Determined; NA = not applicable; MCP = minimum convex polygon; AK = adaptive kernel; KDE = Kernel Density Estimate; OCP = outer convex polygon.

* Studies including values for urban areas

1 Only the urban and rural densities were used for the urban and non-urban population estimates, respectively. The semi-urban density estimate was not used because it does not match either of the defined areas.

2 This study did not report female-female home range overlap. The value reported was not included in the female home range overlap average.

3 This study did not report female-female home range overlap separately. The values reported include male-male, male-female, and female-female overlaps so these data were not included in the female home range overlap average.

Table 4. Statewide and County Raccoon Population Estimates

County	Population Density[1] (7.7/km² or 56.8/km²)	County	Population Density[1] (7.7/km² or 56.8/km²)
Alameda	39,342	Orange	87,354
Alpine	9,340	Placer	40,876
Amador	9,280	Plumas	43,728
Butte	34,759	Riverside	134,062

Table 4. Statewide and County Raccoon Population Estimates

County	Population Density[1] (7.7/km² or 56.8/km²)	County	Population Density[1] (7.7/km² or 56.8/km²)
Calaveras	17,043	Sacramento	52,445
Colusa	10,437	San Benito	13,654
Contra Costa	44,959	San Bernardino	76,610
Del Norte	21,015	San Diego	170,768
El Dorado	40,354	San Francisco	6,475
Fresno	93,235	San Joaquin	31,269
Glenn	12,686	San Luis Obispo	43,252
Humboldt	67,184	San Mateo	26,998
Imperial	16,469	Santa Barbara	58,884
Inyo	4,004	Santa Clara	58,541
Kern	79,452	Santa Cruz	22,141
Kings	20,024	Shasta	77,187
Lake	24,250	Sierra	15,662
Lassen	36,685	Siskiyou	104,492
Los Angeles	230,727	Solano	18,854
Madera	32,113	Sonoma	37,403
Marin	16,398	Stanislaus	22,844
Mariposa	22,422	Sutter	5,590
Mendocino	64,098	Tehama	40,148
Merced	18,314	Trinity	59,560
Modoc	35,127	Tulare	70,765
Mono	14,859	Tuolumne	39,021
Monterey	55,049	Ventura	60,722
Napa	16,623	Yolo	16,165
Nevada	26,154	Yuba	9,196
		Total	**2,557,065**

Note:
1 The non-urban and urban suitable habitat totals are multiplied by the respective non-urban (7.7/km²) and urban (56.8/km²) population density value and the results are summed together for the total population estimate.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Beasley, J.C., T.L. Devault, and O.E. Rhodes Jr. 2007. "Homerange Attributes of Raccoons in a Fragmented Agricultural Region of Northern Indiana." *Journal of Wildlife Management* 71(3): 844–850.

Beasley, J.C., Z.H. Olson, G. Dharmarajan, T.S. Eagan, and O.E. Rhodes. 2011. "Spatio-Temporal Variation in the Demographic Attributes of a Generalist Mesopredator." *Landscape Ecology* 26(7): 937–950.

Berentsen, A.R., Dunbar, M.R., Fitzpatrick, C.E. and Walter, W.D. 2013. Spatial ecology of urban raccoons in northeastern Ohio: implications for oral rabies vaccination.

Blackwell, B.F., Seamans, T.W., White, R.J., Patton, Z.J., Bush, R.M. and Cepek, J.D. 2004. Exposure time of oral rabies vaccine baits relative to baiting density and raccoon population density. Journal of wildlife diseases, 40(2), pp.222-229.

Boydston, E. 2005. *Behavior, Ecology and Detection Survey of Mammalian Carnivores in the Presidio: Final Report*. Sacramento: U.S. Geological Survey, Western Ecological Research Center.

Bozek, C.K., S. Prange, and S.D. Gehrt. 2007. "The Influence of Anthropogenic Resources on Multi-Scale Habitat Selection by Raccoons." *Urban Ecosystems* 10(4): 413–425.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Raccoon Predicted Habitat (CWHR M153). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

Chamberlain, M.J., and B.D. Leopold. 2002. "Spatio-Temporal Relationships among Adult Raccoons (*Procyon lotor*) in Central Mississippi." *American Midland Naturalist* 148(2): 297–308.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Endres, K.M. and W.P. Smith. 1993. "Influence of Age, Sex, Season and Availability on Den Selection by Raccoons within the Central Basin of Tennessee." American Midland Naturalist, Vol. 129, No. 1 (Jan.), pp. 116-131

Frey, S.N., and M.R. Conover. 2007. "Influence of Population Reduction on Predator Home Range Size and Spatial Overlap." *Journal of Wildlife Management* 71(2): 303–309.

Fritzell, E.K. 1978. “Aspects of Raccoon (*Procyon lotor*) Social Organization.” *Canadian Journal of Zoology* 56(2): 260–271.

Gehrt, S.D. 2002. Evaluation of spotlight and road-kill surveys as indicators of local raccoon abundance. *Wildlife Society Bulletin*, pp.449-456.

Gehrt, S.D., and E.K. Fritzell. 1997. “Sexual Differences in Home Ranges of Raccoons.” *Journal of Mammalogy* 78(3): 921–931.

Gehrt, S.D., and E.K. Fritzell. 1998. “Resource Distribution, Female Home Range Dispersion and Male Spatial Interactions: Group Structure in a Solitary Carnivore.” *Animal Behaviour* 55(5): 1211–1227.

Gehrt, S.D. and D.L Spencer. 1990. Raccoon Denning Behavior in Eastern Kansas as Determined from Radio-Telemetry. Transactions of the Kansas Academy of Science (1903-) , 1990, Vol. 93, No. ¾, pp. 71-78

Glueck, T.F., W.R. Clark, and R.D. Andrews. 1988. “Raccoon Movement and Habitat Use During the Fur Harvest Season.” *Wildlife Society Bulletin* 16(1): 6–11.

Graser III, W.H., S.D. Gehrt, L.L. Hungerford, and C. Anchor. 2012. “Variation in Demographic Patterns and Population Structure of Raccoons across an Urban Landscape.” *Journal of Wildlife Management* 76(5): 976–986.

Gross, J., Elvinger, F., Hungerford, L.L. and Gehrt, S.D. 2012. Raccoon use of the urban matrix in the Baltimore Metropolitan Area, Maryland. *Urban Ecosystems*, 15(3), pp.667-682.

Hirsch, B.T., S. Prange, S.A. Hauver, S. D. Gehrt. 2013. “Genetic relatedness does not predict racoon social network structure.” Animal Behaviour 85: 463-470

Kamler, J.F., and P.S. Gipson. 2003. “Space and Habitat Use by Male and Female Raccoons, *Procyon lotor*, in Kansas.” *Canadian Field-Naturalist* 117(2): 218–223.

Kirby, B.R., M.J. Cherry, L.I. Muller; R.J. Warren, M.J. Chamberlain, LM. Conner. 2016. Indirect predation management in a longleaf pine ecosystem: Harwood removal and the spatial ecology of raccoons. Forest Ecology and Management 381 (2016): 327-334.

Kukielka, E.A., B. MartÍnez-Lopez, L.R. Ballweber, D. Buttke, K. Patrick, E.B. Wold, and R. Mazur. 2021. “Spatial – Mark – Resight Model to Estimate Raccoon Abundance in Yosemite Valley, California.” *Wildlife Society Bulletin* 45(2): 206–214.

McClain, J.C. 2017. *Effects of Northern Bobwhite Management on Raccoon Abundance, Habitat Selection, and Home Range in Southwest Missouri*. University of Arkansas.

Melville, H.I. 2012. *The impacts of three common mesopredators on the reintroduced population of eastern wild turkeys in Texas*. Texas A&M University.

Nixon, C.M., Mankin, P.C., Esker, T.L., Sullivan, J.B., Rothering, A.A., Koerkenmeier, R. and Bluett, R.D. 2009. Aspects of Raccoon Life History in West-Central Illinois. *Transactions of the Illinois State Academy of Science*, *102*.

Owen, S.F., Berl, J.L. and Edwards, J.W. 2015. Raccoon spatial requirements and multi-scale habitat selection within an intensively managed central Appalachian forest. *The American Midland Naturalist*, *174*(1), pp.87-95.

Pitt, J.A., S. Larivière, and F. Messier. 2008. “Social Organization and Group Formation of Raccoons at the Edge of their Distribution.” *Journal of Mammalogy* 89(3): 646–653.

Prange, S., Gehrt, S.D. and Hauver, S. 2011. Frequency and duration of contacts between free-ranging raccoons: uncovering a hidden social system. *Journal of Mammalogy*, *92*(6), pp.1331-1342.

Prange, S., Gehrt, S.D. and Wiggers, E.P. 2004. Influences of anthropogenic resources on raccoon (Procyon lotor) movements and spatial distribution. *Journal of Mammalogy*, *85*(3), pp.483-490.

Ramey, P.C., Blackwell, B.F., Gates, R.J. and Slemons, R.D. 2008. Oral rabies vaccination of a northern Ohio raccoon population: relevance of population density and prebait serology. *Journal of wildlife diseases*, *44*(3), pp.553-568.

Riley, S.P., Hadidian, J. and Manski, D.A. 1998. Population density, survival, and rabies in raccoons in an urban national park. *Canadian Journal of Zoology*, *76*(6), pp.1153-1164.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C10 River Otter Population and Distribution

The following describes the distribution and population estimate of North American river otter (*Lontra canadensis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, river otter observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 325 river otter observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of River Otter across California

Dataset	Number of Observations	Date Range
River Otter Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	325	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

Table 2. River Otter Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	7	Orange	0
Alpine	26	Placer	12
Amador	2	Plumas	47
Butte	173	Riverside	0
Calaveras	1	Sacramento	64
Colusa	32	San Benito	0
Contra Costa	58	San Bernardino	0
Del Norte	101	San Diego	0
El Dorado	13	San Francisco	0
Fresno	21	San Joaquin	42
Glenn	38	San Luis Obispo	0
Humboldt	169	San Mateo	0
Imperial	0	Santa Barbara	0
Inyo	15	Santa Clara	11
Kern	0	Santa Cruz	1

Table 2. River Otter Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Kings	0	Shasta	53
Lake	5	Sierra	11
Lassen	14	Siskiyou	36
Los Angeles	0	Solano	270
Madera	6	Sonoma	19
Marin	0	Stanislaus	32
Mariposa	4	Sutter	85
Mendocino	23	Tehama	62
Merced	50	Trinity	14
Modoc	3	Tulare	2
Mono	16	Tuolumne	49
Monterey	15	Ventura	0
Napa	0	Yolo	47
Nevada	10	Yuba	32
		Total Statewide Suitable Habitat	**1,690**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of river otter statewide (Figure 2), and modeled habitat and observations in the Sacramento Valley area (Figure 3). The majority of river otter observations appear to occur *outside* of the top two-thirds of suitable habitat. However, this appearance might be somewhat misleading because river otter habitat is very disperse in California and largely limited to riverine environments. Much of the disperse river otter habitat is not apparent in Figures 1 and 2. The disperse and narrow areas of river otter habitat are more apparent in Figure 3. Most observation data do occur within the species' range (CDFW 2016, data not shown). These data support the accuracy of the CDFW (2016) range data for American mink but suggest that the top two-thirds of suitable habitat might under-represent where the species actually occurs, which would likely lead to an underestimate of the population using these data.

SOURCE: CDFW 2016

DUDEK

0 25 50 Miles

FIGURE 1

Top Two-thirds of Suitable River Otter Habitat from CDFW Habitat Suitability Model

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SOURCE: CDFW 2016; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of River Otter Statewide

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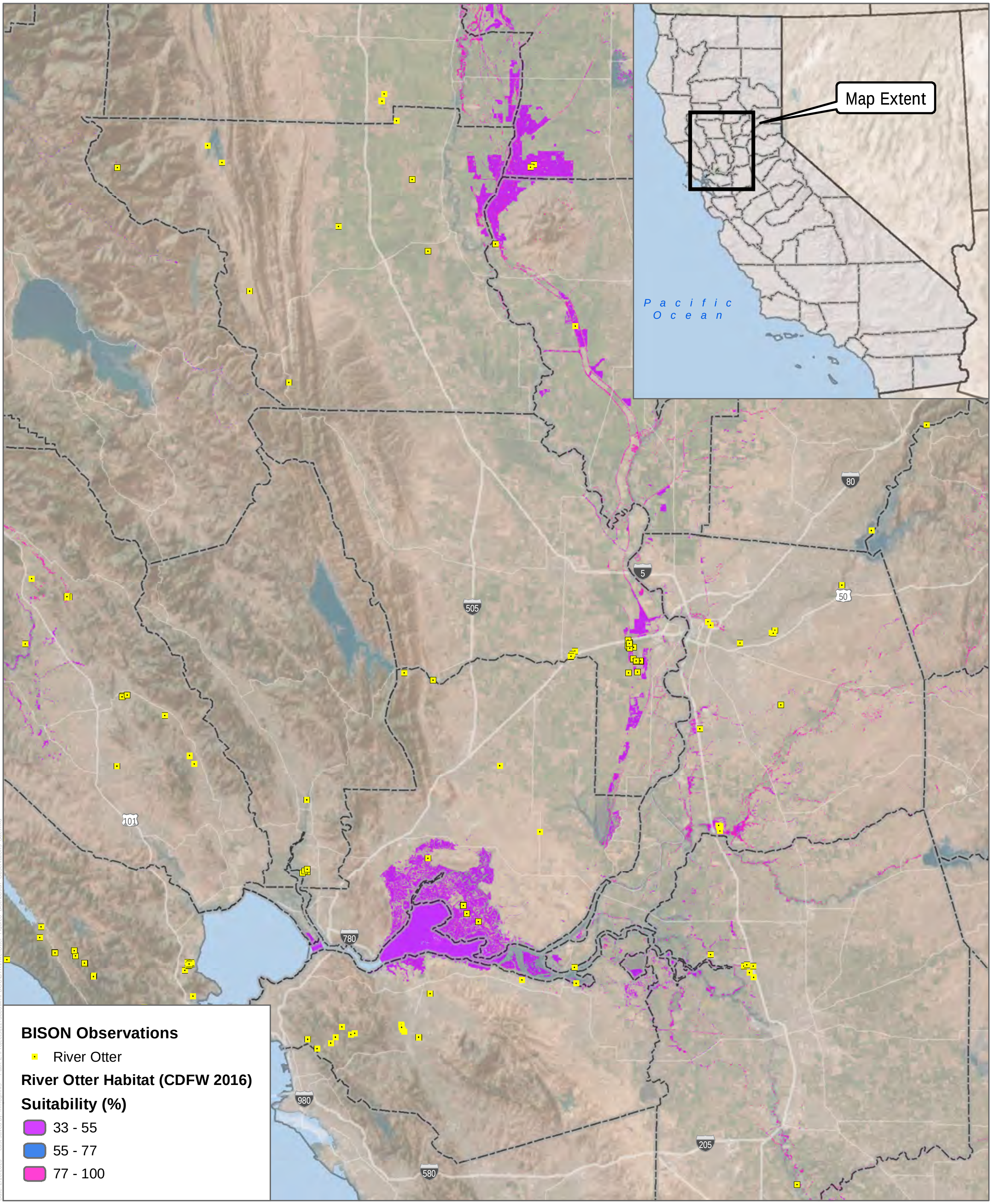

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of River Otter in the Southern Sacramento Valley

DUDEK

0 3.5 7 Miles

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River otters have widely varying home range sizes as described in the various research-literature sources summarized in Table 3. However, due to the social structure of river otter populations (e.g., Blundell et al. 2002; Gorman et al. 2006), female home range size is not a useful tool to estimate population size in this species. To estimate the river otter population by county in California, the average of available published population densities in the literature was used, 0.53 individuals/km^2. Published population densities are typically expressed as individuals per kilometer of waterway. To convert these values from length of waterway (i.e., individuals/km) to individuals per area of waterway (i.e., individuals/km^2), it was assumed that river otters could use 300 meters on either side of a waterway (Gorman et al. 2006) (i.e., 600 meters total), meaning each kilometer of waterway resulted in 0.6 km^2 of habitat. Thus, all linear density values were divided by 0.6 to convert individuals/km into individuals/km^2. A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):

   Average density 0.53 individuals/km^2 ((0.42 + 0.93 + 0.45 + 0.4 + 0.43 individuals/km^2))/5) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat, whereas most density publications report the entire study area, which is more comparable to the range of the species (as opposed to the top two-thirds of suitable habitat) because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For river otter, the top two-thirds of suitable habitat represent only 1.2% (1,690 km^2) (Table 2) of the total estimated species range in California (137,858 km^2) (CDFW 2016). However, for riverine species like river otter, most density studies are limited to riverine environments, which is likely included in the top two-thirds of habitat, so the gap is likely not as dramatic as the 1.2% suggests. The population estimate based on these data is likely to be only slightly conservative. The conservative nature of this method is also supported by the observation data presented herein, the vast majority of which appear to occur outside of the top two-thirds of river otter habitat (Figures 2 and 3) (CDFW 2016). However, the riverine habitat is disperse and much of this habitat is not apparent in Figures 1 and 2. The disperse riverine habitat is more apparent in Figure 3. That said, many of the observation locations do occur outside of the top two-thirds of habitat. River otter occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to underestimate the population.

The estimate of river otter population size in California is 896 individuals using the density-based method (Table 4). This approach assumes the following: that no river otters occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. This method also assumes that density per kilometer of waterway can be converted to density per unit area by using the behavior of the species as described above. This approach also assume that the population density values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California.

The CDFW habitat suitability model may be underestimating the amount of suitable habitat for river otters within the state. For example, Carroll et al. (2020) monitored a recovering river otter population in Marin County, but the CDFW model indicates there is no suitable habitat within the top two-thirds for river otters in Marin County. The statewide and county estimates are provided in Table 4.

Table 3. River Otter Population Densities from the Literature

Literature Source	Tracking Method	Location and Year	Population Density[1]	Sample Size
Bouley 2015	Camera trap, citizen science spotters	San Francisco Bay Area, California (2012-2013)	0.25 individuals/km ~ 0.42 individuals/km^2	50
Brzeski et al. 2013	Fecal DNA, mark-recapture	Humboldt Bay, California (2008)	(2)0.93 individuals/km ~ 1.55 individuals/km^2	44
Godwin et al. 2015	Fecal DNA	Wyoming (2010-2011)	Average 0.56 individuals/km ~ 0.93 individuals/km^2	17 Male, 21 Female
Melquist and Hornocker 1983	Radio-tracker (abdominal)	Idaho (1976-1981)	0.27 individuals/km ~ 0.45 individuals/km^2	7 Male, 9 Female
Mowry et al. 2011	CAPWIRE Program (fecal DNA)	Missouri (2009)	0.24 individuals/km ~ 0.4 individuals/km^2	41 Male, 22 Female
Murphy et al. 2021	SECR (fecal DNA)	New Mexico (2008-2010)	Average: 0.26 individuals/km ~ 0.43 individuals/km^2	33

Notes: SECR = spatially-explicit capture-recapture.

1 Areal population density (per km^2) was estimated to be equivalent to the linear population density per kilometer of waterway, divided by 0.6 km (i.e., width of area used by the species; Gorman et al. 2006) to convert into individuals/km^2.

2 This population density is higher than most, as reported by the authors. It is not likely to be representative of the entire State of California. In an effort to produce conservative population estimates, this estimate was not included in the average density for calculating the river otter population in California.

Table 4. Statewide and County River Otter Population Estimates

County	Population Density (0.53 individuals/km^2)	County	Population Density (0.53 individuals/km^2)
Alameda	4	Orange	0
Alpine	14	Placer	6
Amador	1	Plumas	25
Butte	92	Riverside	0
Calaveras	0	Sacramento	34
Colusa	17	San Benito	0
Contra Costa	31	San Bernardino	0
Del Norte	53	San Diego	0
El Dorado	7	San Francisco	0
Fresno	11	San Joaquin	22
Glenn	20	San Luis Obispo	0
Humboldt	90	San Mateo	0
Imperial	0	Santa Barbara	0
Inyo	8	Santa Clara	6
Kern	0	Santa Cruz	1
Kings	0	Shasta	28
Lake	3	Sierra	6
Lassen	7	Siskiyou	19
Los Angeles	0	Solano	143

Table 4. Statewide and County River Otter Population Estimates

County	Population Density (0.53 individuals/km^2)	County	Population Density (0.53 individuals/km^2)
Madera	3	Sonoma	10
Marin	0	Stanislaus	17
Mariposa	2	Sutter	45
Mendocino	12	Tehama	33
Merced	26	Trinity	7
Modoc	1	Tulare	1
Mono	9	Tuolumne	26
Monterey	8	Ventura	0
Napa	0	Yolo	25
Nevada	5	Yuba	17
		Total	**896**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Blundell, G.M., M. Ben-David, R.T. Bowyer. 2002. “Sociality in river otters: cooperative foraging or reproductive strategies?” Behavioral Ecology Vol. 13 No. 1: 134–141

Bouley, P. 2015. “Return of North American River Otters, *Lontra canadensis*, to Coastal Habitats of the San Francisco Bay Area, California.” *Northwestern Naturalist* 96(1): 1–12.

Brzeski, K.E., M.S. Gunther, and J.M. Black. 2013. “Evaluating River Otter Demography Using Noninvasive Genetic Methods.” *Journal of Wildlife Management* 77(8): 1523–1531.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Northern River Otter Predicted Habitat (CWHR M163). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Godwin, B.L., Albeke, S.E., Bergman, H.L., Walters, A. and Ben-David, M. 2015. Density of river otters (Lontra canadensis) in relation to energy development in the Green River Basin, Wyoming. *Science of the Total Environment*, *532*, pp.780-790.

Gorman, T.A., J.D. Erb, B.R. McMillan, D.J. Martin, and J.A. Homyack. 2006. "Site Characteristics of River Otter (*Lontra canadensis*) Natal Dens in Minnesota." *American Midland Naturalist* 156(1): 109–117.

Melquist, W.E., and M.G. Hornocker. 1983. "Ecology of River Otters in West Central Idaho. *Wildlife Monographs* No. 83: 3–60.

Mowry, R.A., Gompper, M.E., Beringer, J. and Eggert, L.S. 2011. River otter population size estimation using noninvasive latrine surveys. *The Journal of Wildlife Management*, *75*(7), pp.1625-1636.

Murphy, S.M., Adams, J.R., Waits, L.P. and Cox, J.J. 2021. Evaluating otter reintroduction outcomes using genetic spatial capture–recapture modified for dendritic networks. *Ecology and evolution*, *11*(21), pp.15047-15061.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C11 Western Spotted Skunk Population and Distribution

The following describes the distribution and population estimate of western spotted skunk (*Spilogale gracilis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, western spotted skunk observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 16 western spotted skunk observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Western Spotted Skunk across California

Dataset	Number of Observations	Date Range
Spotted Skunk Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)	16	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

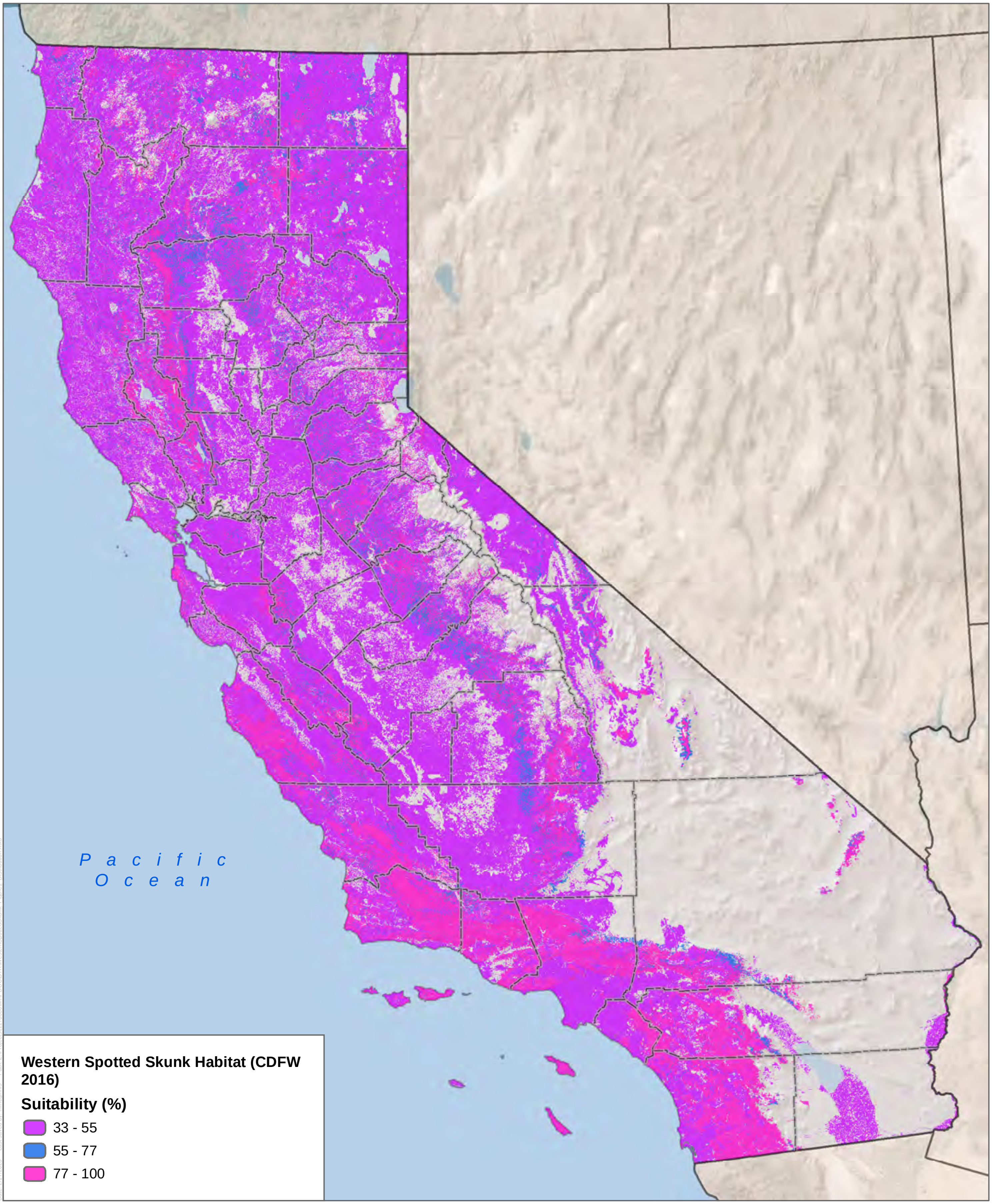
Table 2. Western Spotted Skunk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,766	Orange	1,981
Alpine	1,182	Placer	2,947
Amador	1,330	Plumas	5,766
Butte	3,241	Riverside	6,666
Calaveras	2,454	Sacramento	2,215
Colusa	2,382	San Benito	3,363
Contra Costa	1,738	San Bernardino	4,887
Del Norte	2,303	San Diego	8,514
El Dorado	3,585	San Francisco	115
Fresno	10,015	San Joaquin	2,665
Glenn	2,648	San Luis Obispo	7,924
Humboldt	8,049	San Mateo	1,041

Table 2. Western Spotted Skunk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Imperial	2,049	Santa Barbara	6,591
Inyo	4,944	Santa Clara	3,122
Kern	13,696	Santa Cruz	855
Kings	3,002	Shasta	8,642
Lake	2,824	Sierra	1,797
Lassen	11,117	Siskiyou	13,490
Los Angeles	9,225	Solano	1,561
Madera	3,756	Sonoma	3,338
Marin	1,069	Stanislaus	2,809
Mariposa	3,052	Sutter	1,058
Mendocino	7,966	Tehama	6,805
Merced	3,692	Trinity	7,053
Modoc	9,373	Tulare	8,782
Mono	5,721	Tuolumne	3,584
Monterey	7,903	Ventura	4,211
Napa	1,747	Yolo	2,079
Nevada	1,694	Yuba	1,272
		Total Statewide Suitable Habitat	**258,655**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of western spotted skunk statewide (Figure 2), and modeled habitat and observations in the San Diego area (Figure 3). The figures show that all western spotted skunk observations occur within the top two-thirds of suitable habitat and the range of the species. These data support the accuracy of the CDFW (2016) range and habitat data for western spotted skunk.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Western Spotted Skunk Habitat from CDFW Habitat Suitability Model

DUDEK

0 25 50 Miles

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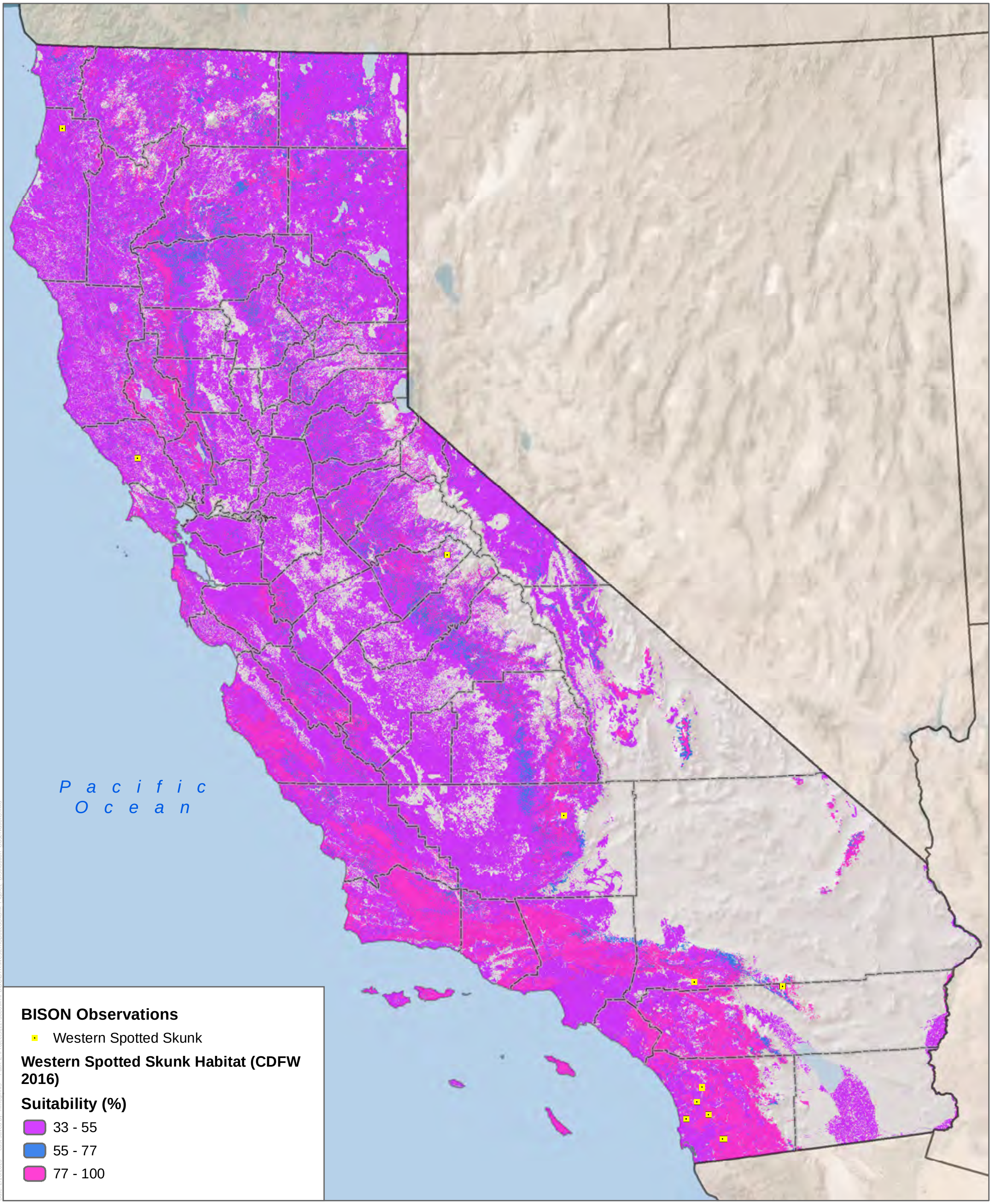

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Western Spotted Skunk Statewide

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0 25 50 Miles

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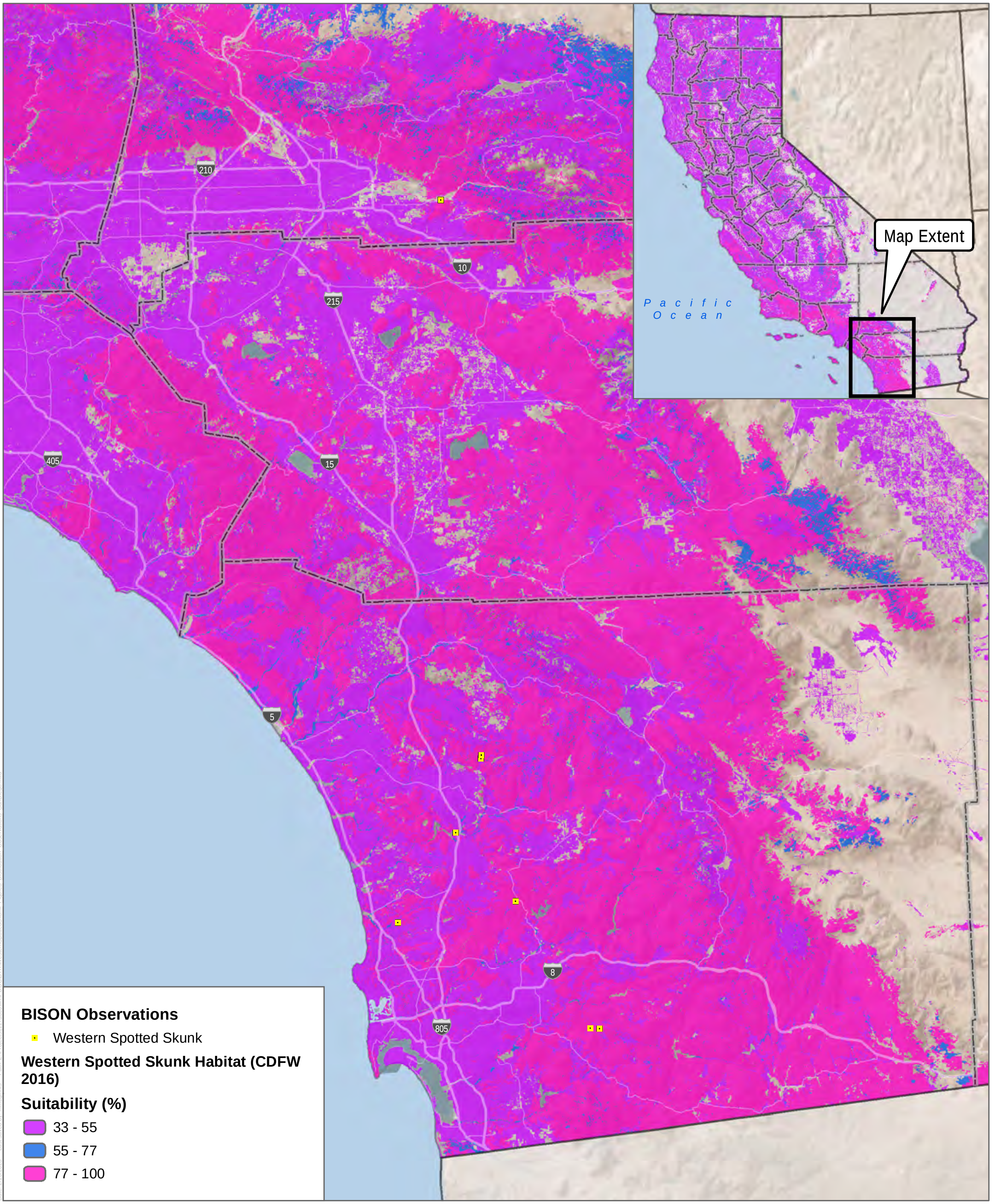

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Western Spotted Skunk in the San Diego County Area

DUDEK

0 3.5 7 Miles

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Very little information was found in the published literature on western spotted skunk density or home range. Therefore, the analysis was expanded to include the closely related eastern spotted skunk (*Spilogale putorius*). These species differ in ecology and range and eastern spotted skunk populations have been declining over many decades (e.g., Lesmeister et al. 2010), so the inclusion of data from this species will likely underestimate the population of western spotted skunks in California. However, there is a paucity of data for western spotted skunk, which is limited to an island subspecies (*S. gracilis amphiala*) whose density and home range might not reflect the entirety of the mainland population. As such, for western spotted skunk, the population estimates include data for eastern spotted skunk, as represented in Table 3.

Two methods were used to estimate the western spotted skunk population by county in California: (1) the average of available published population densities for both species of 11.3 individuals/km^2 and (2) the average female home range sizes for both species of 1.3 km^2, minus an estimated 19.5% overlap per individual (Jones et al. 2013), equaling 1.04 km^2, and multiplied by 2 for a 1:1 male to female ratio. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-based Estimate (see Table 3 for each values reference):

   Average Density 11.3 individuals/km^2 ((5 + 14.91 + 14 individuals/km^2)/3) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

2. Home Range-Based Estimate (see Table 3 for each values reference):

   Suitable Habitat Area (km^2) in each county divided by 1.04 km^2 (average adult female home range value of 1.295 km^2 ((0.45 km^2 + 0.31 km^2 + 0.81 km^2 + 3.61 km^2)/4) – 0.253 km^2 (19.5% home range overlap) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population only, excluding young of the year and juveniles (and non-territorial adults as applicable). The *total* population of western spotted skunks in California is likely to be higher if young and juvenile animals are included. The estimate was not adjusted to include this portion of the population, so the estimate is likely to be conservative.

These methods are inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For western spotted skunk, the top two-thirds of suitable habitat represent only 77% (258,655 km^2) (Table 2) of the total estimated species range in California (335,914 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative.

The estimated western spotted skunk population size in California was 2,922,806 individuals using the density-based method and 497,414 individuals using the home range-based method (Table 4). These approaches assume the following: that there is an average of 19.5% home range overlap among female western spotted skunks (home range-based method only), that no western spotted skunks occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. The statewide and county estimates are provided in Table 4.

Table 3. Spotted Skunk (Western and Eastern) Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Year	Home Range Overlap among Females	Female Home Range Size (km^2)	Population Density (individuals/km^2)	Sample Size
Crabb 1948	Capture/ recapture	NA	Iowa (1939-1942)	ND	ND	5 (eastern spotted skunk)	238
Crooks and Van Vuren 1995	Radio telemetry	95% KDE	Santa Cruz Island, California (1992)	ND	0.296 (wet season); 0.611 (dry season); 0.45 (average) (both sexes) (western spotted skunk)	ND	3 Male, 4 Female (wet season); 1 Female (dry season)
Harris et al. 2021	Mark-recapture, radio-collar	NA	Florida (2016-2018)	ND	ND	14.91 (average) (eastern spotted skunk)	22 Male, 16 Female
Jones et al. 2008	Radio telemetry	95% FK	Santa Cruz Island, California (2003-2004)	ND	0.31 (F) (western spotted skunk)	9 (site 1); 19 (site 2); 14 (average) (western spotted skunk)	16 Male, 17 Female
Jones et al. 2013	Radio telemetry	95% KDE	Santa Cruz Island, California (2003-2004)	19.5% (western spotted skunk)	ND	ND	14 Male, 13 Female
Lesmeister et al. 2009	Radio-collar	95% FK	Arkansas (2005-2006)	ND	0.81 (F) (average among seasons) (eastern spotted skunk)	ND	6 Male, 5 Female (spring, summer); 8 Male, 8 Female (fall); 5 Male, 4 Female (winter)

Table 3. Spotted Skunk (Western and Eastern) Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Year	Home Range Overlap among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Thorne 2020	Radio telemetry	Minimum convex hull, MCP and 95% KDE	West Virginia (2015-2019)	ND (Average: 24.5% among all skunks)[1]	95% KDE = 3.61 (F) (eastern spotted skunk)	ND	10 M, 8 F

Notes: MCP = minimum convex polygon; FK = fixed kernel; KDE = Kernel Density Estimate; ND = Not Determined; NA = not applicable.

1 These home range overlap data were not used in the calculation of population size of western spotted skunk because the author did not report female-female home range overlap. These data also apply to a different species, eastern spotted skunk.

Table 4. Statewide and County Western Spotted Skunk Population Estimates

County	Population Density (11.3km²)	Female Home Range Size (1.04 km²)	County	Population Density (11.3/km²)	Female Home Range Size (1.04 km²)
Alameda	19,951	3,395	Orange	22,381	3,809
Alpine	13,360	2,274	Placer	33,307	5,668
Amador	15,031	2,558	Plumas	65,152	11,088
Butte	36,623	6,233	Riverside	75,328	12,820
Calaveras	27,726	4,718	Sacramento	25,034	4,260
Colusa	26,917	4,581	San Benito	38,007	6,468
Contra Costa	19,637	3,342	San Bernardino	55,220	9,398
Del Norte	26,027	4,429	San Diego	96,214	16,374
El Dorado	40,515	6,895	San Francisco	1,304	222
Fresno	113,164	19,259	San Joaquin	30,118	5,126
Glenn	29,926	5,093	San Luis Obispo	89,542	15,239
Humboldt	90,952	15,479	San Mateo	11,764	2,002
Imperial	23,148	3,939	Santa Barbara	74,474	12,674
Inyo	55,862	9,507	Santa Clara	35,280	6,004
Kern	154,762	26,338	Santa Cruz	9,666	1,645
Kings	33,920	5,773	Shasta	97,653	16,619
Lake	31,909	5,430	Sierra	20,304	3,455
Lassen	125,618	21,378	Siskiyou	152,434	25,942
Los Angeles	104,247	17,741	Solano	17,641	3,002

Table 4. Statewide and County Western Spotted Skunk Population Estimates

County	Population Density (11.3km^2)	Female Home Range Size (1.04 km^2)	County	Population Density (11.3/km^2)	Female Home Range Size (1.04 km^2)
Madera	42,447	7,224	Sonoma	37,718	6,419
Marin	12,076	2,055	Stanislaus	31,744	5,402
Mariposa	34,486	5,869	Sutter	11,954	2,034
Mendocino	90,010	15,318	Tehama	76,892	13,086
Merced	41,721	7,100	Trinity	79,702	13,564
Modoc	105,913	18,025	Tulare	99,241	16,889
Mono	64,649	11,002	Tuolumne	40,503	6,893
Monterey	89,308	15,199	Ventura	47,582	8,098
Napa	19,737	3,359	Yolo	23,492	3,998
Nevada	19,138	3,257	Yuba	14,376	2,446
			Total	**2,922,806**	**497,414**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Spotted Skunk Predicted Habitat (CWHR M161). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Crabb, W.D. 1948. "The Ecology and Management of the Prairie Spotted Skunk in Iowa." *Ecological Monographs* 18(2): 201–232.

Crooks, K.R., and D. Van Vuren. 1995. "Resource Utilization by Two Insular Endemic Mammalian Carnivores, the Island Fox and Island Spotted Skunk." *Oecologia* 104(3): 301–307.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Harris, S.N., J.L. Froehly, S.L. Glass, C.L. Hannon, E.L. Hewett Ragheb, T.J. Doonan, and D.S. Jachowski. 2021. "High Density and Survival of a Native Small Carnivore, the Florida Spotted Skunk *(Spilogale putorius ambarvalis*), in South-Central Florida." *Journal of Mammalogy* 102(3): 743–756.

Jones, K.L., D.H. Van Vuren, and K.R. Crooks. 2008. "Sudden Increase in a Rare Endemic Carnivore: Ecology of the Island Spotted Skunk." *Journal of Mammalogy* 89(1): 75–86.

Jones, K.L., D.H. Van Vuren, M.B. McEachern, K.R. Crooks, J.W. Dragoo, and B. May. 2013. "Spatial and Genetic Organization of the Island Spotted Skunk, *Spilogale gracilis amphiala*." *Southwestern Naturalist* 58(4): 481–486.

Lesmeister, D.B., M.E. Gompper, and J.J. Millspaugh. 2009. "Habitat Selection and Home Range Dynamics of Eastern Spotted Skunks in the Ouachita Mountains, Arkansas, USA." *Journal of Wildlife Management* 73(1): 18–25.

Lesmeister, D.B., J.J. Millspaugh, M.E. Gompper, and T.W. Mong. 2010. "Eastern Spotted Skunk *(Spilogale putorius*) Survival and Cause-Specific Mortality in the Ouachita Mountains, Arkansas." *American Midland Naturalist* 164(1): 52–60.

Thorne, E.D. 2020. "Spatial Ecology of a Vulnerable Species: Home Range Dynamics, Resource Use, and Genetic Differentiation of Eastern Spotted Skunks in Central Appalachia." PhD dissertation; Virginia Tech.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C12 Striped Skunk Population and Distribution

The following describes the distribution and population estimate of striped skunk (*Mephitis mephitis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, striped skunk observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 479 striped skunk observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Striped Skunk across California

Dataset	Number of Observations	Date Range
Striped Skunk Distribution (CDFW 2016)	30-meter cell, state-wide	2016
BISON (USGS 2020)[1]	479	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

Striped skunks are able to live in urban regions, adjacent to natural habitat. This means that striped skunk populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

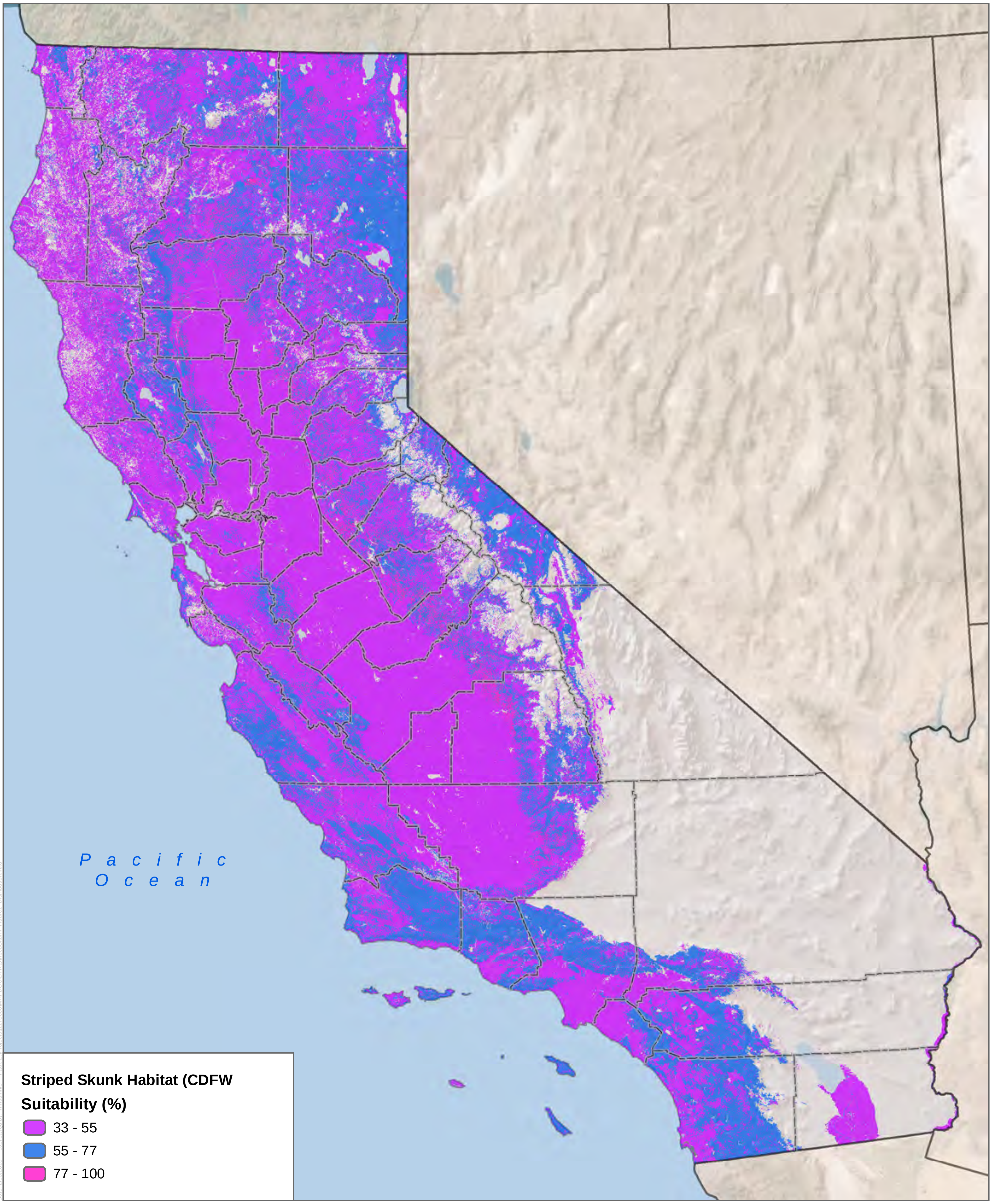
Table 2. Striped-Skunk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,828	Orange	2,025
Alpine	1,211	Placer	3,287
Amador	1,366	Plumas	6,323
Butte	4,140	Riverside	6,256
Calaveras	2,527	Sacramento	2,490
Colusa	2,954	San Benito	3,557
Contra Costa	1,847	San Bernardino	3,702
Del Norte	1,983	San Diego	8,657

Table 2. Striped-Skunk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
El Dorado	3,783	San Francisco	116
Fresno	12,497	San Joaquin	3,593
Glenn	3,329	San Luis Obispo	8,244
Humboldt	6,700	San Mateo	931
Imperial	2,436	Santa Barbara	6,977
Inyo	2,556	Santa Clara	3,246
Kern	14,815	Santa Cruz	912
Kings	3,508	Shasta	9,168
Lake	3,111	Sierra	2,217
Lassen	11,425	Siskiyou	14,113
Los Angeles	7,761	Solano	2,080
Madera	4,707	Sonoma	3,689
Marin	1,230	Stanislaus	3,845
Mariposa	3,379	Sutter	1,555
Mendocino	7,422	Tehama	7,389
Merced	4,981	Trinity	6,164
Modoc	9,919	Tulare	10,226
Mono	5,917	Tuolumne	4,030
Monterey	8,451	Ventura	4,622
Napa	1,884	Yolo	2,600
Nevada	2,064	Yuba	1,533
		Total Statewide Suitable Habitat	**273,274**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of striped skunk statewide (Figure 2), and modeled habitat and observations in the North San Francisco Bay area (Figure 3). The figures show that all striped skunk observations occur within the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). These data support the accuracy of the CDFW (2016) range and habitat data for striped skunk.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Striped Skunk Habitat from CDFW Habitat Suitability Model

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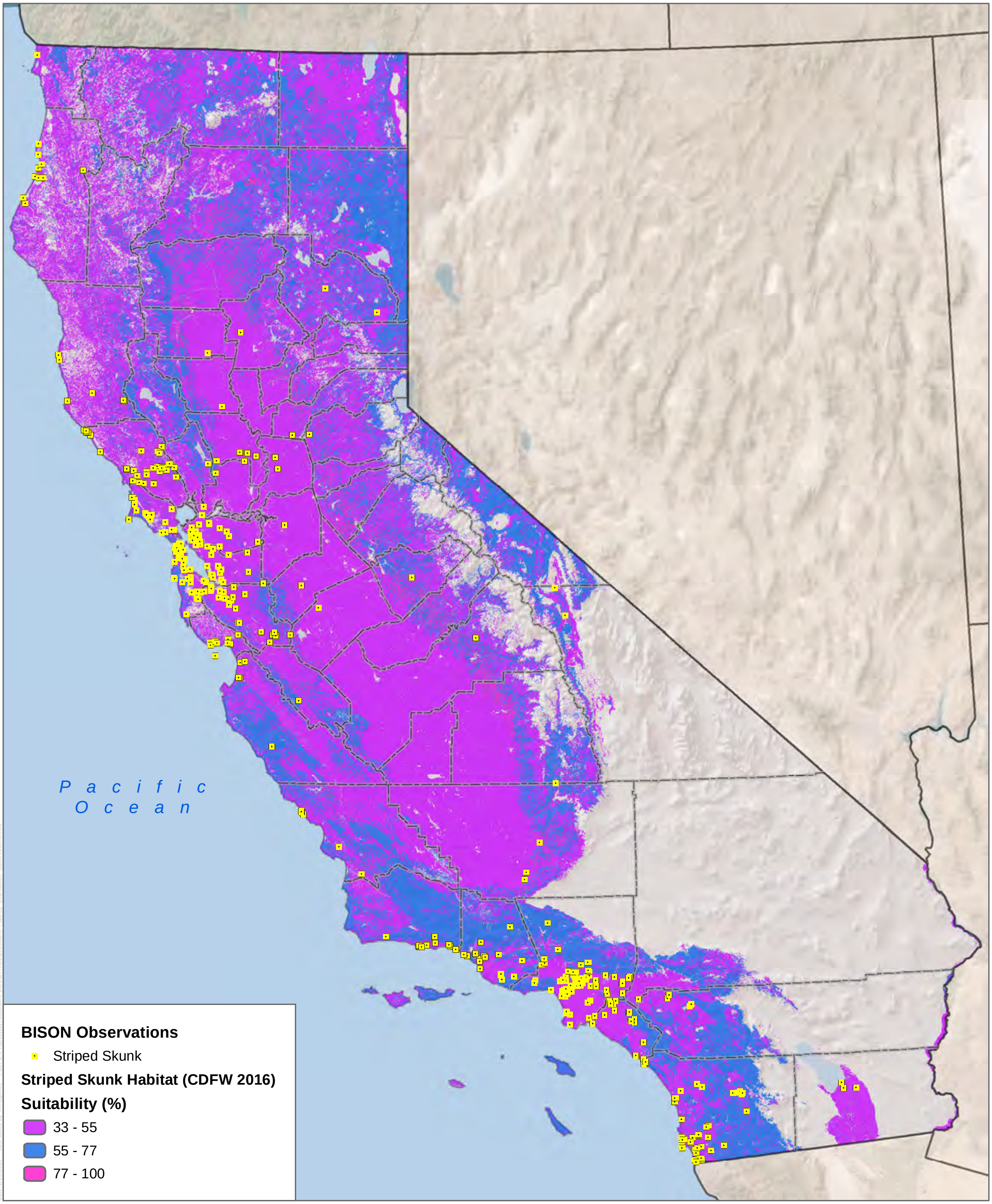

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Striped Skunk Statewide

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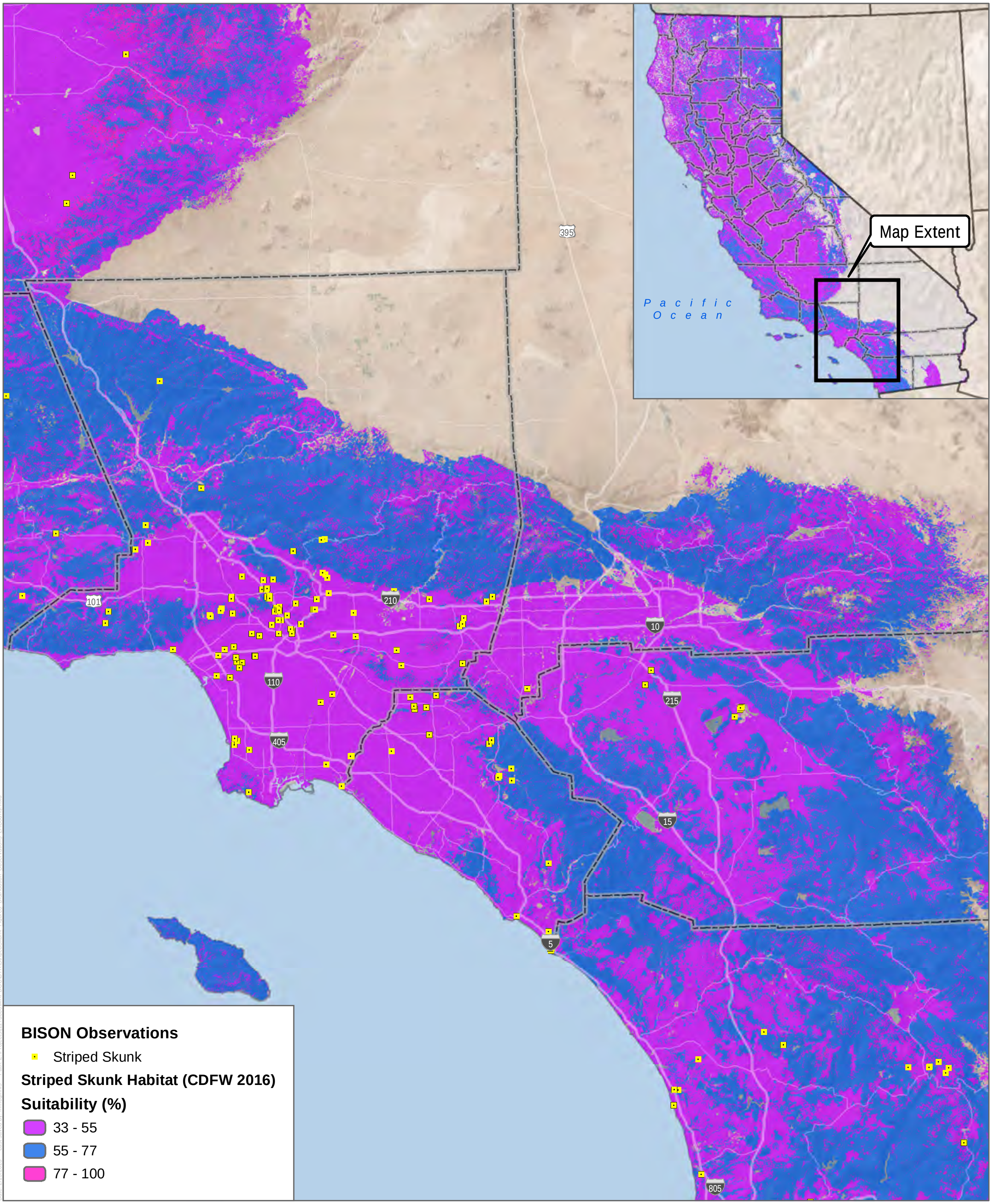

SOURCE: CDFW 2016; USGS 2020

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FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Striped Skunk in the Los Angeles County Area

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Striped skunks have widely varying home range sizes as described in the various research-literature sources as summarized in Table 3; however, there is increasing evidence in the literature that striped skunks are not territorial (e.g., Bixler and Gittleman 2000; Larivière and Messier 1996; Larivière and Messier 1998). For species that do not defend their home ranges against conspecifics (other members of the species), home range data cannot be used to estimate density or population size.

Striped skunks are able to live in suburban and urban regions and many studies show that skunk density is higher in urban areas than in natural areas (e.g., Salek et al. 2015). However, due to the paucity of publications on striped skunk density in urban areas, urban and non-urban population estimates for this species were not separated.

One method was used to estimate the striped skunk population by county in California: the average population density across all published studies for striped skunks, equivalent to 6.7 individuals/km^2 (Table 3). A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for each value reference):

   Average population density of 6.7 individuals/km^2 ((4.6 + 0.95 + 12.7 + 0.405 + 20.5 + 3.6 + 4.3 individuals/km^2)/7) multiplied by the top two-thirds of suitable habitat area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For striped skunk, the top two-thirds of suitable habitat represent only 89% (273,472 km^2) (Table 2) of the total estimated species range in California (307,773 km^2) (CDFW 2016); thus, the population estimate is likely to be somewhat conservative.

The estimated population size for striped skunk in California is 1,830,939 individuals using the density-based method (Table 4). This approach assumes the following: that no striped skunks occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. This approach also assumes that the population density values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California.

Table 3. Striped Skunk Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Density Estimation Method	Location	Population Density (individuals/km^2)	Sample Size
Bailey 1971	Trapping	Capture-recapture	Ohio (1967)	4.6 (12/square mile)	24 (density); 5 Male (home range)
Bjorge et al. 1981	Trapping	Total captures in study area (minimum density)	Alberta and Saskatchewan, Canada (1971-1974)	0.95 [average of 1973 (1.2) and 1974 (0.7)]	155 (Density 1973); 93 (Density 1974); 6 Female (home range)
Ferris and Andrews 1967	Trapping	Capture-recapture	Illinois (1961-1963)	12.7 (capture-recapture) (11.6-25.9 by method)	12
Hansen et al. 2004	Trapping	Jolly-Seber Capture-recapture with 64% added buffers	Texas (1994-1995)	0.405 (Average of four study sites over two years listed in Table 1)	69 Male, 35 Female
Lynch 1972	Trapping	Capture-recapture	Manitoba, Canada (1966)	20.5 (36 per 435 acres)	—
Pengeroth 1991	Trapping	Total captures in the study area (minimum density)	Montana (1988-1990)	3.6 (before removals; 1988 data)	219
Rosatte et al. 1992	Capture-recapture	Modified Petersen capture-recapture Index	Ontario, Canada (1987-1990)	4.3 (average of low and high densities on p. 934)	705

Table 4. Statewide and County Striped Skunk Population Estimates

County	Population Density-Based (6.7 individuals/km^2)	County	Population Density-Based (6.7 individuals/km^2)
Alameda	12,250	Orange	13,568
Alpine	8,111	Placer	22,022
Amador	9,150	Plumas	42,365
Butte	27,739	Riverside	41,917
Calaveras	16,928	Sacramento	16,680
Colusa	19,793	San Benito	23,834

Table 4. Statewide and County Striped Skunk Population Estimates

County	Population Density-Based (6.7 individuals/km^2)	County	Population Density-Based (6.7 individuals/km^2)
Contra Costa	12,377	San Bernardino	24,805
Del Norte	13,285	San Diego	58,001
El Dorado	25,343	San Francisco	775
Fresno	83,731	San Joaquin	24,074
Glenn	22,304	San Luis Obispo	55,232
Humboldt	44,892	San Mateo	6,238
Imperial	16,318	Santa Barbara	46,743
Inyo	17,123	Santa Clara	21,746
Kern	99,261	Santa Cruz	6,112
Kings	23,505	Shasta	61,427
Lake	20,846	Sierra	14,854
Lassen	76,546	Siskiyou	94,556
Los Angeles	51,997	Solano	13,933
Madera	31,536	Sonoma	24,714
Marin	8,239	Stanislaus	25,762
Mariposa	22,637	Sutter	10,420
Mendocino	49,727	Tehama	49,507
Merced	33,371	Trinity	41,298
Modoc	66,456	Tulare	68,513
Mono	39,641	Tuolumne	27,002
Monterey	56,619	Ventura	30,970
Napa	12,621	Yolo	17,420
Nevada	13,829	Yuba	10,274
		Total	**1,830,939**

Notes:

1 The non-urban and urban suitable habitat totals are multiplied by the respective non-urban and urban population density value and the results are summed together for the total population estimate.

2 The non-urban and urban suitable habitat totals are divided by the respective non-urban and urban home range value and the results are summed together for the total population estimate.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Bailey, T.N. 1971. "Biology of Striped Skunks on a Southwestern Lake Erie Marsh. The American Midland Naturalist 85(1).

Bjorge, R.R., J.R. Gunson, and W.M. Samuel. 1981. "Population Characteristics and Movements of Striped Skunks (Mephitis mephitis) in Central Alberta." The Canadian Field-Naturalist 95.

Bixler, A. and J.L. Gittleman. 2000. "Variation in Home Range and Use of Habitat in the Striped Skunk (*Mephitis mephitis*)." *Journal of Zoology* 251(4): 525–533.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Striped Skunk Predicted Habitat (CWHR M162). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Ferris, D.H. and R.D. Andrews. 1967. "Parameters of a Natural Focus of Leptospira pomona in Skunks and Opossums." Bulletin of the Wildlife Disease Association Vol 3. January.

Hansen, L.A., Mathews, N.E., Vander Lee, B.A. and Lutz, R.S. 2004. Population characteristics, survival rates, and causes of mortality of striped skunks (Mephitis mephitis) on the southern high plains, Texas. *The Southwestern Naturalist*, *49*(1), pp.54-60.

Larivière, S., and F. Messier. 1996. "Aposematic Behavior in the Striped Skunk, Mephitis mephitis. Ethology 102: 986-992

Larivière, S., and F. Messier. 1998. "Spatial Organization of a Prairie Striped Skunk Population during the Waterfowl Nesting Season." *Journal of Wildlife Management* 62(1): 199–204.

Lynch, G. 1972. Effect of Strychnine Control on Nest Predators of Dabbling Ducks. Journal of Wildlife Management Vol 36(2)

Pengeroth, D.M. 1991. Characteristics of a striped skunk population in the Mission Valley Montana. Graduate Student Theses, Dissertations, & Professional Papers. 6997. https://scholarworks.umt.edu/etd/6997

Rosatte, R.C., Power, M.J. and MacInnes, C.D. 1992. Density, dispersion, movements and habitat of skunks (Mephitis mephitis) and raccoons (Procyon lotor) in metropolitan Toronto. In *Wildlife 2001: populations* (pp. 932-944). Springer, Dordrecht.

Salek, M., L. Drahnikova, and E. Tkadlec. 2015. "Changes in home range sizes and population densities of carnivore species along the natural to urban habitat gradient." Mammal Review 45: 1-14.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C13 North American Beaver Population and Distribution

The following describes the distribution and population estimate of North American beaver (*Castor canadensis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, North American beaver observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 137 beaver observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of North American Beaver Across California

Dataset	Number of Observations	Date Range
North American Beaver Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	137	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

American beavers are able to live in urban regions, adjacent to natural habitat. This means that beaver populations can occur in urban areas and their home ranges include urban landscapes. Therefore, Table 2 includes urban habitat within the top two-thirds of suitable modeled habitat.

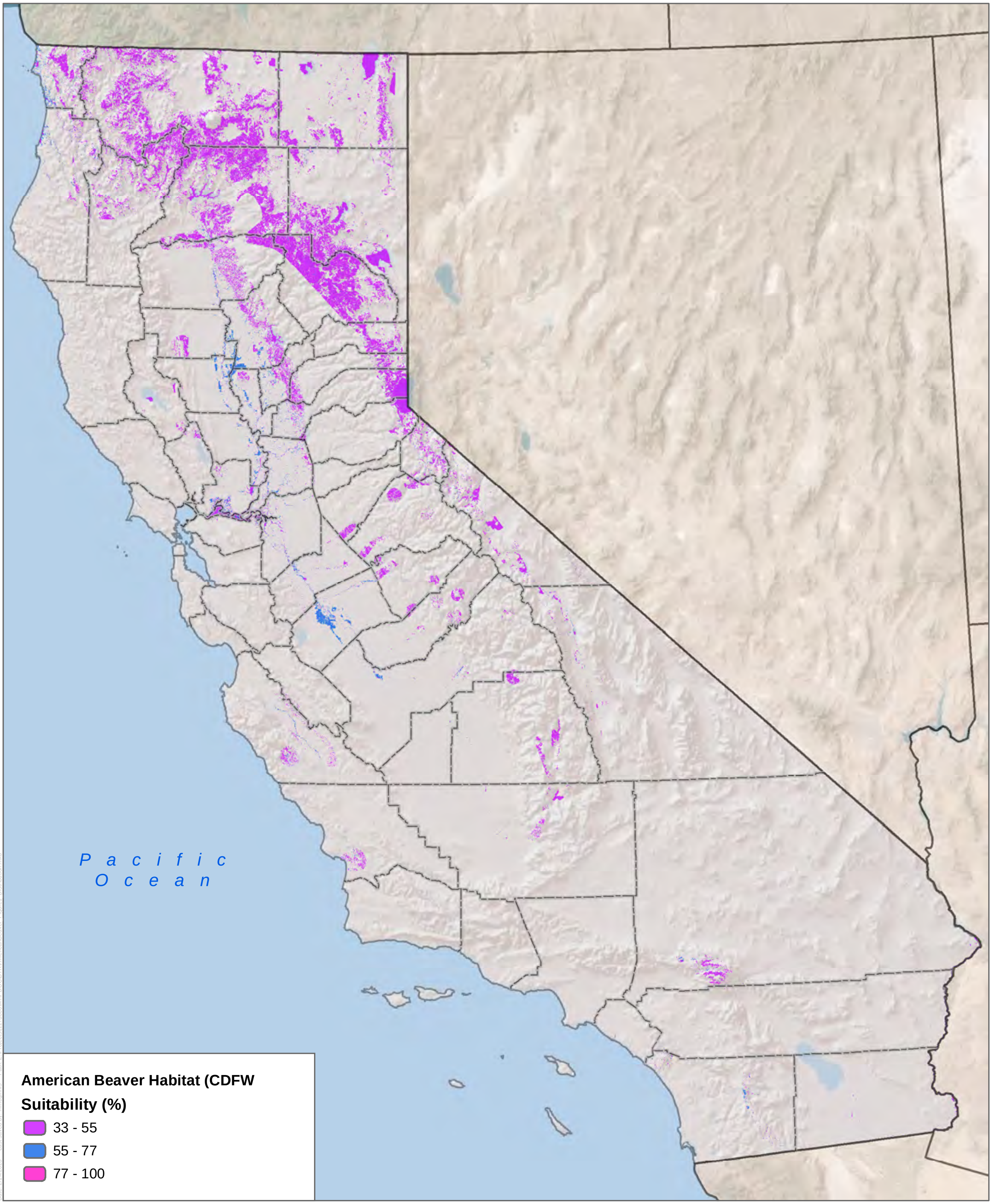
Table 2. North American Beaver Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	0
Alpine	248	Placer	604
Amador	6	Plumas	2,642
Butte	579	Riverside	17
Calaveras	72	Sacramento	188
Colusa	112	San Benito	13
Contra Costa	78	San Bernardino	207

Table 2. North American Beaver Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Del Norte	538	San Diego	69
El Dorado	310	San Francisco	0
Fresno	80	San Joaquin	114
Glenn	159	San Luis Obispo	80
Humboldt	276	San Mateo	0
Imperial	32	Santa Barbara	0
Inyo	100	Santa Clara	0
Kern	96	Santa Cruz	0
Kings	2	Shasta	2,872
Lake	46	Sierra	360
Lassen	1,716	Siskiyou	4,130
Los Angeles	0	Solano	257
Madera	147	Sonoma	0
Marin	0	Stanislaus	76
Mariposa	152	Sutter	154
Mendocino	4	Tehama	758
Merced	252	Trinity	1,123
Modoc	1,263	Tulare	241
Mono	423	Tuolumne	285
Monterey	155	Ventura	0
Napa	26	Yolo	89
Nevada	263	Yuba	234
		Total Statewide Suitable Habitat	**21,646**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of beaver statewide (Figure 2), and modeled habitat and observations in the Sacramento Valley area (Figure 3). The figures show that the majority of beaver observations occur *outside* of the top two-thirds of suitable habitat and many occur *outside* the species' range (CDFW 2016, data not shown). These data suggest that the CDFW (2016) range and habitat data for North American beaver do not accurately represent the entirety of beaver range and habitat in California. This suggests that these methods, which rely on these habitat data, will substantially underestimate the population due to the widespread occurrence of beaver outside of the top two-thirds of suitable habitat and outside of the species' estimated range. This is likely to be especially noticeable for some counties that likely have beaver populations even though they appear not to based on the habitat (and range) data from CDFW. For example, Marin and Santa Clara Counties both have several beaver observations but contain no habitat or range data.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable American Beaver Habitat from CDFW Habitat Suitability Model

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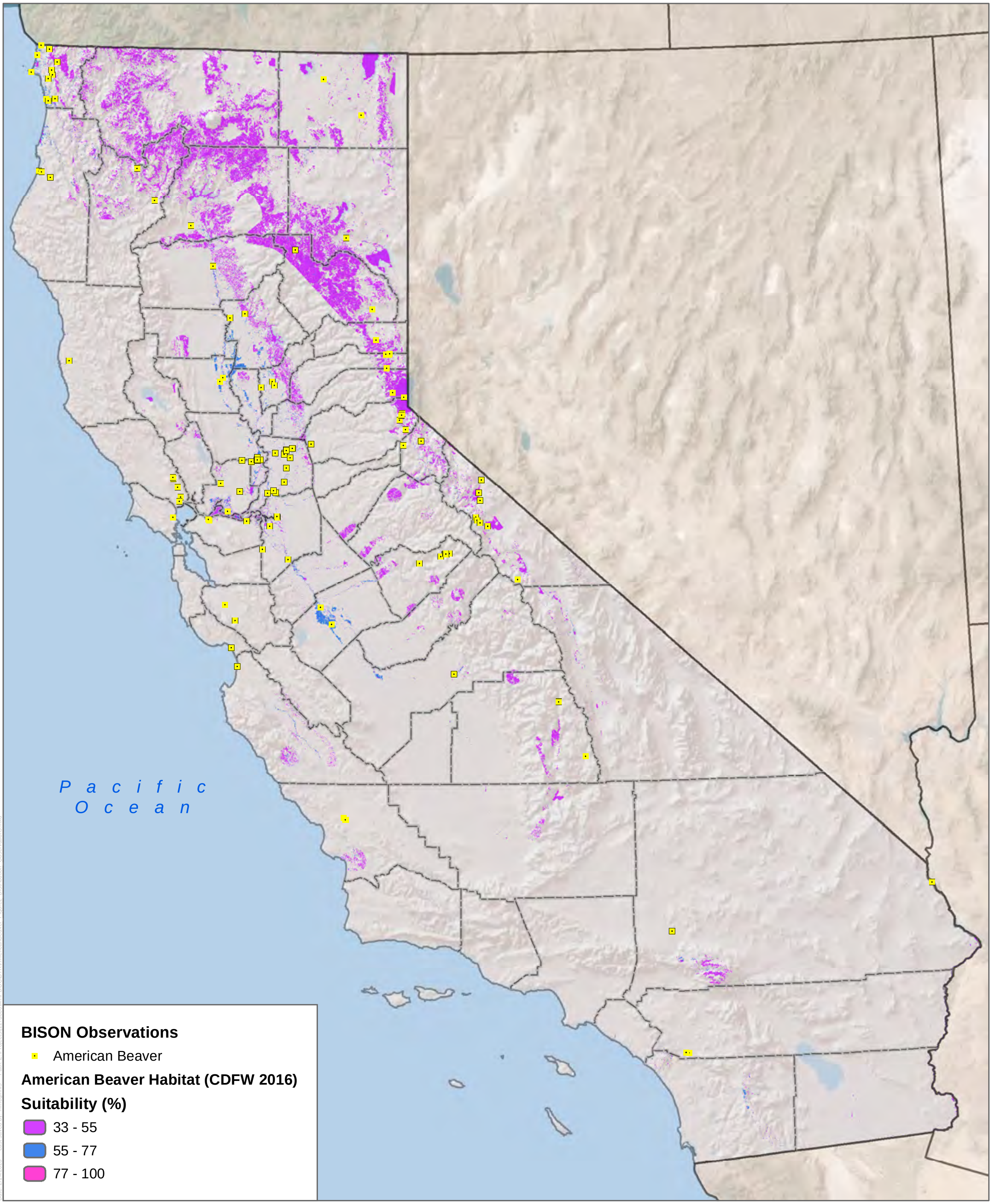

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of American Beaver Statewide

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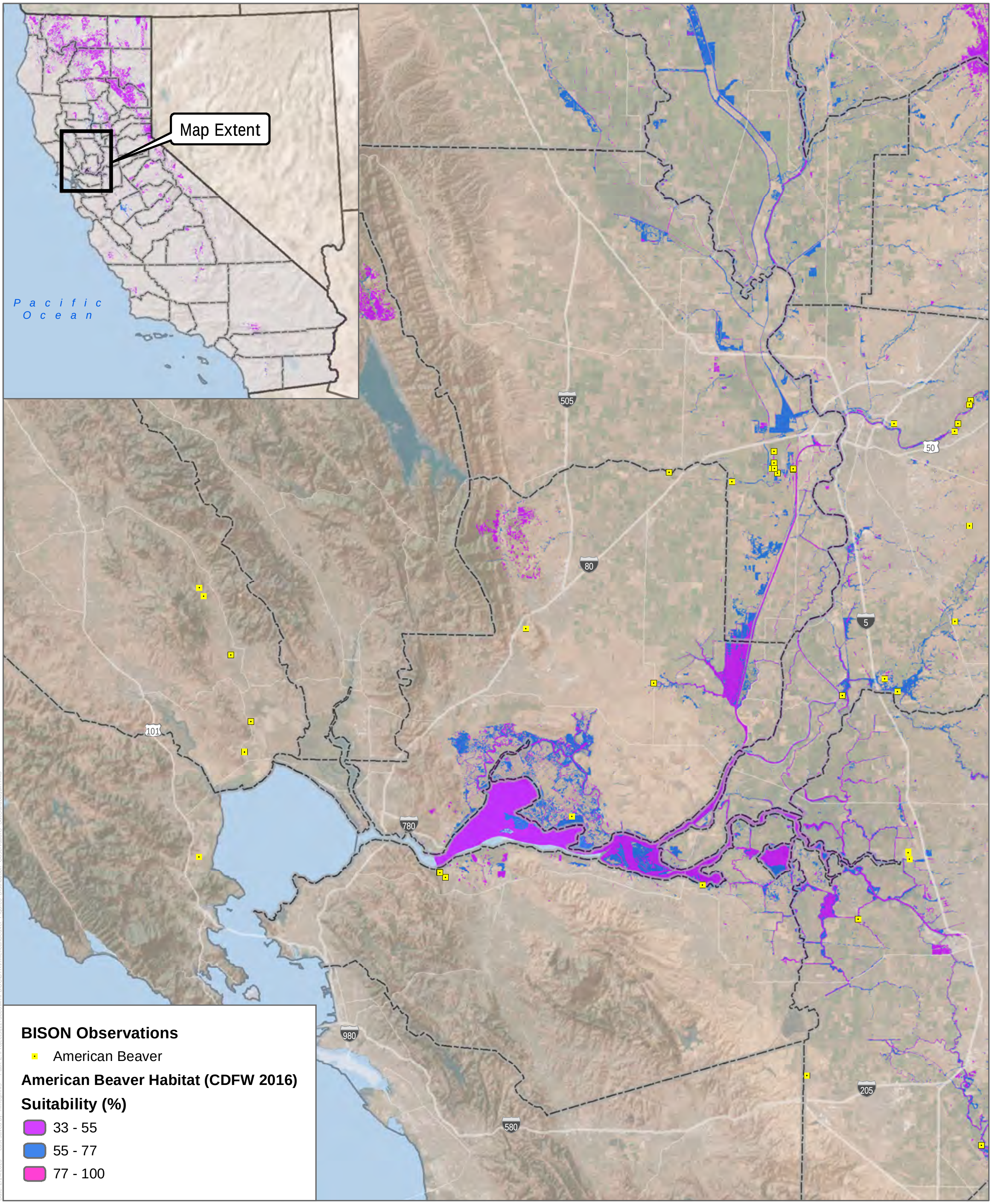

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of American Beaver in the North Sacramento San Joaquin Delta Area

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American beavers have relatively constant reported home range sizes from North American populations as described in the various research-literature sources summarized in Table 3. American beavers are able to live in urban regions. Beaver live in family colonies that occupy a single home range. Colony size ranges from 3.7 to 8.2 beavers (Peterson and Payne 1986; Busher et al. 1983). There were 10 different colony sizes reported in the literature: 3.7 (Peterson and Payne 1986), 7.6 (Novak 1977), 3.5 (Payne 1982), 5.7 (Peterson 1979), 5.9 (Svendsen 1980), 4.8 (site 1) (Busher et al. 1983), 8.2 (site 2) (Busher et al. 1983), 3.7 (study site) (Bergerud and Miller 1977), 5.1 (nuisance beavers nearby) (Bergerud and Miller 1977), and 5.6 (McTaggert and Nelson 2003). The average of these 10 colony sizes is 5.4 beavers per colony. This average was used to estimate the population size in California.

Two methods were used to estimate the North American beaver population by county in California: (1) average beaver colony density as indicated by active colonies/km multiplied by 5 to account for area, and then multiplied by 5.4 beavers per colony (calculated above), and (2) the average adult female home range size across all published studies for North American beaver (0.21 km^2), multiplied by 5.4 beavers per colony (calculated above). Colony densities reported as densities per km were converted to densities per square km by multiplying the linear density by 5 because beavers primarily use areas 100 meters on either side of occupied waterways (i.e., 200 meters total) (Salandre et al. 2017; Touihri et al. 2018). Accordingly, each linear km of waterway is approximately 0.2 km^2 (0.2 km width times 1 km length). In other words, 1 beaver/km is approximately 5 beavers/km^2. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average density of 7.8 beaver/km^2 ((17.7 + 3.03 + 10.8 + 6.0 + 4.6 + 2.4 + 2.16 + 5.1 + 18.1 beaver/km^2)/9) multiplied by the amount of Top Two-Thirds of Suitable Habitat Area (km^2) in each county.
2. Home Range-Based Estimate (see Table 3 for references):

   Top Two-Thirds of Suitable Habitat Area (km^2) in each county divided by average colony home range value of 0.21 km^2 ((0.23 km^2 + 0.19 km^2)/2) and multiplied by 5.4 beavers per colony.

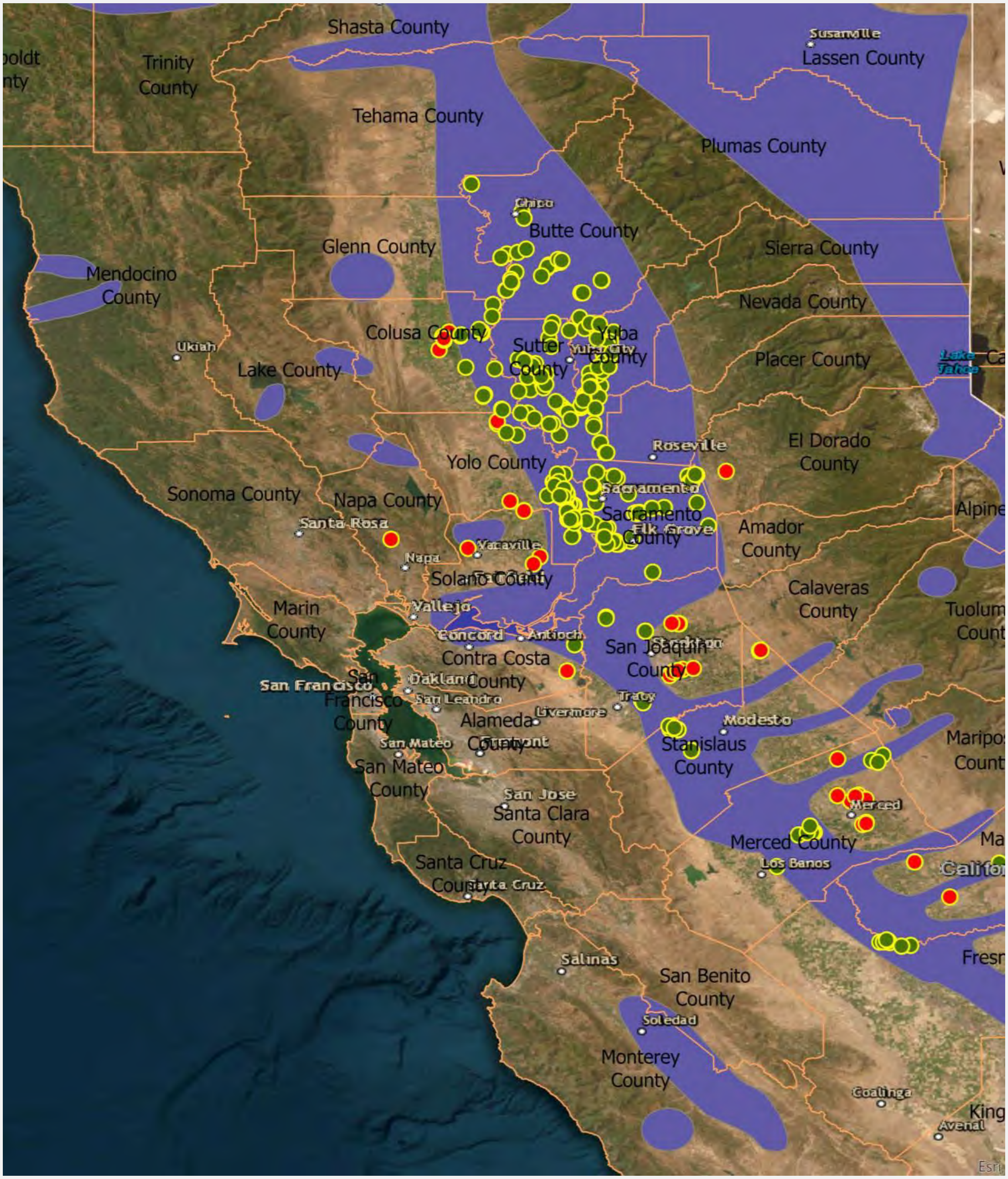
The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For beaver, the top two-thirds of suitable habitat represent only 30% (32,586 km^2) (Table 2) of the total estimated species range in California (109,198 km^2) (CDFW 2016); thus, the populations estimates are likely to be extremely conservative. The conservative nature of these methods is also supported by the observation data presented herein, the majority of which occur outside of the top two-thirds of beaver habitat (Figures 2 and 3) (CDFW 2016), and many of which occur outside of the species estimated range (Figure 2) (CDFW 2016, data not shown). Clearly, beaver occupy areas outside of their top two-thirds habitat and outside of their estimated range, while these methods assume they do not. Therefore, these methods will tend to considerably underestimate the population. In addition, some studies (e.g., Bloomquist et al. 2012; Wheatley 1994) have shown home range overlap among beaver colonies. Because other studies found no such overlap, 0% overlap was assumed among colonies. This conservative assumption will tend to underestimate the population.

WS-California wildlife damage management data also provide evidence that the CDFW range map underestimates current beaver range in California: 64 (9.0%) of 715 recorded locations where WS-California has provided beaver damage management activities were outside of the CDFW beaver range (Figure 4) (CDFW 2016).

The estimates for population size for North American beaver in California are 168,839 individuals based on the density method and 556,612 individuals based on the home range method (Table 4). These approaches assume the following: there is 100% home range overlap among individual adult beavers within a colony (male-male, female-male, and female-female), there is a no colony-colony overlap, each colony contains on average 5.4 individuals, no American beavers occupy any of the bottom one-third of suitable habitat, and all available top-two-thirds suitable habitat is occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Figure 4. WS-California beaver damage management locations from 2019–2022 within (green dots) and outside of (red dots) estimated beaver range (beaver range: dark blue polygons; CDFW 2016) in north-central California.



Notes: CDFW = California Department of Fish and Wildlife.

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Table 3. North American Beaver Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Among Colonies	Colony Home Range Size (km^2)[1]	Population Density[2] (individuals/km^2)
Bloomquist et al. 2012	radio telemetry	95% KDE	Illinois (2005-2006)	9.8%	0.23 (average; no gender difference)	ND
Bloomquist and Nielsen 2010	radio telemetry	NA	Illinois (2004-2005)	ND	ND	17.7 beavers/km^2 (see footnote[3])
Busher 1987	capture/recapture & tracking	NA	Sagehen Creek, California (1977-1979)	ND	ND	3.03 beaver/km^2 (see footnote[4])
Cox and Nelson 2009	tracking & visual survey	NA	Illinois (2001-2002)	ND	ND	10.8 beaver/km^2 (see footnote[5])
Johnston and Naiman 1990	Aerial photography	NA	Minnesota (1961-1986)	ND	ND	6.0 beavers/km^2 (see footnote[6])
Johnston and Windels 2015	Aerial survey of active colonies	NA	Minnesota (1958-2006)	ND	ND	4.6 beaver/km^2 (see footnote[7])
Mayer et al. 2020	direct count active colonies	NA	Minnesota (2008-2010)	ND	ND	2.4 beaver/km^2 (see footnote[8])
Potvin et al. 2005	Aerial survey of active colonies	NA	Quebec, Canada (1990-1995, 2002-2003)	ND	ND	2.16 beaver/km^2 (see footnote[9])
Ribic et al. 2017	Aerial survey of active colonies	NA	Wisconsin (1987-2013)	ND	ND	5.1 beaver/km^2 (see footnote[10])
Smith et al. 1994	Aerial survey & trapping	NA	Wisconsin	ND	ND	18.1 beaver/km^2 (see footnote[11])
Wheatley 1994	radio telemetry	MCP	Manitoba, Canada	ND (16% among colonies which overlapped)	0.19 (overall average)	ND

Notes: NA = Not Applicable, ND = Not Determined; MCP = minimum convex polygon; KDE = Kernel Density Estimate.

1 When home range was reported in kilometers of waterway, the value was multiplied by 0.2 kilometers to get square kilometers.

2 Population density of individuals/km^2 was calculated by taking the colony density in kilometers of waterway, dividing by 0.2 to get km^2 and then multiplying by 5.4, which is the average number of individuals per colony.

3 Authors report 3.27 colonies/km^2 which was converted to 17.7 beavers/km^2 by multiplying by the average of 5.4 beavers/colony: 3.27 x 5.4 = 17.7.

[4] Author reports 3.48 beaver/habitable km stream (average of 2.96 in 1977 and 4.00 in 1979). This was converted to km stream using the author's conversion of 5.75 km stream/1 habitable km stream: 3.48 / 5.75 = 0.605 beaver/km stream. This was converted to beaver/km^2 using the average of 5 km stream/km^2: 0.605 beaver/km stream X 5 km stream/km^2 = 3.03 beaver/km^2.

[5] Authors report 0.40 colonies/km stream which was converted to 10.8 beaver/km^2 by multiplying by 5 km stream/km^2 and average of 5.4 beavers/colony: 0.40 x 5 x 5.4 = 10.8.

[6] Authors report maximum number of beaver colonies on the 294 km^2 site: 234, 278, 398, and 398. The average number of colonies is 327, which is 1.11 colonies/km^2. This was converted to 6.0 beavers/km^2 by multiplying by 5.4 beavers/colony: 327/294 = 1.11; 1.11 x 5.4 = 6.0.

[7] Authors report densities of 0.33, 1.2, 0.9, 0.97, 1.00, and 0.76 colonies/km^2. The average is 0.86 colonies/km^2 which was converted to 4.6 beaver/km^2 by multiplying by 5.4 beavers/colony: 0.86 x 5.4 = 4.6.

[8] Authors report 0.79 and 0.10 active lodges/km^2. The average of these is 0.445 colonies/km^2 which was converted to 2.4 beaver/km^2 by multiplying by the average of 5.4 beaver/colony: 0.445 x 5.4 = 2.4.

[9] Authors report 0.31, 0.35, and 0.54 colonies/km^2. The average of these is 0.4 colonies/km^2 which was converted to 2.16 beavers/km^2 by multiplying by the average of 5.4 beavers/colony: 0.4 x 5.4 = 2.16 beavers/km^2.

[10] Authors report beaver colony densities without beaver removals of 0.226, 0.173, 0.218, 0.213, 0.071, and 0.225 colonies/km stream. The average of these values is 0.188 colonies/km stream which was converted to 5.1 beaver/km^2 by multiplying by 5 km stream/km^2 and 5.4 beavers/colony: 0.188 x 5 x 5.4 = 5.1.

[11] Authors report 0.54, 0.17, 0.04, 0.98, 1.03, and 1.28 colonies/km stream in Table 1. The average of these is 0.67 colonies/km which was converted to 18.1 beavers/km^2 by multiplying by 5km stream/km^2 and 5.4 beavers/colony: 0.67 x 5 x 5.4 = 18.1.

Table 4. Statewide and County North American Beaver Population Estimates

County	Population Density (7.8/km^2)[1]	Adult Female Home Range (0.21 km^2)[2]	County	Population Density (7.8/km^2)[1]	Adult Female Home Range (0.21 km^2)[2]
Alameda	0	0	Orange	0	0
Alpine	1,935	6,380	Placer	4,708	15,522
Amador	48	158	Plumas	20,604	67,926
Butte	4,518	14,894	Riverside	131	432
Calaveras	563	1,856	Sacramento	1,467	4,836
Colusa	870	2,870	San Benito	100	329
Contra Costa	606	1,998	San Bernardino	1,615	5,323
Del Norte	4,194	13,825	San Diego	541	1,783
El Dorado	2,414	7,959	San Francisco	0	0
Fresno	628	2,070	San Joaquin	886	2,919
Glenn	1,238	4,082	San Luis Obispo	623	2,055
Humboldt	2,153	7,097	San Mateo	0	0
Imperial	248	818	Santa Barbara	0	0
Inyo	783	2,580	Santa Clara	0	0
Kern	747	2,463	Santa Cruz	0	0
Kings	18	59	Shasta	22,403	73,857
Lake	356	1,174	Sierra	2,812	9,269

Table 4. Statewide and County North American Beaver Population Estimates

County	Population Density (7.8/km^2)[1]	Adult Female Home Range (0.21 km^2)[2]	County	Population Density (7.8/km^2)[1]	Adult Female Home Range (0.21 km^2)[2]
Lassen	13,382	44,115	Siskiyou	32,216	106,206
Los Angeles	0	0	Solano	2,004	6,606
Madera	1,146	3,778	Sonoma	0	0
Marin	0	0	Stanislaus	591	1,947
Mariposa	1,187	3,914	Sutter	1,199	3,954
Mendocino	28	93	Tehama	5,916	19,502
Merced	1,965	6,479	Trinity	8,759	28,875
Modoc	9,850	32,471	Tulare	1,879	6,193
Mono	3,299	10,874	Tuolumne	2,224	7,332
Monterey	1,205	3,974	Ventura	0	0
Napa	206	679	Yolo	693	2,284
Nevada	2,054	6,772	Yuba	1,829	6,029
			Total	**168,839**	**556,612**

Note:
1 The urban and non-urban suitable habitat is summed together and multiplied by the population density value.
2 The urban and non-urban suitable habitat is summed together and divided by the home range value.

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Bergerud, A.T. and D.R. Miller. 1977. “Population dynamics of Newfoundland beaver.” Canadian Journal of Zoology 55.

Bloomquist, C.K., C.K. Nielsen. 2010. Demographic characteristics of unexploited beavers in southern Illinois. J. Wildl. Manage., 74:228–235.

Bloomquist, C.K., C.K. Nielsen, and J.J. Shew. 2012. “Spatial Organization of Unexploited Beavers (*Castor canadensis*) in Southern Illinois.” *American Midland Naturalist* 167(1): 188–197.

Busher, P.E. 1987. “Population Parameters and Family Composition of Beaver in California.” *Journal of Mammalogy* 68(4): 860–864.

Busher, P.E., R.J. Warner, and S.H. Jenkins. 1983. “Population Density, Colony Composition, and Local Movements in Two Sierra Nevadan Beaver Populations.” *Journal of Mammalogy* 64(2): 314–318.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Beaver Predicted Habitat (CWHR M112). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

Cox, D.R., and T.A. Nelson. 2009. “Beaver Habitat Models for Use in Illinois Streams.” *Transactions of the Illinois State Academy of Science* 102(1&2): 55–64.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Johnston, C.A. and R.J. Naiman. 1990. “Aquatic Patch Creation in Relation to Beaver Population Trends.” Ecology 71(4): 1617-1621.

Johnston, C.A. and Windels, S.K., 2015. Using beaver works to estimate colony activity in boreal landscapes. The Journal of Wildlife Management, 79(7), pp.1072-1080.

Mayer, M., Aparicio Estalella, C., Windels, S.K. and Rosell, F.N. 2020. Landscape structure and population density affect intraspecific aggression in beavers. *Ecology and Evolution*, *10*(24), pp.13883-13894.

McTaggert, S.T., and T.A. Nelson. 2003. "Composition and Demographics of Beaver (*Castor canadensis*) Colonies in Central Illinois." *American Midland Naturalist* 150(1): 139–150.

Novak, M., 1977. "Determining the Average Size and Composition of Beaver Families." Journal of Wildlife Management 41(4)751-754.

Payne, N.F. 1982. "Colony Size, Age and Sex Structure of Newfoundland Beaver." Journal of Wildlife Management 46(3):655-661

Peterson, R.P. 1979. "Nuisance Beaver Biology and Control in North-Central Wisconsin." M.S. Thesis. College of Natural Resources, University of Wisconsin. August.

Peterson, R.P., and N.F. Payne. 1986. "Productivity, Size, Age, and Sex Structure of Nuisance Beaver Colonies in Wisconsin. Journal of Wildlife Management 50(2): 265-268.

Potvin, F., Breton, L. and Courtois, R., 2005. Response of beaver, moose, and snowshoe hare to clear-cutting in a Quebec boreal forest: a reassessment 10 years after cut. Canadian journal of forest research, 35(1), pp.151-160.

Ribic, C.A., Donner, D.M., Beck, A.J., Rugg, D.J., Reinecke, S. and Eklund, D., 2017. Beaver colony density trends on the Chequamegon-Nicolet National Forest, 1987–2013. Plos One, 12(1), p.e0170099.

Salandre, J.A., Beil, R., Loehr, J.A. and Sundell, J. 2017. Foraging decisions of North American beaver (Castor canadensis) are shaped by energy constraints and predation risk. *Mammal Research*, *62*(3), pp.229-239.

Smith, D.W., D.R. Trauba, R.K. Anderson, and R.O. Peterson. 1994. "Black Bear Predation on Beavers on an Island in Lake Superior." *American Midland Naturalist* 132(2): 248–255.

Svendsen, G.E. 1980. "Population Parameters and Colony Composition of Beaver (*Castor canadensis*) in Southeast Ohio." *American Midland Naturalist* 104(1): 47–56.

Touihri, M., Labbé, J., Imbeau, L. and Darveau, M. 2018. North American beaver (Castor canadensis Kuhl) key habitat characteristics: Review of the relative effects of geomorphology, food availability and anthropogenic infrastructure. *Ecoscience*, *25*(1), pp.9-23.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Wheatley, M. 1994. "Boreal Beavers (*Castor canadensis*): Home Range, Territoriality, Food Habits and Genetics of a Mid-Continent Population." PhD dissertation; Department of Zoology, University of Manitoba, Winnipeg. April 1994.

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C14 North American Porcupine Population and Distribution

The following describes the distribution and population estimate of North American porcupine (*Erethizon dorsatum*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, porcupine observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 555 porcupine observations between 2000 and 2020.

Table 1. Observations and Modeled Distribution of North American Porcupine across California

Dataset	Number of Observations	Date Range
Porcupine Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	22	2000–2018
CNDDB (CDFW 2022)	523	2000–2020

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.

[1] Data accessed December 11, 2020.

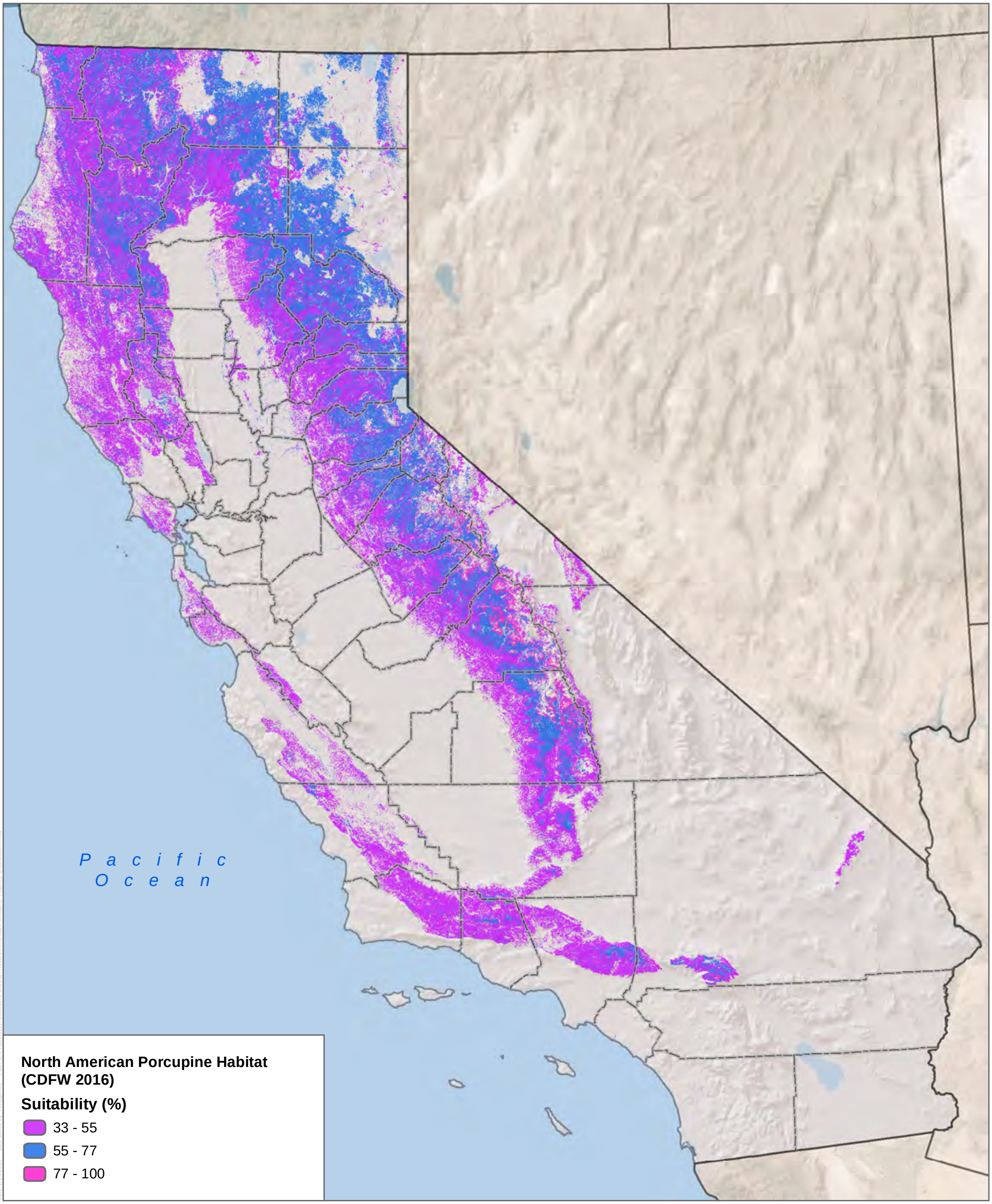
Table 2. North American Porcupine Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	0
Alpine	1,257	Placer	2,633
Amador	1,009	Plumas	5,638
Butte	2,380	Riverside	0
Calaveras	1,929	Sacramento	72
Colusa	326	San Benito	359
Contra Costa	0	San Bernardino	1,371
Del Norte	2,145	San Diego	0
El Dorado	3,592	San Francisco	0
Fresno	4,971	San Joaquin	3

Table 2. North American Porcupine Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Glenn	732	San Luis Obispo	1,660
Humboldt	6,174	San Mateo	269
Imperial	0	Santa Barbara	2,233
Inyo	871	Santa Clara	130
Kern	3,593	Santa Cruz	398
Kings	0	Shasta	7,405
Lake	2,196	Sierra	2,010
Lassen	3,955	Siskiyou	11,859
Los Angeles	2,788	Solano	5
Madera	2,546	Sonoma	1,467
Marin	452	Stanislaus	42
Mariposa	2,752	Sutter	147
Mendocino	5,838	Tehama	3,118
Merced	3	Trinity	7,590
Modoc	2,784	Tulare	6,066
Mono	1,601	Tuolumne	4,432
Monterey	1,229	Ventura	1,952
Napa	460	Yolo	28
Nevada	2,087	Yuba	771
		Total Statewide Suitable Habitat	**119,327**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of porcupine statewide (Figure 2), and modeled habitat and observations in the Lake Tahoe area (Figure 3). The figures show that the majority of porcupine observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). Some observations occur outside of this habitat and outside of the species' range (CDFW 2016, data not shown). Overall, these data support the accuracy of the CDFW (2016) range and habitat data for porcupine and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of porcupine outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable North American Porcupine Habitat from CDFW Habitat Suitability Model

DUDEK

0 25 50 Miles

Biological Technical Report for the Wildlife Damage Management Project

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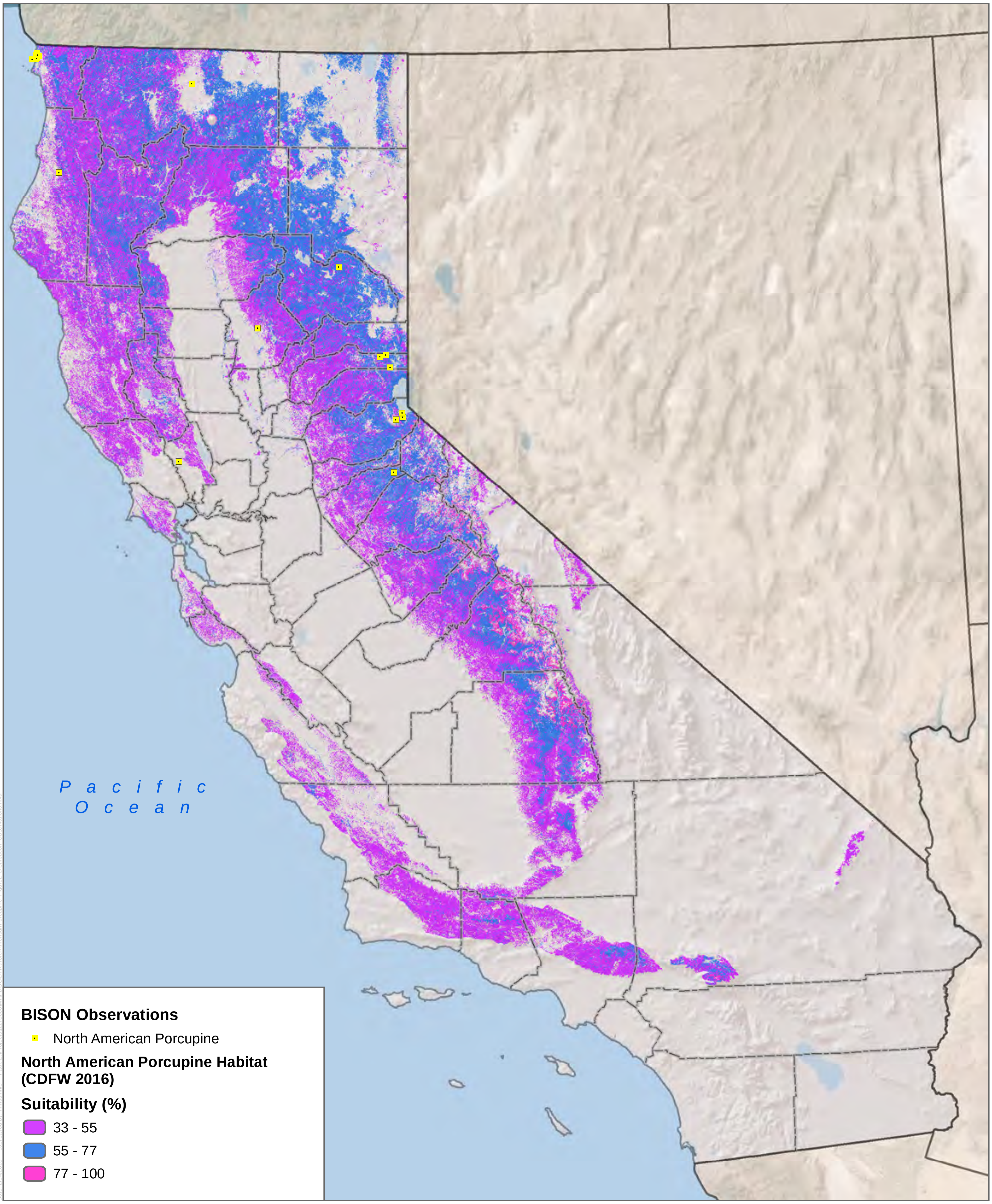

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of North American Porcupine Statewide

DUDEK 0 25 50 Miles

Biological Technical Report for the Wildlife Damage Management Project

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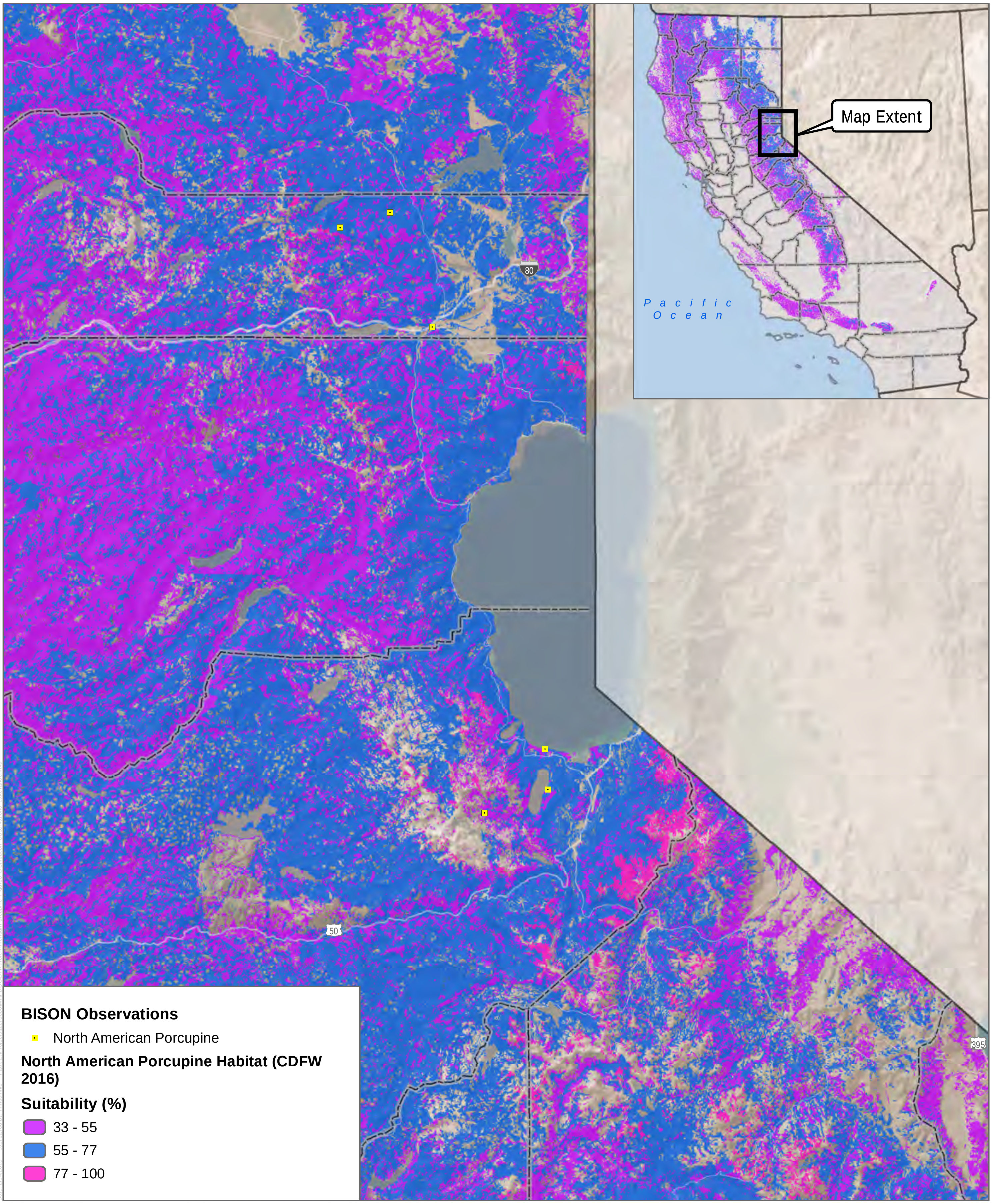

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of North American Porcupine in the Lake Tahoe Area

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0 2 4 Miles

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Porcupines have slightly varying home range sizes as described in the various research-literature sources from North American populations as summarized in Table 3. Two methods were used to estimate the porcupine population by county in California: (1) a published population density of 3.4 individuals/km^2 and (2) a female home range size averaged across all published studies for porcupine equivalent to 0.76 km^2 with no home range overlap and multiplied by 2 for a 1:1 male to female ratio and. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Population Density of 3.4 individuals/km^2 multiplied by the amount of Suitable Habitat Area (km^2) in each county.

2. Home Range-Based Estimate (see Table 3 for references):

   Suitable Habitat Area (km^2) in each county divided by 0.76 km^2 (average adult female home range value (0.39 km^2 + 0.89 km^2 + 1.58 km^2 + 0.79 km^2 + 0.154 km^2)/5) and multiplied by 2 to include males.

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For porcupine, the top two-thirds of suitable habitat represent only 60% (119,327 km^2) (Table 2) of the total estimated species range in California (198,066 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of porcupine habitat (Figure 2) (CDFW 2016). Porcupines appear to occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to considerably underestimate the population.

The estimates for population size for porcupines in California are 405,710 individuals using the density-based method and 314,017 individuals using the home range-based method (Table 4). These approaches assume the following: that there is no home range overlap among female porcupines, that no porcupines occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. North American Porcupine Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Appel et al. 2018	Radio- and GPS collar	95% KDE	Del Norte County, California (2015)	ND	0.39	ND	8 Male, 10 Female
Band 1996	Capture-recapture	NA	Wyoming (1994-1995)	ND	ND	3.4	13 Male, 28 Female
Coltrane and Sinnott 2012	Radio-collar	95% FK	Alaska (2005-2008)	ND	0.89 (winter)	ND	8 Male, 11 Female
Johnson 1977	Radio-collar	100% MCP	South Dakota (1976-1977)	ND	1.58	ND	3 Female
Mally 2008	Radio-collar	99% FK	Montana (2007-2008)	ND	0.79	ND	4 Male, 8 Female
Morin et al. 2005	Radio-collar, direct observation	100% MCP	Quebec, Canada (2001)	ND	0.154	ND	9 Male, 8 Female

Notes: KDE = kernel density estimators; NA = not applicable; ND = Not Determined; FK = fixed kernel; MCP = minimum convex polygon.

Table 4. Statewide and County North American Porcupine Population Estimates

County	Population Density (3.4/km²)	Female Home Range (0.76 km²)	County	Population Density (3.4/km²)	Female Home Range (0.76 km²)
Alameda	0	0	**Orange**	0	0
Alpine	4,274	3,308	**Placer**	8,951	6,928
Amador	3,430	2,655	**Plumas**	19,168	14,836
Butte	8,092	6,263	**Riverside**	0	0

Table 4. Statewide and County North American Porcupine Population Estimates

County	Population Density (3.4/km²)	Female Home Range (0.76 km²)	County	Population Density (3.4/km²)	Female Home Range (0.76 km²)
Calaveras	6,559	5,076	Sacramento	245	190
Colusa	1,108	858	San Benito	1,219	944
Contra Costa	0	0	San Bernardino	4,662	3,608
Del Norte	7,293	5,645	San Diego	0	0
El Dorado	12,213	9,452	San Francisco	0	0
Fresno	16,903	13,083	San Joaquin	10	8
Glenn	2,487	1,925	San Luis Obispo	5,643	4,368
Humboldt	20,990	16,246	San Mateo	914	708
Imperial	0	0	Santa Barbara	7,592	5,876
Inyo	2,960	2,291	Santa Clara	441	341
Kern	12,216	9,455	Santa Cruz	1,352	1,047
Kings	0	0	Shasta	25,178	19,488
Lake	7,467	5,779	Sierra	6,835	5,290
Lassen	13,448	10,409	Siskiyou	40,319	31,207
Los Angeles	9,481	7,338	Solano	18	14
Madera	8,658	6,701	Sonoma	4,988	3,861
Marin	1,537	1,190	Stanislaus	144	111
Mariposa	9,356	7,242	Sutter	498	386
Mendocino	19,850	15,364	Tehama	10,602	8,206
Merced	11	9	Trinity	25,806	19,973
Modoc	9,467	7,327	Tulare	20,625	15,963
Mono	5,443	4,213	Tuolumne	15,070	11,664
Monterey	4,177	3,233	Ventura	6,638	5,138
Napa	1,563	1,210	Yolo	95	73
Nevada	7,095	5,491	Yuba	2,620	2,028
			Total	**405,710**	**314,017**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Appel, C.L., P.N. Belamaric, and W.T. Bean. 2018. "Seasonal Resource Acquisition Strategies of a Facultative Specialist Herbivore at the Edge of its Range." *Journal of Mammalogy* 99(5): 1,159–1,173.

Band, A.L. 1996. "Population Characteristics and Habitat Use of Porcupines in a Partially Burned Landscape in Northwestern Wyoming." Master's thesis; University of Montana.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement /?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Common Porcupine Predicted Habitat (CWHR M145). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Coltrane, J.A., and Sinnott, R. 2012. Winter home range and habitat use by porcupines in Alaska. *The Journal of wildlife management*, *77*(3), pp.505-513.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Johnson, J. 1977. Biology of the Porcupine (Erethizon dorsatum) in northwestern South Dakota.

Mally, K.A. 2008. "Hierarchical Summer Habitat Selection by the North American Porcupine in Western Montana." Master's thesis; University of Montana.

Morin, P., D. Berteaux, and I. Klvana. 2005. "Hierarchical Habitat Selection by North American Porcupines in Southern Boreal Forest." *Canadian Journal of Zoology* 83(10): 1333–1342.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C15 Yellow-Bellied Marmot Population and Distribution

The following describes the distribution and population estimate of yellow-bellied marmot (*Marmota flaviventris*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, yellow-bellied marmot observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 221 marmot observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Yellow-Bellied Marmot across California

Dataset	Number of Observations	Date Range
Marmot Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	221	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

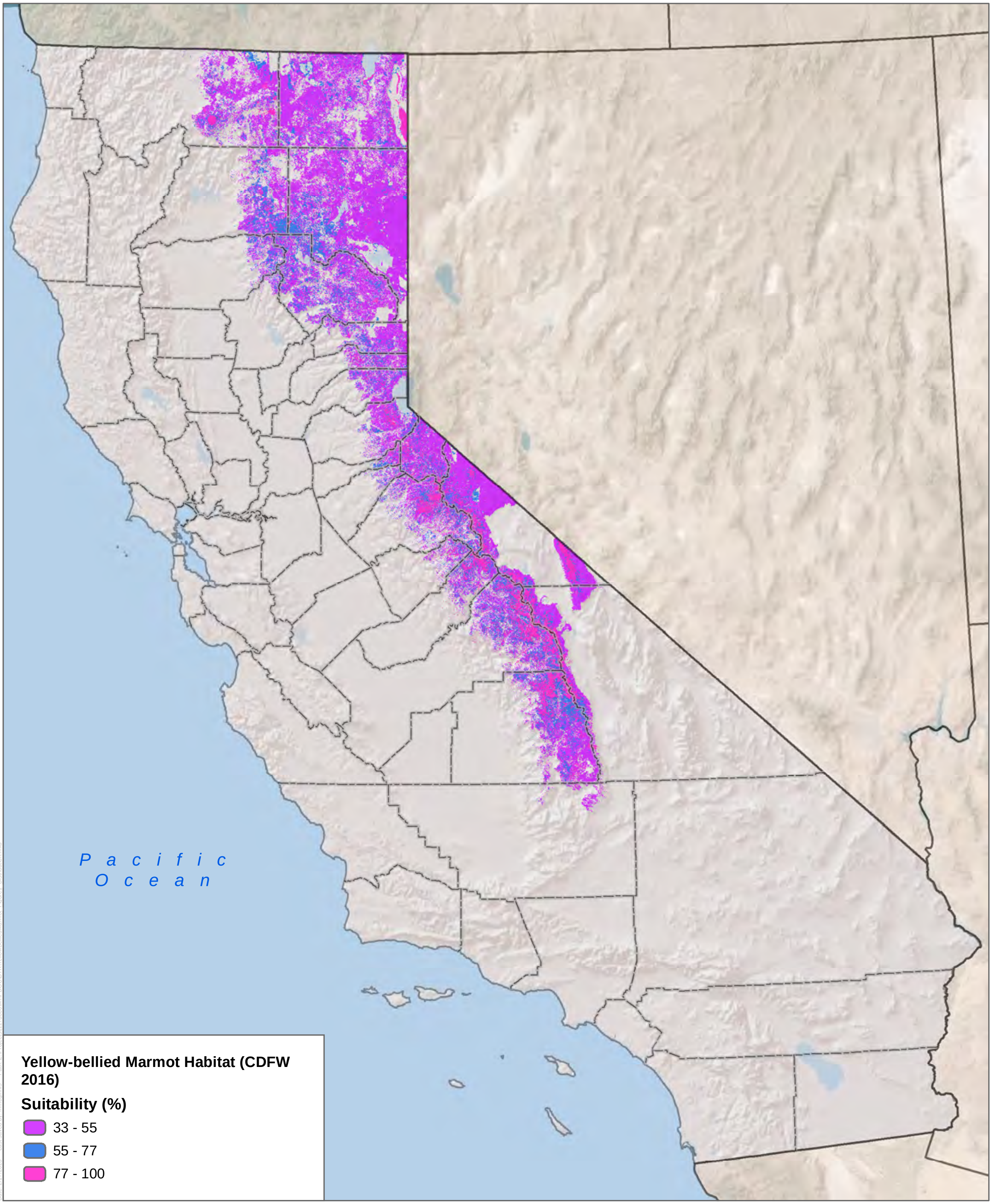
Table 2. Yellow-Bellied Marmot Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Alameda	0	Orange	0
Alpine	1,734	Placer	937
Amador	259	Plumas	4,327
Butte	170	Riverside	0
Calaveras	206	Sacramento	0
Colusa	0	San Benito	0
Contra Costa	0	San Bernardino	0
Del Norte	0	San Diego	0
El Dorado	1,266	San Francisco	0
Fresno	3,402	San Joaquin	0
Glenn	0	San Luis Obispo	0
Humboldt	0	San Mateo	0

Table 2. Yellow-Bellied Marmot Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Imperial	0	Santa Barbara	0
Inyo	1,969	Santa Clara	0
Kern	231	Santa Cruz	0
Kings	0	Shasta	2,241
Lake	0	Sierra	1,189
Lassen	8,958	Siskiyou	3,497
Los Angeles	0	Solano	0
Madera	1,077	Sonoma	0
Marin	0	Stanislaus	0
Mariposa	453	Sutter	0
Mendocino	0	Tehama	668
Merced	0	Trinity	0
Modoc	6,832	Tulare	3,982
Mono	4,119	Tuolumne	2,275
Monterey	0	Ventura	0
Napa	0	Yolo	0
Nevada	645	Yuba	0
		Total Statewide Suitable Habitat	**50,440**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of yellow-bellied marmots statewide (Figure 2), and modeled habitat and observations in the High Sierra/Mono Lake area (Figure 3). The figures show that the majority of yellow-bellied marmot observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). Some observations occur outside of this habitat and outside of the species' range (CDFW 2016, data not shown). Overall, these data support the accuracy of the CDFW (2016) range and habitat data for yellow-bellied marmot and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of yellow-bellied marmots outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Yellow-bellied Marmot Habitat from CDFW Habitat Suitability Model

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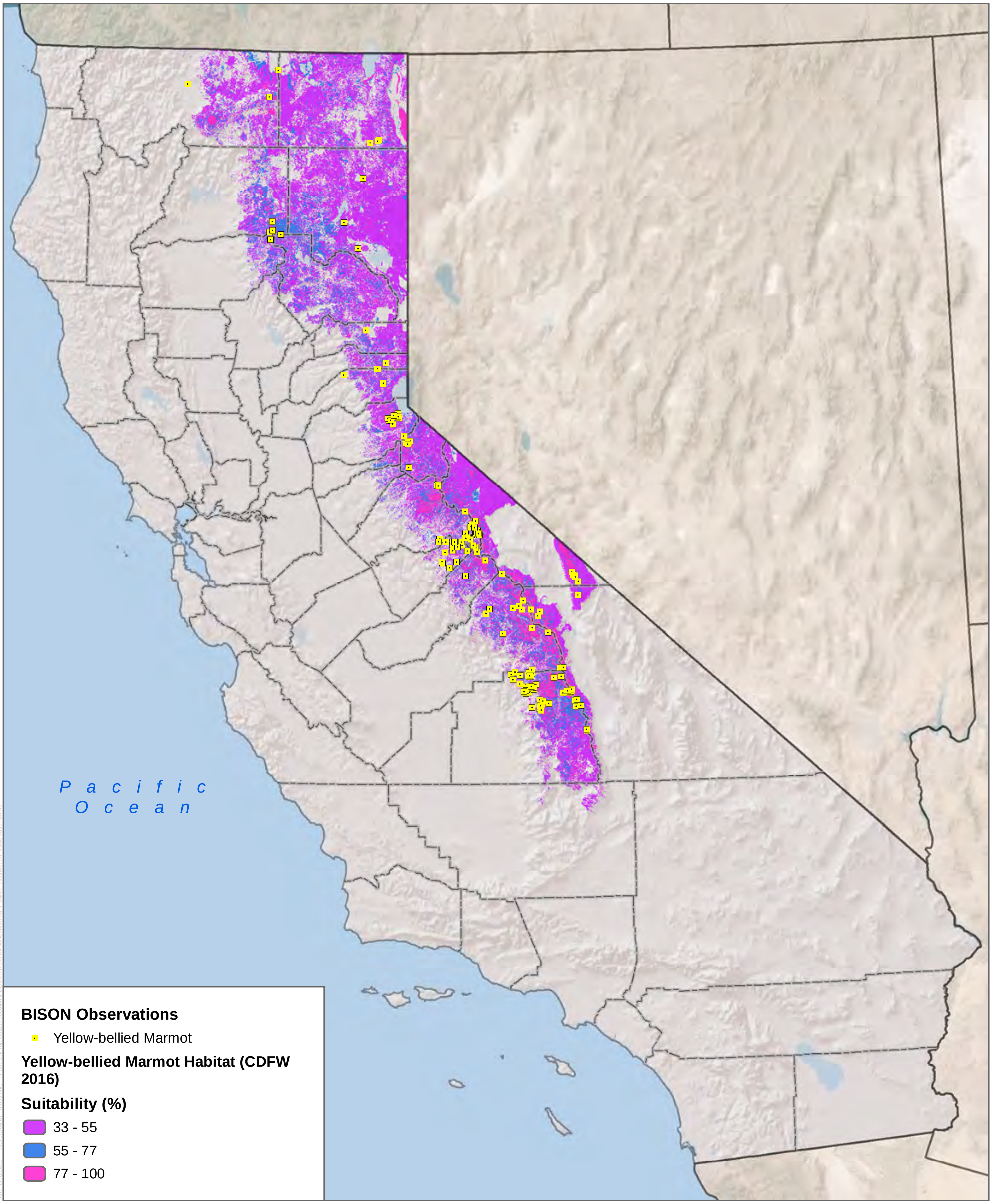

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Yellow-bellied Marmot Statewide

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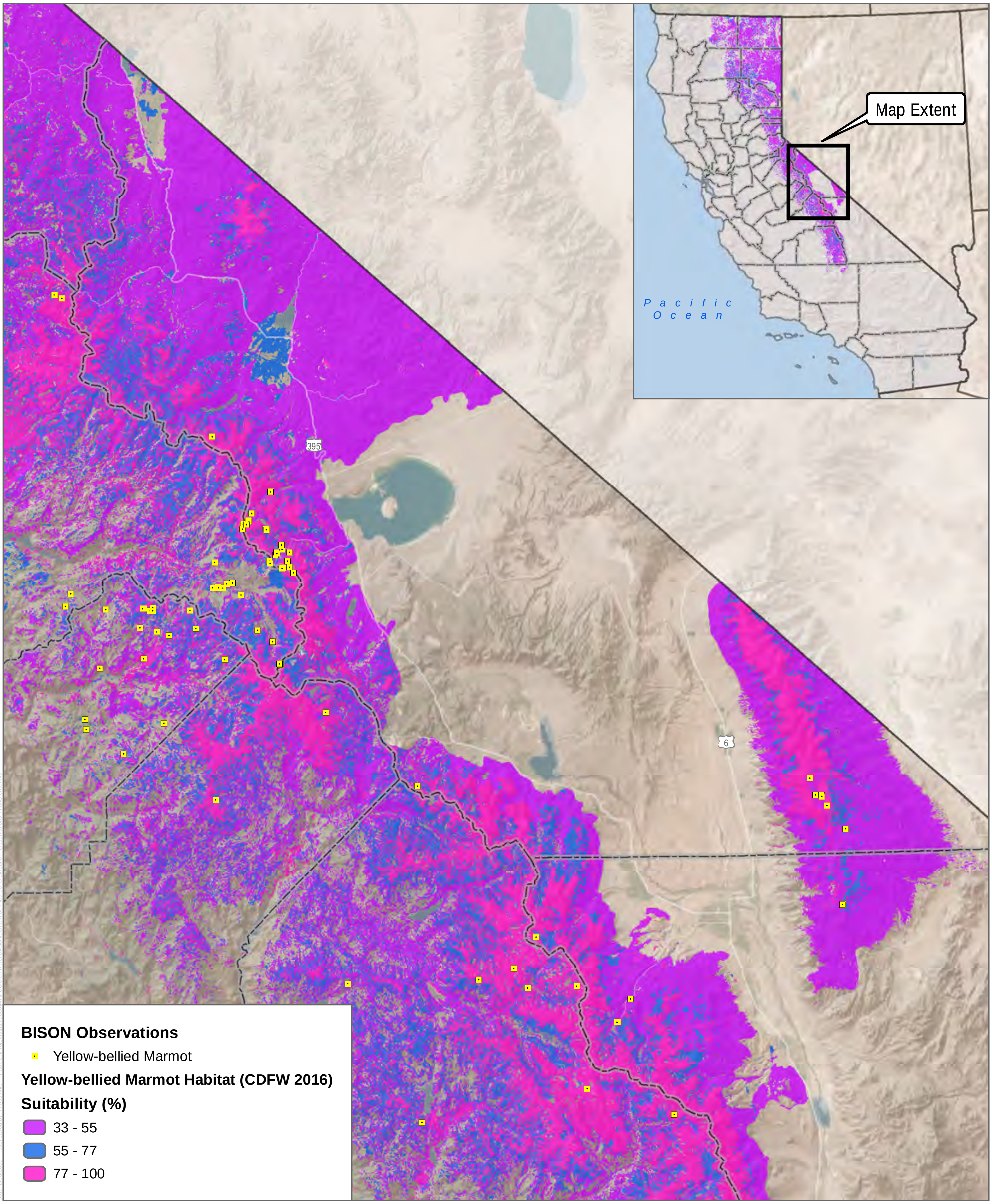

SOURCE: CDFW 2016

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Yellow-bellied Marmot in the High Sierra/Mono Lake Area

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Yellow-bellied marmots have widely varying home range sizes as described in the various research-literature sources from North American populations. However, yellow-bellied marmots form social colonies (Armitage 1962; Johns and Armitage 1979; Armitage 2013) and no evidence was found that females are territorial. As such the use of female home range size to estimate population size is not appropriate for this species. To estimate the yellow-bellied marmot population by county in California, the only published population density found for yellow-bellied marmots was used, 6.9 individuals/km^2 (Table 3). A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):

   Reported Density of 6.9 individuals/km^2 multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For yellow-bellied marmot, the top two-thirds of suitable habitat represent only 65% (50,440 km^2) (Table 2) of the total estimated species range in California (77,446 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of marmot habitat (Figures 2 and 3) (CDFW 2016). Since yellow-bellied marmots occupy areas outside of their top two-thirds habitat, while these methods assume they do not, these methods will tend to considerably underestimate the population.

The estimated yellow-bellied marmot population size in California is 348,034 individuals using the density-based method (Table 4). This approach assumes the following: that no yellow-bellied marmots occupy any of the bottom one-third of suitable habitat, and that all available top-two-thirds suitable habitat is fully occupied. These approaches also assume that the population density range value from the reviewed literature is applicable to California, despite the fact the cited study was for a population outside California.

The statewide and county estimates are provided in Table 4.

Table 3. Yellow-Bellied Marmot Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Svendsen 1974	Trapping, marking, direct observation	Gunnison County, Colorado	6.9

Table 4. Statewide and County Yellow-Bellied Marmot Population Estimates

County	Population Density (6.9 individuals/km^2)	County	Population Density (6.9 individuals/km^2)
Alameda	0	Orange	0
Alpine	11,967	Placer	6,467
Amador	1,790	Plumas	29,859

Table 4. Statewide and County Yellow-Bellied Marmot Population Estimates

County	Population Density (6.9 individuals/km^2)	County	Population Density (6.9 individuals/km^2)
Butte	1,172	Riverside	0
Calaveras	1,424	Sacramento	0
Colusa	0	San Benito	0
Contra Costa	0	San Bernardino	0
Del Norte	0	San Diego	0
El Dorado	8,737	San Francisco	0
Fresno	23,477	San Joaquin	0
Glenn	0	San Luis Obispo	0
Humboldt	0	San Mateo	0
Imperial	0	Santa Barbara	0
Inyo	13,583	Santa Clara	0
Kern	1,594	Santa Cruz	0
Kings	0	Shasta	15,466
Lake	0	Sierra	8,205
Lassen	61,813	Siskiyou	24,130
Los Angeles	0	Solano	0
Madera	7,431	Sonoma	0
Marin	0	Stanislaus	0
Mariposa	3,129	Sutter	0
Mendocino	0	Tehama	4,609
Merced	0	Trinity	0
Modoc	47,139	Tulare	27,476
Mono	28,421	Tuolumne	15,696
Monterey	0	Ventura	0
Napa	0	Yolo	0
Nevada	4,448	Yuba	0
		Total	**348,034**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Armitage, K.B. 1962. "Social behaviour of a colony of the yellow-bellied marmot (Marmota flaviventris)." Animal Behaviour, Volume 10, Issues 3-4: 319–320.

Armitage, K.B. 2013. Social organization, reproductive success and population dynamics in a high-elevation Yellow-bellied Marmot colony. Oecologia Montana, 22(1), pp.1-10.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Yellow-bellied marmot Predicted Habitat (CWHR M066). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Johns, D.W., and Armitage, K.B. 1979. Behavioral ecology of alpine yellow-bellied marmots. Behavioral Ecology and Sociobiology, 5(2), pp.133-157.

Svendsen, G.E. 1974. Behavioral and environmental factors in the spatial distribution and population dynamics of a yellow-bellied marmot population. *Ecology*, *55*(4), pp.760-771.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C16 Big-Eared Woodrat Population and Distribution

The following describes the distribution and population estimate of big-eared woodrat (*Neotoma macrotis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, big-eared woodrat observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 46 big-eared woodrat observations between 2000 and 2020.

Table 1. Observations and Modeled Distribution of Big-Eared Woodrat across California

Dataset	Number of Observations	Date Range
Big Eared Woodrat Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	38	2000–2018
CNDDB (CDFW 2022)	8	2000–2020

Notes: BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database; CDFW = California Department of Fish and Wildlife.

1 Data accessed December 11, 2020.

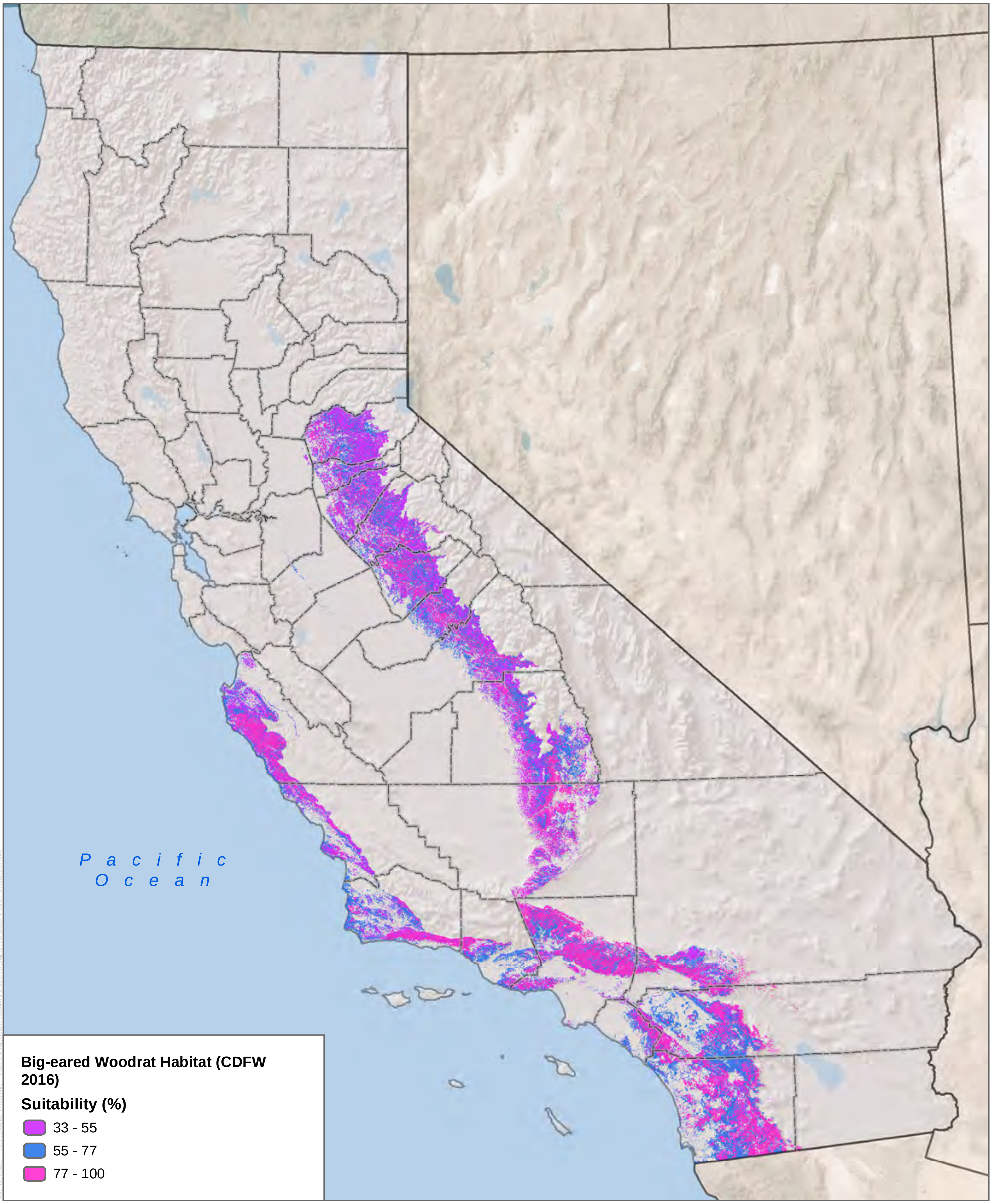
Table 2. Big-Eared Woodrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	658
Alpine	0	Placer	0
Amador	744	Plumas	0
Butte	0	Riverside	3,465
Calaveras	1,723	Sacramento	21
Colusa	0	San Benito	2
Contra Costa	2	San Bernardino	1,889
Del Norte	0	San Diego	5,569
El Dorado	2,592	San Francisco	0

Table 2. Big-Eared Woodrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Fresno	1,946	San Joaquin	12
Glenn	0	San Luis Obispo	1,216
Humboldt	0	San Mateo	0
Imperial	17	Santa Barbara	1,909
Inyo	6	Santa Clara	0
Kern	2,874	Santa Cruz	0
Kings	0	Shasta	0
Lake	0	Sierra	0
Lassen	0	Siskiyou	0
Los Angeles	3,964	Solano	0
Madera	1,398	Sonoma	0
Marin	0	Stanislaus	36
Mariposa	2,194	Sutter	0
Mendocino	0	Tehama	0
Merced	13	Trinity	0
Modoc	0	Tulare	3,613
Mono	0	Tuolumne	2,412
Monterey	2,593	Ventura	1,135
Napa	0	Yolo	0
Nevada	0	Yuba	0
		Total Statewide Suitable Habitat	**42,001**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of big-eared woodrats statewide (Figure 2), and modeled habitat and observations in the San Diego area (Figure 3). The figures show that the majority of big-eared woodrat observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). However, some observations occur outside of this habitat and outside of the species' range (CDFW 2016, data not shown). Considering the small number of observations, the five observations outside of the habitat and range data represent 14% of observations. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for big-eared woodrat and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of big-eared woodrats outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Big-eared Woodrat Habitat from CDFW Habitat Suitability Model

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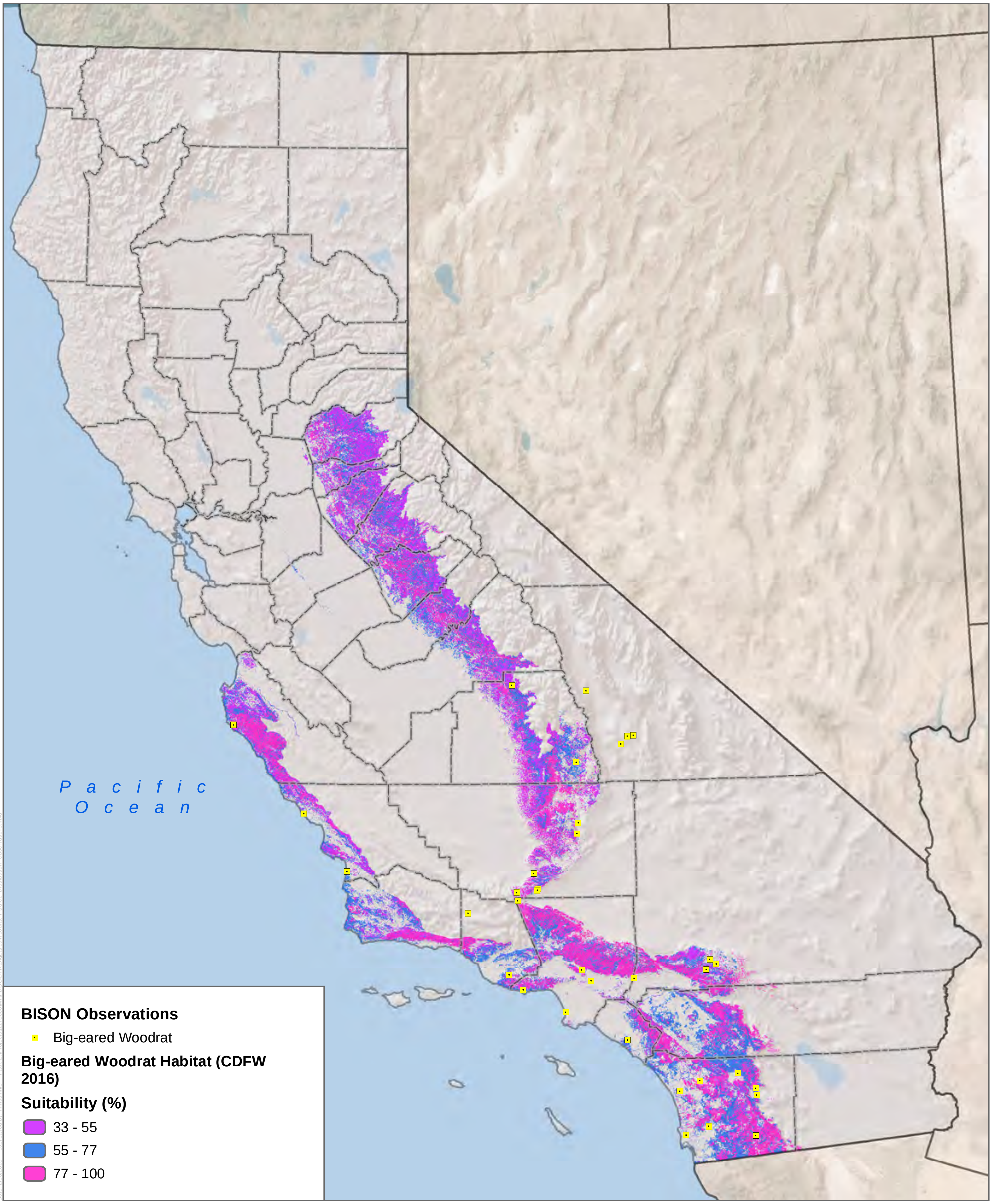

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Big-eared Woodrat Statewide

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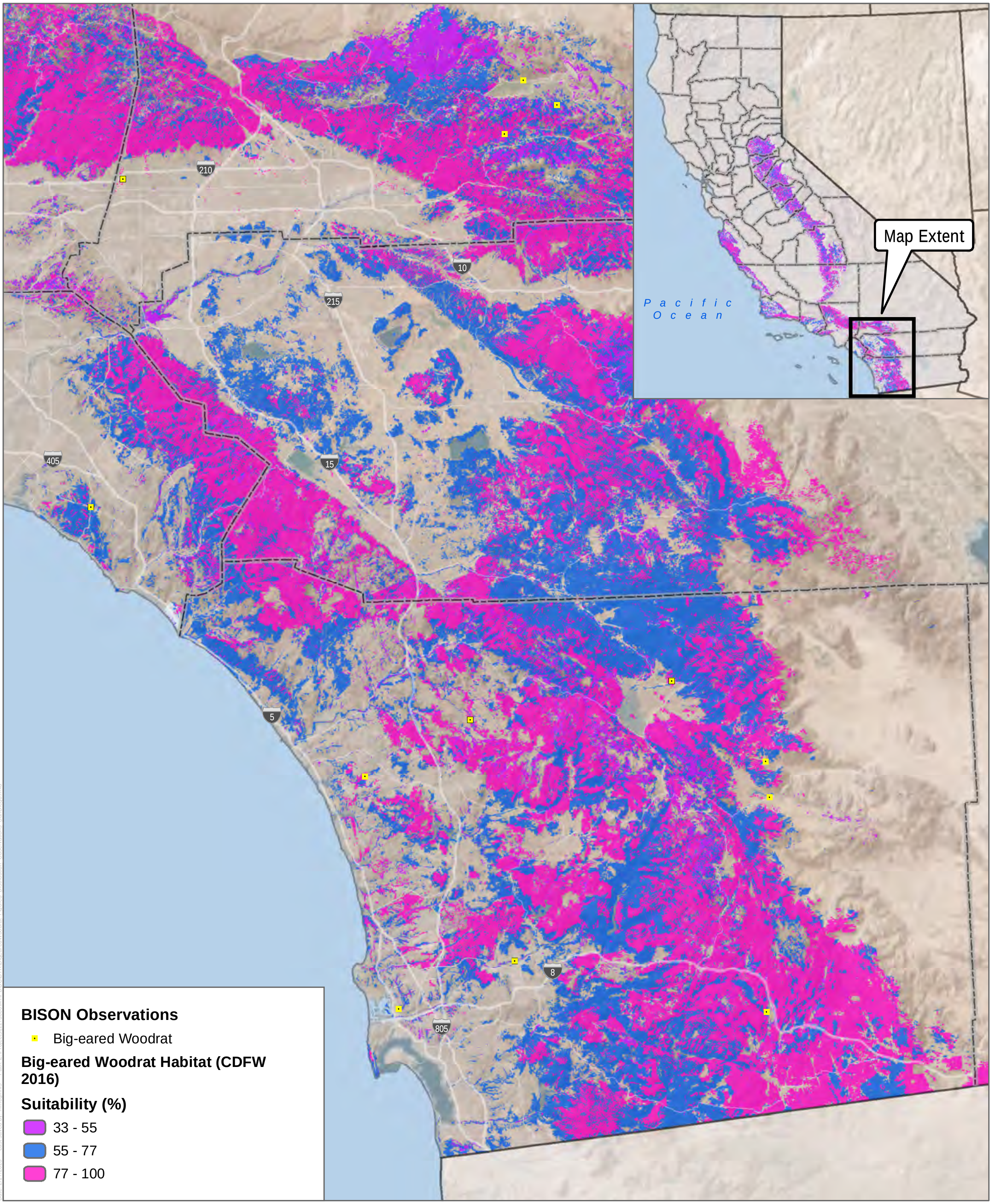

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Big-eared Woodrat in San Diego County

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Although woodrats are considered solitary species and are often considered territorial, they share territory, interact socially, and form kin-structured communities that are not fully understood (Matocq and Lacey 2004; McEachern et al. 2007; Inness et al. 2012). Therefore, the use of home range data to infer population numbers is not appropriate for these species and only density data were used to estimate the population sizes.

Because woodrats are not uniformly distributed on the landscape, data from studies of individual woodrat groups were not used; the inclusion of such studies would have resulted in an artificially high population estimate. Only studies reporting density over larger areas consisting of numerous woodrat groups were used. Woodrat species often occur within communities, where their densities are often very high (e.g., Wallen 1982; Matocq 2004; Abad et al. 2020). However, densities over larger areas are much lower, as reported in Table 3.

The big-eared woodrat population was estimated using the average density estimate for dusky-footed woodrats (*Neotoma fuscipes*) (1,048 woodrats/km^2) because no reliable larger-scale density data were found for big-eared woodrats (Table 3). Dusky-footed woodrats are a very similar species within the same genus (*Neotoma*); big-eared and dusky-footed woodrats were considered to be the same species until 2002 (Matocq 2002). As such, some studies of dusky-footed woodrats prior to 2002 actually studied what are now known as big-eared woodrats. This approach was used to estimate population sizes for each county. A summary of the population estimation method is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average reported Density for dusky-footed woodrat of 1,048 individuals/km^2 multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For big-eared woodrat, the top two-thirds of suitable habitat represent only 56% (42,001 km^2) (Table 2) of the total estimated species range of in California (75,048 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative by this measure. The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of big-eared woodrat habitat (Figures 2 and 3) (CDFW 2016). Big-eared woodrats occupy areas outside of their top two-thirds habitat, while these methods assume they do not.

However, for woodrat species, although the analyses were limited to publications assessing larger-scale areas, it is likely that even these larger-scale study areas are well within ideal habitat for the species. So although the goal was to produce a conservative population estimate for woodrat species, the resulting estimates are not likely to be conservative due to the limitations of the density studies available in the literature.

The population estimate for big-eared woodrats in California is 44,017,269 individuals (Table 4). This approach assumes that no big-eared woodrats occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied at average densities. The statewide and county estimates under each method are provided in Table 4.

Table 3. Big-Eared Woodrat Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Cranford 1977	Radio telemetry	Sonoma County, California	1,700 (average of summer and winter)
Innes et al. 2012	Radio telemetry	Plumas National Forest, California	575 (average of two sites)
McEachern et al. 2007	House survey, capture-recapture	Lassen and Napa Counties, California	266 (average among years and sites)
Sakai and Noon 1993	Nest transects, trapping	Northwestern California	1,650 (average among forest seral stages)

Table 4. Statewide and County Big-Eared Woodrat Population Estimates

County	Population Density (1,048/km^2)	County	Population Density (1,048/km^2)
Alameda	0	Orange	689,944
Alpine	0	Placer	2
Amador	779,427	Plumas	0
Butte	0	Riverside	3,631,328
Calaveras	1,805,540	Sacramento	22,123
Colusa	0	San Benito	1,903
Contra Costa	2,558	San Bernardino	1,980,065
Del Norte	0	San Diego	5,835,939
El Dorado	2,716,708	San Francisco	0
Fresno	2,039,552	San Joaquin	12,158
Glenn	0	San Luis Obispo	1,274,482
Humboldt	0	San Mateo	0
Imperial	17,376	Santa Barbara	2,000,616
Inyo	5,939	Santa Clara	0
Kern	3,011,535	Santa Cruz	181
Kings	0	Shasta	0
Lake	0	Sierra	0
Lassen	0	Siskiyou	0
Los Angeles	4,153,802	Solano	0
Madera	1,465,192	Sonoma	0
Marin	0	Stanislaus	37,732
Mariposa	2,299,289	Sutter	0
Mendocino	0	Tehama	0
Merced	13,304	Trinity	0
Modoc	0	Tulare	3,785,997
Mono	0	Tuolumne	2,527,837
Monterey	2,717,289	Ventura	1,189,450

Table 4. Statewide and County Big-Eared Woodrat Population Estimates

County	Population Density (1,048/km^2)	County	Population Density (1,048/km^2)
Napa	0	Yolo	0
Nevada	0	Yuba	0
		Total	44,017,269

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Abad, W., J. Morales-Doo, C. Pomeroy, and A. Ung. 2020. "Factors Affecting Woodrat Abundance over 70 Years." *California Ecology and Conservation Research* 4(1). https://doi.org/10.21973/N3DD39.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Big-Eared Woodrat Predicted Habitat (CWHR M233). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Cranford, J.A. 1977. "Home Range and Habitat Utilization by Neotoma fuscipes as Determined by Radiotelemetry." Journal of Mammalogy 58(2): 165-172

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Innes, R.J., M.B. McEachern, D.H. Van Vuren, J.M. Eadie, D.A. Kelt, and M.L. Johnson. 2012. "Genetic Relatedness and Spatial Associations of Dusky-Footed Woodrats (*Neotoma fuscipes*)." *Journal of Mammalogy* 93(2): 439–446.

Matocq, M.D., 2002. Morphological and molecular analysis of a contact zone in the Neotoma fuscipes species complex. Journal of Mammalogy, 83(3), pp.866-883.

Matocq, M.D. 2004. "Reproductive Success and Effective Population Size in Woodrats (*Neotoma macrotis*)." *Molecular Ecology* 13(6): 1635–1642.

Matocq, M.D., and E.A. Lacey. 2004. "Philopatry, Kin Clusters, and Genetic Relatedness in a Population of Woodrats (*Neotoma macrotis*)." *Behavioral Ecology* 15(4): 647–653.

McEachern, M.B., J.M. Eadie, D.H. Van Vuren, and Ecology Graduate Group. 2007. Local genetic structure and relatedness in a solitary mammal, Neotoma fuscipes. Behavioral Ecology and Sociobiology 61:1459–1469

Sakai, H.F., and B.R. Noon. 1993. “Dusky-Footed Woodrat Abundance in Different Aged Forests in Northwestern California. Journal of Wildlife Management 57(2):373-382

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Wallen, K. 1982. “Social Organization in the Dusky-Footed Woodrat (Neotoma fuscipes): a Field and Laboratory Study. Animal Behavior 30: 1171-1182

C17 Dusky-Footed Woodrat Population and Distribution

The following describes the distribution and population estimate of dusky-footed woodrat (*Neotoma fuscipes*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, dusky-footed woodrat observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 189 dusky-footed woodrat observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Dusky-Footed Woodrat across California

Dataset	Number of Observations	Date Range
Dusky-Footed Woodrat Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	189	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.

[1] Data accessed December 11, 2020.

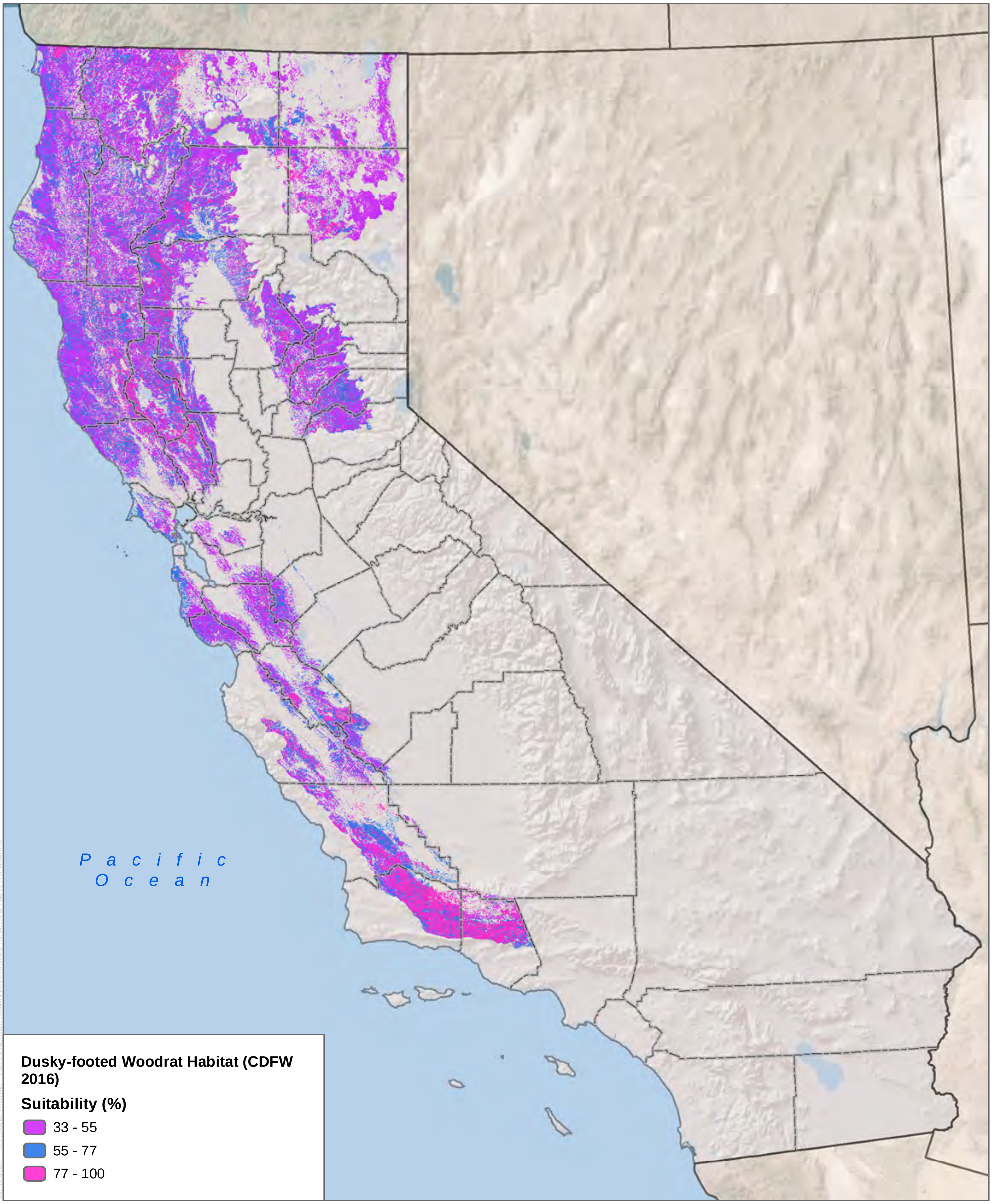
Table 2. Dusky-Footed Woodrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	468	Orange	0
Alpine	0	Placer	1,478
Amador	0	Plumas	588
Butte	1,673	Riverside	0
Calaveras	0	Sacramento	1
Colusa	1,004	San Benito	1,545
Contra Costa	359	San Bernardino	0
Del Norte	1,973	San Diego	0
El Dorado	920	San Francisco	5
Fresno	718	San Joaquin	100
Glenn	1,231	San Luis Obispo	2,456

Table 2. Dusky-Footed Woodrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Humboldt	6,591	San Mateo	588
Imperial	0	Santa Barbara	2,622
Inyo	0	Santa Clara	1,677
Kern	162	Santa Cruz	876
Kings	66	Shasta	4,747
Lake	2,656	Sierra	666
Lassen	3,841	Siskiyou	8,414
Los Angeles	0	Solano	167
Madera	0	Sonoma	2,187
Marin	585	Stanislaus	680
Mariposa	0	Sutter	0
Mendocino	7,237	Tehama	3,503
Merced	267	Trinity	5,606
Modoc	2,181	Tulare	0
Mono	0	Tuolumne	0
Monterey	2,084	Ventura	1,707
Napa	1,279	Yolo	487
Nevada	1,218	Yuba	663
		Total Statewide Suitable Habitat	**77,278**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of dusky-footed woodrat statewide (Figure 2), and modeled habitat and observations in the South San Francisco Bay area (Figure 3). The figures show that the majority of dusky-footed woodrats observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). However, several observations occur outside of this habitat and outside of the species' range (CDFW 2016, data not shown). Of those, most are within big-eared woodrat range and habitat, which suggests that the observation data do not correctly speciate the woodrats of California; these observation are more likely to be big-eared woodrats within their range, rather than dusky-footed woodrats outside of their range. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for dusky-footed woodrat and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of dusky-footed woodrats outside of the top two-thirds of suitable habitat and outside of the estimated range of the species (some such observation data cannot be explained as misidentified big-eared woodrats).



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Dusky-footed Woodrat Habitat from CDFW Habitat Suitability Model

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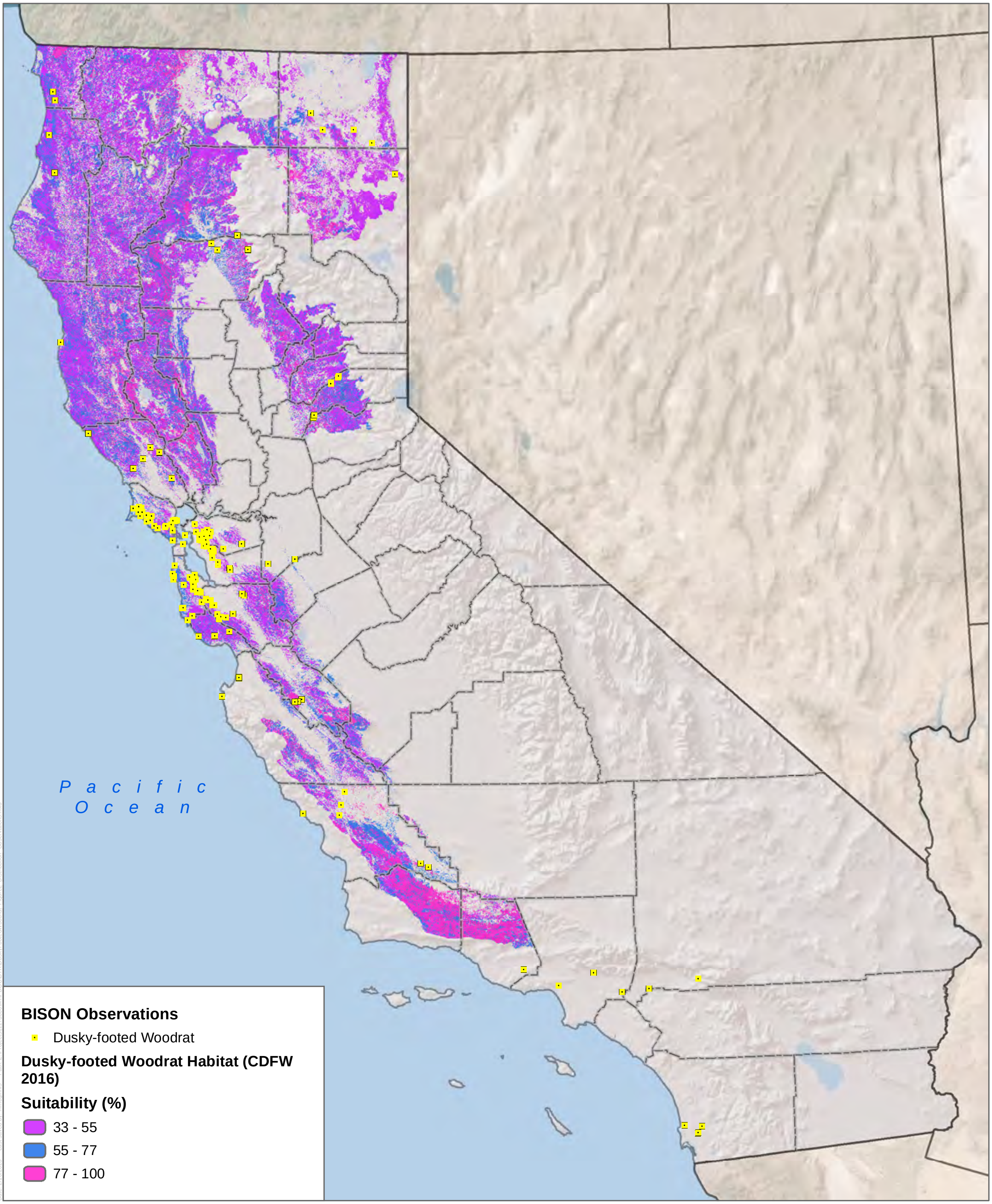

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Dusky-footed Woodrat Statewide

Biological Technical Report for the Wildlife Damage Management Project

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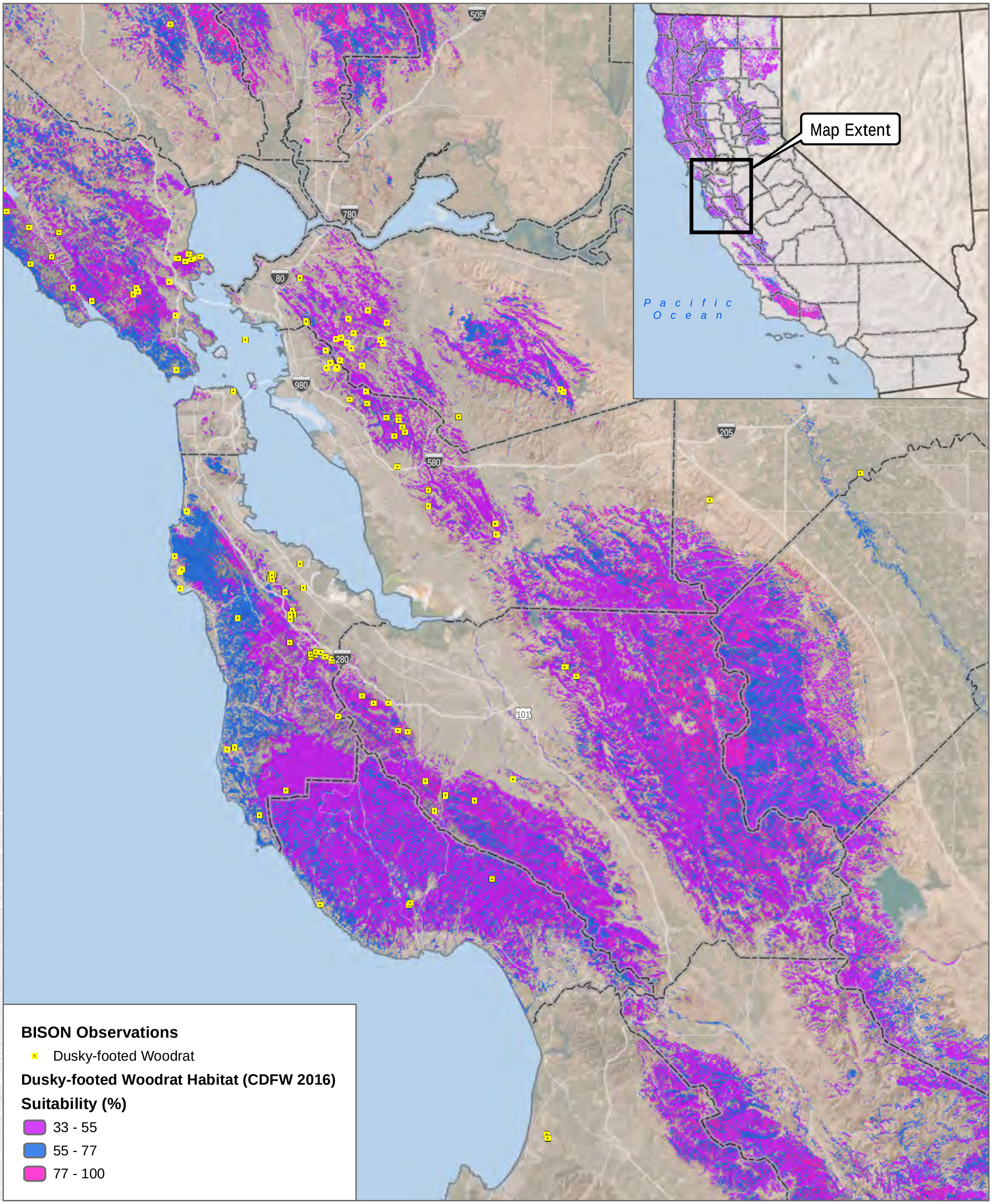

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Dusky-footed Woodrat in the South San Francisco Bay Area

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Although woodrats are considered solitary species and are often considered territorial, they share territory, interact socially, and form kin-structured communities that are not fully understood (Matocq and Lacey 2004; McEachern et al. 2007, Innes et al. 2012). Therefore, the use of home range data to infer population numbers is not appropriate for these species and only density data were used to estimate the population sizes.

Because woodrats are not uniformly distributed on the landscape, data from studies of individual woodrat groups were not used; the inclusion of such studies would have resulted in an artificially high population estimate. Instead, only studies reporting density over larger areas consisting of numerous woodrat groups were used. Woodrat species often occur within communities, where their densities are often very high (e.g., Wallen 1982; Matocq 2004; Abad et al. 2020). However, densities over larger areas are much lower, as reported in Table 3.

The dusky-footed woodrat population was estimated using the average density of estimates in the literature (1,048 woodrats/km^2) (Table 3). Dusky-footed and big-eared woodrats (*Neotoma macrotis*) were considered to be the same species until 2002 (Matocq 2002). As such some studies of dusky-footed woodrats prior to 2002 actually studied what are now known as big-eared woodrats. This approach was used to estimate population sizes for each county. A summary of the population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):

   Average Density 1,048 individuals/km^2 ((1,700 + 575 + 266 + 1,650 individuals/km^2)/4) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For dusky-footed woodrat, the top two-thirds of suitable habitat represent only 58% (77,278 km^2) (Table 2) of the total estimated species range in California (132,100 km^2) CDFW 2016); thus, the populations estimates are likely to be moderately conservative. The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of dusky-footed woodrat habitat (Figures 2 and 3) (CDFW 2016). Dusky-footed woodrats occupy areas outside of their top two-thirds habitat, while these methods assume they do not.

However, for woodrat species, although the analysis was limited to publications assessing larger-scale areas, it is likely that even these larger-scale study areas are well within ideal habitat for the species. So although the goal was to produce a conservative population estimate for woodrat species, the resulting estimates are not likely to be conservative due to the limitations of the density studies available in the literature.

The estimate for population size for dusky-footed woodrat in California is 80,987,432 individuals using the density-based method (Table 4). This approach assumes the following: that that no dusky-footed woodrats occupy any of the bottom one-third of suitable habitat, and that all available top-two-thirds suitable habitat is occupied at the average density. The statewide and county estimates under each method are provided in Table 4.

Table 3. Dusky-Footed Woodrat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Cranford 1977	radio telemetry	Sonoma County, California	1,700 (average of summer and winter)
Innes et al. 2012	radio telemetry	Plumas National Forest, California	575 (average of two sites)
McEachern et al. 2007	house survey, capture-recapture	Lassen and Napa Counties, California	266 (average among years and sites)
Sakai and Noon 1993	Nest transects, trapping	Northwestern California	1,650 (average among forest seral stages)

Table 4. Statewide and County Dusky-Footed Woodrat Population Estimates

County	Population Density (1,048/km^2)	County	Population Density (1,048/km^2)
Alameda	1,223,669	Orange	0
Alpine	490,166	Placer	0
Amador	0	Plumas	1,549,423
Butte	0	Riverside	615,884
Calaveras	1,753,428	Sacramento	0
Colusa	0	San Benito	788
Contra Costa	1,051,971	San Bernardino	1,618,958
Del Norte	375,833	San Diego	0
El Dorado	2,067,689	San Francisco	0
Fresno	964,330	San Joaquin	5,130
Glenn	752,962	San Luis Obispo	104,338
Humboldt	1,290,177	San Mateo	2,573,683
Imperial	6,907,591	Santa Barbara	616,140
Inyo	0	Santa Clara	2,748,050
Kern	0	Santa Cruz	1,757,369
Kings	169,780	Shasta	918,054
Lake	69,636	Sierra	4,975,164
Lassen	2,783,818	Siskiyou	698,128
Los Angeles	4,025,847	Solano	8,818,148
Madera	0	Sonoma	175,415
Marin	0	Stanislaus	2,291,995
Mariposa	613,452	Sutter	712,338
Mendocino	0	Tehama	0
Merced	7,583,993	Trinity	3,671,646
Modoc	279,877	Tulare	5,875,475
Mono	2,285,165	Tuolumne	0

Table 4. Statewide and County Dusky-Footed Woodrat Population Estimates

County	Population Density (1,048/km²)	County	Population Density (1,048/km²)
Monterey	0	Ventura	0
Napa	2,183,977	Yolo	1,789,305
Nevada	1,340,609	Yuba	510,784
		Total	**80,987,432**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Abad, W., J. Morales-Doo, C. Pomeroy, and A. Ung. 2020. "Factors Affecting Woodrat Abundance over 70 Years." *California Ecology and Conservation Research* 4(1). https://doi.org/10.21973/N3DD39.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Big-Eared Woodrat Predicted Habitat (CWHR M233). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Cranford, J.A. 1977. "Home Range and Habitat Utilization by Neotoma fuscipes as Determined by Radiotelemetry." Journal of Mammalogy 58(2): 165-172

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Innes, R.J., M.B. McEachern, D.H. Van Vuren, J.M. Eadie, D.A. Kelt, and M.L. Johnson. 2012. "Genetic Relatedness and Spatial Associations of Dusky-Footed Woodrats (*Neotoma fuscipes*)." *Journal of Mammalogy* 93(2): 439–446.

Matocq, M.D., 2002. Morphological and molecular analysis of a contact zone in the Neotoma fuscipes species complex. Journal of Mammalogy, 83(3), pp.866-883.

Matocq, M.D. 2004. "Reproductive Success and Effective Population Size in Woodrats (*Neotoma macrotis*)." *Molecular Ecology* 13(6): 1635–1642.

Matocq, M.D., and E.A. Lacey. 2004. "Philopatry, Kin Clusters, and Genetic Relatedness in a Population of Woodrats (*Neotoma macrotis*)." *Behavioral Ecology* 15(4): 647–653.

McEachern, M.B., J.M. Eadie, and D.H. Van Vuren. 2007. "Local Genetic Structure and Relatedness in a Solitary Mammal, *Neotoma fuscipes*." *Behavioral Ecology and Sociobiology* 61(9): 1459–1469.

Sakai, H.F., and B.R. Noon. 1993. "Dusky-Footed Woodrat Abundance in Different Aged Forests in Northwestern California. Journal of Wildlife Management 57(2):373-382

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Wallen, K. 1982. "Social Organization in the Dusky-Footed Woodrat (Neotoma fuscipes): a Field and Laboratory Study. Animal Behavior 30:

C18 Black-Tailed Jackrabbit Population and Distribution

The following describes the distribution and population estimate of black-tailed jackrabbit (*Lepus californicus*) in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, black-tailed jackrabbit observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 930 black-tailed jackrabbit observations between 2000 and 2020.

Table 1. Observations and Modeled Distribution of Black-Tailed Jackrabbit across California

Dataset	Number of Observations	Date Range
Black-Tailed Jackrabbit Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	737	2000–2018
CNDDB (CDFW 2022)	193	2000–2020

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.
1 Data accessed December 11, 2020.

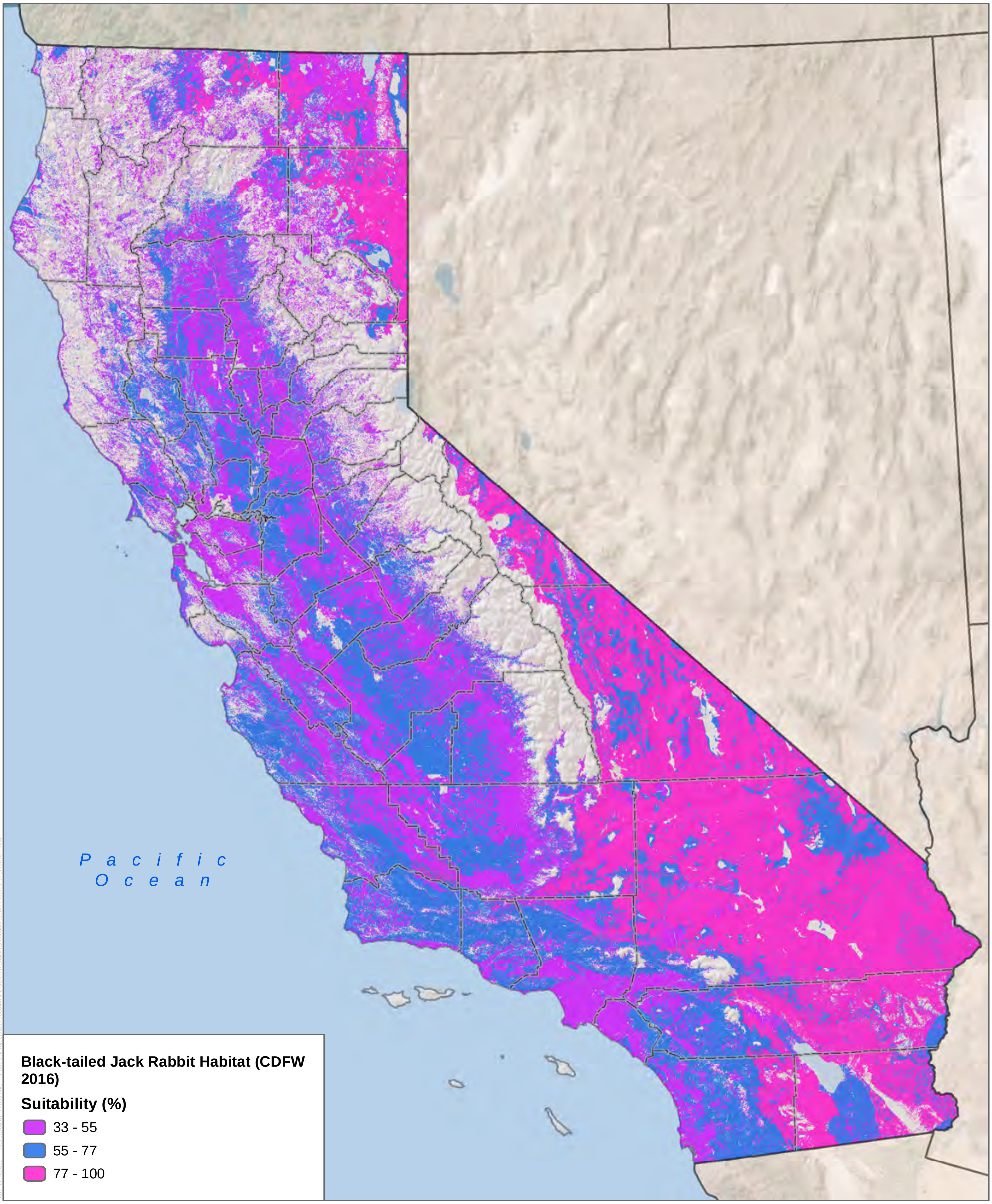
Table 2. Black-Tailed Jackrabbit Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,478	Orange	1,980
Alpine	157	Placer	1,547
Amador	897	Plumas	2,263
Butte	2,802	Riverside	17,332
Calaveras	1,746	Sacramento	2,431
Colusa	2,576	San Benito	3,287
Contra Costa	1,571	San Bernardino	49,784
Del Norte	643	San Diego	10,251
El Dorado	1,538	San Francisco	113

Table 2. Black-Tailed Jackrabbit Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Fresno	10,191	San Joaquin	3,516
Glenn	2,962	San Luis Obispo	7,987
Humboldt	2,347	San Mateo	748
Imperial	9,517	Santa Barbara	5,970
Inyo	23,436	Santa Clara	2,308
Kern	19,344	Santa Cruz	419
Kings	3,492	Shasta	5,091
Lake	2,243	Sierra	529
Lassen	9,720	Siskiyou	8,083
Los Angeles	9,619	Solano	1,808
Madera	3,625	Sonoma	2,361
Marin	908	Stanislaus	3,703
Mariposa	2,119	Sutter	1,473
Mendocino	3,095	Tehama	5,712
Merced	4,609	Trinity	2,275
Modoc	8,498	Tulare	6,761
Mono	5,514	Tuolumne	1,710
Monterey	7,310	Ventura	4,315
Napa	1,437	Yolo	2,398
Nevada	775	Yuba	1,185
		Total Statewide Suitable Habitat	**301,509**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of black-tailed jackrabbit statewide (Figure 2), and modeled habitat and observations in the High Sierra/Mono Lake area (Figure 3). The figures show that the majority of black-tailed jackrabbits observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for black-tailed jackrabbits and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of black-tailed jackrabbits outside of the top two-thirds of suitable habitat.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Black-tailed Jackrabbit Habitat from CDFW Habitat Suitability Model

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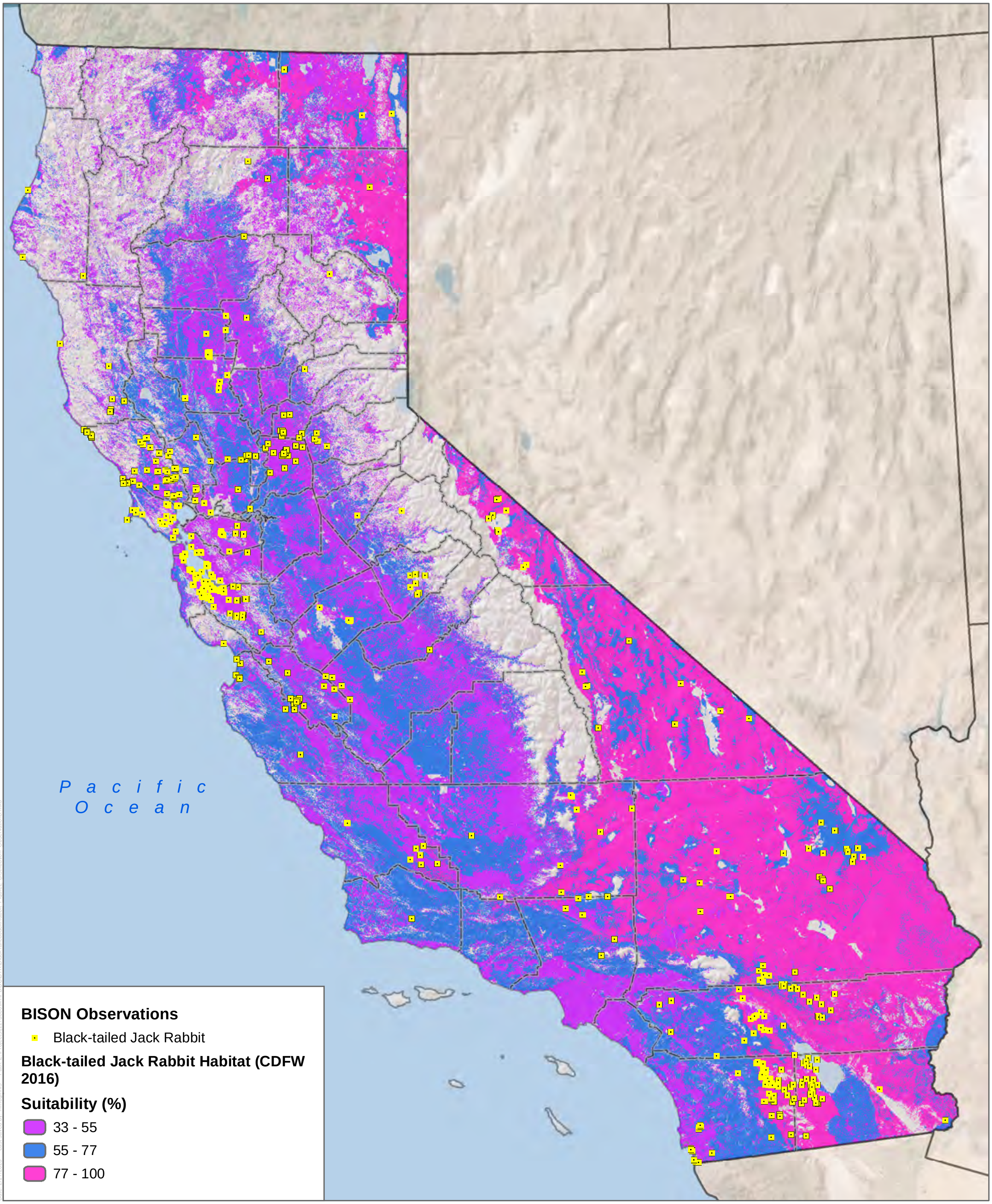

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Black-tailed Jackrabbit Statewide

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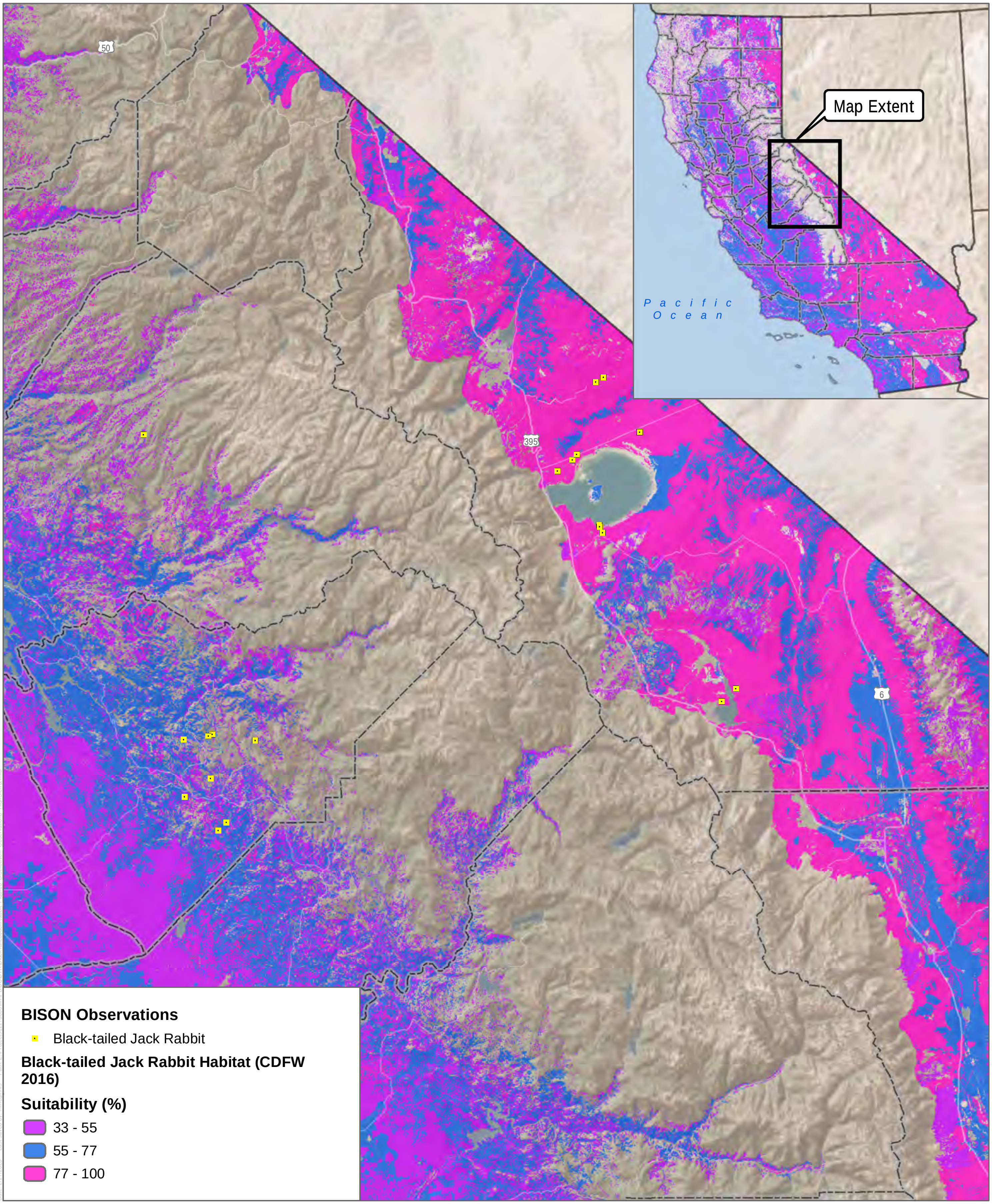

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Black-tailed Jackrabbit in the High Sierra/Mono Lake Area

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Black-tailed jackrabbits have widely varying home range sizes as described in the various research-literature sources from North American populations, which are summarized in Table 3. One method was used to estimate the black-tailed jackrabbit population by county in California: the average population densities as reported in the literature, equivalent to 24.0 jackrabbits per km^2 (Table 3). This approach was used to estimate population sizes for each county. A summary of population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):

   Average Density 24.0 individuals/km^2 ((20 + 67.1 + 4.5 + 6.1 + 4.2 + 25.9 + 11.1 + 53.1 individuals/km^2)/8) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For black-tailed jackrabbit, the top two-thirds of suitable habitat represent only 79% (301,509 km^2) (Table 2) of the total estimated species range in California (380,417 km^2) (CDFW 2016); thus, the populations estimates are likely to be somewhat conservative. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of black-tailed jackrabbit habitat (Figures 2 and 3) and outside of the species' estimated range (CDFA 2016, data not shown). Black-tailed jackrabbits occupy areas outside of their top two-thirds habitat and outside the estimate range for the species, while these methods assume they do not. Therefore, these methods will tend to underestimate the population.

The estimated black-tailed jackrabbit population size in California is 7,236,205 individuals using the density-based method (Table 4). This approach assumes the following: that no black-tailed jackrabbits occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied. This approach also assumes that the population density values from the reviewed literature are applicable to California, despite the fact that the cited studies were for populations outside California.

The statewide and county estimates are provided in Table 4.

Table 3. Black-Tailed Jackrabbit Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Chew and Chew 1970	capture-recapture	Arizona	20
Daniel et al. 1993	ground survey	New Mexico	67.1 (average of sites, seasons, and years, data from Table 1 on page 525)
Desmond 2004	ground survey	Chihuahua, Mexico	4.5 (average among locations and years)
Flinders and Handsen 1973	spotlight line transect	Colorado	6.1 (average of fall and winter)
Flinders and Hansen 1975	spotlight line transect	Colorado	4.2 (Average among sites and seasons)

Table 3. Black-Tailed Jackrabbit Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Gross et al. 1974	drive count surveys	Utah	25.9
Knick and Dyer 1997	Spotlight line transect	Idaho	11.1 (average among years and seasons per Table 1, page 77)
Plettner 1984	Capture-recapture and radio telemetry	Nebraska (1981-1982)	53.1 (average of two sites)

Table 4. Statewide and County Black-Tailed Jackrabbit Population Estimates

County	Population Density (24.0 individuals/km^2)	County	Population Density (24.0 individuals/km^2)
Alameda	35,473	Orange	47,518
Alpine	3,778	Placer	37,135
Amador	21,527	Plumas	54,314
Butte	67,237	Riverside	415,972
Calaveras	41,902	Sacramento	58,344
Colusa	61,817	San Benito	78,884
Contra Costa	37,704	San Bernardino	1,194,824
Del Norte	15,439	San Diego	246,020
El Dorado	36,903	San Francisco	2,703
Fresno	244,587	San Joaquin	84,375
Glenn	71,093	San Luis Obispo	191,694
Humboldt	56,339	San Mateo	17,949
Imperial	228,406	Santa Barbara	143,283
Inyo	562,454	Santa Clara	55,393
Kern	464,255	Santa Cruz	10,063
Kings	83,799	Shasta	122,179
Lake	53,838	Sierra	12,690
Lassen	233,271	Siskiyou	193,997
Los Angeles	230,847	Solano	43,403
Madera	86,999	Sonoma	56,675
Marin	21,785	Stanislaus	88,878
Mariposa	50,846	Sutter	35,361
Mendocino	74,283	Tehama	137,089
Merced	110,617	Trinity	54,596
Modoc	203,961	Tulare	162,256
Mono	132,339	Tuolumne	41,042
Monterey	175,452	Ventura	103,551
Napa	34,478	Yolo	57,540
Nevada	18,604	Yuba	28,445
		Total	**7,236,205**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Black-tailed Jackrabbit Predicted Habitat (CWHR M051). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Chew, R.M., and A.E. Chew. 1970. "Energy Relationships of the Mammals of a Desert Shrub (*Larrea tridentata*) Community." *Ecological Monographs* 40(1): 1–21.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Daniel, A., Holechek, J., Valdez, R., Tembo, A., Saiwana, L., Fusco, M. and Cardenas, M., 1993. Jackrabbit densities on fair and good condition Chihuahuan desert range. Rangeland Ecology & Management/Journal of Range Management Archives, 46(6), pp.524-528.

Desmond, M.J., 2004. Habitat associations and co-occurrence of Chihuahuan Desert hares (Lepus californicus and L. callotis). The American Midland Naturalist, 151(2), pp.414-419.

Flinders, J.T. and Hansen, R.M., 1973. Abundance and dispersion of leporids within a shortgrass ecosystem. Journal of Mammalogy, 54(1), pp.287-291.

Flinders, J.T. and Hansen, R.M., 1975. Spring population responses of cottontails and jackrabbits to cattle grazing shortgrass prairie. Rangeland Ecology & Management/Journal of Range Management Archives, 28(4), pp.290-293

Gross, J.E., L.C. Stoddart, and F.H. Wagner. 1974. "Demographic Analysis of a Northern Utah Jackrabbit Population." *Wildlife Monographs* 40:3–68.

Knick, S.T. and Dyer, D.L., 1997. Distribution of black-tailed jackrabbit habitat determined by GIS in southwestern Idaho. The Journal of wildlife management, pp.75-85

Plettner, R.G. 1984. "Vital Characteristics of the Black-Tailed Jack Rabbit in East-Central Nebraska." Master's thesis; University of Nebraska, Lincoln. May 1984.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C19 Desert Cottontail Population and Distribution

The following describes the distribution and population estimate of desert cottontail rabbit (*Sylvilagus audubonii*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, desert cottontail observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Between the datasets, there were 1,331 desert cottontail between 2000 and 2020. The purpose of the observation data is to visually confirm the distribution model, which was the basis of the population estimate.

Table 1. Observations and Modeled Distribution of Desert Cottontail across California

Dataset	Number of Observations	Date Range
Desert Cottontail Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	1,331	2000–2018
CNDDB (CDFW 2022)	0	2002–2013

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.
1 Data accessed December 11, 2020.

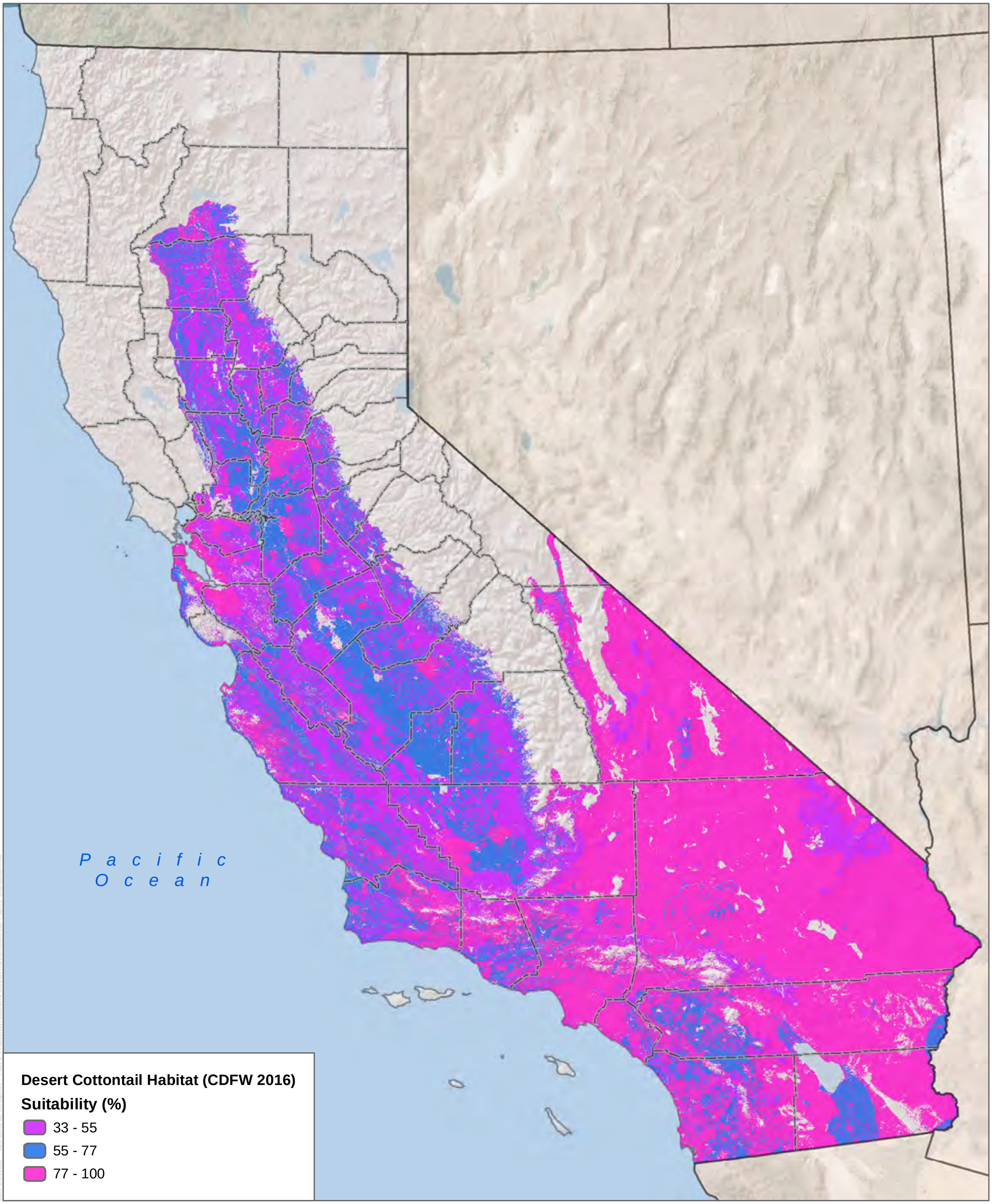
Table 2. Desert Cottontail Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,711	Orange	2,004
Alpine	0	Placer	1,056
Amador	766	Plumas	0
Butte	2,404	Riverside	17,372
Calaveras	1,331	Sacramento	2,437
Colusa	2,364	San Benito	3,436
Contra Costa	1,771	San Bernardino	49,811
Del Norte	0	San Diego	10,336
El Dorado	899	San Francisco	115

Table 2. Desert Cottontail Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Fresno	9,647	San Joaquin	3,545
Glenn	2,371	San Luis Obispo	8,358
Humboldt	0	San Mateo	805
Imperial	9,565	Santa Barbara	6,261
Inyo	21,388	Santa Clara	2,998
Kern	18,987	Santa Cruz	449
Kings	3,498	Shasta	1,656
Lake	84	Sierra	0
Lassen	0	Siskiyou	0
Los Angeles	9,432	Solano	1,775
Madera	3,131	Sonoma	0
Marin	0	Stanislaus	3,812
Mariposa	1,471	Sutter	1,476
Mendocino	0	Tehama	4,971
Merced	4,637	Trinity	0
Modoc	0	Tulare	5,910
Mono	393	Tuolumne	826
Monterey	8,066	Ventura	4,306
Napa	298	Yolo	2,439
Nevada	422	Yuba	1,134
		Total Statewide Suitable Habitat	**241,925**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of desert cottontail statewide (Figure 2), and modeled habitat and observations in the High Sierra/Mono Lake area (Figure 3). The figures show that the majority of desert cottontail observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). However, several observations occur outside of the habitat of the species and outside of the species' range as well. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for desert cottontail and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of desert cottontail outside of the top two-thirds of suitable habitat and outside of the estimated ranges of the species.



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Desert Cottontail Habitat from CDFW Habitat Suitability Model

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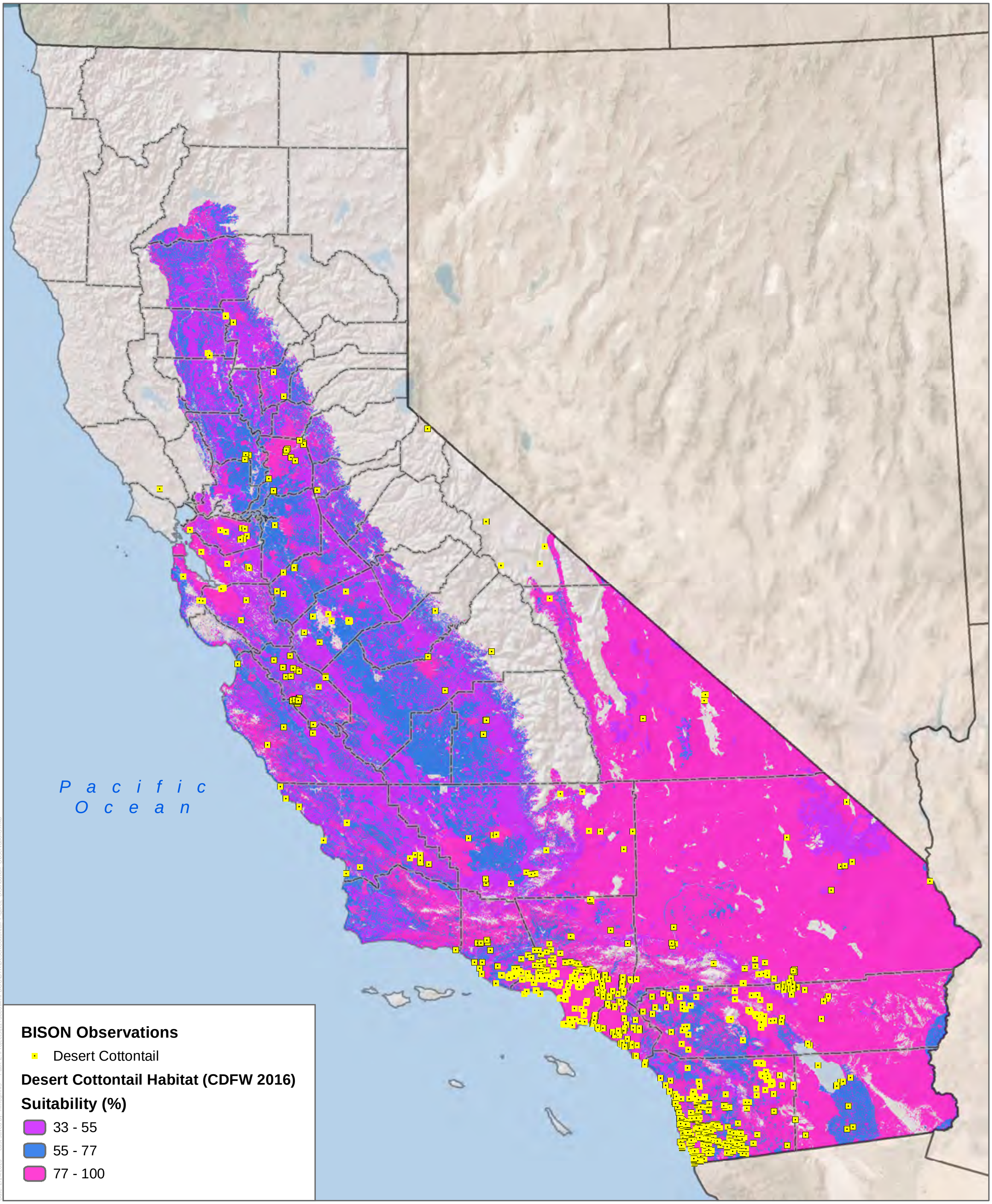

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Desert Cottontail Statewide

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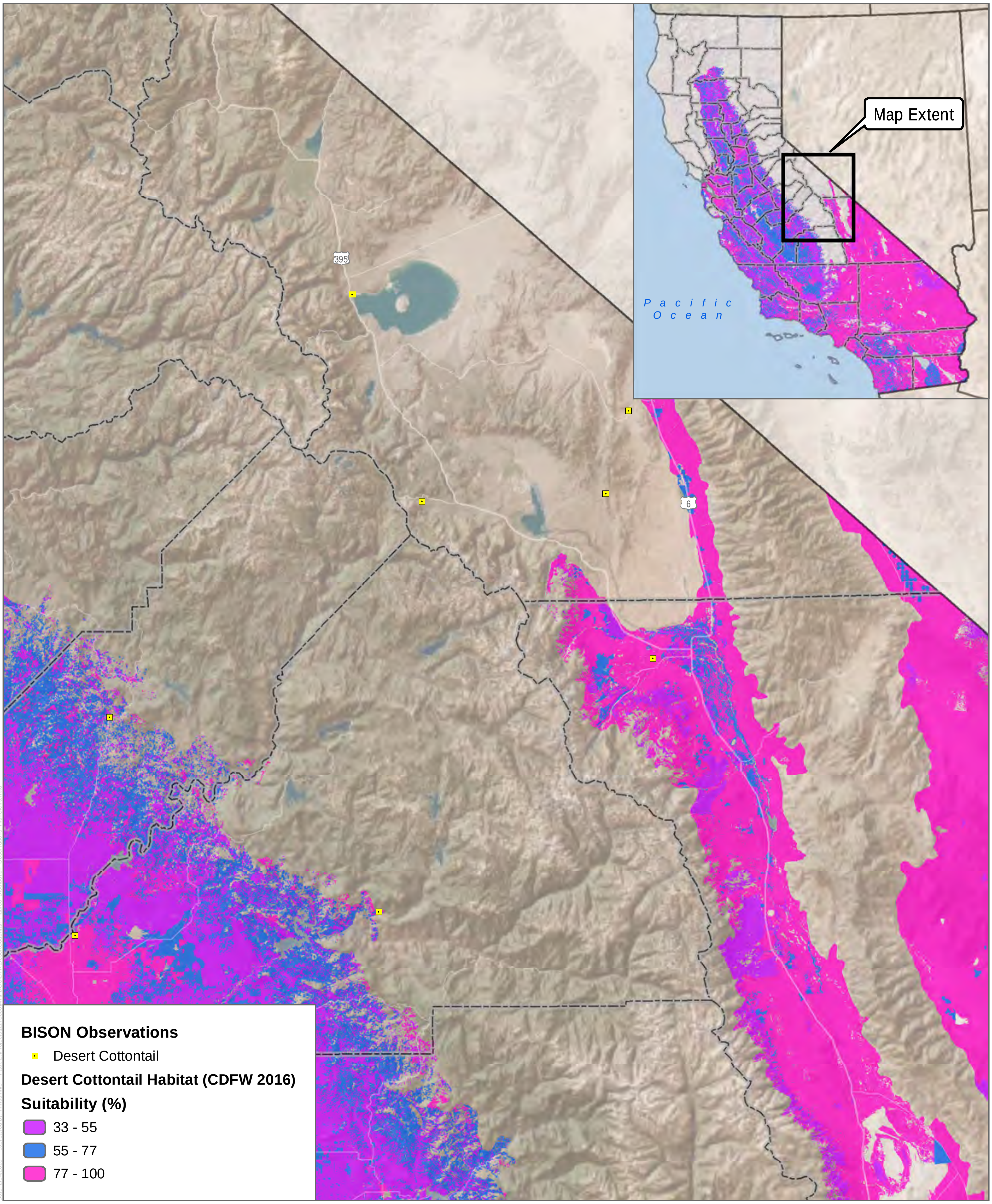

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Desert Cottontail in the High Sierra/Mono Lake Area

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Desert cottontail have widely varying home range sizes as described in the various research-literature sources from North American populations as summarized in Tables 3. Additionally, a summary of the population estimation method based on the literature is provided below.

Equation for Calculating Desert Cottontail Population Estimate

Published density estimates were used to estimate the desert cottontail population by county in California. The average of available published population densities was 106 individuals/km^2. Female home range size was not used to estimate the desert cottontail population because there is no evidence that females defend their home ranges, which is a critical assumption of the use of that method. A summary of this population estimation method is provided below, and all values used are included in Table 3.

1. Density-Based Estimate (see Table 3 for references):
   a. Average Density 106 individuals/km^2 ((50.6 + 161.6 individuals/km^2)/2) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). The top two-thirds of suitable habitat for desert cottontail represent 93% (241,925 km^2) (Table 2) of the total estimated species range in California (259,979 km^2) (CDFW 2016); thus, the population estimates are likely to be slightly conservative. The conservative nature of this method is also supported by the observation data presented herein, several of which occur outside of the top two-thirds of the species' habitat (Figures 2 and 3), as well as outside the species' range (Figure 2) (CDFW 2016, data not shown). Desert cottontails occupy areas outside of their top two-thirds habitat and outside of their estimated range, while this method assumes they do not. Therefore, this method will tend to considerably underestimate the population.

The population estimate for desert cottontails in California is 25,644,085 individuals using the density-based method (Table 4). This approach assumes the following: that no desert cottontails occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied.

Table 3. Desert Cottontail Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Dunagan et al. 2019	visual line surveys	Ventura and Los Angeles Counties, California	50.6
Fitch 2018	capture-recapture	San Joaquin Valley, California	161.6

Table 4. Statewide and County Desert Cottontail Population Estimates

County	Population Density (106 individuals/km^2)	County	Population Density (106 individuals/km^2)
Alameda	181,416	Orange	212,464
Alpine	0	Placer	111,902
Amador	81,189	Plumas	0
Butte	254,803	Riverside	1,841,480

Table 4. Statewide and County Desert Cottontail Population Estimates

County	Population Density (106 individuals/km2)	County	Population Density (106 individuals/km2)
Calaveras	141,035	Sacramento	258,278
Colusa	250,635	San Benito	364,204
Contra Costa	187,687	San Bernardino	5,279,987
Del Norte	0	San Diego	1,095,637
El Dorado	95,283	San Francisco	12,185
Fresno	1,022,606	San Joaquin	375,750
Glenn	251,273	San Luis Obispo	885,899
Humboldt	0	San Mateo	85,363
Imperial	1,013,872	Santa Barbara	663,648
Inyo	2,267,145	Santa Clara	317,804
Kern	2,012,653	Santa Cruz	47,600
Kings	370,786	Shasta	175,521
Lake	8,926	Sierra	0
Lassen	0	Siskiyou	0
Los Angeles	999,822	Solano	188,199
Madera	331,929	Sonoma	0
Marin	0	Stanislaus	404,023
Mariposa	155,946	Sutter	156,434
Mendocino	0	Tehama	526,911
Merced	491,553	Trinity	0
Modoc	0	Tulare	626,506
Mono	41,698	Tuolumne	87,589
Monterey	854,997	Ventura	456,390
Napa	31,591	Yolo	258,556
Nevada	44,700	Yuba	120,208
		Total	**25,644,085**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. "CAL FIRE, Fire and Resource Assessment Program (FRAP)." https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Cottontail/Brush Rabbit Predicted Habitat (CWHR M047; CWHR M045). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Dunagan, S.P., T.J. Karels, J.G. Moriarty, J.L. Brown, and S.P. Riley. 2019. "Bobcat and Rabbit Habitat Use in an Urban Landscape." *Journal of Mammalogy* 100(2): 401–409.

Fitch, H.S. 2018. "Ecology of a Cottontail Rabbit (*Sylvilagus audubonii*) Population in Central California." *California Fish and Game* 104(1): 36–59.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C20 Brush Rabbit Population and Distribution

The following describes the distribution and population estimate of brush rabbit (*Sylvilagus bachmani*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, brush rabbit observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (USGS 2020) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Between the datasets, there were 631 brush rabbit observations between 2000 and 2020 on and off roads.

Table 1. Observations and Modeled Distribution of Brush Rabbit across California

Dataset	Number of Observations	Date Range
Brush Rabbit Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	625	2000–2018
CNDDB (CDFW 2022)[2]	16	2002–2013

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.

1 Data accessed December 11, 2020.

2 All CNDDB observations are for the riparian brush rabbit subspecies.

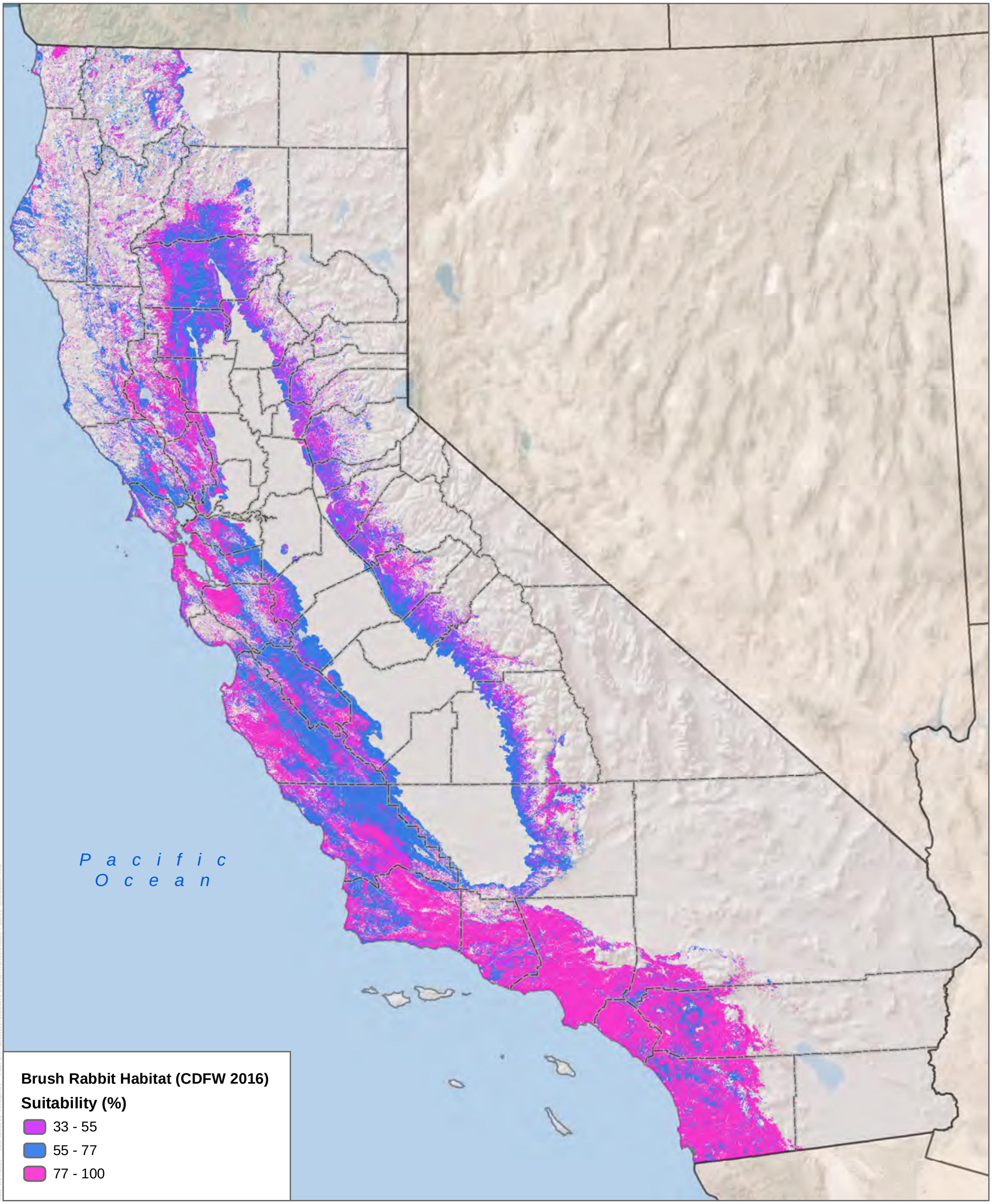
Table 2. Brush Rabbit Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,443	Orange	1,972
Alpine	0	Placer	721
Amador	621	Plumas	106
Butte	1,250	Riverside	5,354
Calaveras	1,328	Sacramento	121
Colusa	1,006	San Benito	3,269
Contra Costa	1,213	San Bernardino	1,973
Del Norte	525	San Diego	7,920
El Dorado	1,194	San Francisco	112

Table 2. Brush Rabbit Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Fresno	3,116	San Joaquin	260
Glenn	2,270	San Luis Obispo	7,676
Humboldt	2,112	San Mateo	731
Imperial	20	Santa Barbara	5,839
Inyo	0	Santa Clara	2,283
Kern	4,158	Santa Cruz	409
Kings	249	Shasta	3,020
Lake	2,095	Sierra	102
Lassen	0	Siskiyou	2,207
Los Angeles	6,365	Solano	556
Madera	1,255	Sonoma	2,149
Marin	928	Stanislaus	1,050
Mariposa	1,904	Sutter	0
Mendocino	2,466	Tehama	5,319
Merced	981	Trinity	1,557
Modoc	0	Tulare	2,291
Mono	0	Tuolumne	1,147
Monterey	7,387	Ventura	3,632
Napa	1,364	Yolo	446
Nevada	584	Yuba	515
		Total Statewide Suitable Habitat	**108,570**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of brush rabbit statewide (Figure 2), and modeled habitat and observations in the Monterey County area (Figure 3). The figures show that the majority of brush rabbit observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). However, several observations occur outside of the top two-thirds of the species' habitat and outside the species' range. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for brush rabbit and also suggest that these methods will produce somewhat conservative population estimate due to the occurrence of brush rabbit outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Brush Rabbits Habitat from CDFW Habitat Suitability Model

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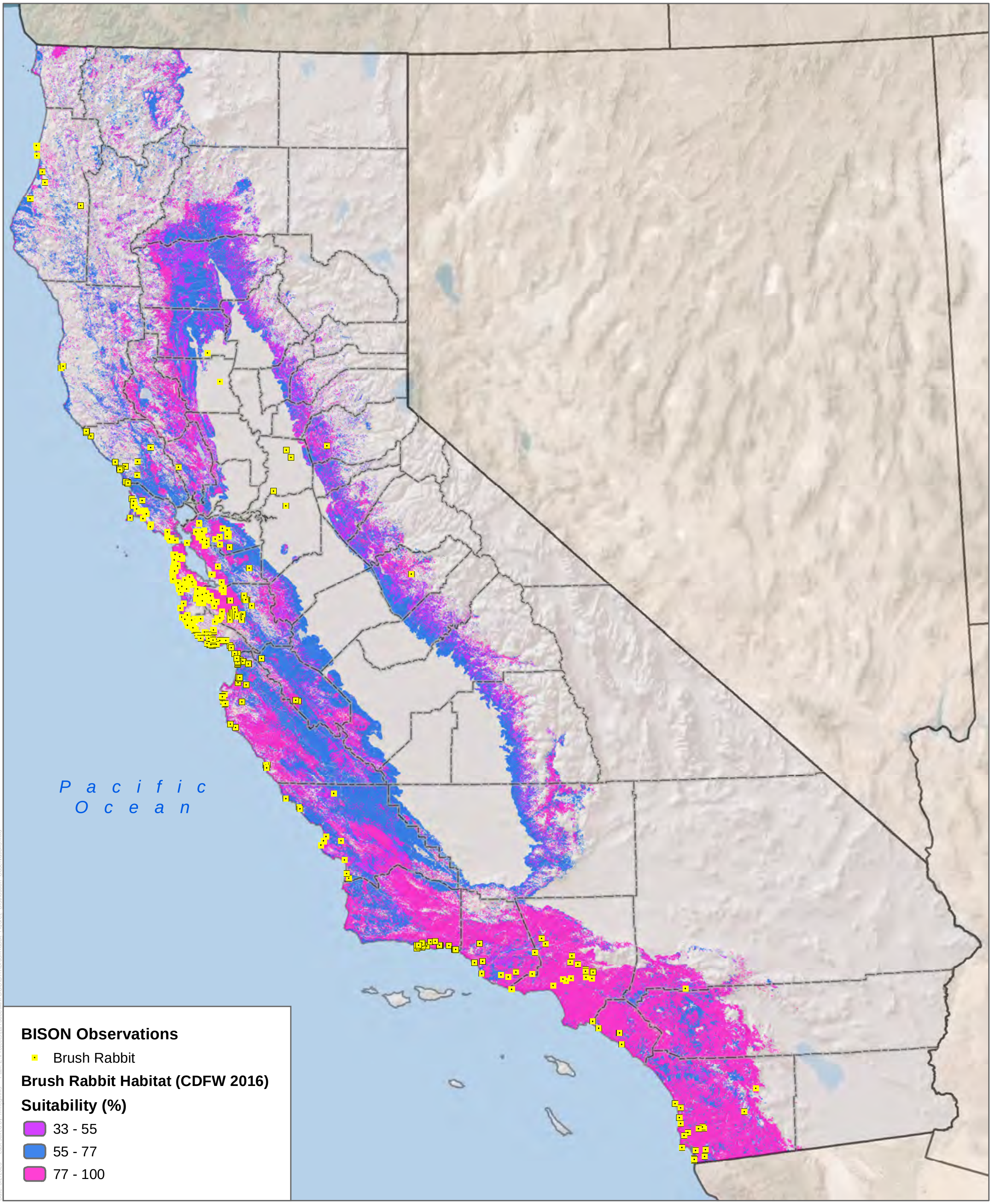

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Brush Rabbits Statewide

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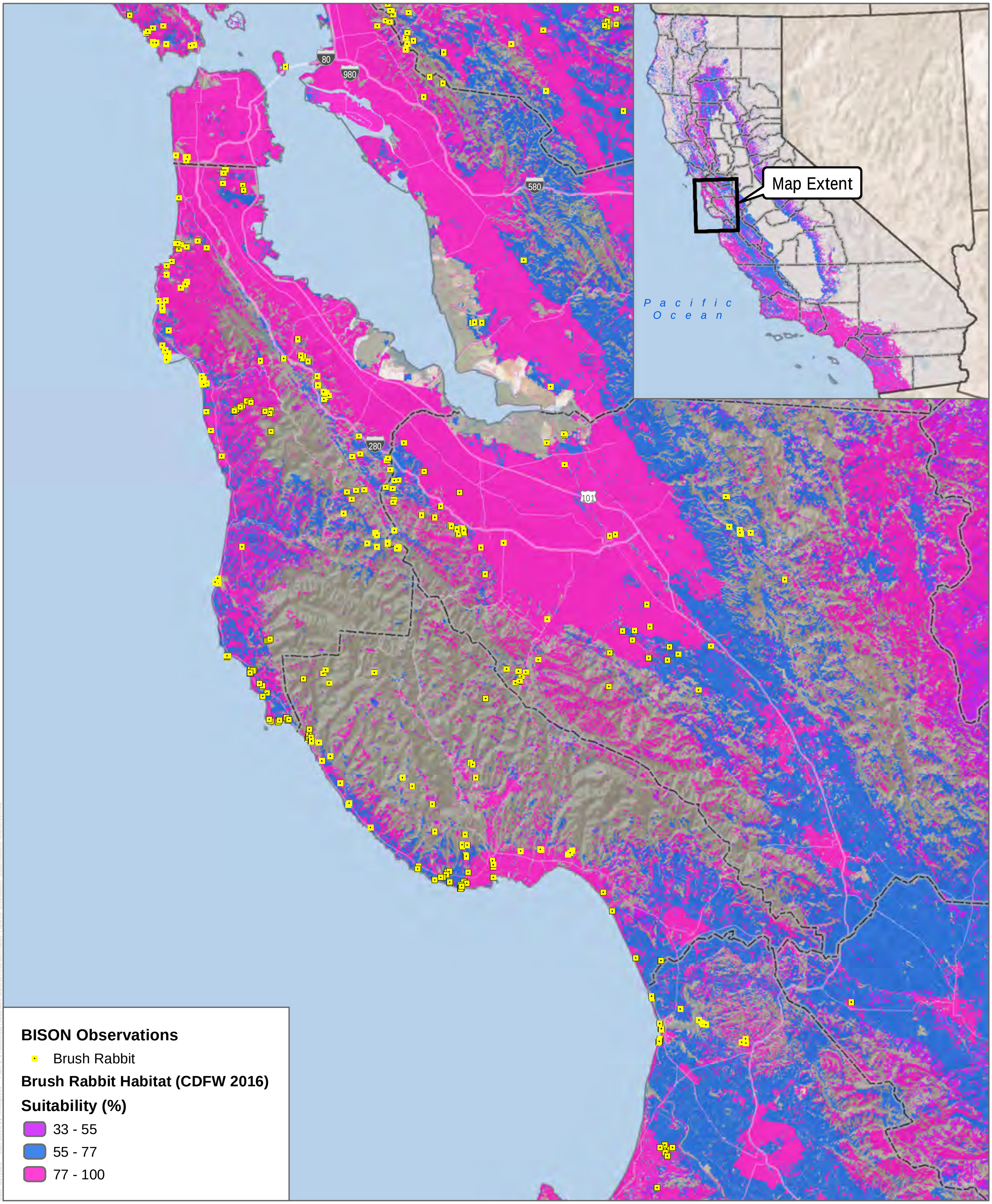

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Brush Rabbits in the Monterey County Area

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Brush rabbits have widely varying home range sizes as described in the various research-literature sources from North American populations as summarized in Table 3. Additionally, a summary of the population estimation method based on the literature is provided below.

Equation for Calculating Brush Rabbit Population Estimate

Only one recent density estimate was found for brush rabbit in the literature, and that was for a federally endangered subspecies, the riparian brush rabbit (*Sylvilagus bachmani riparius*) in the only known location where the subspecies exists (65 FR 8881, Williams 1993). This location is managed for the protection of this endangered rabbit subspecies, and the rabbit density is very high in this location. This density is not believed to be indicative of the rest of the species over its entire range in California, so density data for the closely related species desert cottontail (*Sylvilagus audubonii*) was used instead, the average of which is approximately 1/3 the density of riparian brush rabbit reported by Williams (1993).

Published density estimates for desert cottontail were used to estimate the brush rabbit population by county in California. The average of available published population densities was 106 individuals/km^2. Female home range size was not used to estimate the brush rabbit population because there is no evidence that females defend their home ranges, which is a critical assumption of the use of this method. A summary of this population estimation method is provided below, and all values used are included in Table 3.

1. Density-Based Estimate (see Table 3 for references):
   a. Average Density (for desert cottontail) of 106 individuals/km^2 ((50.6 + 161.6 individuals/km^2)/2) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For brush rabbit, the top two-thirds of suitable habitat represent only 62% (108,570 km^2) (Table 2) of the total estimated species range in California (176,421 km^2) (CDFW 2016); thus, the population estimate is likely to be moderately conservative. The conservative nature of this method is also supported by the observation data presented herein, several of which occur outside of the top two-thirds of the species' habitat (Figures 2 and 3), as well as outside the species' range (Figure 2) (CDFW 2016, data not shown). Brush rabbits occupy areas outside of their top two-thirds habitat and outside of their estimated range, while these methods assume they do not. Therefore, these methods will tend to considerably underestimate the population.

The population estimate for brush rabbits in California is 11,508,386 individuals based on the density method (Table 4). This approach assumes the following: that no brush rabbits occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied.

Table 3. Brush Rabbit Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Dunagan et al. 2019	visual line surveys	Ventura and Los Angeles Counties, California	50.6 (desert cottontail)
Fitch 2018	capture-recapture	San Joaquin Valley, California	161.6 (desert cottontail)
Williams 1993	capture-recapture	San Joaquin County, California	298 (riparian brush rabbit)[1]

1 This population density estimate was not used to calculate average density of brush rabbit because the density is extremely high and not likely to be representative of the species over its entire range in California.

Table 4. Statewide and County Brush Rabbit Population Estimates

County	Population Density (106 individuals/km^2)	County	Population Density (106 individuals/km^2)
Alameda	152,938	Orange	209,015
Alpine	0	Placer	76,411
Amador	65,845	Plumas	11,187
Butte	132,494	Riverside	567,517
Calaveras	140,769	Sacramento	12,821
Colusa	106,618	San Benito	346,513
Contra Costa	128,576	San Bernardino	209,112
Del Norte	55,609	San Diego	839,511
El Dorado	126,563	San Francisco	11,887
Fresno	330,271	San Joaquin	27,508
Glenn	240,613	San Luis Obispo	813,657
Humboldt	223,865	San Mateo	77,530
Imperial	2,106	Santa Barbara	618,933
Inyo	0	Santa Clara	242,017
Kern	440,725	Santa Cruz	43,303
Kings	26,379	Shasta	320,164
Lake	222,107	Sierra	10,798
Lassen	0	Siskiyou	233,993
Los Angeles	674,737	Solano	58,947
Madera	132,999	Sonoma	227,844
Marin	98,345	Stanislaus	111,346
Mariposa	201,818	Sutter	0
Mendocino	261,387	Tehama	563,836
Merced	103,957	Trinity	165,045
Modoc	0	Tulare	242,873
Mono	0	Tuolumne	121,551
Monterey	782,984	Ventura	385,019
Napa	144,615	Yolo	47,277
Nevada	61,898	Yuba	54,552
		Total	**11,508,386**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. "CAL FIRE, Fire and Resource Assessment Program (FRAP)." https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Cottontail/Brush Rabbit Predicted Habitat (CWHR M047; CWHR M045). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Dunagan, S.P., T.J. Karels, J.G. Moriarty, J.L. Brown, and S.P. Riley. 2019. "Bobcat and Rabbit Habitat Use in an Urban Landscape." *Journal of Mammalogy* 100(2): 401–409.

Fitch, H.S. 2018. "Ecology of a Cottontail Rabbit (*Sylvilagus audubonii*) Population in Central California." *California Fish and Game* 104(1): 36–59.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Williams, D.F. 1993. *Population Censuses of Riparian Brush Rabbits and Riparian Woodrats at Caswell Memorial State Park during January 1993*. Final. California Department of Parks and Recreation, Inland Region, California.

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C21 Botta's Pocket Gopher Population and Distribution

The following describes the distribution and population estimate of Botta's pocket gopher (*Thomomys bottae*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, Botta's pocket gopher observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 699 Botta's pocket gopher observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Botta's Pocket Gopher across California

Dataset	Number of Observations	Date Range
Botta's Pocket Gopher Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	699	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

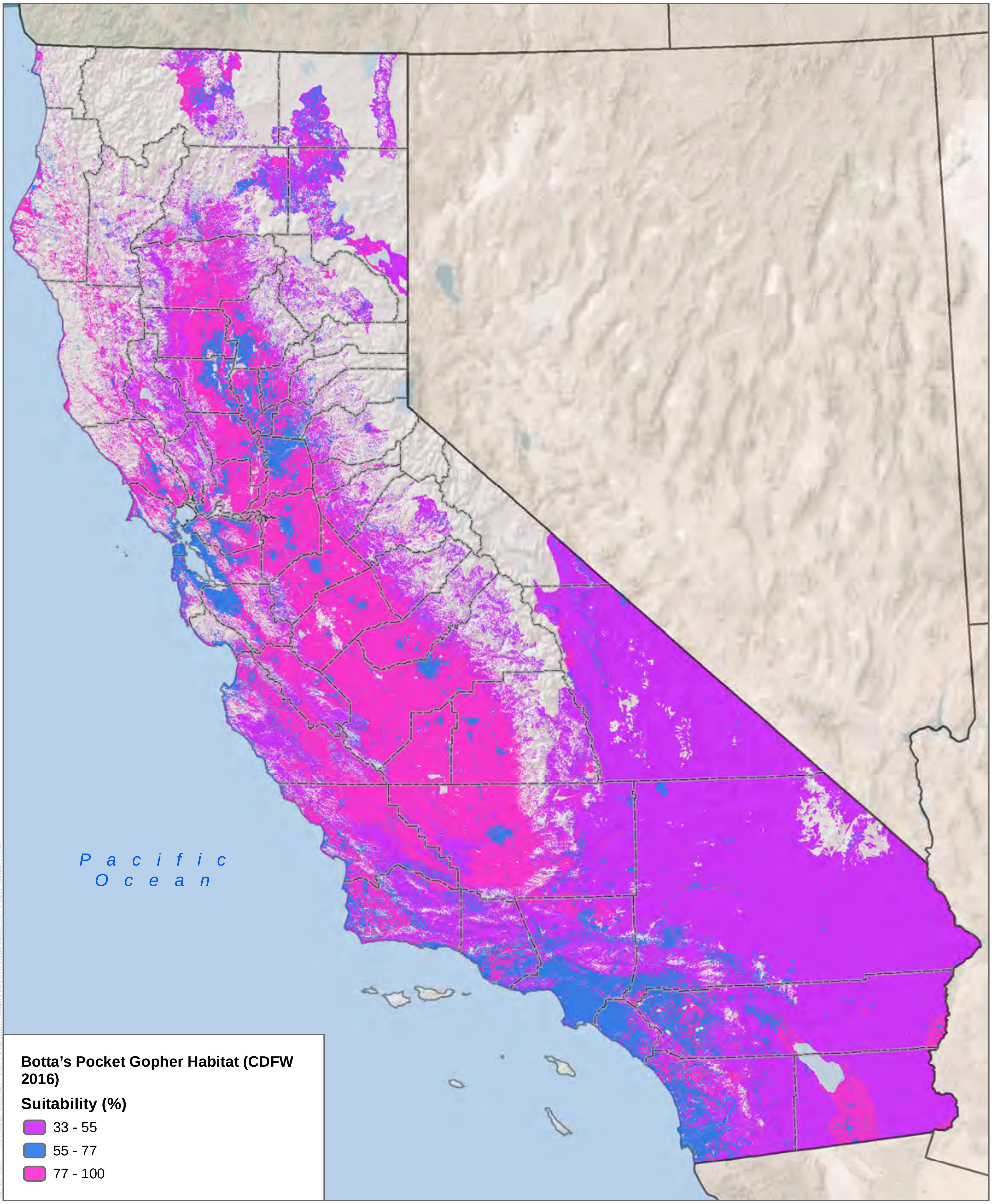
Table 2. Botta's Pocket Gopher Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,439	Orange	1,994
Alpine	0	Placer	1,228
Amador	785	Plumas	1,339
Butte	2,550	Riverside	18,273
Calaveras	1,459	Sacramento	2,433
Colusa	2,481	San Benito	3,230
Contra Costa	1,545	San Bernardino	48,810
Del Norte	173	San Diego	10,436
El Dorado	1,230	San Francisco	113
Fresno	10,846	San Joaquin	3,526
Glenn	2,881	San Luis Obispo	7,877
Humboldt	1,839	San Mateo	751

Table 2. Botta's Pocket Gopher Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Imperial	10,829	Santa Barbara	5,895
Inyo	24,804	Santa Clara	2,280
Kern	19,117	Santa Cruz	408
Kings	3,494	Shasta	3,799
Lake	2,058	Sierra	143
Lassen	4,015	Siskiyou	3,043
Los Angeles	9,683	Solano	1,829
Madera	3,768	Sonoma	2,191
Marin	892	Stanislaus	3,592
Mariposa	2,089	Sutter	1,468
Mendocino	2,468	Tehama	5,045
Merced	4,633	Trinity	1,220
Modoc	2,661	Tulare	8,388
Mono	1,268	Tuolumne	1,932
Monterey	7,172	Ventura	4,333
Napa	1,318	Yolo	2,365
Nevada	533	Yuba	1,122
		Total Statewide Suitable Habitat	**277,093**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of Botta's pocket gopher statewide (Figure 2), and modeled habitat and observations in the Santa Cruz/Monterey Bay area (Figure 3). The figures show that most Botta's pocket gophers observations occur within or on the edge of the top two-thirds of suitable habitat, and all occur within the species' range (CDFW 2016, data not shown). These data fully support the accuracy of the CDFW (2016) range and habitat data for Botta's pocket gopher.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Botta's Pocket Gopher Habitat from CDFW Habitat Suitability Model

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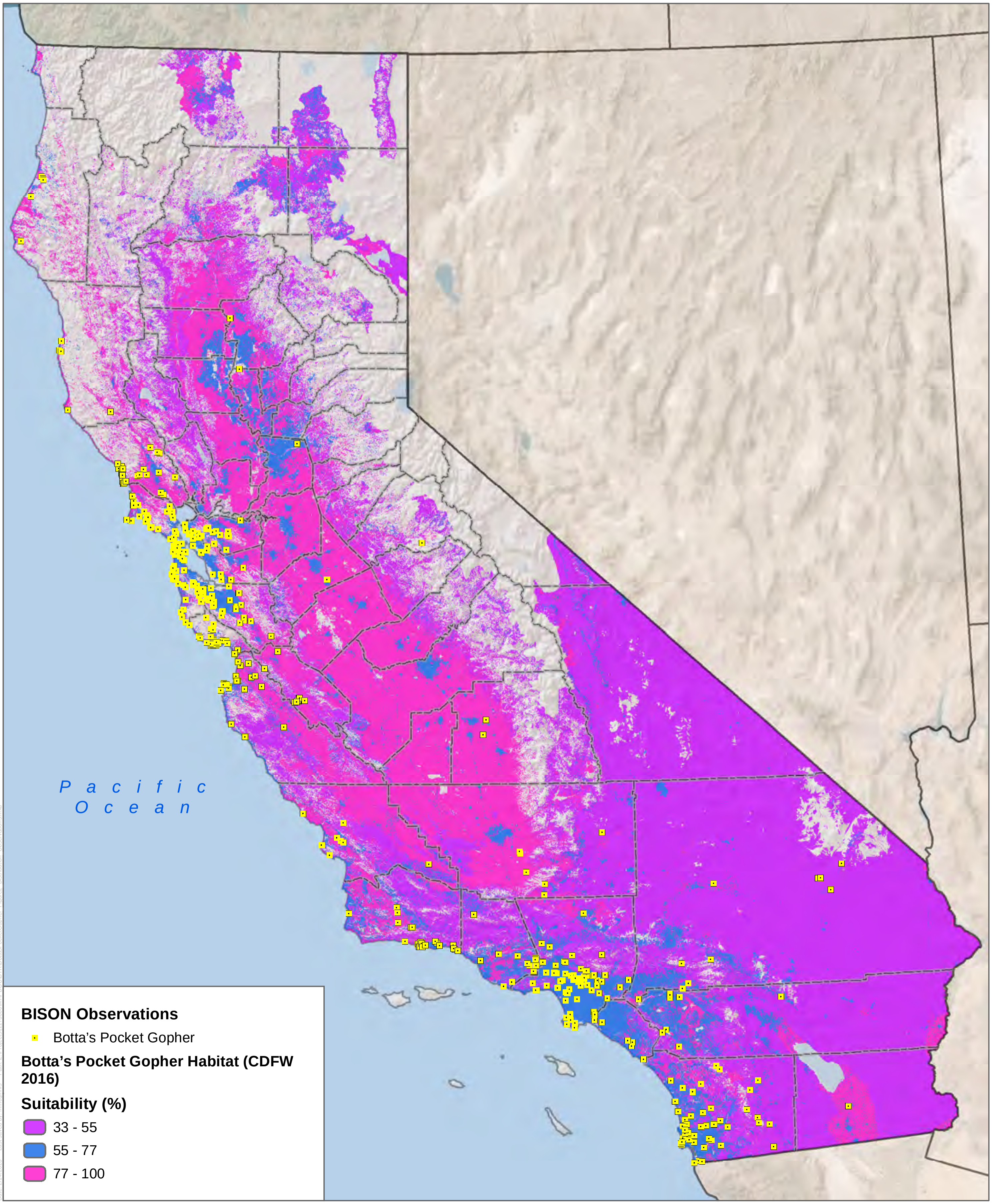

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Botta's Pocket Gopher Statewide

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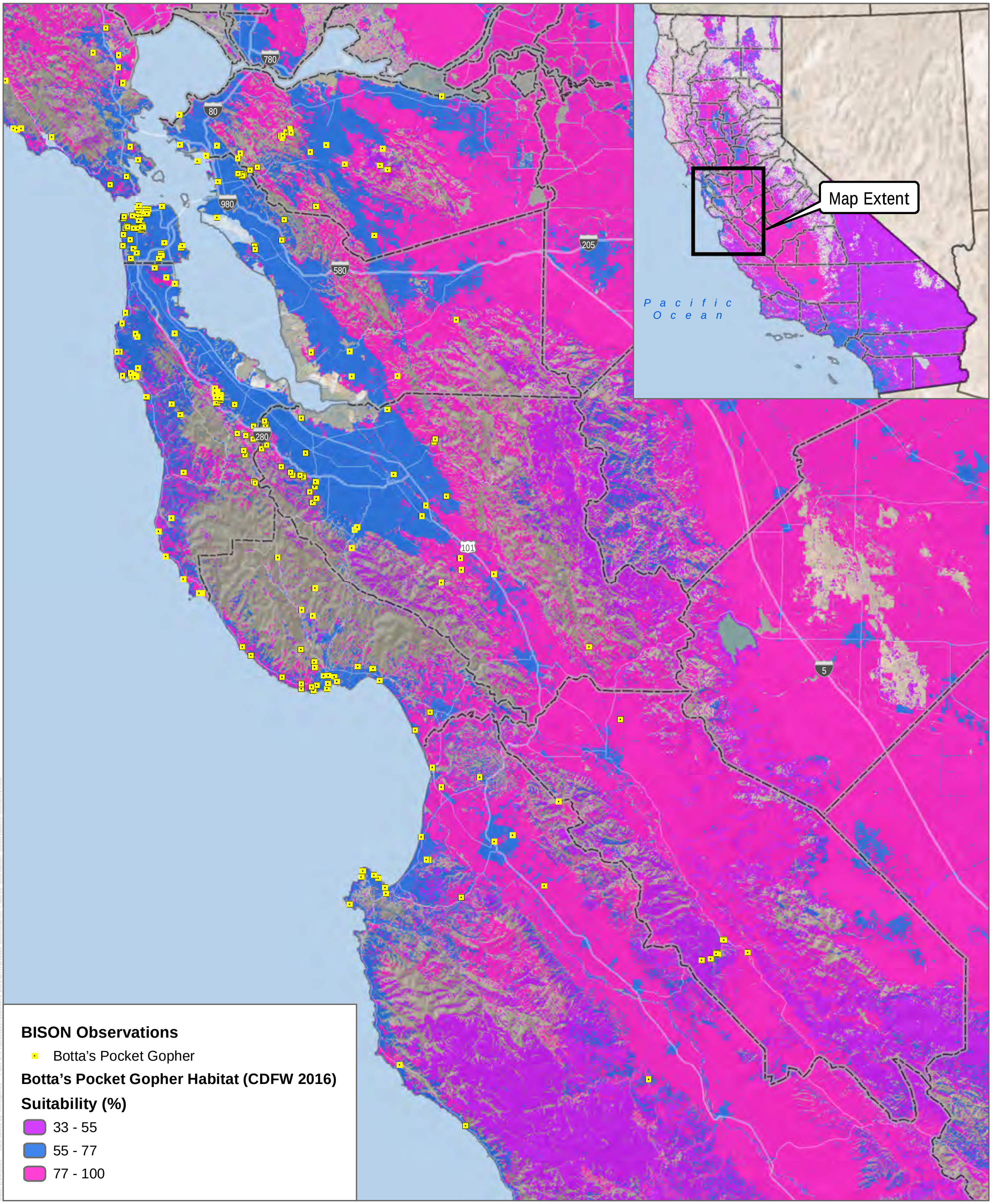

SOURCE: CDFW 2016; USGS 2020

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FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Botta's Pocket Gopher in the Monterey County Area

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Fossorial (underground-dwelling) rodents, such as Botta's pocket gophers and California ground squirrels (*Otospermophilus beecheyi*) (semi-fossorial), are generally allopatric; that is, they do not generally overlap with other fossorial species in the same geographical location due to a limited resource—the soil (Reichman et al. 1982). This is in contrast to most aboveground-dwelling mammals where sympatry (living in the same geographical location) is very common due to the availability of numerous niches (i.e., they use different resources). Sympatry even occurs among species that compete for similar resources—for example, coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*).

While the suitable habitat for many fossorial species overlaps considerably, generally only one of those species will exist in any specific location. Because of this overlap in suitable habitat among allopatric species, the available suitable habitat for each species is reduced by the presence of the other species. Two fossorial/semi-fossorial rodents are analyzed in this report, Botta's pocket gopher and California ground squirrel. Because the top two-thirds of suitable habitat for these two species overlap extensively except in southeastern California, the top two-thirds of suitable habitat was divided by two for each species when estimating population sizes. Thus, these analyses provide for only 50% of the top two-thirds of suitable habitat to be available to each species. In areas like southeastern California, this will likely result in an underestimate of the population of Botta's pocket gophers because both species do not occur there; however, this was more prudent than to overestimate the populations of both species, which would likely be the result of not partitioning the habitat among the two species.

There are other fossorial and semi-fossorial species in California also (for example, the broad-footed mole [*Scapanus latimanus*]), which might also compete for fossorial habitat with both Botta's pocket gophers and California ground squirrels. However, the ranges and habitats of most other fossorial and semi-fossorial species do not overlap these two species to the extent that these two species overlap each other. And because Botta's pocket gopher and California ground squirrel habitats do not completely overlap, the 50% partitioning is conservative enough to account for these other species as well.

For pocket gophers, soil density (i.e., ability to burrow) and dryness (i.e., not flooding or submerging the burrows) are important factors determining the suitability of their habitat (Ingles 1952); these two factors were not considered by CDFW (2016) when assessing habitat suitability for this species because these factors vary on a much smaller scale than the 30-meter by 30-meter scale used by CDFW. For example, in one study, only 30% (0.8 of 2.63 hectares) of the available meadow habitat was suitable for occupancy by Botta's pocket gophers at one of the two study sites (Ingles 1952). Due to these limitations in habitat suitability that cannot be accounted for in the CDFW habitat model, only a portion of the top two-thirds of suitable habitat is truly suitable for this species. For this analysis, 30% will be used as a conservative factor, as reported by Ingles (1952). This is likely to be conservative because some locations, such as the second study site used by Ingles (1952), are fully suitable for the species. However, use of all top two-thirds habitat, even only the 50% available due to allopatry of fossorial species as discussed above, would overestimate the Botta's pocket gopher population, so 30% of that habitat will be used to estimate the population. When combined with the 50% reduction in suitable habitat due to allopatry in fossorial species, the resulting amount of habitat used for the population estimates is 15%. This is reflected in the calculations provided below.

Botta's pocket gophers have widely varying home range sizes in North American populations as described in the various research-literature sources summarized in Table 3. Two methods were used to estimate the Botta's pocket gopher population by county in California: (1) the average of available published population densities of 4,468 individuals/km^2 and (2) the average published female home range sizes for Botta's pocket gopher of 0.00015 km^2, and multiplied by 1.5 for a 1:2 male to female ratio (average of ratios reported by Howard and Childs 1959). This analysis did not adjust for home range overlap because overlap among females is rare (Howard and Childs 1959; Reichman et al. 1982) and was not found in the literature. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average Density 4,468 individuals/km^2 ((860 individuals/km^2 + 7,545 individuals/km^2 + 247 individuals/km^2+ 6,155 individuals/km^2 + 10,600 individuals/km^2 + 1,400 individuals/km^2)/6) multiplied by 15% of the amount of Top Two-Thirds Suitable Habitat Area (km^2) in each county.

2. Home Range-Based Estimate (see Table 3 for references):

   Fifteen percent of the Top Two-Thirds Suitable Habitat Area (km^2) in each county divided by average adult female home range value of 0.00015 km^2 ((0.00029 km^2 + 0.00012 km^2 + 0.000097 km^2 + 0.000031 km^2)/4) and multiplied by 1.5 to include males at a 1:2 male to female ratio (average of ratios reported by Howard and Childs 1959).

The home range-based method estimates the total *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For Botta's pocket gopher, the top two-thirds of suitable habitat represent only 79% (277,093 km^2) (Table 2) of the total estimated species range in California (351,568 km^2) (CDFW 2016). This suggests that the populations estimates are likely to be somewhat conservative. However, as noted above, the top two-thirds of habitat were further limited to only 15% of that reported by CDFW due to allopatry among fossorial species and habitat limitations not included in the CDFW (2016) habitat data. The use of only 15% of habitat to estimate populations should keep these estimates conservative. All of the observation locations appear to occur within the top two-thirds of Botta's pocket gopher habitat (Figures 2 and 3) (CDFW 2016), which suggests that the species does not commonly occur outside of this range of habitat.

The estimates for population size for Botta's pocket gopher in California are 185,707,698 individuals using the density-based method and 415,639,432 individuals using the adult female home range-based method (Table 4). These approaches assume the following: that there is no home range overlap among adult female Botta's pocket gophers, that no Botta's pocket gophers occupy any of the bottom one-third of suitable habitat, and that 15% of available top two-thirds suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Botta's Pocket Gopher Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location and Year	Home Range Overlap Among Females	Female Home Range Size (km^2)	Population Density (individuals/km^2)
Bandoli 1987	Radio telemetry	MCP	New Mexico (1981-1982)	ND	0.00029	860
Howard and Childs 1959	Capture-recapture	MCP	O'Neals, California (1947-1954)	ND ("rarely")	0.00012	7,545
Ingles 1952	Capture-recapture	area of surveyed home range by distance moved	Fresno, California (1947-1950)	ND	0.000097	247
Powers et al. 2011	Belt transects	NA	Yosemite National Park, California (2009)	ND	ND	6,155 (average)
Reichman et al. 1982	Harvest and excavation of burrows	circular diameter of burrow	Arizona (1977-1978)	ND	0.000031	10,600 (average of two sites)
Smallwood et al. 2001	Survey of burrows	NA	Yolo County, California (1992-1994)	ND	ND	1,400

Notes: NA = Not Applicable; ND = Not Determined; MCP = minimum convex polygon.

Table 4. Statewide and County Botta's Pocket Gopher Population Estimates

County	Population Density (15% of Habitat x 4,468/km^2)	Female Home Range (15% of habitat x 0.00015 km^2)	County	Population Density (15% of Habitat x 4,468/km^2)	Female Home Range (15% of habitat x 0.00015 km^2)
Alameda	964,204	2,158,022	Orange	1,336,272	2,990,760
Alpine	0	0	Placer	822,985	1,841,954
Amador	526,152	1,177,600	Plumas	897,300	2,008,282
Butte	1,709,187	3,825,396	Riverside	12,246,882	27,410,211
Calaveras	977,677	2,188,176	Sacramento	1,630,721	3,649,779
Colusa	1,663,032	3,722,096	San Benito	2,164,896	4,845,335
Contra Costa	1,035,251	2,317,035	San Bernardino	32,712,398	73,214,856

Table 4. Statewide and County Botta's Pocket Gopher Population Estimates

County	Population Density (15% of Habitat x 4,468/km^2)	Female Home Range (15% of habitat x 0.00015 km^2)	County	Population Density (15% of Habitat x 4,468/km^2)	Female Home Range (15% of habitat x 0.00015 km^2)
Del Norte	115,659	258,860	San Diego	6,994,051	15,653,651
El Dorado	824,019	1,844,267	San Francisco	76,012	170,124
Fresno	7,268,975	16,268,969	San Joaquin	2,363,060	5,288,855
Glenn	1,930,795	4,321,386	San Luis Obispo	5,279,346	11,815,903
Humboldt	1,232,726	2,759,010	San Mateo	503,188	1,126,205
Imperial	7,257,925	16,244,237	Santa Barbara	3,950,663	8,842,129
Inyo	16,623,649	37,206,019	Santa Clara	1,528,162	3,420,237
Kern	12,812,228	28,675,534	Santa Cruz	273,570	612,287
Kings	2,341,980	5,241,673	Shasta	2,545,857	5,697,979
Lake	1,379,215	3,086,874	Sierra	95,864	214,557
Lassen	2,690,787	6,022,353	Siskiyou	2,039,402	4,564,463
Los Angeles	6,489,632	14,524,691	Solano	1,226,124	2,744,235
Madera	2,525,234	5,651,822	Sonoma	1,468,174	3,285,976
Marin	597,692	1,337,718	Stanislaus	2,407,351	5,387,984
Mariposa	1,400,242	3,133,935	Sutter	983,524	2,201,263
Mendocino	1,654,070	3,702,038	Tehama	3,380,983	7,567,106
Merced	3,105,356	6,950,214	Trinity	817,907	1,830,589
Modoc	1,783,489	3,991,694	Tulare	5,621,861	12,582,501
Mono	849,799	1,901,968	Tuolumne	1,295,018	2,898,428
Monterey	4,806,863	10,758,421	Ventura	2,903,725	6,498,938
Napa	883,104	1,976,508	Yolo	1,584,747	3,546,883
Nevada	356,988	798,989	Yuba	751,723	1,682,459
			Total	**185,707,698**	**415,639,432**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Bandoli, J.H. 1987. "Activity and Plural Occupancy of Burrows in Botta's Pocket Gopher *Thomomys bottae*." *American Midland Naturalist* 118(1): 10–14.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Botta's Pocket Gopher Predicted Habitat (CWHR M081). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Howard, W., and H. Childs. 1959. "Ecology of Pocket Gophers with Emphasis *on Thomomys bottae mewa.*" *Hilgardia* 29(7): 277–358.

Ingles, L.G. 1952. "The Ecology of the Mountain Pocket Gopher, *Thomomoys monticola*." *Ecology* 33(1): 87–95.

Powers, B., M.D. Johnson, J.A. LaManna, and A. Rich. 2011. "The Influence of Cattle Grazing on Pocket Gophers in the Central Sierra Nevada Mountains, California: Potential Implications for Great Gray Owls." *Northwestern Naturalist* 92(1): 13–18.

Reichman, O.J., T.G. Whitham, and G.A. Ruffner. 1982. "Adaptive Geometry of Burrow Spacing in Two Pocket Gopher Populations." *Ecology* 63(3): 687–695.

Smallwood, K.S., S. Geng, and M. Zhang. 2001. "Comparing Pocket Gopher (*Thomomys bottae*) Density in Alfalfa Stands to Assess Management and Conservation Goals in Northern California." *Agriculture, Ecosystems & Environment* 87(1): 93–109.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C22 California Ground Squirrel Population and Distribution

The following describes the distribution and population estimate of California ground squirrel (*Otospermophilus beecheyi*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, California ground squirrel observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 2,763 California ground squirrel observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of California Ground Squirrel across California

Dataset	Number of Observations	Date Range
American California Ground Squirrel Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	2,763	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

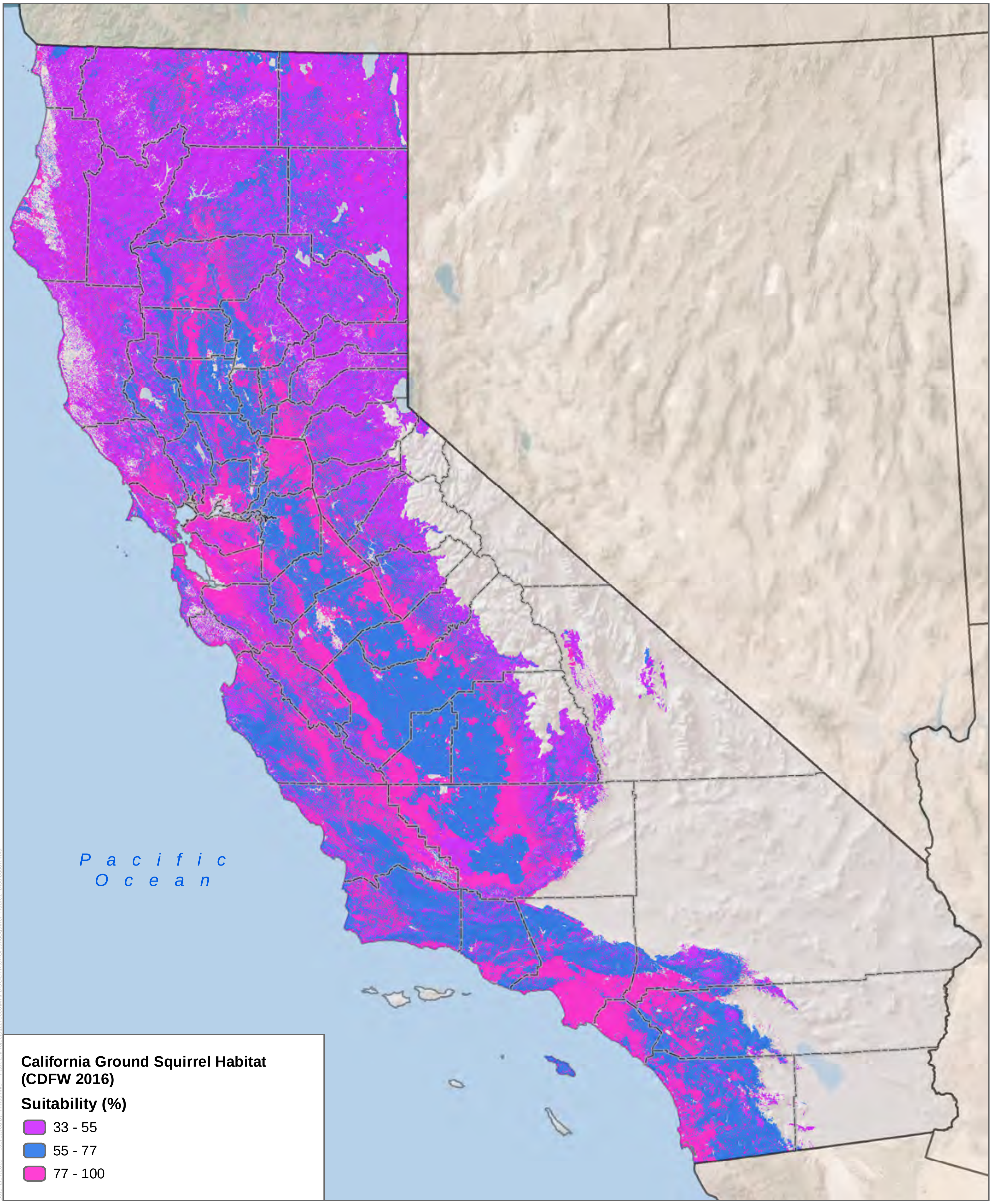
Table 2. California Ground Squirrel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,799	Orange	2,042
Alpine	218	Placer	3,552
Amador	1,383	Plumas	6,520
Butte	4,062	Riverside	6,114
Calaveras	2,572	Sacramento	2,464
Colusa	2,844	San Benito	3,574
Contra Costa	1,809	San Bernardino	3,746
Del Norte	2,204	San Diego	8,660
El Dorado	3,954	San Francisco	119
Fresno	11,131	San Joaquin	3,582
Glenn	3,332	San Luis Obispo	8,332

Table 2. California Ground Squirrel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Humboldt	7,407	San Mateo	990
Imperial	96	Santa Barbara	6,572
Inyo	1,285	Santa Clara	3,253
Kern	14,776	Santa Cruz	828
Kings	3,513	Shasta	9,691
Lake	3,162	Sierra	2,385
Lassen	11,655	Siskiyou	15,661
Los Angeles	7,717	Solano	1,906
Madera	3,966	Sonoma	3,662
Marin	1,272	Stanislaus	3,839
Mariposa	2,913	Sutter	1,497
Mendocino	7,246	Tehama	7,549
Merced	4,716	Trinity	8,093
Modoc	10,228	Tulare	9,780
Mono	0	Tuolumne	3,123
Monterey	8,496	Ventura	4,697
Napa	1,865	Yolo	2,536
Nevada	2,290	Yuba	1,578
		Total Statewide Suitable Habitat	**264,256**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of California ground squirrels statewide (Figure 2), and modeled habitat and observations in the Los Angeles County area (Figure 3). The figures show that the majority of California ground squirrels observations occur within or on the edge of the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). However, numerous observations occur outside of this habitat and outside of the species' range. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for California ground squirrels and also suggest that these methods will produce somewhat conservative population estimates due to the occurrence of California ground squirrels outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Desert California Ground Squirrel Habitat from CDFW Habitat Suitability Model

DUDEK 0 25 50 Miles

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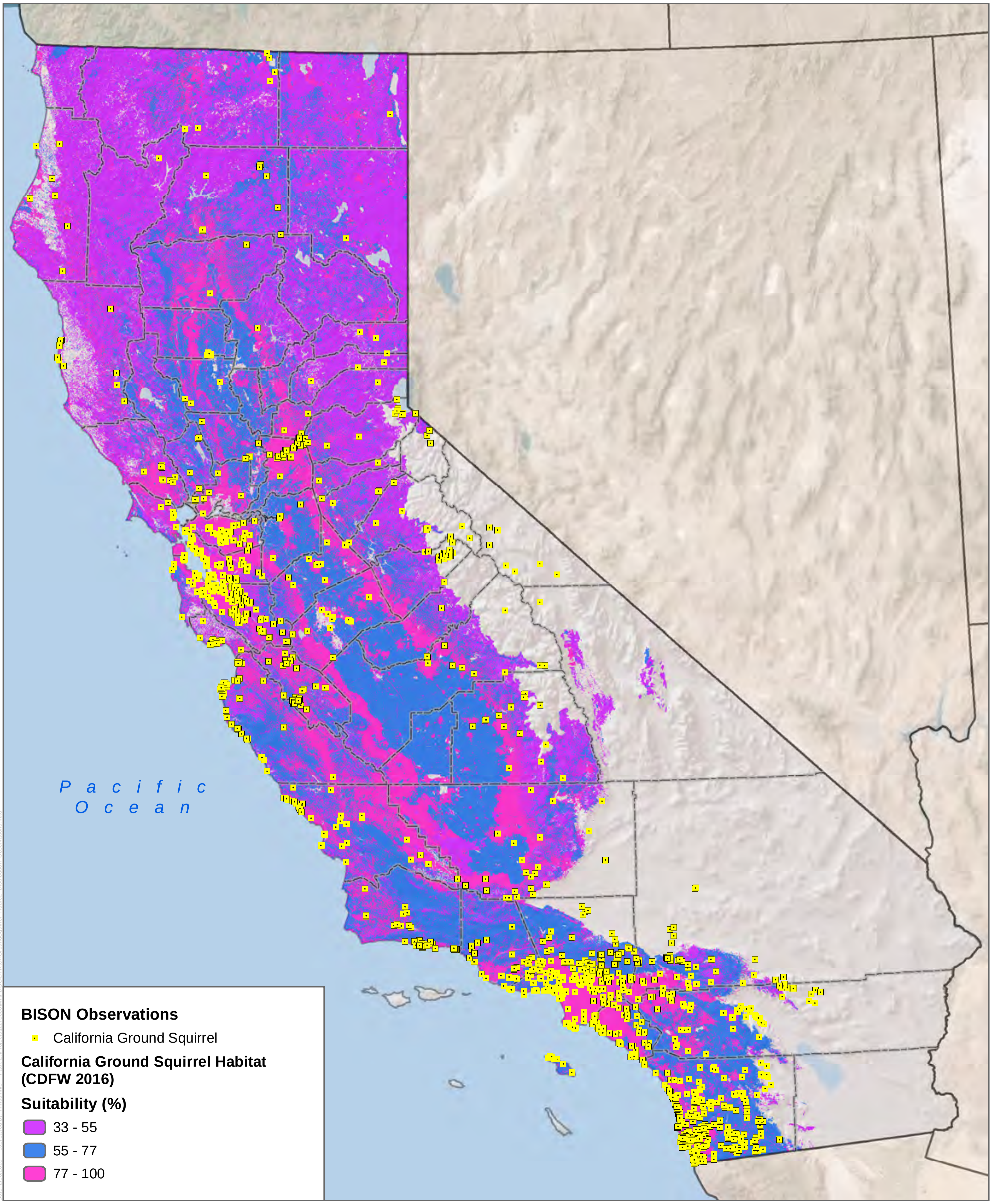

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of California Ground Squirrel Statewide

0 25 50 Miles

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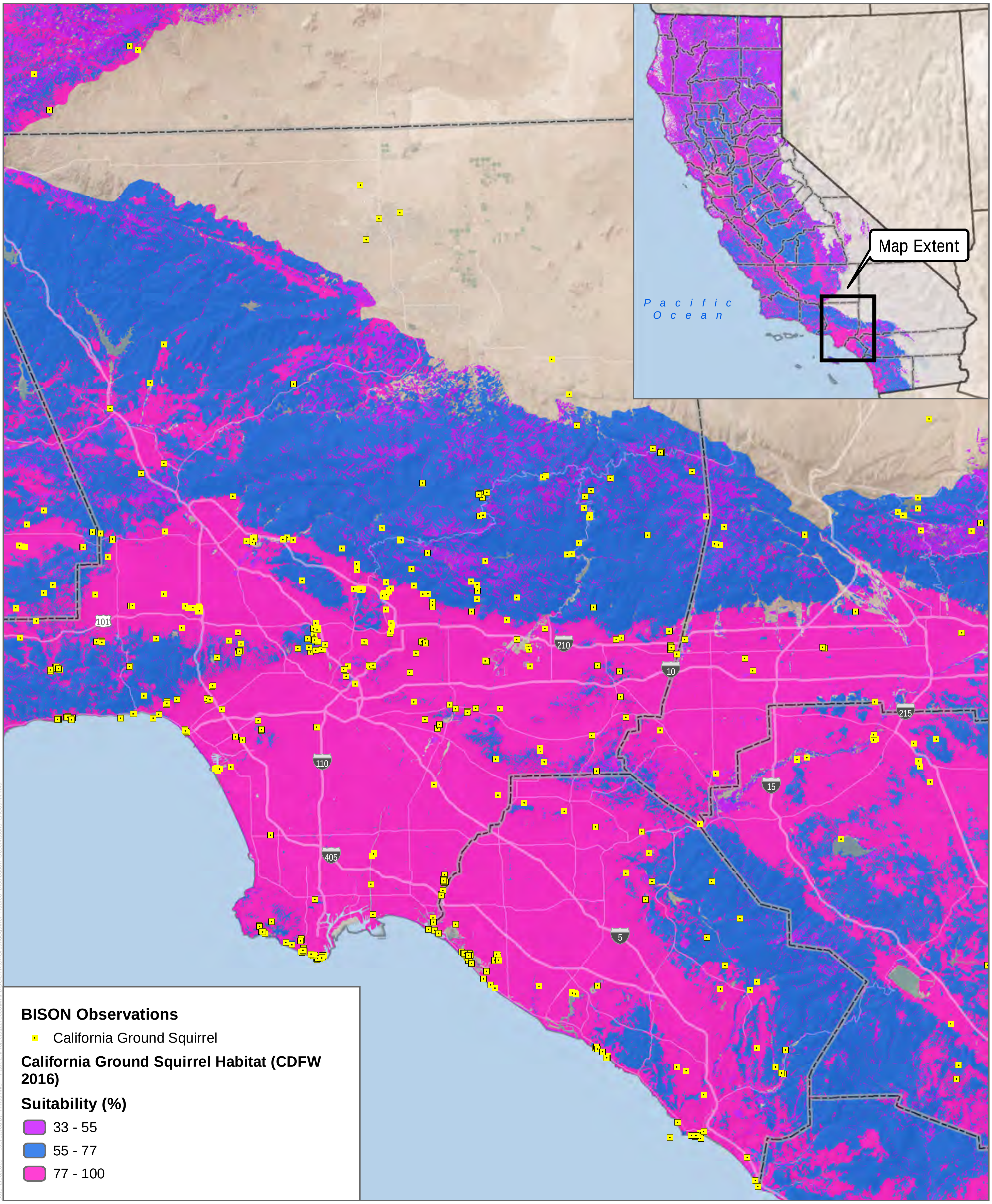

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of California Ground Squirrel in the Los Angeles County Area

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Biological Technical Report for the Wildlife Damage Management Project

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Fossorial (underground-dwelling) rodents, such as Botta's pocket gophers (*Thomomys bottae*) and California ground squirrels (*semi-fossorial*), are generally allopatric; that is, they do not generally overlap with other fossorial species in the same geographical location due to a limited resource—the soil (Reichman et al. 1982). This in in contrast to most aboveground-dwelling mammals where sympatry (living in the same geographical location) is very common due to the availability of numerous niches (i.e., they use different resources). Sympatry even occurs among species that compete for similar resources—for example, coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*).

While the suitable habitat for many fossorial species overlaps considerably, generally only one of those species will exist in any specific location. Because of this overlap in suitable habitat among allopatric species, the available suitable habitat for each species is reduced by the presence of the other species. Two fossorial/semi-fossorial rodents are analyzed in this report, Botta's pocket gopher and California ground squirrel. Because the top two-thirds of suitable habitat for these two species overlap extensively except in southeastern California, the top two-thirds of suitable habitat were divided by two for each species when estimating population sizes. Thus, these analyses provide for only 50% of the top two-thirds of suitable habitat to be available to each species. In areas like southeastern California, this will likely result in an underestimate of the population of Botta's pocket gophers because both species do not occur there; however, this was more prudent than to overestimate the populations of both species, which would likely be the result of not partitioning the habitat among the two species.

There are other fossorial and semi-fossorial species in California also (for example, the broad-footed mole [*Scapanus latimanus*]), which might also compete for fossorial habitat with both Botta's pocket gophers and California ground squirrels. However, the ranges and habitats of most other fossorial and semi-fossorial species do not overlap these two species to the extent that these two species overlap each other. And because Botta's pocket gopher and California ground squirrel habitats do not completely overlap, the 50% partitioning is conservative enough to account for these other species as well.

For pocket gophers, soil density (i.e., ability to burrow) and dryness (i.e., not flooding or submerging the burrows) are important factors determining the suitability of their habitat (Ingles 1952); these two factors were not considered by CDFW (2016) when assessing habitat suitability for this species because these factors vary on a much smaller scale than the 30-meter by 30-meter scale used by CDFW. For example, in one study, only 30% (0.8 of 2.63 hectares) of the available meadow habitat was suitable for occupancy by Botta's pocket gophers at one of the two study sites (Ingles 1952). Due to these limitations in habitat suitability that cannot be accounted for in the CDFW habitat model, only a portion of the top two-thirds of suitable habitat is truly suitable for this species. These factors are likely true for California ground squirrels also, though to a lesser extent because ground squirrels are only semi-fossorial (pocket gophers rarely move above ground, but ground squirrels frequently do) and use habitats less prone to flooding. For this analysis, the same 30% partitioning will be used that was used for Botta's pocket gophers, per the data of Ingles (1952). This is likely to be very conservative for California ground squirrels due to the differences noted above and because some locations, such as the second study site used by Ingles (1952), will be fully suitable for the species. However, use of all top two-thirds habitat, even only the 50% available due to allopatry of fossorial species as discussed above, would overestimate the California ground squirrel population, so only 30% of that habitat will be used to estimate the population. When combined with the 50% reduction in suitable habitat due to allopatry in fossorial species, the resulting amount of habitat used for the population estimates is 15%. This is reflected in the calculations provided below.

California ground squirrels have widely varying home range sizes as described in the various research-literature sources from North American populations as summarized in Table 3. However, female home range estimates were not used to estimate California ground squirrel populations because females are not territorial, and the species has a complex social structure which is not completely understood (Owings et al. 1977; Boellstorff and Owings 1995).

The California ground squirrel population by county in California was estimated using 15% of the top two-thirds of habitat in each county multiplied by the average of published population densities of 3,494 individuals/km². A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for value reference as well as other reference values):

   Average density of 3,494 individuals/km² ((8,145 + 1,729 + 568 + 6,211 + 3,200 + 1,110 individuals/km²)/6) multiplied by 15% of the amount of Top Two-Thirds Suitable Habitat Area (km²) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For California ground squirrel, the top two-thirds of suitable habitat represent 93% (264,256 km²) (Table 2) of the total estimated species range in California (283,344 km²) (CDFW 2016); thus, the populations estimates are likely to be slightly conservative. The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of California ground squirrel habitat (Figures 2 and 3) and even outside of the species' estimated range (Figure 2) (CDFW 2016, data not shown). California ground squirrels occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to considerably underestimate the population.

The estimate for population size for California ground squirrel in California is 138,496,766 individuals (Table 4). This approach assumes the following: that no California ground squirrels occupy any of the bottom one-third of suitable habitat, and that 15% of available top-two-thirds suitable habitat is fully occupied at the average density. The statewide and county estimates under each method are provided in Table 4.

Table 3. California Ground Squirrel Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km²)
Boellstorff and Owings 1995	Marked animal behavioral surveys	Alameda County, California	8,145
Evans and Holdenried 1943	Mark-recapture and marked animal behavioral surveys	Alameda County, California	1,729
Fitch 1948	Mark-recapture and marked animal behavioral surveys	Madera County, California	568
Owings et al. 1977	Mark-recapture and marked animal behavioral surveys	Yolo County, California	6,211
Loredo-Prendeville et al. 1994	Mark-recapture and mark-observation	Contra Costa County, California	High Density = 3,200 Moderate Density = 1,110

Table 4. Statewide and County California Ground Squirrel Population Estimates

County	Population Density (1,110/km²)	County	Population Density (1,110/km²)
Alameda	942,915	Orange	1,070,343
Alpine	114,130	Placer	1,861,691
Amador	724,779	Plumas	3,417,084
Butte	2,129,101	Riverside	3,204,566
Calaveras	1,348,065	Sacramento	1,291,298
Colusa	1,490,638	San Benito	1,873,250
Contra Costa	947,980	San Bernardino	1,963,531
Del Norte	1,154,858	San Diego	4,538,840
El Dorado	2,072,169	San Francisco	62,271
Fresno	5,833,673	San Joaquin	1,877,305
Glenn	1,746,534	San Luis Obispo	4,367,048
Humboldt	3,882,009	San Mateo	518,743
Imperial	50,343	Santa Barbara	3,444,148
Inyo	673,331	Santa Clara	1,705,050
Kern	7,744,137	Santa Cruz	433,788
Kings	1,840,909	Shasta	5,079,201
Lake	1,656,971	Sierra	1,250,022
Lassen	6,108,614	Siskiyou	8,207,839
Los Angeles	4,044,465	Solano	998,747
Madera	2,078,559	Sonoma	1,919,196
Marin	666,787	Stanislaus	2,012,198
Mariposa	1,526,740	Sutter	784,426
Mendocino	3,797,564	Tehama	3,956,211
Merced	2,471,916	Trinity	4,241,781
Modoc	5,360,334	Tulare	5,125,949
Mono	0	Tuolumne	1,636,664
Monterey	4,452,809	Ventura	2,461,518
Napa	977,569	Yolo	1,329,189
Nevada	1,199,992	Yuba	826,976
		Total	**138,496,766**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Boellstorff, D.E., and D.H. Owings. 1995. "Home Range, Population Structure, and Spatial Organization of California Ground Squirrels." *Journal of Mammalogy* 76(2): 551–561.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. California ground squirrel Predicted Habitat (CWHR M072). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Evans, F.C., and R. Holdenried. 1943. "A Population Study of the Beechey Ground Squirrel in Central California. " *Journal of Mammalogy* 24(2): 231–260.

Fitch, H.S. 1948. "Ecology of the California Ground Squirrel on Grazing Lands." *American Midland Naturalist* 39(3): 513–596.

Ingles, L.G. 1952. "The Ecology of the Mountain Pocket Gopher, *Thomomoys monticola*." *Ecology* 33(1): 87–95.

Loredo-Prendeville, I., Van Vuren, D., Kuenzi, A.J. and Morrison, M.L., 1994, February. California ground squirrels at Concord Naval Weapons Station: alternatives for control and the ecological consequences. In Proceedings of the Sixteenth Vertebrate Pest Conference (1994) (p. 32).

Owings, D.H., M. Borchert, and R. Virginia. 1977. "The Behaviour of California Ground Squirrels." *Animal Behaviour* 25(1): 221–230.

Reichman, O.J., T.G. Whitham, and G.A. Ruffner. 1982. "Adaptive Geometry of Burrow Spacing in Two Pocket Gopher Populations." *Ecology* 63(3): 687–695.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C23 Western Gray Squirrel Population and Distribution

The following describes the distribution and population estimate of western gray squirrel (*Sciurus griseus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, western gray squirrel observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 814 western gray squirrel observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Western Gray Squirrel across California

Dataset	Number of Observations	Date Range
Western Gray Squirrel Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	814	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

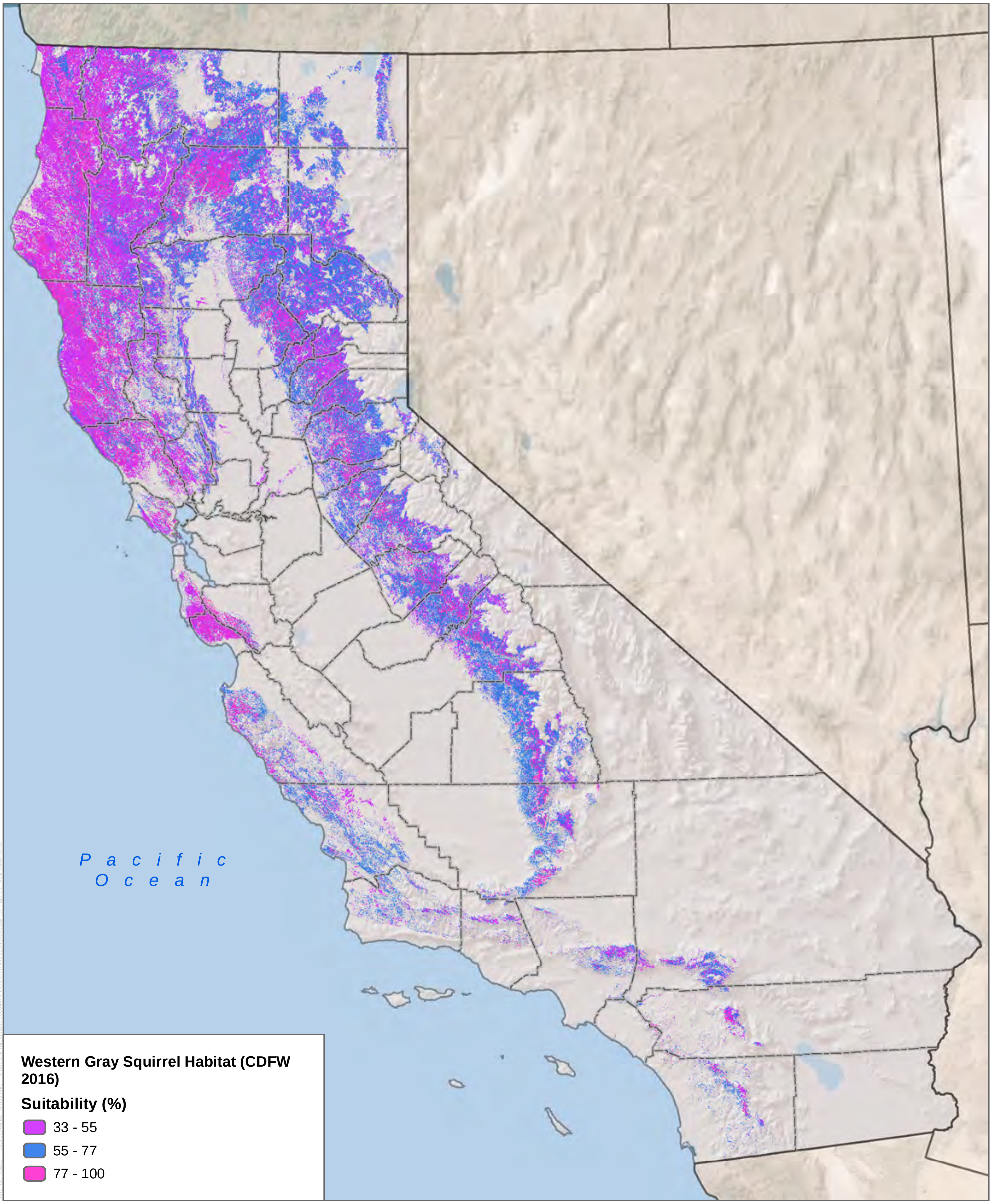
Table 2. Western Gray Squirrel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	0	Orange	32
Alpine	226	Placer	1,449
Amador	695	Plumas	4,641
Butte	2,051	Riverside	461
Calaveras	1,461	Sacramento	82
Colusa	629	San Benito	9
Contra Costa	0	San Bernardino	785
Del Norte	2,033	San Diego	613
El Dorado	2,728	San Francisco	4
Fresno	2,470	San Joaquin	13
Glenn	790	San Luis Obispo	1,837
Humboldt	7,174	San Mateo	417

Table 2. Western Gray Squirrel Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Imperial	0	Santa Barbara	845
Inyo	4	Santa Clara	433
Kern	1,865	Santa Cruz	704
Kings	0	Shasta	6,498
Lake	1,479	Sierra	673
Lassen	2,881	Siskiyou	9,012
Los Angeles	636	Solano	94
Madera	1,654	Sonoma	2,275
Marin	464	Stanislaus	39
Mariposa	1,864	Sutter	25
Mendocino	7,030	Tehama	3,755
Merced	3	Trinity	6,546
Modoc	2,047	Tulare	3,041
Mono	28	Tuolumne	2,137
Monterey	1,532	Ventura	320
Napa	964	Yolo	413
Nevada	1,277	Yuba	718
		Total Statewide Suitable Habitat	**91,858**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of western gray squirrels statewide (Figure 2), and modeled habitat and observations in the High Sierra/Mono Lake area (Figure 3). The figures show that the majority of western gray squirrel observations occur within or on the edge of the top two-thirds of suitable habitat and largely within the species' range (CDFW 2016, data not shown). However, numerous observations occur outside of this habitat and outside of the species' range. Overall, these data mostly support the accuracy of the CDFW (2016) range and habitat data for western gray squirrels and also suggest that these methods will produce moderately conservative population estimates due to the frequent occurrence of western gray squirrels outside of the top two-thirds of suitable habitat and outside of the estimated range of the species.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Western Gray Squirrel Habitat from CDFW Habitat Suitability Model

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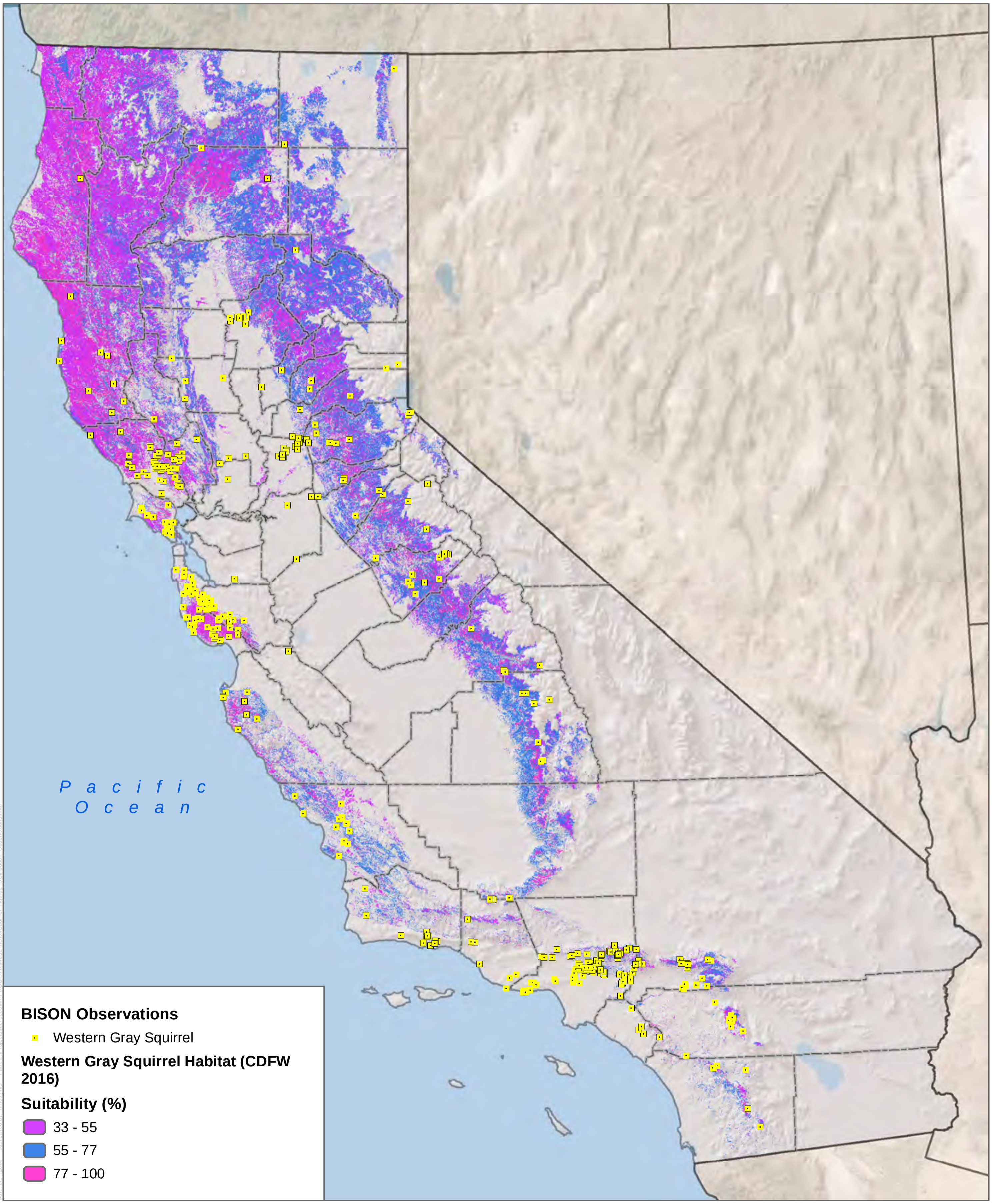

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Western Gray Squirrel Statewide

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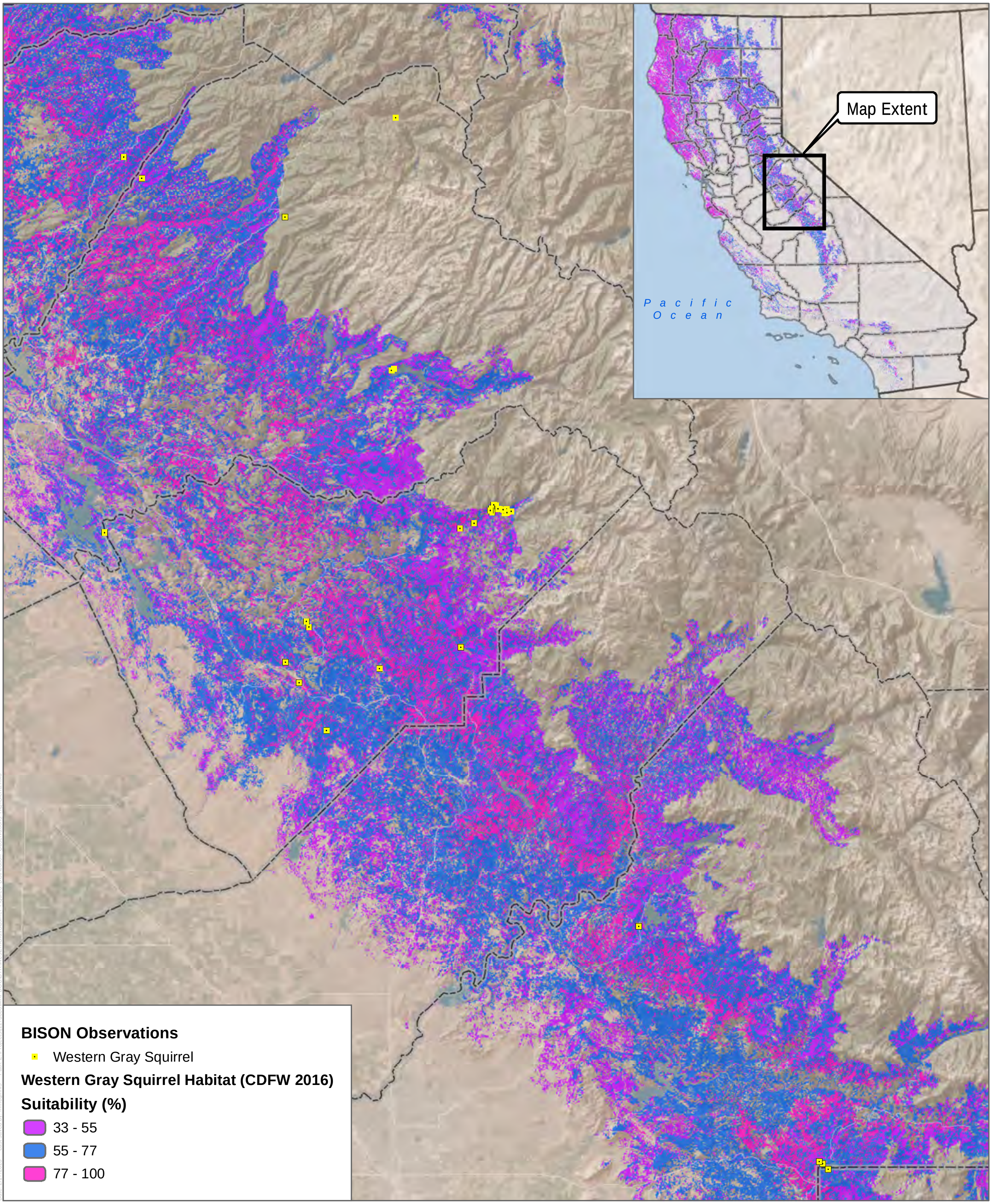

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Western Gray Squirrel in the High Sierra/Mono Lake Area

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0 3.5 7 Miles

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Western gray squirrels have widely divergent home range sizes in coastal western states as described in the various research-literature sources. In Washington, western gray squirrels are state-listed as threatened due to dramatic population declines over the past century (Vander Haegen et al. 2005; Linders and Stinson 2006). The density of the species is considerably higher and the home ranges are considerably smaller in California, where the species continues to flourish (Vander Haegen et al. 2005; Linders and Stinson 2006). Due to these differences, population density and home range data from Washington were not used. In Oregon, densities are similar to those in California or Washington depending on the part of the state sampled (south or north, respectively) (Vander Haegen et al. 2005; Linders and Stinson 2006). The data used for these population estimates was limited to relatively recent data from California and Oregon. There are more data available from the 1940s through 1970s but this analysis focused on more recent data. For density, these historic data were all higher. For home range, historic data were similar to recent data in Table 3. See Linders and Stinson (2006) for a review of density and home range data.

Two methods were used to estimate the western gray squirrel population by county in California: (1) the published population density in California of 130 individuals/km^2 (Gilman 1986) and (2) the average female home range size across published studies of 0.029 km^2, and multiplied by 2 for a 1:1 male to female ratio (Table 3). This analysis assumed no home range overlap among females because no California or Oregon data was found that reported such overlap. Two studies from Washington reported female home range overlap (Linders et al. 2004, Johnston 2013) but data from Washington were not included in these analyses. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references): Population Density of 130 individuals/km^2 (Gilman 1986) multiplied by the amount of Suitable Habitat Area (km^2) in each county.
2. Home Range-Based Estimate (see Table 3 for references): Suitable Habitat Area (km^2) in each county divided by 0.029 (average adult female home range value of 0.033 km^2 ((0.04 + 0.026 km^2)/2) – 0.004 (13% home range overlap) and multiplied by 2 to include males.

The home range-based method estimates the *adult* population, excluding young of the year and juveniles (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year, although this varies by study. Therefore, the density-based method generally represents the *total* population and not just the *adult* population. Consequently, the density-based estimate is generally, though not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For gray squirrel, the top two-thirds of suitable habitat represent only 48% (91,858 km^2) (Table 2) of the total estimated species range in California (190,664 km^2) (CDFW 2016); thus, the populations estimates are likely to be very conservative. The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of gray squirrel habitat (Figures 2 and 3) and even outside of the species' estimated range (Figure 2) (CDFW

2016, data not shown). Since gray squirrels occupy many areas outside of their top two-thirds habitat, while these methods assume they do not, these methods will tend to considerably underestimate the population.

The estimates for population size for western gray squirrel in California are 11,941,516 individuals using the density-based method and 6,335,022 individuals using the home range-based method (Table 4). These approaches assume the following: that there is 13% home range overlap among females, that no western gray squirrels occupy any of the bottom one-third of suitable habitat, and that all available top-two-thirds suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that one of the cited studies was for a population outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Western Gray Squirrel Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	State	Home Range Overlap Among Females	Female Home Range Size (km²)	Population Density (individuals/km²)	Sample Size
Foster 1992	Trap data and radio-collar	AUTO-CAD software	Oregon	ND	0.04	ND	52Male, 25 Female trapped; 5 Male, 3 Female radio collared
Gilman 1986	Radio-collar	Minimum polygon	California (1985)	13%	0.026	130	6 Male, 4 Female

Notes: ND = Not Determined.

Table 4. Statewide and County Western Gray Squirrel Population Estimates

County	Population Density (130/km²)	Female Home Range (0.029 km²)	County	Population Density (130/km²)	Female Home Range (0.029 km²)
Alameda	4	2	Orange	4,122	2,187
Alpine	29,387	15,590	Placer	188,372	99,932
Amador	90,360	47,936	Plumas	603,307	320,057
Butte	266,692	141,481	Riverside	59,897	31,776
Calaveras	189,903	100,744	Sacramento	10,634	5,641
Colusa	81,759	43,373	San Benito	1,217	646
Contra Costa	55	29	San Bernardino	102,032	54,128
Del Norte	264,262	140,192	San Diego	79,658	42,259
El Dorado	354,580	188,106	San Francisco	474	251
Fresno	321,157	170,375	San Joaquin	1,703	903
Glenn	102,714	54,490	San Luis Obispo	238,859	126,716
Humboldt	932,666	494,783	San Mateo	54,259	28,784
Imperial	20	11	Santa Barbara	109,869	58,286
Inyo	474	252	Santa Clara	56,292	29,863
Kern	242,493	128,644	Santa Cruz	91,573	48,580
Kings	0	0	Shasta	844,741	448,139
Lake	192,230	101,979	Sierra	87,548	46,445

Table 4. Statewide and County Western Gray Squirrel Population Estimates

County	Population Density (130/km^2)	Female Home Range (0.029 km^2)	County	Population Density (130/km^2)	Female Home Range (0.029 km^2)
Lassen	374,553	198,702	Siskiyou	1,171,578	621,527
Los Angeles	82,640	43,841	Solano	12,219	6,482
Madera	215,041	114,080	Sonoma	295,795	156,920
Marin	60,348	32,015	Stanislaus	5,026	2,666
Mariposa	242,285	128,533	Sutter	3,301	1,751
Mendocino	913,925	484,841	Tehama	488,142	258,961
Merced	390	207	Trinity	850,940	451,427
Modoc	266,127	141,182	Tulare	395,383	209,752
Mono	3,648	1,935	Tuolumne	277,838	147,394
Monterey	199,110	105,629	Ventura	41,646	22,093
Napa	125,292	66,468	Yolo	53,702	28,489
Nevada	165,994	88,060	Yuba	93,280	49,485
			Total	**11,941,516**	**6,335,022**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Western Gray Squirrel Predicted Habitat (CWHR M077). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Foster, S.A. 1992. "Studies of Ecological Factors that Affect the Population and Distribution of the Western Gray Squirrel in Northcentral Oregon." PhD dissertation; Portland State University.

Gilman, K.N. 1986. "The Western Gray Squirrel (Sciurus griseus), Its Summer Home Range, Activity Times, and Habitat Usage in Northern California." M.S. Thesis. California State University, Sacramento.

Johnston, A.N. 2013. "Eastern Gray Squirrel Ecology and Interactions with Western Gray Squirrels." PhD dissertation; University of Washington.

Linders, M.J., S.D. West, and W.M. Vander Haegen. 2004. "Seasonal Variability in the Use of Space by Western Gray Squirrels in Southcentral Washington." *Journal of Mammalogy* 85(3): 511–516.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Vander Haegen, W.M., G.R. Orth, and L.M. Aker. 2005. *Ecology of the Western Gray Squirrel in South-Central Washington*. Progress Report. Olympia: Washington Department of Fish and Wildlife. January 2005.

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C24 North American Deer Mouse Population and Distribution

The following describes the distribution and population estimate of North American deer mouse (*Peromyscus maniculatus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, deer mouse observation data were obtained from two datasets: the Biodiversity Information Serving Our Nation (created and maintained by the U.S. Geological Survey) and the California Natural Diversity Database (CDFW 2022). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Among the datasets, there were 175 deer mouse observations between 2000 and 2020.

Table 1. Observations and Modeled Distribution of North American Deer Mouse across California

Dataset	Number of Observations	Date Range
Deer Mouse Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	172	2000–2018
CNDDB (CDFW 2022)	3	2000–2020

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey; CNDDB = California Natural Diversity Database.

1 Data accessed December 11, 2020.

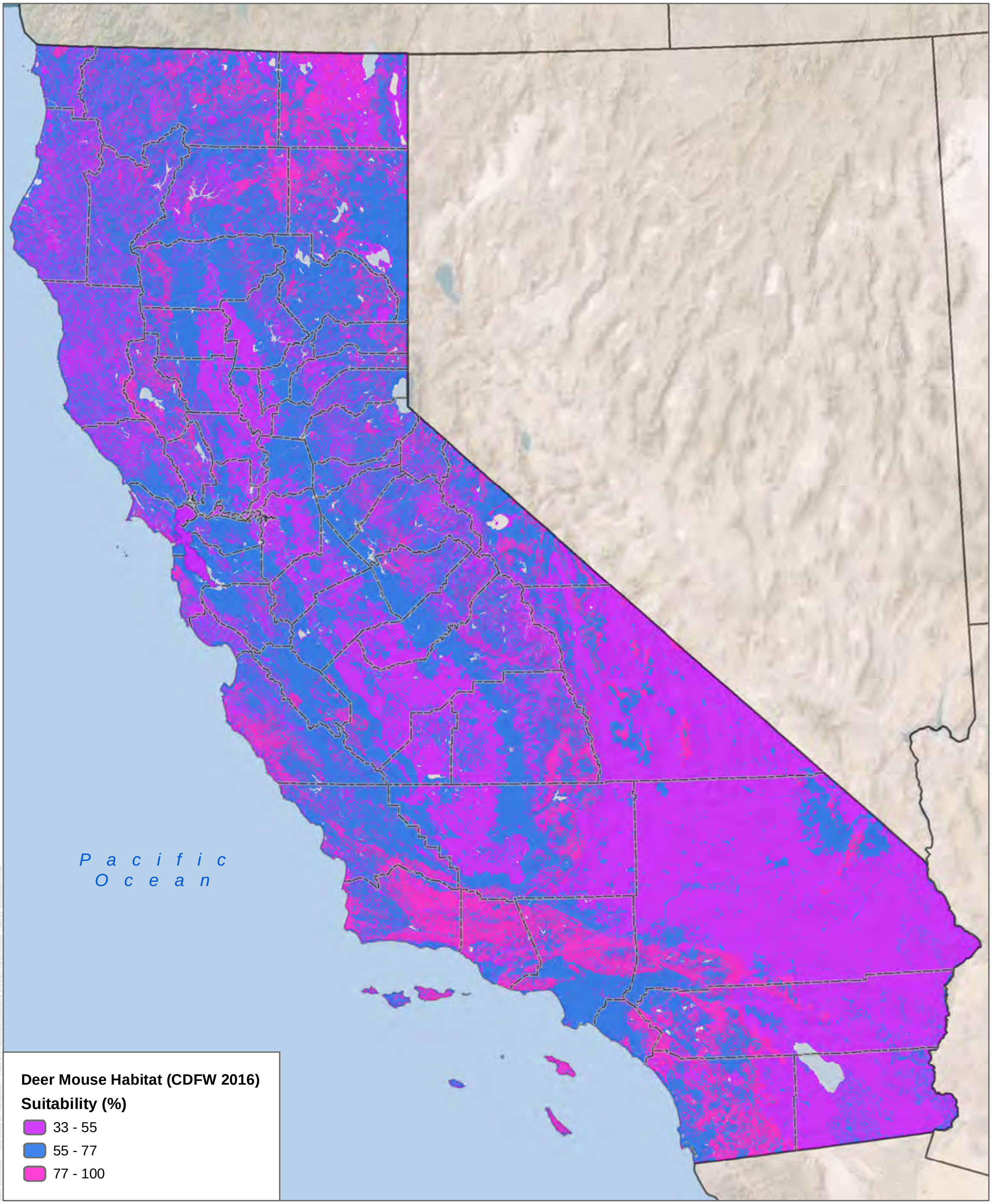
Table 2. North American Deer Mouse Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	2,026	Orange	2,055
Alpine	1,904	Placer	3,636
Amador	1,537	Plumas	6,604
Butte	4,241	Riverside	18,638
Calaveras	2,614	Sacramento	2,496
Colusa	2,971	San Benito	3,588
Contra Costa	1,974	San Bernardino	52,027
Del Norte	2,598	San Diego	10,913
El Dorado	4,417	San Francisco	253

Table 2. North American Deer Mouse Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km²)	County	Top 2/3 Suitable Habitat (km²)
Fresno	15,380	San Joaquin	3,608
Glenn	3,405	San Luis Obispo	8,540
Humboldt	9,196	San Mateo	1,399
Imperial	10,830	Santa Barbara	7,083
Inyo	26,466	Santa Clara	3,319
Kern	21,004	Santa Cruz	1,151
Kings	3,520	Shasta	9,785
Lake	3,243	Sierra	2,468
Lassen	11,724	Siskiyou	16,272
Los Angeles	10,504	Solano	2,254
Madera	5,520	Sonoma	4,108
Marin	1,511	Stanislaus	3,852
Mariposa	3,744	Sutter	1,556
Mendocino	9,069	Tehama	7,609
Merced	5,024	Trinity	8,221
Modoc	10,278	Tulare	12,474
Mono	7,849	Tuolumne	5,757
Monterey	8,556	Ventura	4,775
Napa	1,924	Yolo	2,607
Nevada	2,478	Yuba	1,624
		Total Statewide Suitable Habitat	**404,179**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of deer mouse statewide (Figure 2), and modeled habitat and observations in the Santa Cruz/Monterey Bay area (Figure 3). The figures show that most deer mouse observations occur within the top two-thirds of suitable habitat and within the species' range (CDFW 2016, data not shown). This is likely due to the ubiquitous range for the species (410,540 km^2), which covers 99.95% of the State of California (410,727 km^2). These data fully support the accuracy of the CDFW (2016) range and habitat data for deer mouse.



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Deer Mouse Habitat from CDFW Habitat Suitability Model

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SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Deer Mouse Statewide

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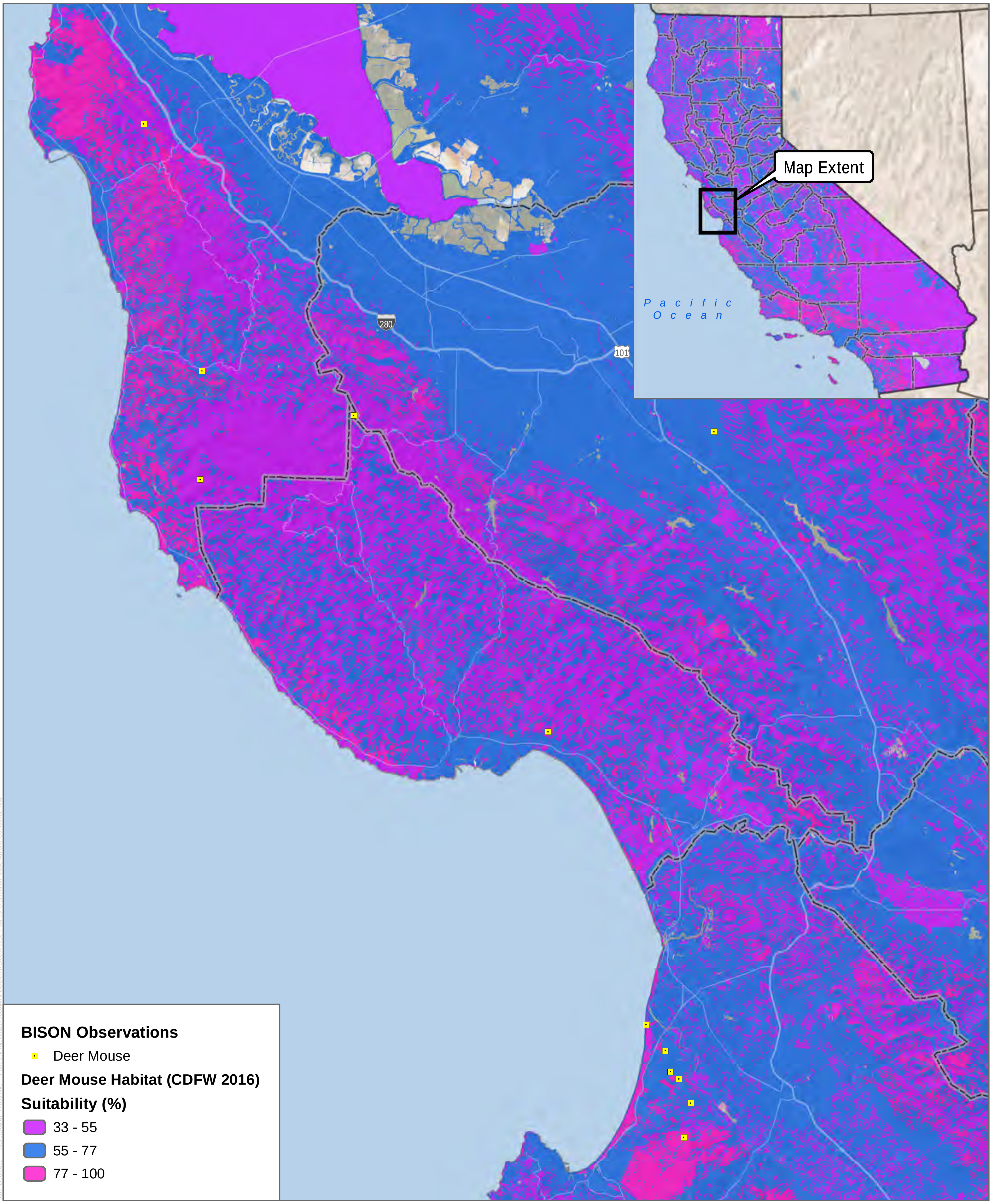

SOURCE: CDFW 2016; USGS 2020

DUDEK

0 3.5 7 Miles

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Deer Mouse in the Santa Cruz Area

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Deer mice have widely varying home range sizes as described in the various research-literature sources from North American populations as summarized in Table 3. However, home range data were not used to estimate the deer mouse population because they are not territorial and often live in groups (Wolff 1994; Bunker 2001; Salonen 1969). Individual females do not guard their territory from other females (Wolff 1994; Bunker 2001; Salonen 1969), which is a critical assumption of this method.

Published density estimates were used to estimate the deer mouse population by county in California. The average of available published population densities was 2,028 individuals/km^2 (Table 3). A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):
   Average Density 2,028 individuals/km^2 ((1,545 + 3,600 + 2,470 + 1,690 + 835 individuals/km^2)/5) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For North American deer mouse, the top two-thirds of suitable habitat represent 98% (404,179 km^2) (Table 2) of the total estimated species range in California (410,540 km^2) (CDFW 2016). Because deer mouse habitat is so ubiquitous in California, these estimates are likely only slightly conservative. The vast majority (98%) of the State of California (410,727 km^2) is in the top two-thirds of suitable deer mouse habitat (404,179 km^2), so the observation data presented herein largely or entirely occur within that habitat (Figures 2 and 3) (CDFW 2016). The methods used likely do not substantially underestimate the deer mouse population.

The population estimate for deer mice in California is 819,674,844 individuals using the density-based method (Table 4). This approach assumes the following: that no deer mice occupy any of the bottom one-third of suitable habitat and that all available top-two-thirds suitable habitat is fully occupied. This approach also assumes that the population density values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. North American Deer Mouse Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Chew and Chew 1970	Mark-recapture	Arizona	70[1]
Clay et al. 2009	Live-trapping (DISTANCE software)	Utah	1,545
Davidson and Morris 2001	Live-trapping	Ontario, Canada	3,600
Drost and Fellers 1991	Mark-recapture	Santa Barbara Island, California	21,600[2]
Luis et al. 2010	Mark-recapture	Montana	2,470
Madhav et al. 2007	Mark-recapture	Montana	1,690
Wood et al. 2010	PIT-tag monitoring	Utah	5,000[3]

Table 3. North American Deer Mouse Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Zwolak and Foresman 2008	Mark-recapture	Western Montana	835

Notes: PIT = Passive Integrated Transponder.
1 This density estimate was not used for the population estimate because it is far below all other estimates.
2 This density estimate was not used for the population estimate because the authors note that it "far exceed[s]" average densities by "an order of magnitude."
3 This density estimate was not used for the population estimate because the authors report that is was "the highest recorded for this site across 8 years of sampling."

County	Population Density (2,028/km^2)	County	Population Density (2,028/km^2)
Alameda	4,109,434	Orange	4,168,523
Alpine	3,861,530	Placer	7,373,700
Amador	3,117,150	Plumas	13,393,763
Butte	8,600,693	Riverside	37,797,298
Calaveras	5,300,209	Sacramento	5,061,637
Colusa	6,024,910	San Benito	7,275,815
Contra Costa	4,002,932	San Bernardino	105,510,245
Del Norte	5,268,100	San Diego	22,131,981
El Dorado	8,957,167	San Francisco	514,002
Fresno	31,191,294	San Joaquin	7,316,301
Glenn	6,906,024	San Luis Obispo	17,319,086
Humboldt	18,650,414	San Mateo	2,836,932
Imperial	21,962,230	Santa Barbara	14,365,209
Inyo	53,673,191	Santa Clara	6,730,571
Kern	42,595,850	Santa Cruz	2,335,035
Kings	7,138,078	Shasta	19,843,616
Lake	6,577,431	Sierra	5,004,735
Lassen	23,775,639	Siskiyou	32,998,899
Los Angeles	21,301,455	Solano	4,571,599
Madera	11,195,461	Sonoma	8,332,018
Marin	3,063,622	Stanislaus	7,812,062
Mariposa	7,592,334	Sutter	3,154,769
Mendocino	18,391,509	Tehama	15,431,135
Merced	10,188,975	Trinity	16,673,176
Modoc	20,843,386	Tulare	25,297,352
Mono	15,917,911	Tuolumne	11,674,839
Monterey	17,351,620	Ventura	9,684,314
Napa	3,902,727	Yolo	5,287,807
Nevada	5,024,662	Yuba	3,292,487
		Total	**819,674,844**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Bunker, A. 2001. "*Peromyscus maniculatus* deer mouse" (Online). Animal Diversity Web, University of Michigan Museum of Zoology. Accessed November 19, 2022 at https://animaldiversity.org/accounts/Peromyscus_maniculatus/

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Deer Mouse Predicted Habitat (CWHR M117). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. California Natural Diversity Database (CNDDB). RareFind 5: Commercial version. CDFW, Biogeographic Data Branch. https://apps.wildlife.ca.gov/rarefind/view/RareFind.aspx.

Chew, R.M., and A.E. Chew. 1970. "Energy Relationships of the Mammals of a Desert Shrub (*Larrea tridentata*) Community." *Ecological Monographs* 40(1): 2–21.

Clay, C.A., E.M. Lehmer, S. St. Jeor, and M.D. Dearing. 2009. Testing Mechanisms of the Dilution Effect: Deer Mice Encounter Rates, Sin Nombre Virus Prevalence and Species Diversity. EcoHealth 6: 250-259.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Davidson, D.L. and D.W. Morris. 2001. "Density-Dependent Foraging Effort of Deer Mice (Peromyscus maniculatus)." Functional Ecology 15: 575-583.

Drost, C.A., and G.M. Fellers. 1991. "Density Cycles in an Island Population of Deer Mice, Peromyscus maniculatus." *Oikos* 60(3): 351–364.

Luis, A.D., R.J. Douglass, J.N. Mills, and O.N. Bjørnstad. 2010. "The effect of seasonality, density and climate on the population dynamics of Montana deer mice, important reservoir hosts for Sin Nombre hantavirus." Journal of Animal Ecology 79: 462-470.

Madhav, N.K., K.D. Wagoner, R.J. Douglass, and J.N. Mills. 2007. "Delayed Density-Dependent Prevalence of Sin Nombre Virus Antibody in Montana Deer Mice (*Peromyscus maniculatus*) and Implications for Human Disease Risk." Vector-Borne and Zoonotic Diseases 7(3):353-364

Salonen, J.J. 1969. Experimental induction of territorial behavior in the deer mouse, Peromyscus maniculatus. M.S. Thesis. Montana State University.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

Wolff, J.O. 1994. "Reproductive success of solitarily and communally nesting white-footed mice and deer mice"/ Behavioral Ecology 5(2):206-209

Wood, B.A., L. Cao, and M.D. Dearing. 2010. "Deer Mouse (*Peromyscus maniculatus*) Home-Range Size and Fidelity in Sage-Steppe Habitat." *Western North American Naturalist* 70(3): 345–354.

Zwolak, R. and K.R. Foresman. 2008. "Deer mouse demography in burned and unburned forest: no evidence for source–sink dynamics." Canadian Journal of Zoology 86: 83-91.

C25 Mule Deer Population and Distribution

The following describes the distribution and population estimate of mule deer (*Odocoileus hemionus*) in California, including all subspecies, such as the Columbian black-tailed deer (*Odocoileus hemionus columbianus*). The population estimate is based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, mule deer and black-tailed deer observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 1,598 mule and black-tailed deer observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Mule and Black-Tailed Deer across California

Dataset	Number of Observations	Date Range
Mule and Black-Tailed Deer Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	1,598	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

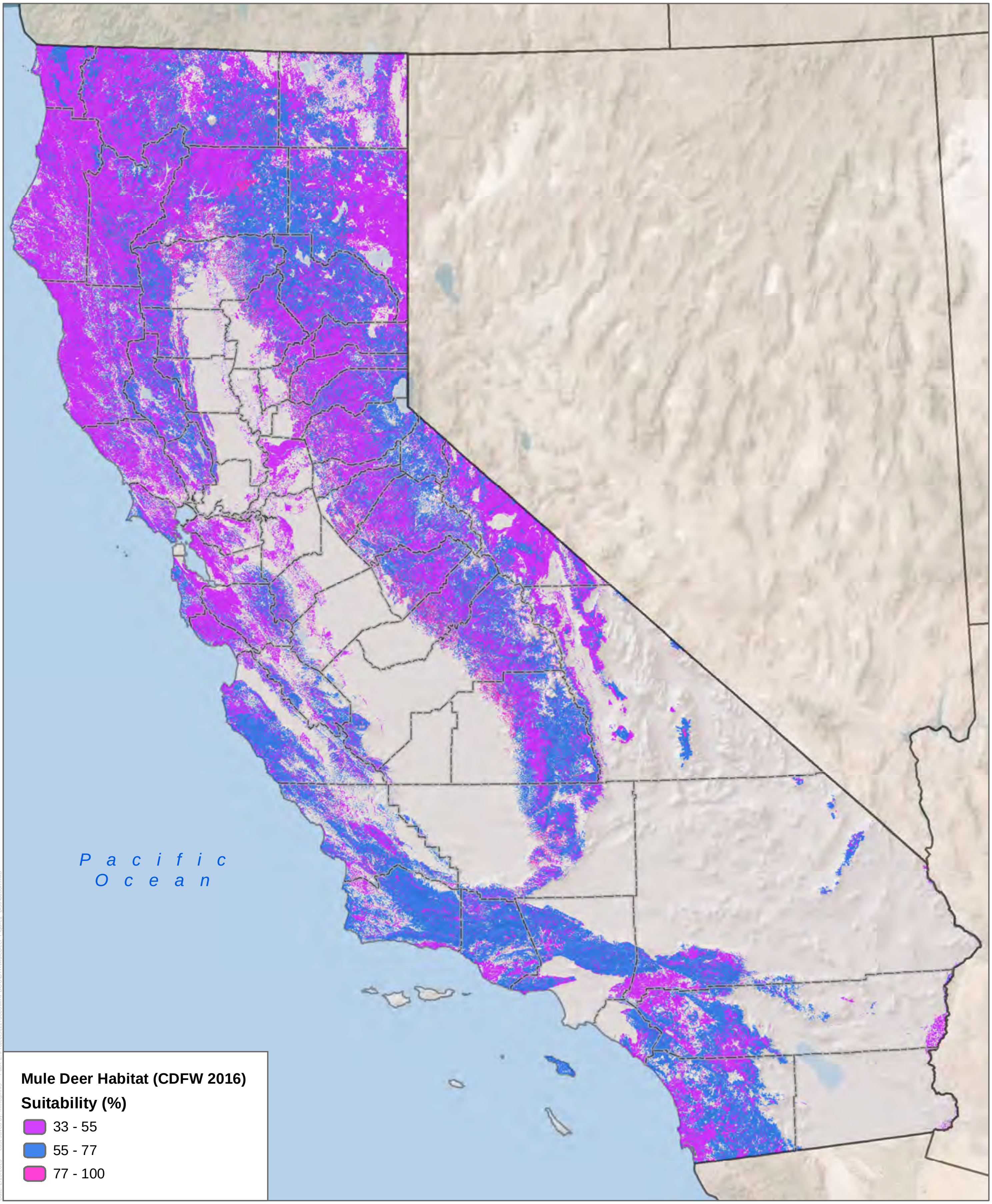
Table 2. Mule and Black-Tailed Deer Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,059	Orange	901
Alpine	1,531	Placer	2,854
Amador	1,039	Plumas	6,054
Butte	2,405	Riverside	5,698
Calaveras	2,001	Sacramento	1,024
Colusa	924	San Benito	1,727
Contra Costa	965	San Bernardino	3,927
Del Norte	2,541	San Diego	7,485
El Dorado	3,858	San Francisco	0
Fresno	5,816	San Joaquin	702
Glenn	1,288	San Luis Obispo	4,124
Humboldt	8,164	San Mateo	898

Table 2. Mule and Black-Tailed Deer Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Imperial	103	Santa Barbara	5,101
Inyo	3,532	Santa Clara	2,508
Kern	4,175	Santa Cruz	992
Kings	66	Shasta	8,853
Lake	2,861	Sierra	2,257
Lassen	10,378	Siskiyou	14,339
Los Angeles	4,724	Solano	182
Madera	2,632	Sonoma	2,946
Marin	962	Stanislaus	921
Mariposa	2,916	Sutter	141
Mendocino	7,865	Tehama	4,869
Merced	460	Trinity	7,731
Modoc	6,209	Tulare	6,376
Mono	5,940	Tuolumne	4,611
Monterey	4,897	Ventura	3,971
Napa	1,399	Yolo	539
Nevada	2,245	Yuba	873
		Total Statewide Suitable Habitat	**195,561**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of mule and black-tailed deer statewide (Figure 2), and modeled habitat and observations in the Eastern Sierra area (Figure 3).



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Mule Deer Habitat from CDFW Habitat Suitability Model

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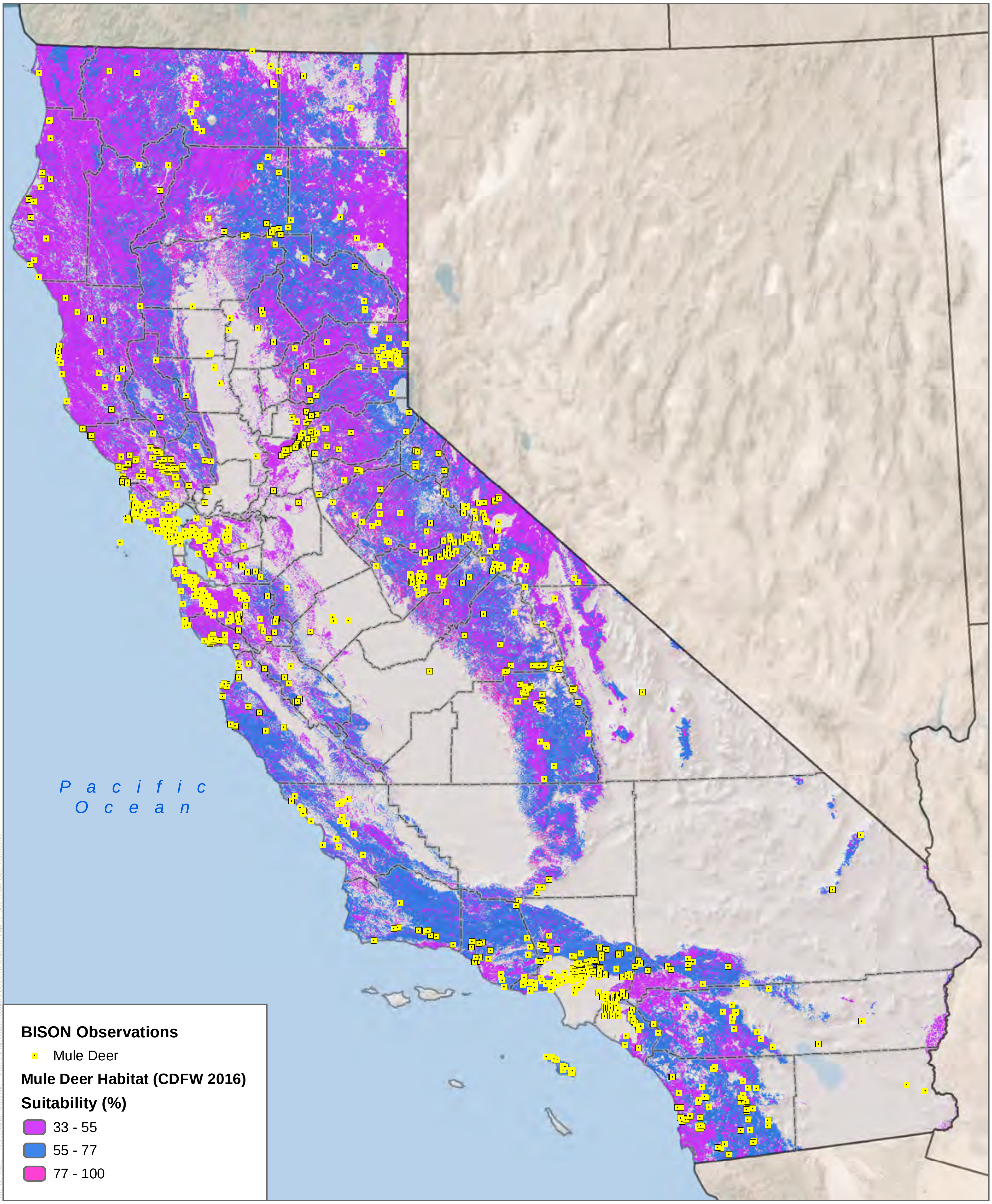

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Mule Deer Statewide

Biological Technical Report for the Wildlife Damage Management Project

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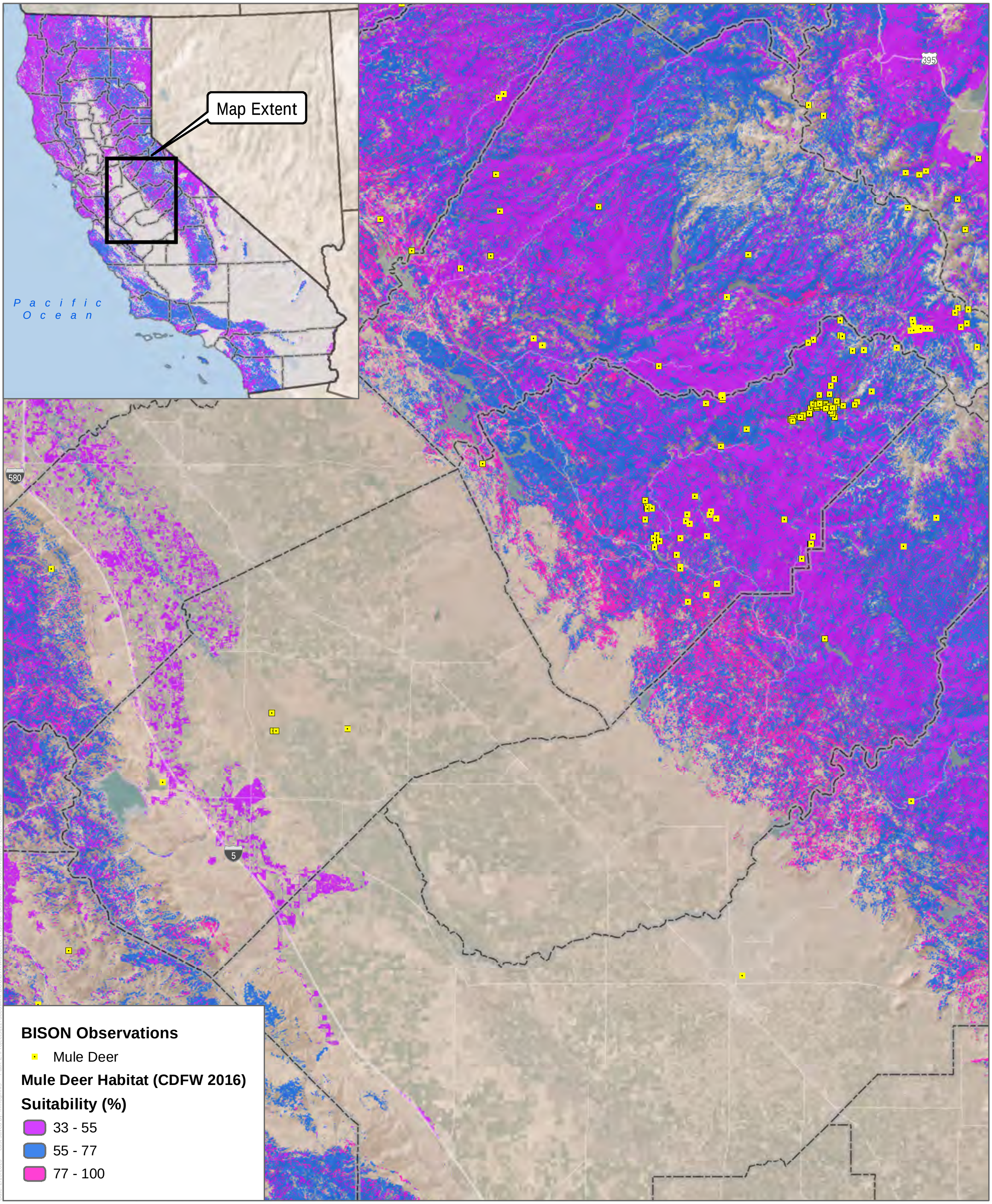

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Mule Deer in the Eastern Sierra Area

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The mule deer population by county in California was estimated based on population density estimates from published studies (Table 3). Many mule deer in California are migratory (Higley 2002), and therefore occupy different home ranges in summer and winter. Because this analysis cannot adequately adjust for the use of these different home ranges throughout the year, home range data were not used to estimate the mule deer population.

Because many mule deer in California are migratory (Higley 2002), the available habitat is not reflective of their overall density throughout the year. Migratory mule deer have summer and winter ranges; both of these ranges support the same mule deer population over different times of the year. For migratory mule deer, density might be 5.2 mule deer per square kilometer in the summer range (Furnas et al. 2018), but few or no deer would be found in their winter range during that time. To roughly estimate this habitat partitioning, the top two-thirds of mule deer habitat were divided by two. This is a very rough approximation of summer versus winter range for mule deer because not all California mule deer are migratory (Higley 2002). Also, winter range is typically smaller than summer range, and therefore the deer are more dense in winter. For example, the highest density found in the literature was 24 deer/km^2, which was in the winter range of a migratory population (Pierce et al. 2012). This rough approximation was used as a conservative approach to estimating the mule deer population in California.

Mule deer density varies considerably in California based on the quality of the available habitat; density estimates in the literature ranged from 0.1 to 24 deer per square kilometer (Marshal et al. 2006 and Pierce et al. 2012, respectively). This shows mule deer are up to 240 times more dense in some areas than others. These wide variations make statewide population estimates difficult. For example, desert mule deer (*O. hemionus eremicus*) live in the Sonoran Desert of southeastern California; not surprisingly, they are the least dense of the California mule deer subspecies (0.1/km^2) (Marshal et al. 2006). Also, in Marin County, the density of a Columbian black-tailed deer population referred to as "overabundant" has been estimated as high as 18.3 deer/km^2 (Furnas et al. 2020). Neither of these values represents the average mule deer density in California, and these extremes do not compensate for each other. Including these high and low density extremes would result in an overestimate of the mule deer population because the "highs" are farther from the median than the "lows."

As such, the high and low density extremes were excluded from the estimate. Three density estimates remained near the median of the range of densities reported in the literature (see Table 3). These represent the overall density in California; the average of these values was used to estimate mule deer populations within each county and statewide. A summary of this population estimation method is provided below, and all values used are included in Table 3.

One disadvantage of this method is that by applying the same average density to all counties, the mule deer population will be overestimated in some counties (for example, Imperial County, where the deer population is largely in the sparsely-populated Sonoran desert) and underestimated in other counties (Marin County for example, where the urban population may still be "overabundant"). However, no better data were found to estimate these county populations. CDFW (2022) estimates mule deer populations within each hunting zone, but these zones do not line up with county lines, so they are of limited use for this analysis. The best data available were used for these estimates.

Equation for Calculating Population Estimate

1. Density-Based Estimate (see Table 3 for references):

   Average Density 5.75 individuals/km^2 ((5.05 + 7 +5.2 individuals/km^2)/3), divided by two to account for migratory habits, and multiplied by the amount of Top Two-Thirds Suitable Habitat Area (km^2) in each county and statewide.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For mule deer, the top two-thirds of suitable habitat represent only 69% (195,561 km^2) (Table 2) of the total estimated species range in California (283,062 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative. The conservative nature of these methods is also supported by the observation data presented herein, many of which occur outside of the top two-thirds of mule deer habitat (Figures 2 and 3) and outside of the species' estimated range (Figure 2) (CDFW 2016). Mule deer occupy areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods are likely to underestimate the population. As discussed above, many California mule deer populations are migratory, using higher elevations habitat in the summer and lower elevations in the winter (Higley 2002). These methods attempt account for this migratory behavior by assuming all California mule deer are migratory. This assumption is also conservative; thus, these methods will likely tend to underestimate the mule deer population in California.

The statewide population estimate for mule deer in California is 562,237 individuals (Table 4). This estimate is slightly higher than the most recent mule deer population estimate provided by CDFW of approximately 532,621 mule deer in California in 2017, but very similar to the average of the 5 most recent years (551,640 for 2013–2017) (CDFW 2022). This approach assumes the following: that no deer occupy any of the bottom one-third of suitable habitat and that one-half of the top two-thirds of available suitable habitat is fully occupied (i.e., partitioned 50/50 by season). This approach also assumes that the population density values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California.

The statewide and county estimates are provided in Table 4.

Table 3. Mule and Black-Tailed Deer Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km^2)
Brazeal et al. 2017	Spatially-Explicit Capture-Recapture	Sierra Nevadas, California	5.05
Freddy et al. 2004	Direct aerial survey	Colorado	7
Furnas et al. 2018	Fecal DNA, camera traps and GPS collars	Northern California	5.2
Furnas et al. 2020	Fecal DNA, camera traps	Marin County, California	18.3(1)
Koenen et al. 2002	Direct count	Arizona	1.47(1)
Marshal et al. 2006	Radio collar, camera traps, spatial capture-recapture	Imperial County, California	0.1(1)
Pierce et al. 2012	Radio collar, helicopter survey	East-central California	24(1)

Note:

1 These density estimates were not included in the average for estimating the population size in California because they represent outlier conditions—either extremely high or extremely low densities which are not typical of most of California. While such habitats and conditions (high densities and low densities) do exist in California, the majority of the state is more moderate habitat, and including these high and low outliers would skew the estimate toward a much higher density, thus overestimating the mule deer population (the average of these four densities is 11 deer/km2m which is almost twice as high as the average that was used).

Table 4. Statewide and County Mule and Black-Tailed Deer Population Estimates

County	Population Density (5.75/km^2)/2	County	Population Density (5.75/km^2)/2
Alameda	3,044	Orange	2,590
Alpine	4,401	Placer	8,204
Amador	2,987	Plumas	17,406
Butte	6,913	Riverside	16,382
Calaveras	5,753	Sacramento	2,944
Colusa	2,656	San Benito	4,965
Contra Costa	2,775	San Bernardino	11,291
Del Norte	7,306	San Diego	21,519
El Dorado	11,092	San Francisco	0
Fresno	16,722	San Joaquin	2,017
Glenn	3,703	San Luis Obispo	11,857
Humboldt	23,471	San Mateo	2,582
Imperial	296	Santa Barbara	14,665
Inyo	10,153	Santa Clara	7,210
Kern	12,004	Santa Cruz	2,852
Kings	191	Shasta	25,453
Lake	8,225	Sierra	6,488
Lassen	29,838	Siskiyou	41,225
Los Angeles	13,581	Solano	524
Madera	7,568	Sonoma	8,470
Marin	2,765	Stanislaus	2,649
Mariposa	8,385	Sutter	406
Mendocino	22,613	Tehama	13,999
Merced	1,323	Trinity	22,227
Modoc	17,850	Tulare	18,330
Mono	17,079	Tuolumne	13,256
Monterey	14,079	Ventura	11,416
Napa	4,023	Yolo	1,549
Nevada	6,454	Yuba	2,510
		Total	**562,237**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Brazeal, J.L., T. Weist, B.N. Sacks. 2017. "Noninvasive Genetic Spatial Capture-Recapture for Estimating Deer Population Abundance." The Journal of Wildlife Management 81(4):629–640

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Mule Deer Predicted Habitat (CWHR M181). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. Annual California Deer Population Estimates 1992-2017. Wildlife Branch – Game Program. Accessed September 2022. https://wildlife.ca.gov/Conservation/Mammals/Deer/Population

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Freddy, D.J., G.C. White, M.C. Kneeland, R.H. Kahn, J.W. Unsworth, W.J. deVergie, V.K. Graham, J.H. Ellenberger, and C.H. Wagner. 2004. "How Many Mule Deer are There? Challenges of Credibility in Colorado." *Wildlife Society Bulletin* 32(3): 916–927.

Furnas, B.J., R.H. Landers, S. Hill, S.S. Itoga, and B.N. Sacks. 2018. "Integrated Modeling to Estimate Population Size and Composition of Mule Deer." *Journal of Wildlife Management* 82(7): 1429–1441.

Furnas, B.J., R.H. Landers, R.G. Paiste, and B.N. Sacks. 2020. "Overabundance of Black-Tailed Deer in Urbanized Coastal California." *Journal of Wildlife Management* 84(5): 979–988.

Higley, J. 2002. "Hunting Deer in California." Prepared for California Department of Fish and Game Wildlife Programs Branch. Second Edition. August.

Koenen, K.K.G., S. DeStefano, and P.R. Krausman. 2002. "Using Distance Sampling to Estimate Seasonal Densities of Desert Mule Deer in a Semidesert Grassland." *Wildlife Society Bulletin* 30(1): 53–63.

Marshal, J.P., L.M. Lesicka, V.C. Bleich, P.R. Krausman, G.P. Mulcahy, and N.G. Andrew. 2006. "Demography of Desert Mule Deer in Southeastern California." *California Fish and Game* 92(2): 55.

Pierce, B.M., V.C. Bleich, K.L. Monteith, and R.T. Bowyer. 2012. "Top-Down versus Bottom-Up Forcing: Evidence from Mountain Lions and Mule Deer." *Journal of Mammalogy* 93(4): 977–988.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov.

C26 Elk Population and Distribution

The following describes the distribution and population estimate of elk (*Cervus canadensis*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, elk observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 458 elk observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Elk across California

Dataset	Number of Observations	Date Range
Elk Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	458	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

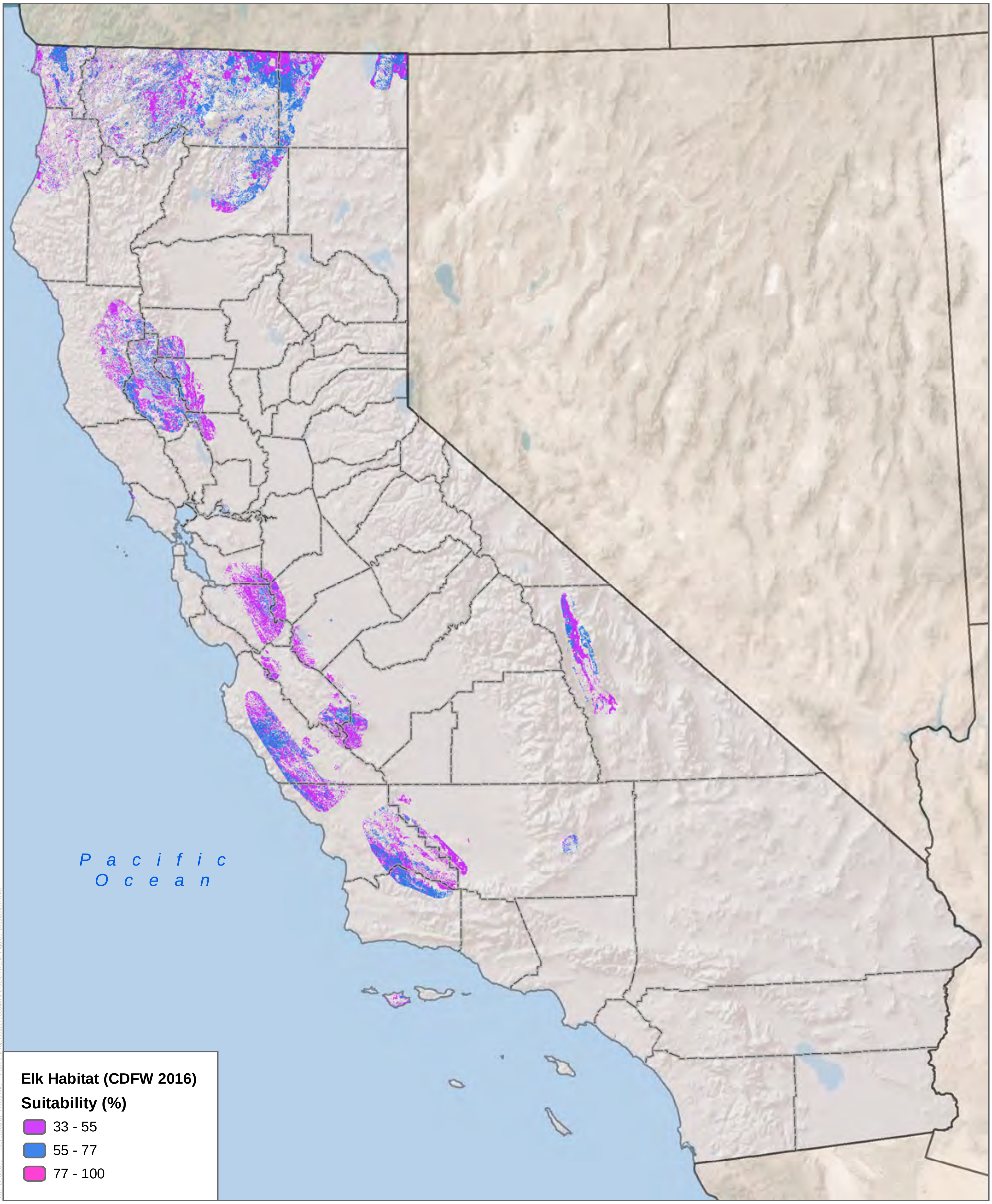
Table 2. Elk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	268	Orange	0
Alpine	0	Placer	0
Amador	0	Plumas	0
Butte	0	Riverside	0
Calaveras	0	Sacramento	0
Colusa	667	San Benito	565
Contra Costa	0	San Bernardino	0
Del Norte	804	San Diego	0
El Dorado	0	San Francisco	0
Fresno	468	San Joaquin	73
Glenn	297	San Luis Obispo	1,754
Humboldt	570	San Mateo	0
Imperial	0	Santa Barbara	639
Inyo	981	Santa Clara	896
Kern	464	Santa Cruz	0

Table 2. Elk Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Kings	0	Shasta	1,036
Lake	1,569	Sierra	0
Lassen	0	Siskiyou	5,080
Los Angeles	0	Solano	25
Madera	0	Sonoma	4
Marin	8	Stanislaus	314
Mariposa	0	Sutter	0
Mendocino	918	Tehama	0
Merced	197	Trinity	186
Modoc	1,953	Tulare	0
Mono	0	Tuolumne	0
Monterey	1,797	Ventura	0
Napa	20	Yolo	247
Nevada	0	Yuba	0
		Total Statewide Suitable Habitat	**21,801**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of elk statewide (Figure 2), and modeled habitat and observations in Santa Clara County (Figure 3).



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Elk Habitat from CDFW Habitat Suitability Model

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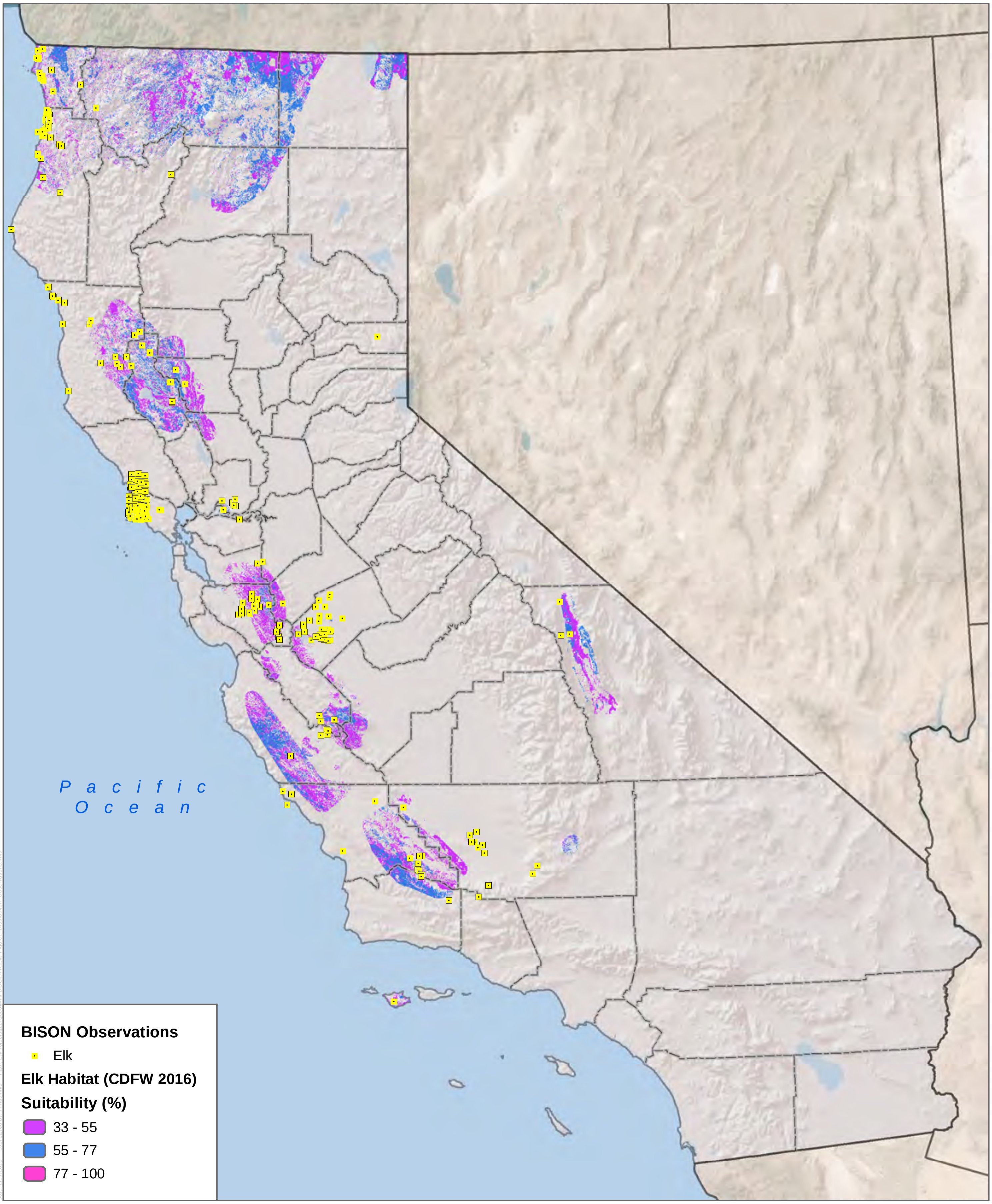

SOURCE: CDFW 2016; USGS 2020

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Elk Statewide

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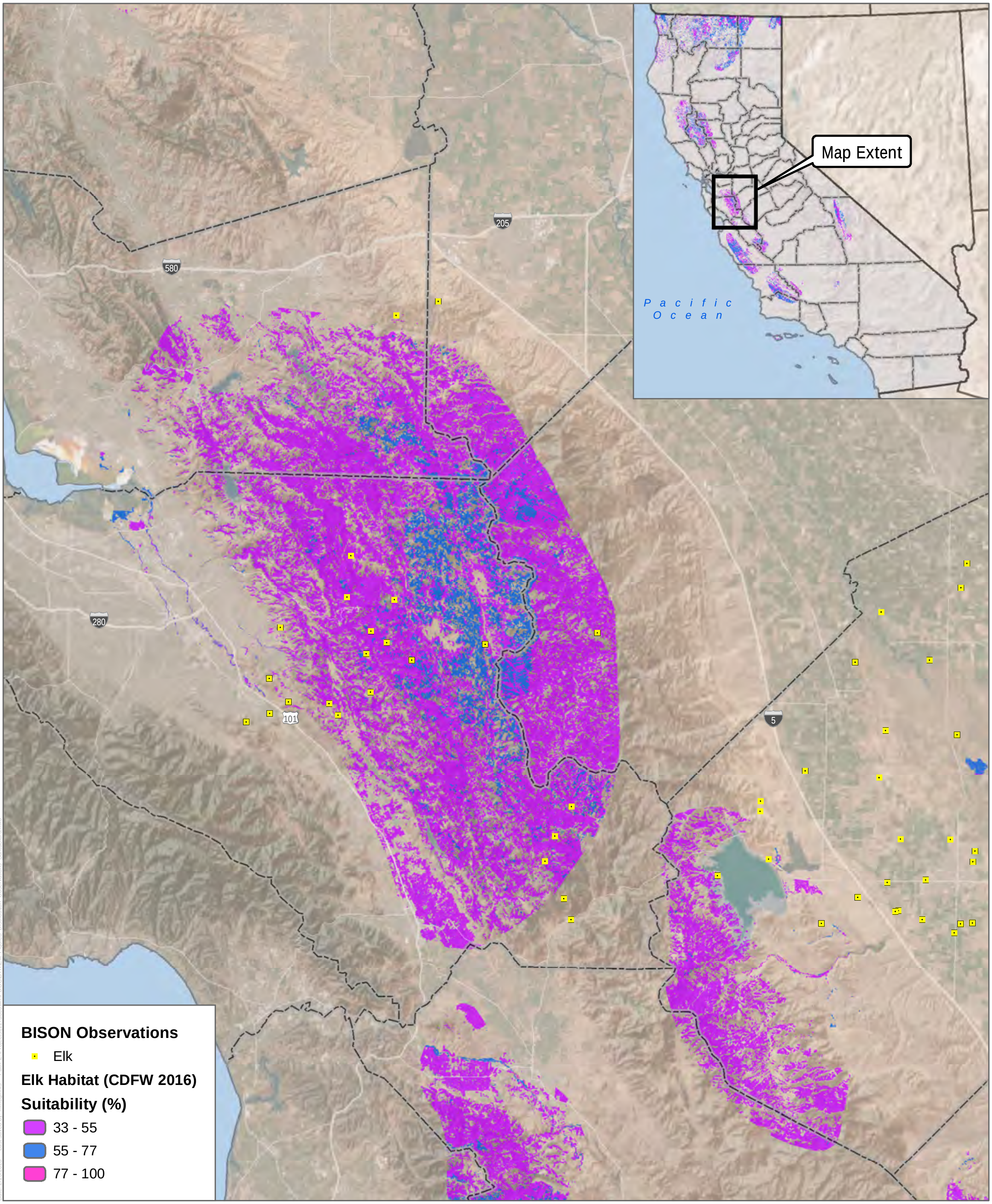

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Elk in the Santa Clara County Area

DUDEK 0 3.5 7 Miles

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Elk have widely varying reported home range sizes as described in the various research-literature sources from North American populations as summarized in Table 3. One method was used to estimate the elk population by county in California: the average published female home range sizes for elk of 30.2 km^2, minus an estimated 15.5% overlap per individual, equaling 25.5 km^2, multiplied by the average herd size of 15 (Galea 1990). A population density-based method was considered, but the population density values available in the literature were for areas with known and concentrated elk herds, which would have resulted in overestimates for large areas of suitable habitat. For example, using the population density-based approach would result in an estimate of 1,792,697 elk in California, whereas the CDFW estimate for elk in California is approximately 12,900 individuals (CDFW 2018). Therefore, only the home range size approach was used to estimate elk population sizes for each county. A summary of the population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Home Range-Based Estimate (see Table 3 for references):

   Suitable Habitat Area (km^2) in each county divided by 25.5 km^2 (average adult female home range value of 30.2 km^2 ((134.7 + 29.3 + 3.8 + 3.3 + 10.6 + 25.5 + 25 + 9.54 km^2)/8) – 4.7 km^2 (15.5% average home range overlap (11% + 20%)/2)) and multiplied by 15 to include group size.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most home range publications report the entire home range, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For elk, the top two-thirds of suitable habitat represent only 21% (21,801 km^2) (Table 2) of the total estimated range of elk in California (101,865 km^2) (CDFW 2016); thus, the populations estimates are likely to be conservative. Elk is the only species assessed for which some CDFW-determined suitable habitat falls outside of the CDFW-estimated range (CDFW 2016, data not shown). This represents only a small proportion of the statewide habitat and it does not affect these analyses; even though a small amount of habitat occurs outside of the estimated range, the top two-thirds of elk habitat only represents 21% of estimated elk range statewide.

The conservative nature of this analysis is supported by the observation data presented herein, many of which occur outside of the top two-thirds of elk habitat (Figures 2 and 3) and even outside of the species' estimated range (Figures 2 and 3) (CDFW 2016). Since elk occupy areas outside of their top two-thirds habitat, while this method assumes they do not, this method will tend to underestimate the population.

However, some California elk populations are migratory, using higher elevations habitat in the summer and lower elevations in the winter (CDFW 2008). Because these methods do not account for this migratory behavior, these methods might tend to overestimate some elk populations. The degree to which this might compensate for the likely underestimation above is unknown.

The estimate for population size for elk in California is 12,824 individuals using the home range-based method (Table 4). This value is very similar to the CDFW estimate for California of approximately 12,900 elk (CDFW 2018). The approach assumes the following: that there is 100% home range overlap among individual adult elk (male-male, female-male, and female-female) within a group, that there is a herd-herd overlap of 15.5%, that each herd contains on average 15 individuals (Galea 1990), that no elk occupies any of the bottom one-third of suitable habitat, and that the top-two-thirds suitable habitat is fully occupied. This approach also assumes that the home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates are provided in Table 4.

Table 3. Elk Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap Among Herds	Female Home Range Size (km²)	Average Herd Size (individuals)
Anderson et al. 2005	Radio telemetry	95% FK	Wisconsin; Wyoming; Alberta, Canada	ND	134.7	ND
Craighead et al. 1973	Radio telemetry	MCP	Wyoming	ND	29.3	ND
Galea 1990	Aerial mark-recapture and radio telemetry	MCP	Humboldt County, California	ND	3.8	15
Howell et al. 2002	Radio telemetry	90% AK	Point Reyes National Seashore, California	ND	3.3	ND
Jenkins and Starkey 1982	Radio telemetry	elliptical home range model	Olympic National Park, Washington	20%	10.64	ND
Jenkins and Starkey 1984	Radio telemetry	95% confidence ellipses	Washington	ND	25.5	ND
Kolbe and Weckerly 2015	GPS collars	95% FK	Humboldt County, California	11%	25	ND
Sevigny et al. 2018	Radio telemetry	95% KDE	North Cascades, Washington	ND	9.54	ND

Notes: ND = Not Determined; MCP = minimum convex polygon; AK = adaptive kernel; FK = Fixed Kernel; KDE = Kernel Density Estimate.

Table 4. Statewide and County Elk Population Estimates

County	Average Adult Female Home Range (25.5 km²)	County	Average Adult Female Home Range (25.5 km²)
Alameda	158	Orange	0
Alpine	0	Placer	0
Amador	0	Plumas	0
Butte	0	Riverside	0
Calaveras	0	Sacramento	0
Colusa	393	San Benito	332
Contra Costa	0	San Bernardino	0

Table 4. Statewide and County Elk Population Estimates

County	Average Adult Female Home Range (25.5 km^2)	County	Average Adult Female Home Range (25.5 km^2)
Del Norte	473	San Diego	0
El Dorado	0	San Francisco	0
Fresno	275	San Joaquin	43
Glenn	175	San Luis Obispo	1,032
Humboldt	336	San Mateo	0
Imperial	0	Santa Barbara	376
Inyo	577	Santa Clara	527
Kern	273	Santa Cruz	0
Kings	0	Shasta	610
Lake	923	Sierra	0
Lassen	0	Siskiyou	2,988
Los Angeles	0	Solano	15
Madera	0	Sonoma	2
Marin	5	Stanislaus	184
Mariposa	0	Sutter	0
Mendocino	540	Tehama	0
Merced	116	Trinity	109
Modoc	1,149	Tulare	0
Mono	0	Tuolumne	0
Monterey	1,057	Ventura	0
Napa	12	Yolo	145
Nevada	0	Yuba	0
		Total	**12,824**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Anderson, D.P., J.D. Forester, M.G. Turner, J.L. Frair, E.H. Merrill, D. Fortin, J.S. Mao, and M.S. Boyce. 2005. "Factors Influencing Female Home Range Sizes in Elk (*Cervus elaphus*) in North American Landscapes." *Landscape Ecology* 20(3): 257–271.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFG (California Department of Fish and Game). 2008. Elk. California Wildlife Habitat Relationships System. Written by G. Ahlborn. Originally published in Zeiner, D.C., W.F.Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1988-1990. California's Wildlife. Vol. I-III. California Depart.of Fish and Game, Sacramento, California.

CDFW (California Department of Fish and Wildlife). 2016. Elk Predicted Habitat (CWHR M177). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2018. Elk Conservation and Management Plan. Sacramento, California. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=162912&inline

Craighead, J.J., F.C. Craighead, R.L. Ruff, and B.W. O'Gara. 1973. "Home Ranges and Activity Patterns of Nonmigratory Elk of the Madison Drainage Herd as Determined by Biotelemetry." *Wildlife Monographs* No. 33: 3–50.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Galea, F.L. 1990. "Mark-Recapture for Estimation of Roosevelt Elk Numbers at Big Lagoon, Humboldt County, California." Master's thesis; Humboldt State University.

Howell, J.A., G.C. Brooks, M. Semenoff-Irving, and C. Greene. 2002. "Population Dynamics of Tule Elk at Point Reyes National Seashore, California." *Journal of Wildlife Management* 66(2): 478–490.

Jenkins, K.J., and E.E. Starkey. 1982. "Social Organization of Roosevelt Elk in an Old-Growth Forest." *Journal of Mammalogy* 63(2): 331–334.

Jenkins, K.J., and E.E. Starkey. 1984. "Habitat Use by Roosevelt Elk in Unmanaged Forests of the Hoh Valley, Washington." *The Journal of Wildlife Management* 48(2): 642–646.

Kolbe, N.R., and F.W. Weckerly. 2015. "Home-Range Overlap of Roosevelt Elk Herds in the Bald Hills of Redwood National Park." *California Fish and Game* 101(4): 208–217.

Sevigny, J., M. Sevigny, E. George-Wirtz, and A. Summers. 2018. "Spatial Distribution, Site Fidelity, and Home Range Overlap in the North Cascades Elk Herd: Implications for Management." Northwest Science 92(4): 251-266

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C27 Mountain Lion Population and Distribution

The following describes the distribution and population estimate of mountain lion (*Puma concolor*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied. The estimated statewide total of 187,490 km^2 of top two-thirds suitable habitat from CDFW's habitat data (CDFW 2016) is very similar to the statewide estimate provided in Using Mountain Lion Habitat Selection in Management (Dellinger et al. 2020) of 165,350 to 218,892 km^2.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, mountain lion observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. There were 223 mountain lion observations between 2000 and 2018.

Table 1. Observations and Modeled Distribution of Mountain Lion Across California

Dataset	Number of Observations	Date Range
Mountain Lion Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	223	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
[1] Data accessed December 11, 2020.

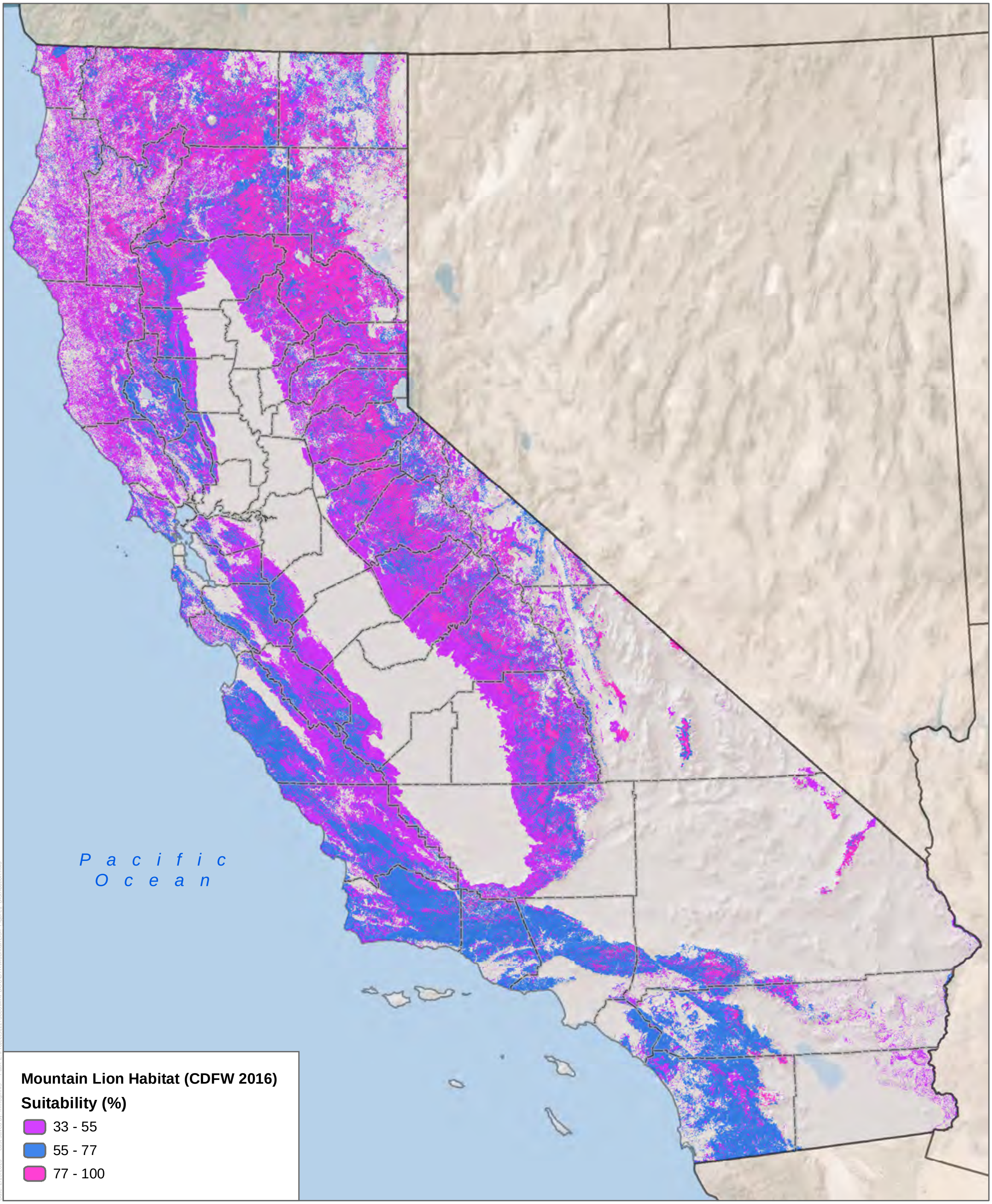
Table 2. Mountain Lion Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	1,162	Orange	767
Alpine	1,405	Placer	2,717
Amador	1,201	Plumas	5,853
Butte	2,355	Riverside	5,252
Calaveras	2,313	Sacramento	94
Colusa	1,121	San Benito	3,275
Contra Costa	1,013	San Bernardino	3,677
Del Norte	1,566	San Diego	6,657
El Dorado	4,016	San Francisco	0
Fresno	7,652	San Joaquin	316

Table 2. Mountain Lion Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Glenn	1,613	San Luis Obispo	7,357
Humboldt	5,412	San Mateo	565
Imperial	656	Santa Barbara	5,706
Inyo	2,648	Santa Clara	2,342
Kern	6,146	Santa Cruz	631
Kings	254	Shasta	8,505
Lake	2,759	Sierra	2,060
Lassen	5,009	Siskiyou	12,548
Los Angeles	4,200	Solano	153
Madera	3,124	Sonoma	2,629
Marin	848	Stanislaus	1,190
Mariposa	3,592	Sutter	0
Mendocino	6,341	Tehama	6,075
Merced	1,076	Trinity	5,477
Modoc	5,285	Tulare	7,406
Mono	3,134	Tuolumne	5,042
Monterey	7,028	Ventura	3,599
Napa	1,361	Yolo	465
Nevada	2,053	Yuba	793
		Total Statewide Suitable Habitat	**187,490**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of mountain lion statewide (Figure 2), and modeled habitat and observations in the south San Francisco Bay Area (Figure 3). These figures show that the vast majority of mountain lion observations occur within or on the edge of suitable habitat areas.



SOURCE: CDFW 2016

FIGURE 1

Top Two-thirds of Suitable Mountain Lion Habitat from CDFW Habitat Suitability Model

Biological Technical Report for the Wildlife Damage Management Project

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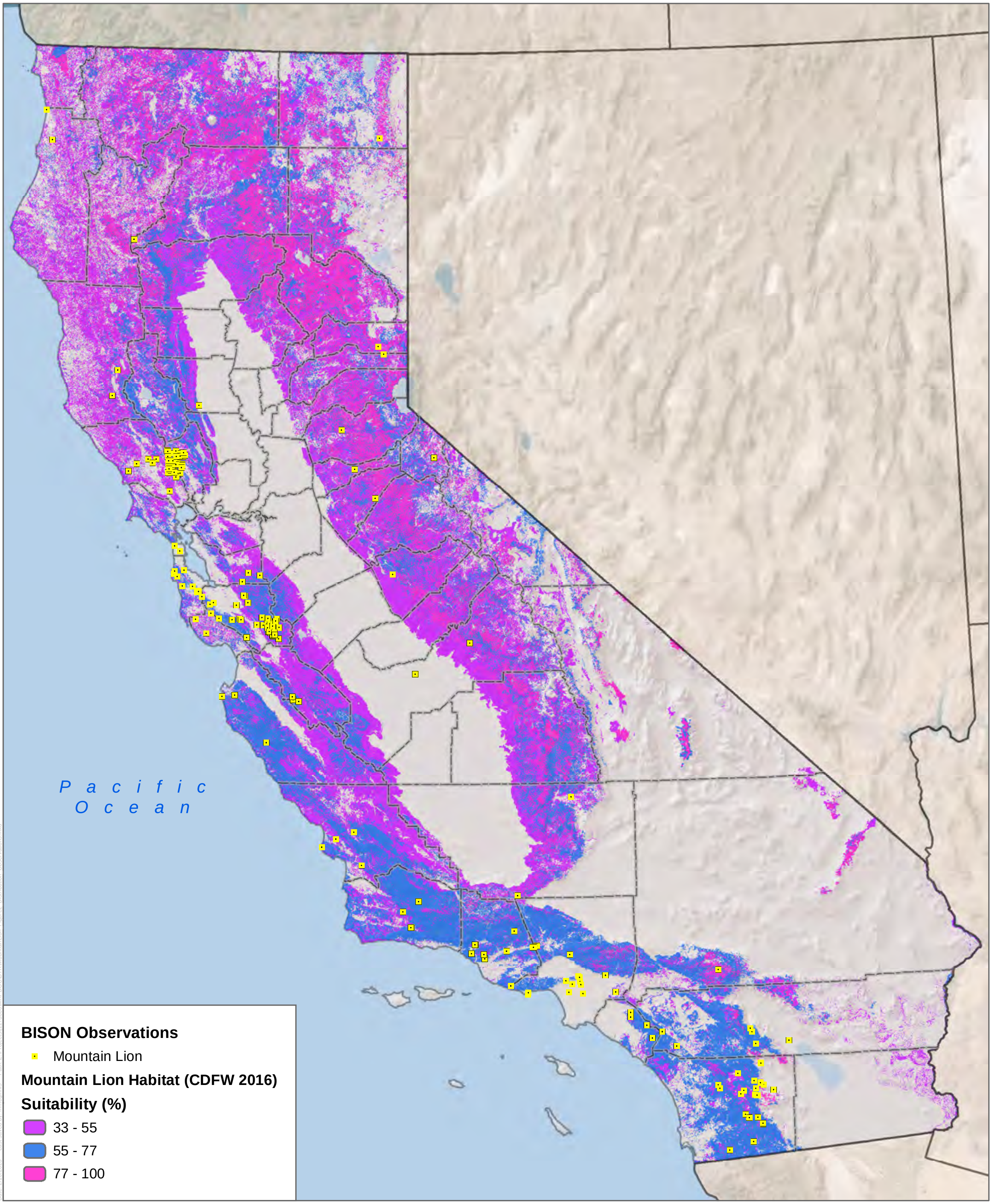

SOURCE: CDFW 2016; USGS 2020

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FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Mountain Lion Statewide

Biological Technical Report for the Wildlife Damage Management Project

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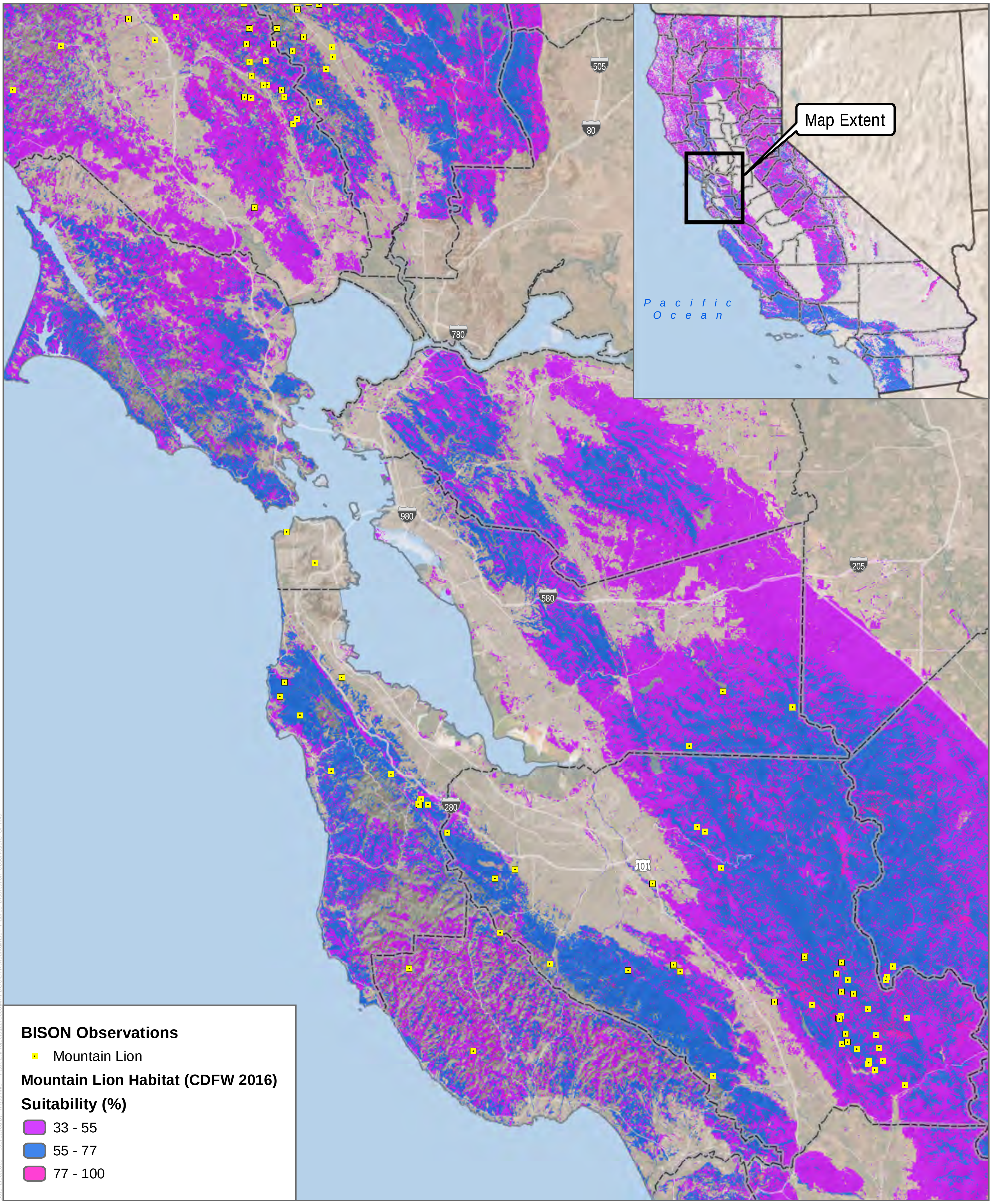

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Mountain Lion in the South San Francisco Bay Area

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Mountain lions have widely varying home range sizes as described in the various research-literature sources summarized in Table 3. Mountain lion home ranges have been reported to have “nearly complete” overlap (Neal et al. 1987), home ranges vary seasonally in California (Grigione et al. 2002) and some are migratory while others are not (Neal et al. 1987). All of these factors make it infeasible to use home rage size to estimate population size in California.

To estimate the mountain lion population by county in California, the average of population densities from the scientific literature was used, 0.027 individuals/km^2 (Table 3). A summary of this population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimate

1. Density-Based Population Estimate (see Table 3 for references):

   Average density 0.027 individuals/km^2 ((0.0068 + 0.0289 + 0.034 + 0.030 + 0.0465 + 0.00348 + 0.0225 + 0.027 + 0.0037 + 0.0108 + 0.0479 + 0.021 + 0.0486 + 0.0485 individuals/km^2)/14) multiplied by the amount of Suitable Habitat Area (km^2) in each county.

The density-based method generally includes non-territorial adults, juveniles, and young of the year. Therefore, the density-based method represents the total population and not just the adult population. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young.

This method is inherently conservative because the area used for the calculations was limited to the top two-thirds of suitable habitat. Most density publications report the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). This is especially important for large carnivores with large home ranges. For mountain lion, the top two-thirds of suitable habitat represent only 69% (187,490 km^2) (Table 2) of the total estimated species range in California (272,758 km^2) (CDFW 2016); thus, the populations estimates are likely to be moderately conservative. This determination is supported by the observation data presented herein, some of which occur outside of the top two-thirds of mountain lion habitat (Figures 2 and 3) and even outside of the species’ estimated range (Figure 2) (CDFW 2016, data not shown). Since mountain lion occupy areas outside of their top two-thirds habitat, while this method assumes they do not, this method will tend to underestimate the population.

The estimate for population size for mountain lion in California is 5,062 individuals using the density-based method (Table 4). This approach assumes the following: that no mountain lions occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. This approach also assumes that the population density values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4. In 1996, CDFW estimated the statewide mountain lion population at 4,000–6,000 animals (CDFW 2022). The estimate from this analysis is almost exactly in the middle of this range.

Table 3. Mountain Lion Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Location	Population Density (individuals/km2)	Sample Size
Allen et al. 2015	GPS collar	Mendocino, Tehama, Lake, and Glenn Counties, California (2010-2012)	0.0068	2 Male, 5 Female
Anderson and Lindzey 2005	Radio collar, hunting take	Wyoming (1997-2002)	0.0289	29 Male, 32 Female
Beausoleil and Kertson 2013	Not Reported (unpublished data)	Washington	0.034	Not Reported
Choate et al. 2006	Radio collar, track counts, direct count, hunter take	Utah (1996-1997)	0.030	93
Davidson et al. 2014	Spatially-Explicit Capture-Recapture	Oregon (2011)	0.0465	171 individuals
Harveson et al. 2012	Radio collar	Texas (1992-1997)	0.00348	36 Male, 27 Female
Laundre and Clark 2003	Radio collar, trapping, hunting	Idaho, Utah (1991-2001)	0.0225	12 Male, 4 Female
Lewis et al. 2015	Cameras, GPS collars	Colorado (2010)	0.027	17
Lindzey et al. 1994	Radio collar	Utah (1982-1984)	0.0037	72
Murphy et al. 2019	Camera traps and GPS collar	New Mexico (2017)	0.0108	26 individuals
Neal et al. 1987	Radio collars	Fresno, California (1985)	0.0479	7 Male, 9 Female
Pitman 2010	GPS collar, cameras	New Mexico (2009-2010)	0.021	2 Male, 3 Female
Proffitt et al. 2015	Spatially-Explicit Capture-Recapture	Montana (2012-2013)	0.0486	62 individuals
Russell et al. 2012	Spatially-Explicit Capture-Recapture	Montana (2005-2006)	0.0485	19 Male, 30 Female, 1 Unknown

Table 4. Statewide and County Mountain Lion Population Estimates

County	Population Density ($0.027/km^2$)	County	Population Density ($0.027/km^2$)
Alameda	31	Orange	21
Alpine	38	Placer	73
Amador	32	Plumas	158
Butte	64	Riverside	142
Calaveras	62	Sacramento	3

Table 4. Statewide and County Mountain Lion Population Estimates

County	Population Density (0.027/km²)	County	Population Density (0.027/km²)
Colusa	30	San Benito	88
Contra Costa	27	San Bernardino	99
Del Norte	42	San Diego	180
El Dorado	108	San Francisco	0
Fresno	207	San Joaquin	9
Glenn	44	San Luis Obispo	199
Humboldt	146	San Mateo	15
Imperial	18	Santa Barbara	154
Inyo	71	Santa Clara	63
Kern	166	Santa Cruz	17
Kings	7	Shasta	230
Lake	75	Sierra	56
Lassen	135	Siskiyou	339
Los Angeles	113	Solano	4
Madera	84	Sonoma	71
Marin	23	Stanislaus	32
Mariposa	97	Sutter	0
Mendocino	171	Tehama	164
Merced	29	Trinity	148
Modoc	143	Tulare	200
Mono	85	Tuolumne	136
Monterey	190	Ventura	97
Napa	37	Yolo	13
Nevada	55	Yuba	21
		Total	5,062

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Allen, M.L., M. Elbroch, D.S. Casady, and H.U. Wittmer. 2015. "Feeding and Spatial Ecology of Mountain Lions in the Mendocino National Forest, California." *California Fish and Game* 101(1): 51–65.

Anderson Jr, C.R. and Lindzey, F.G., 2005. Experimental evaluation of population trend and harvest composition in a Wyoming cougar population. *Wildlife Society Bulletin*, *33*(1), pp.179-188.

Beausoleil, R.A. and B. N. Kertson. 2013. Unpublished data. Reported in: Beausoleil, R.A., Koehler, G.M., Maletzke, B.T., Kertson, B.N. and Wielgus, R.B., 2013. Research to regulation: Cougar social behavior as a guide for management. Wildlife Society Bulletin, 37(3), pp.680-688.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. Mountain Lion Predicted Habitat (CWHR M165). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CDFW. 2022. "Mountain Lions in California." Accessed December 20, 2022. https://wildlife.ca.gov/Conservation/Mammals/Mountain-Lion.

Choate, D.M., Wolfe, M.L. and Stoner, D.C., 2006. Evaluation of cougar population estimators in Utah. *Wildlife Society Bulletin*, *34*(3), pp.782-799.

CROS (California Roadkill Observation System). April 2022. https://www.wildlifecrossing.net/california/

Davidson, G.A., Clark, D.A., Johnson, B.K., Waits, L.P. and Adams, J.R., 2014. Estimating cougar densities in northeast Oregon using conservation detection dogs. The Journal of Wildlife Management, 78(6), pp.1104-1114.

Dellinger, J.A., B. Cristescu, J. Ewanyk, D.J. Gammons, D. Garcelon, P. Johnston, Q. Martins, C. Thompson, T.W. Vickers, C.C. Wilmers, and H.U. Wittmer. 2020. "Using Mountain Lion Habitat Selection in Management." *The Journal of Wildlife Management*, 84(2): 359–371.

Grigione, M.M., P. Beier, R.A. Hopkins, D. Neal, W.D. Padley, C.M. Schonewald, and M.L. Johnson. 2002. "Ecological and Allometric Determinants of Home - Range Size for Mountain Lions (*Puma concolor*)." *Animal Conservation* 5(4): 317–324.

Harveson, P.M., L.A. Harveson, L. Hernandez-Santin, M.E. Tewes, N.J. Silvy, and M.T. Pittman. 2012. "Characteristics of Two Mountain Lion *Puma concolor* Populations in Texas, USA." *Wildlife Biology* 18(1): 58–66.

Laundré, J. and Clark, T.W., 2003, May. Managing puma hunting in the western United States: through a metapopulation approach. In *Animal Conservation forum* (Vol. 6, No. 2, pp. 159-170). Cambridge University Press.

Lewis, J.S., Logan, K.A., Alldredge, M.W., Bailey, L.L., VandeWoude, S. and Crooks, K.R., 2015. The effects of urbanization on population density, occupancy, and detection probability of wild felids. *Ecological Applications*, *25*(7), pp.1880-1895.

Lindzey, F.G., W.D. Van Sickle, B.B. Ackerman, D. Barnhurst, T.P. Hemker, and S.P. Laing. 1994. "Cougar Population Dynamics in Southern Utah." *Journal of Wildlife Management* 58(4): 619–624.

Murphy, S.M., D.T. Wilckens, B.C. Augustine, M.A. Peyton, and G.C. Harper. 2019. “Improving Estimation of Puma (*Puma concolor*) Population Density: Clustered Camera-Trapping, Telemetry Data, and Generalized Spatial Mark-Resight Models.” *Scientific Reports* 9(1): 1–13.

Neal, D.L., G.N. Steger, and R.C. Bertram. 1987. “Mountain Lions: Preliminary Findings on Home-Range Use and Density, Central Sierra Nevada.” Research Note PSW-392. Berkeley, California: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Pitman, M.E., 2010. *Developing a management tool to estimate unmarked puma (Puma concolor) populations with a remote camera array* (Doctoral dissertation, Clemson University).

Proffitt, K.M., Goldberg, J.F., Hebblewhite, M., Russell, R., Jimenez, B.S., Robinson, H.S., Pilgrim, K. and Schwartz, M.K., 2015. Integrating resource selection into spatial capture - recapture models for large carnivores. Ecosphere, 6(11), pp.1-15.

Russell, R.E., Royle, J.A., Desimone, R., Schwartz, M.K., Edwards, V.L., Pilgrim, K.P. and Mckelvey, K.S., 2012. Estimating abundance of mountain lions from unstructured spatial sampling. The Journal of Wildlife Management, 76(8), pp.1551-1561.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

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C28 Ringtail Distribution and Occurrence

The following describes the distribution and population estimate of ringtail (*Bassariscus astutus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Observation data were also analyzed to visually confirm the habitat model, which is the basis of the population estimate. As summarized in Table 1, ringtail observation data were obtained from one dataset: the Biodiversity Information Serving Our Nation (USGS 2020). The California Roadkill Observation System (CROS 2022) also contains observation data, but the data were not provided after numerous requests. Nineteen ringtail occurrences were documented across the state during the 2000-2018 period.

Table 1. Observations and Modeled Distribution of Ringtail across California

Dataset	Number of Observations	Date Range
Ringtail Distribution (CDFW 2016)	30-meter cell, statewide	2016
BISON (USGS 2020)[1]	19	2000–2018

Notes: CDFW = California Department of Fish and Wildlife; BISON = Biodiversity Information Serving Our Nation; USGS = U.S. Geological Survey.
1 Data accessed December 11, 2020.

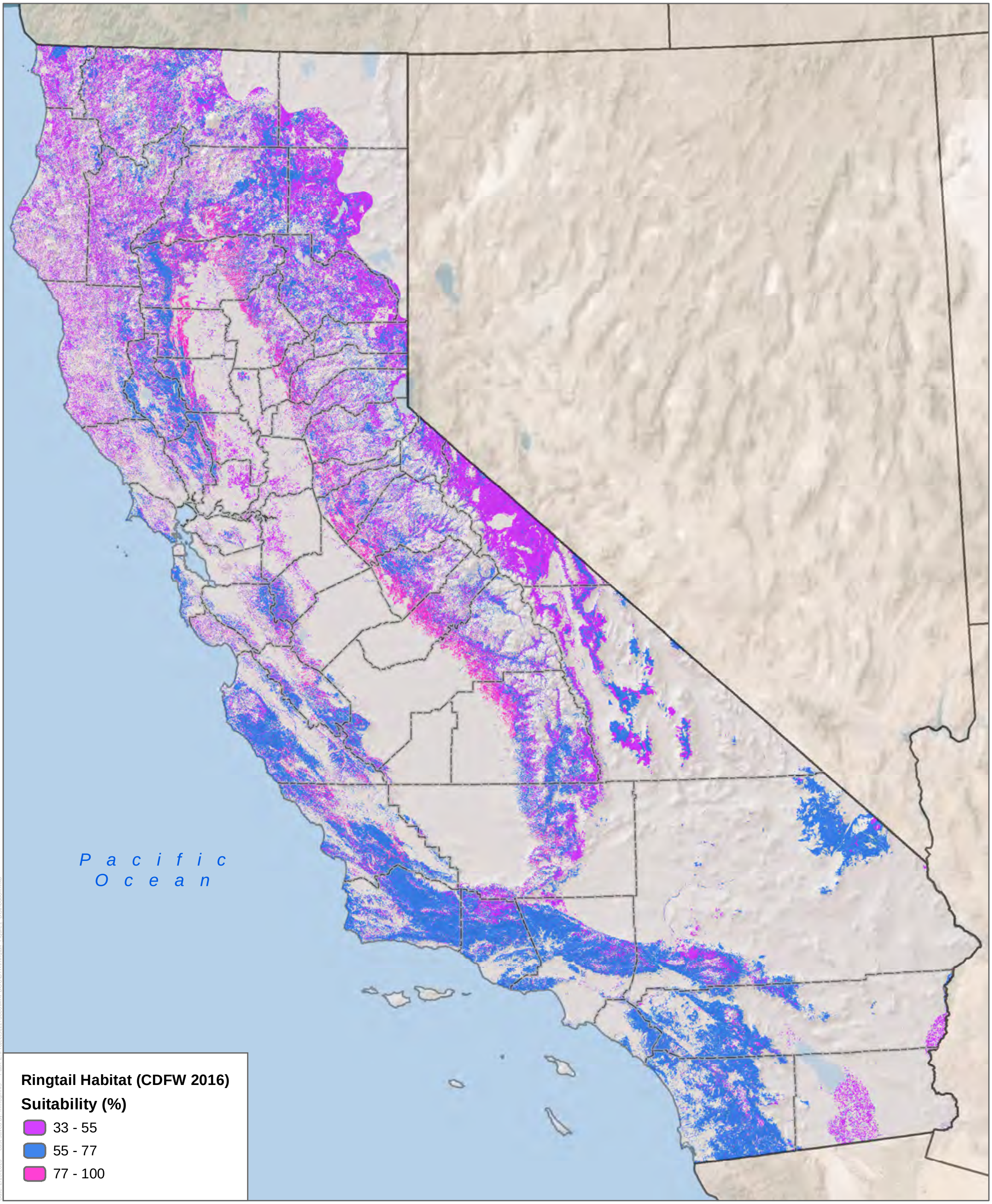
Table 2. Ringtail Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Alameda	213	Orange	638
Alpine	938	Placer	1,365
Amador	638	Plumas	4,154
Butte	1,322	Riverside	4,322
Calaveras	1,353	Sacramento	298
Colusa	949	San Benito	1,466
Contra Costa	241	San Bernardino	6,115
Del Norte	1,317	San Diego	5,649
El Dorado	1,877	San Francisco	3
Fresno	3,000	San Joaquin	382
Glenn	1,121	San Luis Obispo	3,647
Humboldt	3,313	San Mateo	327
Imperial	993	Santa Barbara	4,417
Inyo	4,561	Santa Clara	965
Kern	3,534	Santa Cruz	324

Table 2. Ringtail Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km^2)	County	Top 2/3 Suitable Habitat (km^2)
Kings	64	Shasta	5,455
Lake	2,095	Sierra	1,220
Lassen	4,532	Siskiyou	7,141
Los Angeles	4,244	Solano	417
Madera	1,467	Sonoma	931
Marin	372	Stanislaus	796
Mariposa	1,738	Sutter	127
Mendocino	3,246	Tehama	3,875
Merced	262	Trinity	3,975
Modoc	1,399	Tulare	3,860
Mono	5,173	Tuolumne	2,236
Monterey	4,098	Ventura	3,258
Napa	963	Yolo	710
Nevada	972	Yuba	483
		Total Statewide Suitable Habitat	**124,556**

The following three maps show the top two-thirds of modeled habitat statewide (Figure 1), the combination of that modeled habitat with observations of ringtail statewide (Figure 2), and modeled habitat and observations in the north Sacramento Valley area (Figure 3).



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Ringtail Habitat from CDFW Habitat Suitability Model

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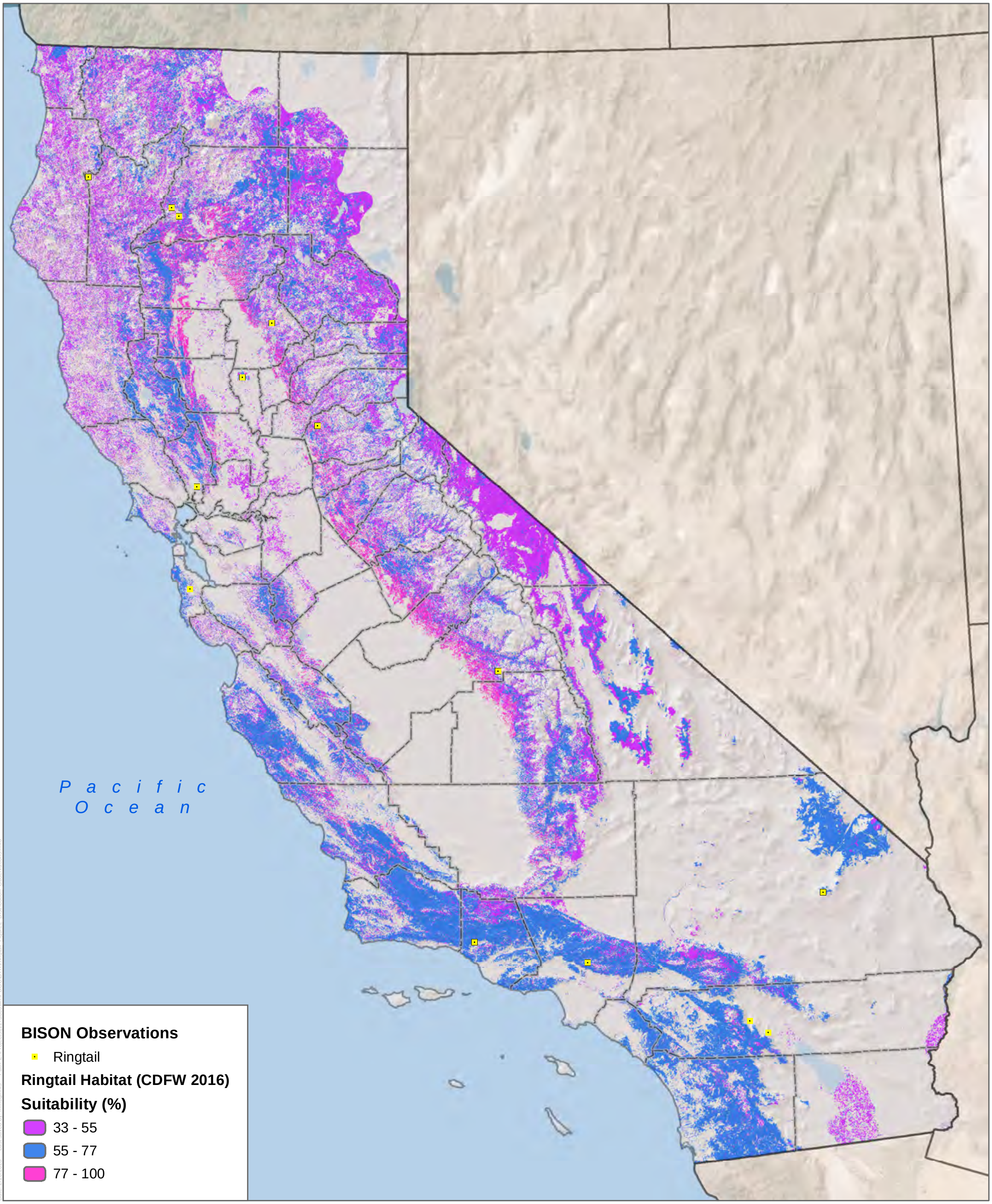

SOURCE: CDFW 2016; USGS 2020

0 25 50 Miles

FIGURE 2

Top Two-thirds of Suitable Habitat and Observations of Ringtail Statewide

Biological Technical Report for the Wildlife Damage Management Project

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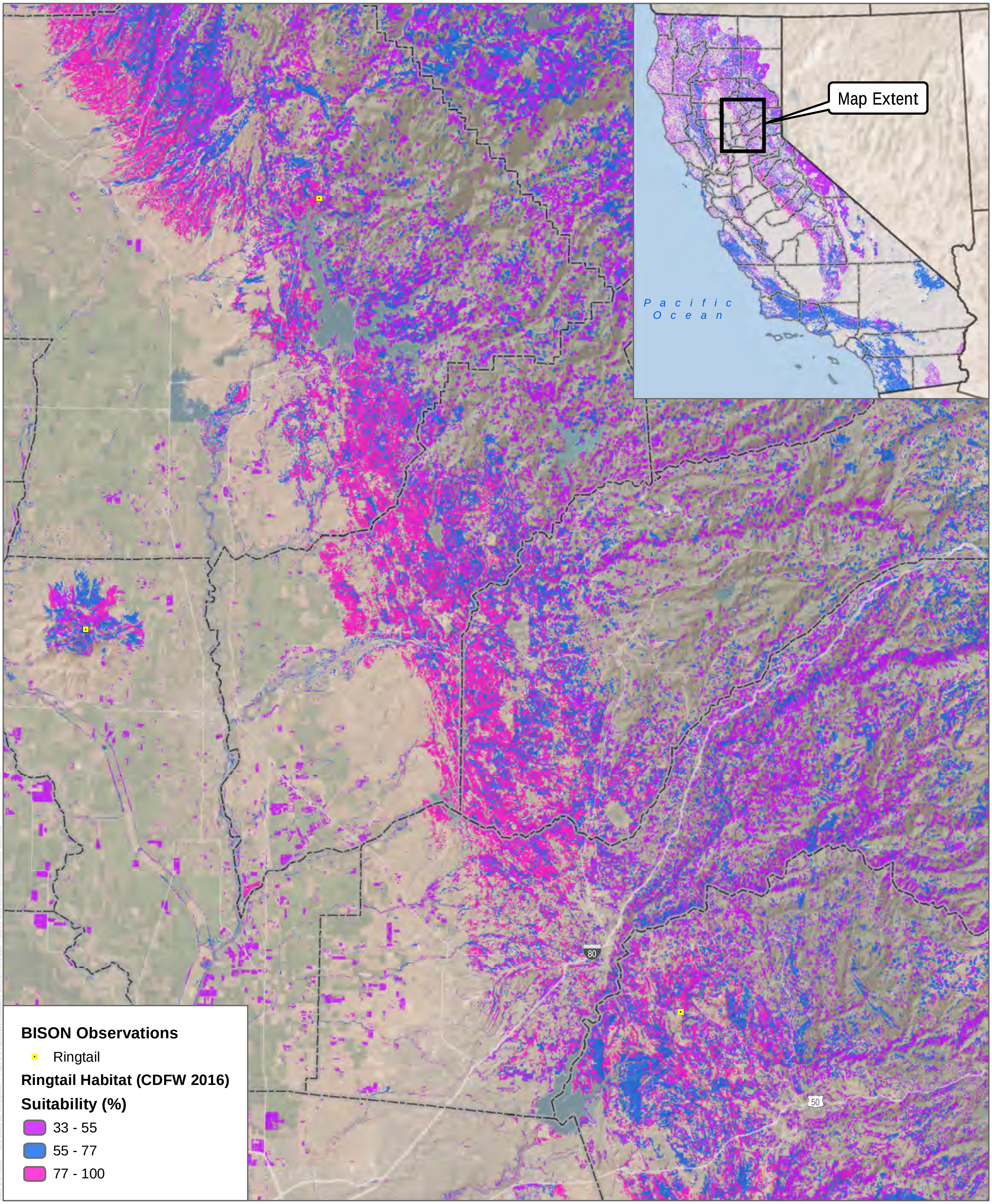

SOURCE: CDFW 2016; USGS 2020

FIGURE 3

Top Two-thirds of Suitable Habitat and Observations of Ringtail in the North Sacramento Valley Area

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0 3.5 7 Miles

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Ringtails have widely varying densities and home range sizes as described in the various research-literature sources summarized in Table 3. Two methods were used to estimate the ringtail population by county in California: (1) an average population density of 4.1 individuals/km^2 and (2) the average female home range of 0.86 km^2, corrected for average female home range overlap of 25%, resulting in a corrected home range size of 0.64 km^2 and multiplied by 2 for a 1:1 male to female ratio. These two approaches were used to estimate population sizes for each county. A summary of the two population estimation methods is provided below, and all values used are included in Table 3.

Equations for Calculating Population Estimates for Each Method

1. Density-Based Estimate (see Table 3 for references):

   Average Density 4.1 individuals/km^2 (average of 5.9, 15.8, 2.6, 0.8, 0.25, 1.04, and 2.2 individuals/km^2) multiplied by the top two-thirds of Suitable Habitat Area (km^2) in each county.

2. Home Range-Based Estimate (see Table 3 for references):

   Top two-thirds of Suitable Habitat Area (km^2) in each county divided by 0.64 km^2 (average adult female home range of 0.86 ((0.42, 2.21, 0.94, 0.088, 0.203, and 1.29 km^2)/6) minus 0.21 km^2 (25% home range overlap (average of 39.9% and 10.5%)) and multiplied by 2 to include males.

The home range-based method estimates the total adult population, excluding young of the year and juvenile animals (and non-territorial adults as applicable). The density-based method generally includes non-territorial adults, juveniles, and young of the year. Therefore, the density-based method represents the total population and not just the adult population. Consequently, the density-based estimate is generally, but not always, higher than the home range-based estimate for most species analyzed. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

Both of these methods are inherently conservative because the area used in the calculations was limited to the top two-thirds of suitable habitat. Most density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For ringtail, the top two-thirds of suitable habitat represent only 36% (124,556 km^2) (Table 2) of the total estimated species range in California (350,428 km^2) (CDFW 2016); thus, the populations estimates are likely to be very conservative. The conservative nature of these methods is also supported by the observation data presented herein, some of which occur outside of the top two-thirds of ringtail habitat (Figures 2 and 3) (CDFW 2016). Ringtail occupy many areas outside of their top two-thirds habitat, while these methods assume they do not. Therefore, these methods will tend to considerably underestimate the population. However, ringtail density is reported to have decreased in recent years, and the assumption that all available home ranges are occupied will likely tend to overestimate the population. Likewise, the use of older density estimates and those from other states might tend to overestimate current density within the range of the species in California. The degree to which these factors might compensate for the underestimating factors above is unknown.

The estimates for population size for ringtail in California are 510,678 individuals using the density-based method and 389,236 individuals using the home range-based method (Table 4). These approaches assume the following: that there is 25% home range overlap among female ringtails, that no ringtails occupy any of the bottom one-third of suitable habitat, and that the top two-thirds of available suitable habitat is fully occupied. These approaches also assume that the population density and home range values from the reviewed literature are applicable to California, despite the fact that several of the cited studies were for populations outside California. The statewide and county estimates under each method are provided in Table 4.

Table 3. Ringtail Female Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Female Home Range Overlap	Female Home Range Size (km^2)	Population Density (individuals/km^2)	Sample Size
Ackerson 2001	Radio-collar	100% MCP	Texas	Reported in Ackerson and Harveson 2006	0.42 (average); 0.28 (summer); 0.63 (winter) (sexes similar)	ND	5 (1 Male, 4 Female)
Ackerson and Harveson 2006	Radio-collar	100% MCP	Texas	39.9 (average; range 31.5 to 46.6)	Already reported in Ackerson 2001	5.9 (average)	Home Range: 5 (1 Male, 4 Female); Density: 17
Belluomini and Trapp 1984	Capture-recapture	ND	Sacramento Valley, California	ND	ND	15.8 (average of 20.5, 17.1, 19.5, 11.4, and 10.5)	5 sites
Brody and Koch 1983	Radio-collar	Harmonic mean	Sonoma County, California	ND	2.21	2.6	4 Male
Callas 1987	Radio-collar	100% MCP	Northwest California	ND	ND (denning range = 1.24; no home range reported)	0.8	8 (4 Male, 4 Female)
Harrison 2012	Radio-collar	95% FK	New Mexico	ND	0.94	ND	6 Male, 7 Female
Harrison 2013	Capture-recapture	NA	New Mexico	ND	ND	0.25 (average of 0.17 and 0.33)	66
Koch and Brody 1981	Radio-collar	95% MCP	Sonoma and Lake Counties, California	10.5% (average of the two reported overlaps of zero and 21%)	2.21 (Male)[1]	1.04	4 Male
Lacy 1983	Radio-collar	Minimum polygon	Sacramento Valley, California	ND	0.088	13.5 (average; range 7-20)[2]	4 (2 Male, 2 Female)

Table 3. Ringtail Female Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Female Home Range Overlap	Female Home Range Size (km^2)	Population Density (individuals/km^2)	Sample Size
Montacer 2009	Radio-collar	100% MCP	Texas	ND	0.0276[(3)]	ND	3 Male, 1 Female
Toweill and Teer 1981	Radio-collar	100% minimum polygon	Texas	ND	0.203	2.2 (minimum); 4.2 (maximum)[4]	3 Female, 2 Male
Trapp 1978	Radio-collar	Minimum polygon	Zion National Park, Utah	ND	1.29	ND	2 Female (x 2 seasons = 4 home ranges); 7 Male (9 home ranges)

Notes: MCP = minimum convex polygon; NA = Not Applicable; ND = not determined; FK = fixed kernel.
1 This home range was not included in the average because it appears to be based on the same data as Brody and Koch 1983 which is already included in the average.
2 This density estimate was excluded from the average because this is the same high-density population reported by Belluomini and Trapp 1984 which is already included in the average.
3 This home range estimate was not included in the average due to the small sample size; it was from a single female (n=1).
4 Minimum density was used for the average.

Table 4. Statewide and County Ringtail Population Estimates

County	Population Density (4.1/km^2)	Female Home Range (0.64 km^2)	County	Population Density (4.1/km^2)	Female Home Range (0.64 km^2)
Alameda	874	666	Orange	2,618	1,995
Alpine	3,844	2,930	Placer	5,598	4,267
Amador	2,615	1,993	Plumas	17,033	12,982
Butte	5,422	4,132	Riverside	17,722	13,507
Calaveras	5,549	4,229	Sacramento	1,222	931
Colusa	3,890	2,965	San Benito	6,011	4,581
Contra Costa	988	753	San Bernardino	25,071	19,109
Del Norte	5,401	4,117	San Diego	23,161	17,653

Table 4. Statewide and County Ringtail Population Estimates

County	Population Density (4.1/km²)	Female Home Range (0.64 km²)	County	Population Density (4.1/km²)	Female Home Range (0.64 km²)
El Dorado	7,694	5,864	San Francisco	13	10
Fresno	12,299	9,374	San Joaquin	1,567	1,194
Glenn	4,598	3,505	San Luis Obispo	14,953	11,397
Humboldt	13,582	10,352	San Mateo	1,339	1,020
Imperial	4,073	3,105	Santa Barbara	18,108	13,802
Inyo	18,701	14,254	Santa Clara	3,958	3,017
Kern	14,487	11,042	Santa Cruz	1,330	1,014
Kings	264	201	Shasta	22,367	17,048
Lake	8,589	6,547	Sierra	5,004	3,814
Lassen	18,582	14,163	Siskiyou	29,280	22,317
Los Angeles	17,402	13,264	Solano	1,711	1,304
Madera	6,015	4,585	Sonoma	3,817	2,910
Marin	1,527	1,164	Stanislaus	3,262	2,486
Mariposa	7,126	5,431	Sutter	522	398
Mendocino	13,310	10,145	Tehama	15,889	12,110
Merced	1,073	818	Trinity	16,297	12,422
Modoc	5,735	4,371	Tulare	15,824	12,061
Mono	21,209	16,165	Tuolumne	9,167	6,987
Monterey	16,803	12,807	Ventura	13,358	10,181
Napa	3,947	3,008	Yolo	2,912	2,219
Nevada	3,985	3,037	Yuba	1,980	1,509
			Total	**510,678**	**389,236**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Ackerson, B.K. 2001. "Characteristics of a Ringtail Population at Elephant Mountain Wildlife Management Area, Texas." Master's thesis; Sul Ross State University.

Ackerson, B.K. and Harveson, L.A., 2006. Characteristics of a ringtail (Bassariscus astutus) population in Trans Pecos, Texas. The Texas Journal of Science, 58(2), pp.169-185.

Belluomini, L., and G.R. Trapp. 1984. "Ringtail Distribution and Abundance in the Central Valley of California." In *California Riparian System; Ecology, Conservation, and Productive Management*, 906–914. Berkeley: University of California Press.

Brody, A.J. and D.B. Koch, D.B., 1983. Spring Ranges, Food habits, and Habitat Utilization of Ringtails in the Geysers. Transactions of the Western Section of the Wildlife Society, 19, pp.67-75.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

Callas, R., 1987. Ringtail (Bassariscus astutus) den and habitat use in northwestern California (Doctoral dissertation, Humboldt State University).

CDFW (California Department of Fish and Wildlife). 2016. Ringtail Predicted Habitat (CWHR M152). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

CROS (California Roadkill Observation System). 2022. https://www.wildlifecrossing.net/california/.

Harrison, R.L. 2012. "Ringtail (*Bassariscus astutus*) Ecology and Behavior in Central New Mexico, USA." *Western North American Naturalist* 72(4): 495–506.

Harrison, R.L. 2013. "Ringtail (*Bassariscus astutus*) Noninvasive Survey Methods, Density, and Occupancy in Central New Mexico, USA." *Western North American Naturalist* 73(3): 365–372.

Koch and Brody. 1981. Investigation of the ringtail (Bassariscus astutus) in a portion of the Geysers-Calistoga known geothermal resource area. California Energy Comm. Rep., Contract6 700-80-030. 43pp.

Lacy, M.K., 1983. Home range size, intraspecific spacing, and habitat preference of ringtails (Bassariscus astutus) in a riparian forest in California (Doctoral dissertation, California State University, Sacramento).

Montacer, N.J., 2009. Survey and habitat use of select carnivores with a further investigation on ringtails (Bassariscus astutus) in Palo Duro Canyon State Park, Texas (Doctoral dissertation, West Texas A & M University).

Toweill, D.E. and Teer, J.G., 1980, August. Home range and den habits of Texas ringtails (Bassariscus astutus flavus). In Proceedings of the Worldwide Furbearer Conference. Frostburg, MD (pp. 3-11).

Trapp, G.R., 1978. Comparative behavioral ecology of ringtail and gray fox in southwestern Utah. Carnivore, 1(MAY), pp.3-32.

USGS (U.S. Geological Survey). 2020. Biodiversity Information Serving Our Nation (BISON). Accessed December 11, 2020. https://bison.usgs.gov

C29 Muskrat Distribution and Occurrence

The following describes the distribution and population estimate of muskrat (*Ondatra zibethicus*) by county in California based on range and habitat data from the California Department of Fish and Wildlife (CDFW) (CDFW 2016). The CDFW habitat model has a resolution of 30 meters statewide (CDFW 2016) (Table 1) and was based on the Wildlife Habitat Relationships modeling approach, using the California Department of Forestry and Fire Protection-FRAP "Fveg" vegetation map (CAL FIRE 2015). The CDFW estimates of habitat suitability are limited to the estimated range of the species in California, which was also prepared by CDFW (2016) (Figure 1). This limitation might result in underestimation of available habitat and population size calculated from that habitat. Table 2 summarizes the square kilometers of land within the top two-thirds of suitable modeled habitat within each county. The top two-thirds of suitable habitat was chosen in an effort to produce conservative population estimates and because the bottom one third of habitat is lower quality habitat that is not likely to be fully occupied.

Table 1. Modeled Distribution of Muskrat across California

Dataset	Habitat Measurement	Date Range
Muskrat Distribution	30-meter cell, statewide	2016

Source: CDFW 2016.

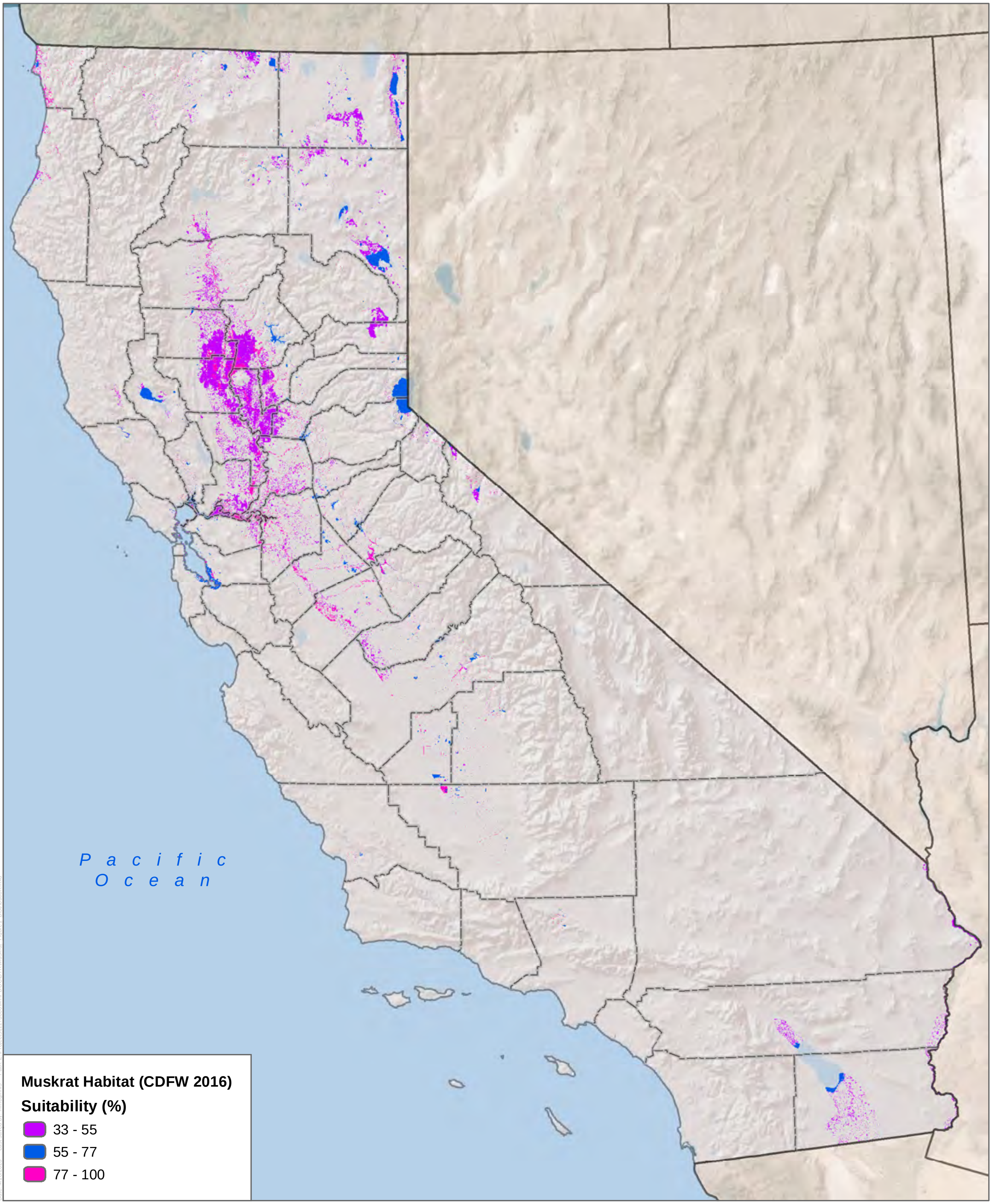
Table 2. Muskrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km2)	County	Top 2/3 Suitable Habitat (km2)
Alameda	86	Orange	0
Alpine	33	Placer	438
Amador	54	Plumas	115
Butte	848	Riverside	135
Calaveras	83	Sacramento	385
Colusa	910	San Benito	0
Contra Costa	166	San Bernardino	53
Del Norte	117	San Diego	0
El Dorado	212	San Francisco	1
Fresno	130	San Joaquin	309
Glenn	649	San Luis Obispo	7
Humboldt	48	San Mateo	27
Imperial	319	Santa Barbara	3
Inyo	0	Santa Clara	17
Kern	69	Santa Cruz	0
Kings	68	Shasta	190
Lake	153	Sierra	113
Lassen	646	Siskiyou	319
Los Angeles	9	Solano	505
Madera	114	Sonoma	20

Table 2. Muskrat Suitable Habitat (Top Two-Thirds) per County

County	Top 2/3 Suitable Habitat (km2)	County	Top 2/3 Suitable Habitat (km2)
Marin	8	Stanislaus	157
Mariposa	44	Sutter	815
Mendocino	17	Tehama	327
Merced	200	Trinity	3
Modoc	662	Tulare	48
Mono	102	Tuolumne	87
Monterey	0	Ventura	0
Napa	52	Yolo	511
Nevada	24	Yuba	315
		Total Statewide Suitable Habitat	**10,725**

The following map shows the top two-thirds of modeled habitat statewide (Figure 1).



SOURCE: CDFW 2016

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FIGURE 1

Top Two-thirds of Suitable Muskrat Habitat from CDFW Habitat Suitability Model

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Muskrats have widely varying densities and home range sizes as described in the various research-literature sources summarized in Table 3. An average population density of 16.5 individuals/km^2 was used to estimate the muskrat population by county in California. Home range data were not used to estimate the population size in California due to the extremely wide range of home ranges found in the literature (four orders of magnitude, i.e., a 10,000-fold difference) (Ganoe 2019; Proulx and Gilbert 1983) (see Table 3). A summary of the population estimation method is provided below, and all values used are included in Table 3.

Equation for Calculating Population Estimates

3. Density-Based Estimate (see Table 3 for references):

   Average Density 16.5 individuals/km^2 (average of 35.5, 11, and 3 individuals/km^2 multiplied by the top two-thirds of Suitable Habitat Area (km^2) in each county).

This density-based method generally includes non-territorial adults, juveniles, and young of the year. Therefore, the density-based method represents the total population and not just the adult population. In some cases where reproductive adults bear their young in burrows or dens, the young may not have been counted until they emerged. In these cases, the population density may not include pre-emergent young. The estimates were not adjusted to reflect these differences.

This method is inherently conservative because the area used for the calculations was limited the to the top two-thirds of suitable habitat, whereas most or all density and home range publications report the entire home range or the entire study area, which is more comparable to the range of the species (as opposed to the top two-thirds of suitable habitat) because these data invariably include some poor habitat (bottom one-third) and unsuitable habitat (zero suitability). For muskrat, the top two-thirds of suitable habitat represent only 10,725 km^2 (Table 2) of the total estimated species range in California (95,500 km^2) (CDFW 2016); thus, the populations estimates are likely to be very conservative.

The estimate for population size for muskrat in California is 176,959 individuals using the density-based method (Table 4). This approach assumes the following: that no muskrats occupy any of the bottom one-third of suitable habitat and that the top two thirds of available suitable habitat is fully occupied.

Table 3. Muskrat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap	Home Range Size	Population Density (individuals/km^2)
Le Boulengé and Le Boulengé-Nguyen 1981	Live capture	NA	Belgium	ND	ND	3 (winter), 11 (summer high)
Proulx and Gilbert 19831	Live capture, defecation sites, feeding sites, trails	Estimation of immediate, intensively used area	Ontario, Canada	ND	470 m2 (June–July) to 1,112 m2 (Aug–Sept)	ND
Brooks and Dodge 1986	Literature review of published telemetry and	NA	Massachusetts and Pennsylvania	ND	ND	23 and 48 (2 areas): 35.5 average

Table 3. Muskrat Home Range Sizes and Population Densities from the Literature

Literature Source	Tracking Method	Home Range Size Estimation Method	Location	Home Range Overlap	Home Range Size	Population Density (individuals/km^2)
	live-trapping studies					
Clark and Kroeker 1993[2]	Live capture	NA	Manitoba, Canada	ND	ND	>30/ha high, <1/ha low
Ahlers et al. 2010[3]	Radio-collar	Linear Home Range (LHR)	Illinois	ND	529 m to 804 m	ND
Ganoe 2019[4]	Radio-collar	Kernel Density Estimator (KDE)	Pennsylvania	57% (adults)	3.58 km2	ND

Notes: NA = Not Applicable; ND = not determined.
1 This home range estimate was not included because of the estimation method.
2 This density estimate was excluded from the average because it reports estimate ranges.
3 This home range estimate was not included because it provides linear home ranges estimates along a river.
4 This home range estimate was not included because it is based on a small sample size (n = 11).

Table 4. Statewide and County Muskrat Population Estimates

County	Population Density (16.5/km^2)	County	Population Density (16.5/km^2)
Alameda	1,419	Orange	0
Alpine	545	Placer	7,221
Amador	891	Plumas	1,897
Butte	13,996	Riverside	2,226
Calaveras	1,369	Sacramento	6,351
Colusa	15,022	San Benito	0
Contra Costa	2,743	San Bernardino	877
Del Norte	1,936	San Diego	0
El Dorado	3,494	San Francisco	21
Fresno	2,147	San Joaquin	5,104
Glenn	10,704	San Luis Obispo	122
Humboldt	787	San Mateo	437
Imperial	5,271	Santa Barbara	49
Inyo	3	Santa Clara	283
Kern	1,136	Santa Cruz	0
Kings	1,129	Shasta	3,140
Lake	2,517	Sierra	1,859
Lassen	10,652	Siskiyou	5,256
Los Angeles	143	Solano	8,339
Madera	1,889	Sonoma	338
Marin	133	Stanislaus	2,595
Mariposa	722	Sutter	13,447
Mendocino	275	Tehama	5,395

Table 4. Statewide and County Muskrat Population Estimates

County	Population Density (16.5/km²)	County	Population Density (16.5/km²)
Merced	3,297	Trinity	43
Modoc	10,924	Tulare	793
Mono	1,686	Tuolumne	1,441
Monterey	0	Ventura	0
Napa	866	Yolo	8,437
Nevada	388	Yuba	5,204
		Total	**176,959**

Literature Cited

The following references were used in the preparation of the above population and distribution analyses. Additional literature not listed below was reviewed but was not used for population size estimates due to one or more of the following reasons: the literature was not primary literature (i.e., original reports of research reviewed by experts and published in scholarly, peer reviewed journals; Masters and Doctorate theses were assumed to be reviewed by academic advisors to the students and therefore included as scientific literature); the literature provided only relative densities, or were described by the authors as not reflecting absolute population densities or home range sizes; the methods were out-of-date or did not meet current standards for estimating population density or home range size; and/or the approach violated basic assumptions about home range size or population density estimation.

Ahlers, A. A., E. J. Deske, R. L. Schooley, and M. A. Mitchell. 2010. Home ranges and space use of muskrats Ondatra zibethicus in restricted linear habitats. Wildlife Biologist 16:400-408.

Brooks, R. P. and W. E. Dodge. 1986. Estimation of habitat quality and summer population density for muskrats on a watershed basis. Journal of Wildlife Management 50(2):269-273.

CAL FIRE (California Department of Forestry and Fire Protection). 2015. CAL FIRE, Fire and Resource Assessment Program (FRAP). https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.

CDFW (California Department of Fish and Wildlife). 2016. American Badger Predicted Habitat (CWHR M160). California Department of Fish and Wildlife, California Interagency Wildlife Task Group. Accessed January 2022. Sacramento, CA.

Clark, W. R. and D. W. Kroeker. 1993. Population dynamics of muskrats in experimental marshes at Delta, Manitoba. Canadian Journal of Zoology 71:1620-1628. Pp 127.

Ganoe, L. S. 2019. Using a multi-faceted approach to assess ecological components affecting muskrat (*Ondatra zibethicus*) populations. Master's Thesis. Pennsylvania State University.

Le Boulengé, E. and P. Le Boulengé-Nguyen. 1981. Ecological study of a muskrat population. Acta Theriologica 26(4):47-82.

Proulx, G. and F. F. Gilbert. 1983. The ecology of the muskrat, *Ondatra zibethicus*, at Luther Marsh, Ontario. Canadian Field-Naturalist 97(4):377-390.

Appendix D
Summary of Scientific Literature Related to Trophic Cascades

Appendix D

Summary of the Relevant Scientific Literature: Trophic Cascades

The study of ecological trophic cascades is relatively new and very complex, with potentially many highly interrelated factors and inherent complications to developing and implementing robust studies and ecological computer models. Statistical analyses must be carefully chosen and applied to develop strong correlations and reasonable interpretation of study results. Different ecosystems may have inherently higher productivity than others, resulting in different comparative study outcomes. Each study looks at a very small question related to very broad and complicated interrelated systems, and a particular study addressing a specific question cannot be expected to provide an answer that can be applied broadly.

Therefore, this appendix simply briefly summarizes the scientific literature relevant to the broader questions related to trophic cascades and related factors subsumed within that possible ecological relationship. It is not intended to be an impact analysis related to Proposed Project actions, but rather provides the context for impact analysis. This appendix focuses on peer-reviewed published scientific literature, but because certain unpublished or non-peer-reviewed documents are frequently raised by commenters, they are included for context.

1 What Foundational Ecological Topics Inform the Discussion on Trophic Cascades?

1.1 How do Carnivores Contribute to Ecosystem Biodiversity?

Large terrestrial mammalian carnivores, such as wolves, coyotes, and dingoes, have been historically seen as threats to human lives, property, and domestic livestock (Schwartz et al. 2003, Ray et al. 2005a, Prugh et al. 2009, Estes et al. 2011). Large mammalian carnivores have high metabolic demands due to being warm-blooded, and they have a large body size with large surface to volume ratio. Therefore, they typically require large prey and expansive, connected, unfragmented habitats. These characteristics often bring them into conflict with humans, their property, and livestock, and compete for wildlife that are also regulated game species.

Large carnivores are vulnerable to many human-created conditions, including habitat loss, degradation, and fragmentation, invasive and exotic species, climate change, and hunting, as well as to widespread lethal control conducted in response to human intolerance, often resulting in population depletion, extirpations, and extinctions (Ripple et al. 2014). Hunting by humans does not duplicate or replace natural predation because it differs in intensity and timing, resulting in dissimilar effects on prey behavior, age, and sex (Ray et al. 2005a, Ripple et al. 2014). However, where large carnivores were once seen as impediments to conservation goals, including for protection of endangered species, they are now increasingly considered as essential players in efforts to preserve ecosystem biodiversity through structuring ecosystem interactions and providing ecological services (Ray et al. 2005b, Wallach et al. 2009b).

1.2 How are Ecosystems Structured?

Ecosystems are structured through the dynamic interactions of abiotic factors such as weather, soil productivity, climate change, and surface and subsurface hydrology, natural perturbations such as wildfire, and the variety, composition, and abundance of fauna and vegetation present. Those dynamics change in abundance, variety, and distribution as components of the ecosystems change.

Studies suggest that large carnivores may directly and/or indirectly affect the populations of certain species in terms of presence, abundance, reproductive success, activities, and function within the ecosystem. These effects may partially result from their predatory activities on smaller animals, including other carnivorous predators (such as foxes, coyotes, and cats), animals that eat only vegetation (herbivores, such as rabbits and deer), and animals that eat both vegetation and meat (omnivores, such as bears, badgers, and raccoons). These effects can also change the biomass, variety, and productivity of the vegetation that is eaten by herbivores and omnivores. These relationships based on consumption is called a **food web**, which recognizes the web-like interaction of a set of interrelated food chains, including species that share the same foods and carnivores that consume other carnivorous species.

Within these webs, animals with similar food habits create **trophic levels**, where energy is transferred and transformed as animals from one level feed on animals or plants from a lower level. If interactions occur from one trophic level of the web to a higher or lower trophic level, this is considered a **vertical relationship**. If the interaction occurs within the same trophic level, such as when a larger predator kills or feeds on a smaller predator or omnivore, it is considered a **horizontal relationship**. Therefore, the large carnivores are considered apex predators (in the vertical relationship), because they are not naturally preyed on by other animals, except by humans (Duffy et al. 2007).

Therefore, an **apex** or **top predator** is defined as a species that feeds at or near the top of the food web of their supporting ecosystem and that are relatively free from predation themselves once they reach adult size (Sergio et al. 2014). As animals in each trophic level need to use some of the energy obtained through consumption for maintenance, growth, activities, and reproduction, a much smaller amount of energy is transferred from a lower trophic level to a higher one. This generally results in a fewer number of animals within each higher trophic level. The top trophic level of a food web generally has fewer species and smaller population sizes than lower levels (and typically larger body sizes), resulting in the need to feed on larger prey with less energy expended in order to meet their energy requirements for survival. Top carnivores also tend to be more vulnerable to sustained adverse perturbations in their environment and persistent high mortality rates, and therefore more susceptible to extirpation and extinction.

2 What is the History of the Study of Ecosystem Functions and Roles of Apex Predators?

The history of recognizing the ecological roles of apex predators as something other than vermin or pests is relatively new (Ray et al. 2005a). The concept was popularly introduced by Charles Darwin's *Origin of Species* (1859) in his concept of mutualism (domestic cats controlling mice, that that would otherwise eat bee honeycombs, affecting plants and pollinators; Ripple et al. 2016). In more contemporary times, the concept of top predators was publicized primarily by Aldo Leopold in 1943. In the 1950s and 1960s, relatively simple studies were conducted on the dynamic interrelationships of predators and their prey, using uncomplicated models and limited field experiments. In the 1970s, simple modeling and empirical field studies began to test the capabilities of top predators to ecologically structure lower trophic levels, evaluate the relationships between predator and prey, confer stability to populations, and cause ecosystem shifts between alternative stable states (e.g., Ballard et al. 1997, Stenseth et al. 1997).

In the 1980s, modeling and field studies expanded in complexity to include predator-prey relationships, population dynamics, and adaptive social behavior in response to the risk of being predated, including how behavior changes affected foraging behavior and life history of prey and how these dynamics interrelate ecologically. Studies also began considering the potential for some predators to eat other predators, acknowledging a food web that interacts both vertically and horizontally, and the potential to cause trophic cascades. In the 1990s, these studies became increasingly complex, further investigating the roles of predation risk and anti-predator behavior adaptations, and how these affect the fitness of an individual animals, populations, and communities, potentially contributing to behavior-mediated trophic cascades (Sergio et al. 2014).

Presently, studies are branching into increased use of field and interdisciplinary research to investigate more realistic community, food web, population, ecological community, and individual animal responses to manipulations, and intended perturbations of communities of predators and prey, including direct and indirect behavior adaptations, ecological roles, predators killing other predators, and individual and species specializations of apex predators. Empirical field studies are increasingly using more sophisticated technologies to study wide ranging and secretive top predators, such as GPS satellite tags and collars (Sergio et al. 2014).

Originally, field studies were conducted on mostly sessile or low mobility species and webs, such as invertebrates, spiders, plankton, and small fish in localized ecosystems in relatively high productivity streams, lakes, intertidal zones, grasslands, and agricultural areas (e.g., Schmitz et al. 2004, Ray et al. 2005a, Beschta and Ripple 2006). Expanding these studies to open ocean marine and terrestrial ecosystems with more wide-ranging predators and prey that are inherently more difficult to manipulate and create perturbations in, especially without causing moral, ethical, and political controversy, created extensive challenges in methodologies and complexity (e.g., Ray et al. 2005a, Brashares et al. 2010, Estes et al. 2011, Sergio et al. 2014). Researchers also questioned whether the correlative results of studies that are small scale in time and/or space and conducted in ecologically relatively simple and localized ecosystems such as grasslands, agricultural fields, salt marshes, and marine intertidal zones could be extrapolated and applied to larger scale circumstances associated with trophic interactions in marine and terrestrial ecosystems across broad land and seascapes (e.g., Loreau et al. 2001, Srivastava and Vellend 2005).

It is extremely difficult to establish complex causal links between the indirect effects of top predators cascading over several trophic levels, and is still the subject of modern studies. Only recently have researchers conducted empirical studies of the roles of large carnivores in structuring communities, including the roles in ecosystem stability, biodiversity, and ecosystem functions (Ray et al. 2005a).

3 What is a Trophic Cascade?

In theory, apex predators may shape major shifts in the structure and function of ecosystems, as their predation and behavior ripple down and across food webs. These apparent ripple effects can create alternative and possibly long-term ecologically stable states that differ from the original state before the perturbation to apex predators, which ultimately becomes the persistent state (**homeostasis**). These changes may progress smoothly over time as the changes themselves occur, or, more likely, may occur when some threshold or “tipping point” is reached, at which point the structure and/or function shifts to different stable condition. During this phase shift, the conditions may rapidly fluctuate and species populations may rapidly increase then crash, before settling into the subsequent new and persistent condition.

Theoretically, the loss of one or more apex predators may result in shorter links within the food web because the apex predator is no longer present. This can potentially result in the release (in terms of numbers, distribution, biomass, etc.) of smaller predator and/or omnivore species that the apex predator preyed upon or behaviorally controlled. **Behavioral control** means that the prey exhibited adaptive anti-predator behavior that lowered its ability to forage optimally or kept individual animals in chronic physiological stress, resulting in lower overall fitness at the individual and community levels. In other words, the species' population was controlled by apex predators in such a way that the prey population could not reach the **carrying capacity**, or the maximum number of a species that the environment can support indefinitely (i.e., due to natural abundance of food and habitat resources). When the apex predator is at too low an abundance or density to create ecological restrictions on the prey population, or is no longer present, the controlled predator species may be released from the top-down control formerly exerted by the apex predator, and typically becomes the apex predator of the now-shifted system.

Theoretically, populations controlled by the new top predator may now release control on their prey, which may be herbivores, small mammals, or even vegetation. For a simple example, coyotes may now exert a greater predatory pressure on red foxes, decreasing their numbers, which may then release control on small rodents, resulting in increasing rodent populations. If this release is sufficiently high, the small rodent population may then increase dramatically, which may subsequently suppress the species composition or biomass of the vegetation eaten by the mice. This vertical control from top predators that may ripple through the food web is called **top-down control**.

The web is further complicated by a horizontal interaction within a food web, when one predator preys upon or otherwise controls another predator. This sideways feeding is called **intraguild predation** or **IGP**. A **guild** is made up of species that tend to play similar roles within a food web, such as carnivore, omnivore, or herbivore.

When the population of the smaller predator (intraguild prey) is released by the extirpation, extinction, or severe control of the intraguild predator, that dynamic is called **mesopredator release**. A mesopredator species tends to be an intermediate predator within a food web, one that is typically smaller than the lost apex predator species, more of a generalist in terms of diet, and may be small enough to exploit more potential food niches. Mesopredator species often have a relatively high intrinsic rate of increase because of high reproductive rates and/or because they respond with higher reproductive rates when their populations are below carrying capacity (called a **density dependent response**) and the populations are released from suppression. Examples of mesopredators that may be released when wolves (as top carnivore) are severely suppressed or extirpated from an area could be coyotes, badgers, foxes, raccoons, and feral and free-ranging cats, depending on the composition of the ecological community. Generally, under these circumstances, the coyote population then fills the trophic role of apex predator, alternatively exerting control and releasing species, depending on whether the impact is direct or indirect on the particular trophic level.

It is also possible that predator species may be indirectly controlled by lack of prey or low vegetative productivity. For example, a multi-year drought may reduce the plant forage of rabbits, reducing both the rabbit population and its intrinsic reproductive rate. This, in turn (with a lag time), may suppress the physiological fitness and intrinsic reproductive rate of its primary predator, for example, a coyote. This is called **bottom-up control**. Coyotes may then begin to feed more on foxes (an IGP situation occurring within the relatively same trophic level), which were not affected by the drought, because the plants that the small rodents fed on (different from the plants that the rabbits fed on) were more resistant to the effects of drought. If the IGP by coyotes on foxes is sufficiently high, the fox population may again be suppressed, releasing the mouse populations. Complicating this concept is that both top-down and bottom-up controls may occur simultaneously for the same and different components within the same ecosystem (Borer et al. 2005, Ritchie and Johnson 2009). Such top-down and bottom-up effects can be complicated by **interference competition** (where dominant predators interfere in the ability of subordinate predators to obtain resources), site productivity, behavioral adaptation to avoiding the risk of predation and obtaining high quality resources, and intrinsic "noise" in the ecosystem due to natural variation (Elmhagen et al. 2010). In the above example, coyotes could switch from rabbits to other smaller rodents and insects (prey switching) that foxes prey on and compete with the foxes for the same prey base.

These apparent up and down (or lateral) alternating trophic interrelationships (when one population increases, it may cause a decrease in another (a direct effect) and increase in a species in the next lower trophic level (an indirect effect), which may indicate an interrelationship among trophic levels called a **statistical correlation** (Section 6.1). However, such correlations do not indicate that one relationship is actually caused by the other. For example, large irruptions of mouse populations may be interpreted as being indirectly related to, for example, removal of a predator that feeds on mice, but may actually be caused by factors that were not considered, such as human food subsidies.

Polis et al. (2000) also recommend that researchers distinguish between potential cascading or rippling interactions at the species level (those occurring within a subset of the food web of a community, such that changes in predator numbers affect the success of one or more subsets of the plant species) and at the community level (those occurring where cascades considerably alter the distribution of plant biomass through the trophic levels of the entire system). This adds further complexity to empirical studies and interpreting results.

It is inherently extremely difficult, if not impossible in many circumstances, to develop and implement study protocols for field experiments resulting in statistically strong correlations. It is also inherently difficult to determine, even with replication of studies resulting in similar correlations, that inter- and intra-trophic relationships are caused by ecological perturbations, such as the removal of an apex predator, or that the removal results in a trophic cascade. Frequently, top-down effects do not appear as strong or to produce predicted cascading effects in terrestrial ecosystems due to the complexity of factors, such as the effects of dispersal and immigration, social regulation, and interference competition among predators, and abiotic factors, such as weather, soil, ecosystem productivity, and spatial and temporal habitat heterogeneity (Halaj and Wise 2001, Ray et al. 2005a, Berger et al. 2008, Estes et al. 2011).

Section 13 details the inherent challenges of modeling and designing empirical field studies that determine statistically-correlated interrelationships between ecological factors. These studies may indicate needs for further investigation or potentially establish factors that can be shown to create a direct causation for the observed effect through study replications. Terrestrial ecosystems, food webs, and their processes are especially complex, with wide-ranging apex predators and intricate and adaptive predator and prey behaviors.

4 What is the History of the Concept of Trophic Cascades and its Definitions?

Since the 1980s when Paine (1980) used the term "trophic cascade" to describe food webs in intertidal marine communities, trophic cascade has been a central or major theme of more than 2,000 scientific articles across many different ecosystems worldwide. Polis et al. (2000) and Ripple et al. (2016) expressed concern that, after decades of studies and modeling in many different ecosystems, the definitions and language used to describe trophic cascades have become inconsistent, obscuring and impeding both communication among researchers and the usefulness of the concepts for application in ecological management and conservation. To be useful and contribute to clarity, the definition must be both widely applicable yet sufficiently explicit to exclude extraneous interactions.

Ripple et al. (2016) provide a summary of the various definitions provided by researchers between 1994 and 2006. Trophic cascades were thought to only occur from upper trophic levels to lower trophic levels (top-down), until Terborgh et al. (2006) suggested that cascades can ripple either up or down a food web, with alternating negative and positive effects at successive levels. The first indirect effects of predators on plankton in lakes were suggested in the 1960s (Brooks and Dodson 1965, Hrbáček and Straškraba 1966). Subsequently, Estes and Palmisano (1974) described the role of sea otters in structuring nearshore communities of sea urchins and kelp, later modified to include orcas and sea lions, based on changes caused by humans (Estes et al. 1998), a frequently cited example in the literature to this day. The research on trophic cascades began to shift from being dominated by studies in freshwater systems and old field grasslands and croplands to being dominated by terrestrial and marine systems in the early 2000s.

Based on a recent meta-analysis of scientific literature, Ripple et al. (2016) suggest trophic cascades be defined as indirect species interactions that originate with predators and spread downward through food webs. According to the authors, this definition does not require that trophic cascades begin with apex predators, nor that trophic cascades end with plants. The authors suggest that bottom-up effects are not downward trophic cascades, but what they call **knock-on effects**, in which effects spin-off from the main top-down interactions. Whether or not bottom-up effects are incorporated into the definition of trophic cascades (as suggested in Terborgh et al. 2001, Ripple et al. 2013, Ripple et al. 2015), research has indicated that effects may flow both directions at different times in dynamic ecological systems in which top and mesopredators are present and active. Such top-down and bottom-up effects can be complicated by **interference competition** (as mentioned in the coyote example above).

5 What is the Difference between Correlation and Causation in Interpreting Statistical Study Results?

Before evaluating the scientific literature, it is important to explicitly define the difference between correlation and causation in order to better understand the statistical results of these studies. These terms are often misunderstood and misused when interpreting scientific papers.

This discussion on correlation and causation is adapted from the Australian Bureau of Statistics (2013).

5.1 Correlation

A **correlation** is a statistical measure (expressed as a number) that describes the size and direction of a relationship between two or more variables. A correlation is suggested by a positive or negative relationship – when one factor increases, another may also increase (**positive correlation**) or decrease (**negative**, or **inverse**, **correlation**). If an apparent correlation is observed statistically, it does not mean that one factor causes the other, only that the one factor either goes up or down in relation to the other factor.

The strength of the apparent correlation, or the indication that there truly is some level of interrelationship, is determined using statistical formulas that should meet assumptions pertinent to the context of the data and the system being studied. The formulae provide a figure, known as the square of the correlation coefficient, or R^2, which is always a number between 0 and 1. A value closer to 1 suggests that a stronger correlation exists, indicating that the relationship may warrant further investigation and study. However, it is possible to identify strong, but meaningless, correlations, and many other factors may introduce complexity into the relationships as well as confound the apparent results.

As an example of an apparent, but not necessarily actual, correlation, we can use the observance of the onset of cold weather in the winter and increasing numbers of colds. As the temperature decreases in December, it may appear that people get more colds, an apparent inverse correlation. That could be a correlation, and an R^2 value may actually indicate a strong correlation. However, the cold temperatures also tend to occur during the holiday season. The suggested correlation between decreasing temperatures and increasing rates of illness may actually be more closely related to depressed immune systems from eating more sugar and increased exposure to viruses from greater contact with people. Despite an apparent correlation, it is also possible that decreasing December temperatures themselves do not directly cause increased rates of illness, and therefore wearing warmer clothes will not necessarily decrease the number of colds or the risk that an individual person will catch one.

The suggested statistical correlation can be confounded by many variables that may or may not have been incorporated into the statistical analysis, potentially resulting in misleading results. In another well-known example, the R^2 for the number of highway fatalities in the US between 1996 and 2000 and the quantity of lemons imported from Mexico during the same period is $R^2=0.97$ – a very strong correlation – but it is extremely unlikely that one causes the other. Generally, scientists and researchers will reject factors that show a weak correlation, but completely irrelevant factors can produce a statistically high R^2 coefficient, potentially leading researchers in the wrong direction.

5.2 Causation

Causation indicates that one event is the result of the occurrence of the other event. Proving that a strong statistical correlation is directly responsible for an observed result requires more than a high R^2 value. Once a strong correlation is indicated, researchers experimentally need to test their hypotheses for causation to determine if indeed the factor(s) considered in the statistical analysis caused the result (cause-and-effect relationship), rather than just suggesting a relationship. They need to determine that the result is not just varying up or down statistically in unrelated or potentially indirect ways, or that the results may be confounded by untested or unmeasured factors. For strengthening a potentially causal relationship, the tests must be replicated by other researchers using the same methods, scale, and contexts to determine if the results are truly causative.

A powerful research protocol is one that holds all factors constant but one, and then tests for statistically significant changes that indicate a causative relationship. The variable factor can also be changed and the results tested to further clarify a causative relationship. A statistically significant finding is one that would occur more often than it would if it were to occur randomly.

5.3 Conclusion

When relying on studies, it is critical to understand that statistical correlations, which are offered by researchers as suggestive or indicative results often without replication, are different from conclusions of statistically significant causation. Ray et al. (2005) state that researchers are often influenced by numerous factors, including their education, cultural background, and inherent conditions of the ecological systems on which they work. Ecologists who specialize in some systems often favor certain hypotheses, interpretations, and factors measured, and discount others developed, to inform work on other systems.

Misinterpreting weak, or even strong, correlations or the results of theoretical models as indicative of causation is inappropriate and does not credibly represent the state of the science or the robustness of data and research protocols. More importantly, it can lead to uninformed decision-making and poor choices regarding conservation and management actions that may have unintended and damaging consequences. APHIS-WS reviews the pertinent literature and places priorities on studies that accurately account for correlations, have relevant assumptions, and disclose study and statistical limitations and strengths.

6 What do Relevant Studies Suggest about Trophic Cascades?

The following studies are representative of empirical field research conducted on large predators in terrestrial ecosystems that are useful for understanding the complexities of trophic cascades and contributing processes:

Hebblewhite et al. (2005), in a study in Banff National Park (NP), suggested that human activity, including recreation, in one valley restricted the use of the area by wolves, while limited human activity in an adjacent valley allowed higher wolf use. Survival recruitment of female elk and recruitment of calves was higher in the valley with human activity and lower wolf numbers. Elk competed with beaver for willow in riparian areas could have important impacts on biodiversity and ecosystem function and structure. The authors suspected wolves were the primary correlating factor in the observed cascading effect, but recognized that other predators may be implicated to an unknown degree.

Ripple and Beschta (2006a) hypothesize that an increase in human recreation in Zion NP resulted in a catastrophic regime shift to lower cougar densities and higher mule deer densities, higher herbivory on cottonwood trees, lower recruitment of young trees, increased bank erosion, and reductions in both terrestrial and aquatic species abundance. A top-down trophic cascade model would predict an increase in producer biomass following predator removal, while a bottom-up model would predict little or no change in consumer or producer biomass. Additionally, other likely interaction pathways include increased species interactions, improved nutrient cycling, limited mesopredator populations, and food web support for scavengers. The canyon with low human activity showed high recruitment of cottonwoods, hydrophytic plants, wildlife, amphibians, lizards, and butterflies along the creek, as well as presence of small endemic fish, with fewer eroded banks and altered channel widths. The diminishment of cottonwood forests in the riparian area reflects a potentially strong trophic cascade with ultimate effects on the structure and ecology of stream floodways, with decreased biodiversity. Without an appreciation of the potential for abrupt regime shifts and resulting new and persistent ecological stasis, the authors hypothesize that studies involving the removal of top predators are likely to provide conflicting results regarding function and structure of perturbed systems.

Ripple and Beschta (2007) reported evidence of reduced browsing and increased heights of young aspen, particularly at areas with high predation risk (riparian areas with downed logs) after wolves were reintroduced into Yellowstone NP. Young aspen in upland settings showed continued suppression, consistent with the combined effects of trophic cascades, mediated by adaptive behavior related to predator risk avoidance by elk and lower densities of elk, indicating a recovering ecosystem. Much of the aspen growth observed in riparian areas after the reintroduction of wolves appears due to reduced browsing by elk at sites with poor escape terrain and reduced visibility, rather than climate change or site productivity. The patchy recovery of as evidenced by increases in aspen height in the uplands as compared to riparian areas is consistent with recently reported patchy release of willow in Yellowstone (Ripple and Beschta 2006a). The authors suggest that elk may be avoiding browsing certain riparian areas as an anti-predator strategy. The authors recognized that the broad-scale application of the results of this study are limited by the lack of an experimental control (area with no wolves) since the entire area was recolonized by wolves and that the data most likely represent the beginning of aspen recovery and not aspen population responses across Yellowstone's northern range. Concurrent increases in bison populations in Yellowstone's northern range may also be affecting the status of aspen communities.

Berger et al. (2008), in an often-cited article, suggested that wolf predation on coyotes in the Greater Yellowstone Ecosystem released the heavy coyote predation on pronghorn antelope fawns, resulting in increased pronghorn survival. The pronghorn population studied had not recovered from heavy market hunting, and the study found that fawn survival was four times higher in areas used by wolves where wolves predated on coyotes than in areas not used by wolves. Observed differences in fawn survival in areas with wolves may be sufficient to reverse the currently declining pronghorn population.

Kauffman et al. (2010) suggest that, contrary to Ripple and Beschta (2006, 2007), survivorship of young browsable aspen are not currently recovering in Yellowstone NP, even in the presence of a large wolf population. A marked reduction in elk followed wolf reintroduction at the same time that drought reduced forage availability and hunting by humans increased outside the park during and after winter elk migration, indicating that the difference in aspen recover may be based on factors other than response to predation. Contrary to findings of previous researchers, the authors suggest that much of the variation in aspen reproduction was not due to elk browsing levels in response to predation risk, but to site productivity. Patterns of aspen recruitment are consistent with the effects of a slow and steady increase in elk abundance following the end of market hunting in the late 1800s and wolf extirpation in the 1920s. The authors' interpretation suggests that landscape level differences in habitat more strongly determined where wolves killed elk. Also contrary to Ripple and Beschta (2007), these authors suggest that aspen growth differences were due to the confounding patterns associated with abiotic factors such soil moisture, mineral content or patterns of snow accumulations, which vary widely across the landscape. Aspen sucker survivorship was lower near wolf territory core areas, likely due to wolves maintaining territories in areas of high elk densities, limiting the cascading impacts of behavioral changes due to predation risk, which apparently occur only in response to the near imminent threat of wolf predation. The authors suggest that aspen recovery across the northern range of Yellowstone NP will occur only if wolves in combination with climate and other predators further reduce elk populations.

Brown and Conover (2011) conducted a large-scale removal of coyotes on twelve large areas in Utah and Wyoming to study effects on pronghorn antelope and mule deer populations. Their data suggest that coyote removal conducted during the winter and spring provided greater benefit than removals conducted during the prior fall or summer for increasing pronghorn survival and abundance. Unlike that for pronghorn, the data suggest that coyote removal during any season does not affect mule deer populations.

Ripple et al. (2011) suggest that it is possible that disrupted trophic and competitive interactions among wolves, coyotes, lynx and snowshoe hares after wolf extirpation may be sufficient to chronically depress hare and lynx populations; human-caused habitat fragmentation and livestock presence may have added to the depressed populations in Banff NP. With wolf extirpation, coyotes predated on hares, competing with lynx. The authors hypothesize that warming climates may increase coyote predation on hares in areas with lower snowpack even at higher elevations typically used by lynx, because coyotes can better traverse areas with less deep snow.

Beschta and Ripple (2012) report that, following extirpation of large predators (wolves, cougar, and grizzly bears) in Yellowstone, Olympic, and Zion National Parks in the early 1900s, large ungulate populations irrupted, with increased herbivory on riparian cottonwood, willow, and aspen communities. Beavers abandoned willow communities, resulting in loss of pond habitat and deepening of streams with bank erosion within twenty years. Nearly two-thirds of Neotropical migrant birds depend on riparian vegetation during the breeding season, even though riparian systems make up 1% to 2% of total land areas in the western US. As streambanks eroded, the level of coarse streambed sediments decrease with an influx of finer sediments during the erosion of floodplains which effectively fill in gravel interstices, changing benthic habitats in streams, increasing water temperature degrading fish habitats with losses of stable overhanging banks and ripple flows with low sediment loads. If apex predators are reintroduced, the effects may or may not be reversible, depending on whether the level of reduced herbivory can be sufficiently maintained.

Levi and Wilmers (2012) analyzed 30 years of data involving intraguild predation involving wolves, coyotes, and foxes to determine any effect on trophic cascades found correlational interrelationships, based on a plausible mechanism of increased interference competition between closely-sized canids. Theory suggests that guild interactions with an even number of species will result in the smallest competitor being suppressed, while guild interactions with an odd number of species may result in the smaller predator being released (Levi and Wilmers 2012).

Ripple and Beschta (2012) repeat earlier aspen and cottonwood surveys and measure browsing heights to determine recovery of aspen in the northern range of Yellowstone NP. The authors suggest that browsing on the tallest aspen stems decreased from 100% in 1998 to averages of less than 25% in the uplands and less than 20% in the riparian areas by 2010, increasing aspen recruitment and growth. Synthesis of trophic cascade studies conducted in Yellowstone NP within 15 years after wolf reintroduction generally indicate that the reintroduction of wolves restored trophic cascade with woody browse species growing taller and canopy cover increasing in some areas. After wolf reintroduction, elk populations decreased and beaver and bison populations increased. Despite indications that wolf reintroduction created substantial initial effects on both plants and animals, northern Yellowstone NP appears to be in the early stages of ecosystem recovery and results may differ over time.

Squires et al. (2012) question the interpretations of the data published by Ripple et al. (2011), finding the correlations between recovering wolf populations and benefits to lynx populations through reduced coyote populations and through reduced competition among ungulates and snowshoe hare have weak or contradictory empirical support in the available literature. The authors believe that these findings cast doubt on the usefulness of Ripple et al. (2011) hypotheses and demonstrate the importance of experimental and comparative documentation when proposing trophic cascades in complex food webs. The authors caution against “publishing unsupported opinions as hypotheses that concern complex trophic interactions is a potential disservice to lynx conservation through misallocated research, conservation funding, and misplaced public perception.”

Callan et al. (2013) suggest that deer in Wisconsin were more abundant at the peripheries of wolf territories, based on evidence of higher deer herbivory (deer feeding on plants) on the territory margins than in core wolf territories. Understory vegetation in white cedar stands may be more influenced by bottom-up hydrology and ecological edge effects than by trophic effects. Areas with high plant diversity may increase deer densities that then attract and maintain higher wolf densities. Addressing wolf impacts at the scale of wolf territory rather than at a regional scale (rather than studying results within particular wolf territory, studies are conducted on whether wolves are present in a larger area) could have implications for study results. Research is essential to determine the level of scale at which a pattern becomes detectable above the ambient noise of ecological variation for understanding relationships between patterns and process.

Marshall et al. (2013) refute conclusions of previous researchers regarding willow recovery after wolf reintroduction. In Yellowstone NP, the authors found that moderating browsing by elk alone is not sufficient to restore willows in riparian areas along small streams – such recovery depends on eliminating browsing and restoring hydrological conditions that occurred before wolves were extirpated. Beavers were common in the park, and interacted symbiotically with ecologically healthy riparian systems by the ecosystem. The riparian system provided tall willows that the beavers used to provide food and build dams, which created the hydrological conditions for healthy and sustained willow communities. Loss of beavers in the 20th century amplified the direct effects of herbivory by elk, lowered water tables, and compressed bare moist soils needed for willow establishment. In the absence of beaver creating necessary hydrologic conditions, ten years of total protection from elk browsing was not sufficient to allow willows to grow greater than two meters tall (resilient to browsing). This study indicated clearly that bottom-up control of willow productivity due to beavers exceeded top-down control by herbivory.

Painter et al. (2015) further and refute the conclusions of both Kauffman et al. (2010) and Ripple and Beschta (2007). The authors suggest that increased wolf predation on elk after wolf reintroduction played a role in substantial decreases in elk populations, interacting with other influences such as increased predation by grizzly bears, competition for forage with expanding bison populations, and shifting patterns of human land use outside the park towards irrigated agriculture (which become more important during droughts), reduced livestock densities, and increased hunting on the elk winter ranges. Currently, a large proportion of elk now winter on irrigated fields outside the park, a strong shift in distribution. Even with the near elimination of winter elk hunting after 2005, lower wolf numbers after 2007, mild winters after 1999, a major wildfire in 1988, and the end of the regional drought in 2007, the trend of declining elk density inside the park continued through 2012. Increasing bison populations inside the park (growth of three times between 1998 and 2012), either expanded into vacated elk winter range or perhaps displaced elk. The authors argue that research conducted by Kauffman et al. (2010) and Ripple and Beschta (2007) used protocols that differed in both timing and design, potentially missing patchy aspen recovery or recovery that was in the initial stages. Where herbivory has been reduced, bottom-up factors such as site productivity may become more important drivers of young aspen and willow height. The authors conclude that changing elk dynamics and beginning aspen recovery are consistent with top-down control of large herbivores by large carnivores.

Ripple et al. (2015) suggest that increases in wolf numbers after reintroduction into Yellowstone NP resulted in decreased elk populations and increases in berry-producing shrubs, including serviceberry. Increases in serviceberry may partially be due to the 1988 wildfires or other factors. With increases in berries, grizzly bears increased fruit consumption, possibly in associated with decreased whitebark pine nuts rather than the effects of trophic cascades. Evidence of a trophic cascade associated with increases in wolf populations, decreases in elk populations, and associated increases in berries, may have resulted in grizzly bears increasing consumption of berries. This may show both a top-down cascade from wolf-elk-berries, and a bottom-up response with increased berry production and grizzly bears switching to now-available berries during periods of low production of whitebark pine nuts.

Benson et al. (2017) suggest that eastern coyotes have ascended to the role of apex predators since the extirpation of wolves in northeastern North America. Eastern coyote packs consumed less ungulate prey and more human-provided food than wolf packs, being more generalists. Eastern coyotes are effective deer predators and are larger than western coyote (eastern wolves are smaller than western wolves), but their dietary flexibility as generalists and low kill rates on moose suggest that they have not replaced the ecological role of wolves as apex carnivores in eastern North America.

7 What is the Relationship of Intraguild Predation (IGP) and Mesopredator Release (MPR) to the Potential Occurrence of Trophic Cascades?

7.1 Intraguild Predation

Interference competition, also known as competitive exclusion (Polis et al. 1989, Arjo et al. 2002, Finke and Denno 2005), is a system in which species in a community use similar diets and/or space and one species interferes with the ability of the other to optimize the use of food and habitat. Individuals of one or both species attempt to avoid this competition by using different parts of the same habitat, using the habitat at different times, and/or shifting to different foods (**resource partitioning**).

The **competitive exclusion theory** implies that coexistence of closely-related competitive species depends on resource partitioning and the degree to which shared resources are limited (Arjo et al. 2002). This is especially important when one or more predators interfere with other predator(s), called **IGP**. Relative body size and degree of trophic specialization are the two most important factors influencing the frequency and direction of IGP (Polis et al. 1989). Inherent live history characteristics such as litter size, growth rates, social structure, and density dependent interactions may influence the strength and direction of IGP correlations. IGP interactions may be directed preferentially towards predators with the closest rate of competition, often with the larger predator being dominant over the smaller (Polis et al. 1989). A review of the IGP literature found that the effects of IGP vary across different ecosystems, with the strongest patterns of IGP in terrestrial invertebrate systems. However, it is difficult to compare across systems and literature because of differences among study scales, sample sizes, and sampling methods (Vance-Chalcraft et al. 2007).

Polis et al. (1989) identified the complexities of potential types of interactions and responses associated with IGP at the population level: intraguild predators may benefit from reduced competition, especially when local resources are limited; IGP may be sufficiently intense to control populations of intraguild prey populations; intraguild predators may paradoxically increase populations of intraguild prey if the prey has density dependent responses to decreased abundance and competition; and/or presence of the IG predator may increase competition for habitat refugia.

At the community level, interactions over ecological and evolutionary time strongly influence the abundance of species. These interactions may influence distribution, resource use, and body structure, as intraguild prey often use habitat differently than their intraguild predator in space and time to avoid the risk of predation. In these early papers, Polis et al. (1989) and Arim and Marquet (2004) suggest that IGP is ubiquitous through various ecosystems, is not due to chance (found by Arim and Marquet 2004 to be statistically significant), and is a powerful interaction central to the structure and functioning of many natural communities.

Many researchers agree that the effect of IGP on trophic systems is understudied (e.g., Palomares et al. 1995, Litvaitis and Villafuerte 1996, Palomares et al. 1996, Finke and Denno 2005). IGP is more likely to occur in predator guilds with many predator species, which increases the chances of IGP interactions (the intra-guild predator competing for shared prey and predating on other predators) and the potential for dampening trophic cascades (Finke and Denno 2005, Daugherty et al. 2007). Based on a review of the literature on IGP theory and modeling, Holt and Huxel (2007) concluded that most models are oversimplifications of natural systems, including by not considering richer webs of interacting species across heterogeneous landscapes.

Wolves may control coyote populations through IGP and competition (Berger and Gese 2007 found a statistically significant correlation) in the Greater Yellowstone Ecosystem and Grand Teton NP. Survival rates of resident coyotes were higher than that of transient coyotes. Humans were responsible for 88% of all resident coyote deaths; predation caused 67% of all transient coyote deaths, with wolves causing 83% and cougars 17% of that predation. Despite IGP on coyotes by wolves, it is possible that coyotes may arrange their territories to overlap wolf activity areas, possibly in response to increased scavenging opportunities within wolf territories.

7.2 Mesopredator Release

Early studies related to the conservation effectiveness of removing large predators indicated that such removals may result in unintended increases of populations of smaller predators. The increase of smaller predator populations may have further impacts on the prey populations of those smaller predators. This concept is now referred to as **mesopredator release**.

Cote and Sutherland (1997), in an analysis of the literature, concluded that predator control is often the one factor, other than human exploitation, that can be directly managed (the others being climate, productivity, diseases and parasites, availability of territories, and accidents). Predator control may increase target populations of breeding birds, but not reliably, based on immigration and the availability of the area's carrying capacity to support more birds.

On closed systems associated with oceanic islands (systems with highly restricted opportunities for emigration and immigration) on which exotic predators such as feral cats or rats are introduced, removing the apex predator may result in irruptions of mesopredators (removing the cats eliminated the suppressive effects on rats), which may lead to extinction of the shared prey. Rats, being omnivores, may maintain high abundance and high levels of predation, even when bird populations are low (Courchamp et al. 1999, Bergstrom et al. 2009, Roemer et al. 2009). Release of mesopredators by removal of apex predators on insular islands may have many unintended consequences, including reducing nutrient subsidies from predation by small mammalian predators on large colonies of birds, altering vegetation communities; driving native species to extinction or extremely low abundance; filling niches that can no longer be filled by apex predators; and creating reservoirs of diseases carried by mesopredators (Roemer et al. 2009). Despite these problems, Russell et al. (2009) argue that removing apex predators from oceanic islands may outweigh the negative effects of MPR.

Large mammalian carnivores are particularly vulnerable to extirpation and extinction in fragmented habitat due to human development, which may result in MPR of smaller predators, which are more resilient to extirpation (Crooks and Soule 1999, Roemer et al. 2009). In an area highly fragmented due to residential development, the authors found positive statistical correlation between coyote abundance and mesopredator abundance, especially opossums and foxes, and negative correlation between bird diversity and grey foxes, domestic cats, opossums, and raccoons. Mesopredators avoided areas of high coyote presence both temporally and spatially. Because domestic cats are recreational hunters subsidized by their owners, approximately 35 cats (from a neighborhood of 100 homes) were present in bird habitat fragments containing a very small number of birds (Crooks and Soule 1999).

Prugh et al. (2009) asserted that collapses in top predators caused by human influences are often associated with dramatic increases in the abundance of smaller mesopredators across many types of communities and ecosystems. The authors defined a **mesopredator** as a mid-ranking predator in a food web regardless of size or taxonomy. A mesopredator in one food web may be an apex predator in another, and may not directly fulfill the original apex predator's ecological role in the web. The occurrence of a MPR is often symptomatic of fundamental ecological imbalances due to human activities, such as habitat fragmentation, introduction of exotic species, and provision of human subsidies. Overabundant populations of mesopredators are difficult to control because the species are usually characterized by the potential for high densities, high reproductive rates and rates of recruitment, and high rates of dispersal. The authors also assert that it is difficult to root out alternative explanations for mesopredator overabundance, such as habitat changes, that often occur with or cause the loss of apex predators. Uncertainty regarding the causal mechanisms underlying mesopredator outbreaks muddies prescriptions for management.

In a commonly cited meta-analysis by Ritchie and Johnson (2009), the authors reported that more than 95% of the papers reviewed suggested evidence of MPR and/or suppression of mesopredator populations by apex predators. The only exceptions involved species with specialized defenses, such as skunks or those that use specialized structural niches, such as arboreal behavior. Apex predators can affect mesopredator abundance through killing (and sometimes eating) them; through forcing behavioral shifts in foraging or use of habitats in time and space; and through direct aggressive interactions. These changes can have effects on population growth, predation rates, fitness, and survival. Bottom-up effects of vegetation productivity and community composition and distribution can affect abundance of species at all trophic levels, including IGP, attenuating or exacerbating the nature, strength, and direction of interactions among species (Thompson and Gese 2007, Ritchie and Johnson 2009). Apex predators may be more effective in controlling mesopredators in productive ecosystems (Ritchie and Johnson 2009).

In another commonly cited meta-analysis, Brashares et al. (2010) found evidence that MPR is a common result of the loss of apex predators in many systems throughout the world. Many current apex predators in some systems are exotic or invasive species. Loss of apex predators may or may not result in MPR, depending on the context. Additionally, increased abundance of mesopredators may or may not cause prey populations to decline, with mesopredators gaining dominance in areas of low productivity and high habitat fragmentation, and apex predators having more resilience in areas with high productivity and low habitat fragmentation. If a high diversity of apex and mesopredators consume a wide variety of prey, the potential for MPR and trophic cascades is weakened. Challenges in detecting MPR is difficult because of short duration studies, inherent natural variation, complex interactions among trophic levels, and researchers often invoke MPR when the apex predator has already been extirpated.

Another recent meta-analysis conducted by Ripple et al. (2013) suggested that any MPR effects due to wolves could be dependent on the context, and may be influenced by bottom-up factors, such as the productivity of a system without wolves. Factors such as human-provided food subsidies, scavenging opportunities on livestock and large ungulates, and existence of alternative prey may confound results. The authors suggest that a link exists between wolf population declines and expansion in the ecological influence of coyotes. The strength of any trophic cascade created by wolf recolonization may be dependent on whether wolf populations may reach ecologically-effective densities (also suggested by Letnic et al. (2007)), the amount of unfragmented habitat available, levels of wolf harvests and removals, and presence of refugia and food subsidies available to coyotes.

In Australia, researchers have suggested that widespread and intensive control of dingoes using aerial distribution of 1080-poisoned baits has resulted in releases of mesopredators, especially introduced foxes and cats (Wallach et al. 2009a, Letnic et al. 2011, Brook et al. 2012), although Allen et al. (2014) argues that other plausible explanations may exist. Letnic et al. (2011) suggested factors that may also limit the control of dingoes on foxes include the abundance of prey (particularly introduced rabbits), seasonal activity patterns, levels of site and vegetation productivity, predator control regimes used, human food subsidies, and reproductive rates. Importantly, the authors argue that it is possible that top predators can ecologically express control over mesopredator populations only when apex predator population densities reach a certain threshold (also suggested by Ripple et al. 2013), which is likely to be above that at which apex predators pose a threat to livestock of human safety. Lack of human tolerance to predators may not allow that ecological threshold of abundance to be reached.

Similarly, Newsome et al. (2017) found that top predators suppressed mesopredators in areas where top predator densities were highest (core area), supporting the notion that removal of top predators can cause MPR. At areas outside the top predators core area, mesopredators and top predators have been shown to coexist, indicating that MPR may not occur when top predators are removed in those areas since mesopredators already had a realized ecological role. However, there is uncertainty with their results, since mesopredators could coexist in the high density core of a top predator's territory, but those individual animals are thought to be difficult to detect. The authors note that abiotic factors, such as human disturbance and agriculture, caused both top predators and mesopredators to be absent from the area, dampening the strength of top-down forces enough to create a bottom-up driven system.

Wallach et al. (2009a) suggest that dingoes originally coexisted with two endangered species (a ground-nesting bird and a rock-wallaby), and extensive dingo baiting may be the unintended cause of Australia's extinction crisis due to MPR of introduced foxes and cats. Intensively baited dingoes may have managed to preserve pack cohesiveness due to learned behavior in response to human persecution, including becoming difficult to sample and highly secretive in areas of human presence and where they were expected to be exterminated. After intensive baiting of dingoes, endangered species may either crash (which is improperly attributed to the baiting program) or exhibit an exponential increase followed by a crash after a lag period (mesopredator populations increase during the lag period before adversely affecting the population of the endangered species). Brook et al. (2012) found evidence that controlled dingo populations hunted less at dusk (dusk being their common hunting period concurrent with prey activity), and therefore feral cats hunted more at dusk with higher efficiency. Cats may also have the additional behavioral advantage of climbing trees both to access prey and avoid predation by dingoes. Dingo densities may actually increase for a time following intense baiting due to dispersal of young dingoes.

Allen et al. (2013) demonstrated that the removal of dingoes did not result in increased mesopredator abundance. Further, Allen et al. (2014) argues that three often-cited studies purporting to provide evidence of MPR in Australia are actually plagued by imprecise sampling of predator populations. Additionally, none of the studies provide reliable evidence of MPR because there was no verification of reduced dingo populations due to baiting. The authors assert that, despite broad patterns of MPR demonstrations in some contexts, MPR cannot be reliably separated from other equally plausible explanations for the suggested interrelationships among dingoes, foxes, and cats. Additional research by Allen et al. (2018) has indicated that bottom-up effects (habitat and food availability) have a greater influence on hopping-mice (prey item of mesopredators) than the abundance of dingoes.

8 What is the Relationship of Adaptive Behavior, Resource Partitioning, and Human Subsidies to the Potential for Terrestrial Trophic Cascades?

8.1 Adaptive Behavior

Since the late 1990s, researchers have recognized that individuals and groups of herbivorous and/or carnivorous prey animals use behavior that may be evolutionary-based or learned as part of a social system to reduce the risk of predation. Other non-consumptive and abiotic factors such as snowpack, system productivity, rainfall, and climate change may also affect how predators and prey (including predators as prey, or IGP) interact (Peckarsky et al. 2008). Although top predators will kill smaller predators, other factors, including behavioral responses such as shifting territories, adapting anti-predator behavior, and resource partitioning, are the primary mechanisms by which dominant predators can limit smaller predator populations (Casanovas et al. 2012).

Berger-Tal et al. (2011) suggest that adaptive behavior by predators and prey should be integrated into models of conservation theory, and recognize the role that human behavior plays in impacting animal behavior, such as overharvesting, habitat fragmentation, disturbance, and the introduction of exotic species. The key animal behaviors affecting survival, reproduction, and recruitment are changes in movements and use of space, behaviors related to foraging and avoidance of predation, and social behaviors.

Gese (1999) reported that elk and bison act more aggressively toward the alpha pair of wolves than toward betas and juveniles. Female elk with young act more aggressively toward predators than males to determine the most effective level of anti-predator behavior with the least use of energy (Gese 1999), perhaps responding to behavioral clues emitted by the predators themselves (Peckarsky et al. 2008). The type of hunting style use by different terrestrial large predators, such as “coursing” versus “sit-and-wait” may cause different anti-predator responses by prey. For example, it may be easier to respond with less energy to coursing predators, such as wolves and coyotes, because it is easier to know if they are present or absent from an area than an animal that may be hiding and waiting for prey to mistakenly enter their attack range (Schmitz et al. 2004, Ritchie and Johnson 2009). However, Orrock et al. (2010), working primarily with fish and invertebrates, suggested that predators may change prey movements and behavior by “remote threat,” even when the predator is not present (the predator causing a threat has been called a "keystone intimidator" by Peckarsky et al. 2008).

It is difficult to interpret the rationale for certain wildlife behaviors. Creel and Winnie Jr. (2005) disagreed with Hebblewhite and Pletscher (2002) interpretation of elk grouping behavior near and far from cover. The latter interpreted elk foraging in meadows as a means to avoid predator attacks emerging from cover, the former reinterpreted the same behavior as release from anti-predator behavior when the short-term risk of predation was low, providing an opportunity for foraging in the best habitats. Creel and Winnie Jr. (2005) suggested that elk can assess temporal variations in predation risk on a sufficiently fine scale to determine the daily comings and goings of wolves through the senses, patterns of predator presence, and/or distribution of prey carcasses.

Prey may change their behavior to avoid chronic predation, including by humans, by changing the timing of activity (temporal behavioral change during the day or night) or the how they use the available habitat spatially in relation to the activity of the larger predator (Kitchen et al. 2000, Wilson et al. 2010). For example, Kitchen et al. (2000) reported coyote populations being significantly more active during the time period when predators are not (for coyotes, more active during the night while their eyesight is more adapted for optimal hunting during the day or dawn). Social animals may also be forced into behavioral and associated physiological changes under heavy human predation. Wallach et al. (2009b) asserted that heavy predator control against dingoes (wolf-like canid) in Australia through aerial 1080 baiting fractured the social structure of packs, leading to changes in age composition, group size, survival rates, hunting abilities, territory size and stability, and genetic identity and diversity. When heavily controlled, dingoes learned to survive in areas deep in reserves and, conversely, directly near humans, livestock and areas of heavy baiting, utilizing additional food sources and passing on the anti-predator/human behavior to offspring.

Free-ranging domestic dogs were found to control distribution and habitat use of a small wild deer in South America due to high potential for harassment and attacks and resulting high lethality of attacks. Recreational hunting by subsidized domestic predators can cause behavioral and habitat shifts, reduction in fitness, and populations declines (Silva-Rodriguez and Sieving 2012).

Other important behaviors affecting the role of species abundance and recovery within trophic systems is dispersal, immigration into and out of a system or population, and territoriality. In species with social structures, such as wolves, dingoes, and coyotes, dispersal by beta and juvenile individuals may be due to little interaction with other pack members, lack of breeding opportunities, restriction to food resources by higher ranking members, and increased social aggressions from more dominant pack members (Gese et al. 1996a;b). Territories are areas that are defended from emigration by individuals that are not pack members, usually by the dominant pair, to limit or exclude competition for mates, food, and space (Gese 1998). Berger and Gese (2007) suggested that differential effects of wolf competition with coyotes on transient coyote survival and dispersal are important mechanisms by which wolves reduce coyote densities.

A challenge to interpreting the role of adaptive behaviors and other non-consumptive traits such as habitat or temporal shifts that are acquired over evolutionary time is that, when evaluating statistical correlations, these factors may have the same sign as consumptive factors (factors related to trophic interrelationships), moving in the same direction, so they may be overlooked or masked. Conversely, adaptive behaviors may also potentially increase the magnitude of trophic cascades that would otherwise be mediated by consumption. Non-consumptive effects may also be easily interpreted as bottom-up effects, or be considered as an afterthought to explain observations inconsistent with consumption-based theory, further confounding interpretation of study results (Peckarsky et al. 2008).

8.2 Resource Partitioning

Partitioning of resources in time and space are key behavioral methods for coexisting and minimizing competition between predators and prey, including predators that kill and/or eat other predators (IGP). Polis et al. (1989) identified **interference competition** (also called competitive exclusion; Arjo et al. 2002, Finke and Denno 2005, Brook et al. 2012), in which taxa in a community use similar diets and/or space and one interferes with the ability of the other to optimize the use of such resources. For example, hungry consumers may have greater movement in search of food, encountering predators or prey more frequently. Behavioral adaptations to minimize the risk of prey encountering predators can involve switching the use of habitats by using them at a time when it is likely that the predator would not be present (Palomares et al. 1996, Finke and Denno 2005, Hunter and Caro 2008) or switching their diet to minimize competition (Schmitz et al. 2004, Thompson and Gese 2007, Elbroch et al. 2015).

Several authors have reported that coyotes may eat smaller prey compared to wolves (such as deer, rabbits, or rodents rather than elk), while at the same time obtaining food directly provided by wolves through scavenging on large carcasses that the wolf pack cannot completely consume, such as elk and moose (Paquet 1992, Wilmers et al. 2003). Prior to wolf reintroduction in Yellowstone NP, coyotes depended on small mammals and scavenging carcasses late in the winter season, when animals were naturally weakened and died (Gese et al. 1996b, Wilmers et al. 2003). However, after wolves are reintroduced or they recolonize an area after extirpation, carcasses are provided throughout the winter, making direct interaction with wolves at a carcass, despite increased aggression and the risk of being killed, more energetically efficient than hunting (Arjo et al. 2002, Wilmers et al. 2003, Atwood et al. 2007, Thompson and Gese 2007). Food subsidies provided by scavenging introduces complexity into food webs. In Rocky Mountain National Park, over 30 species of mammalian and avian scavengers use wolf kills (Wilmers et al. 2003).

After reintroduction of wolves into Yellowstone NP, competition between cougars and wolves suggested that cougars significantly increased the proportion of deer in their summer diet and decreased the proportion of elk. Both wolves and cougars predated on elk calves in the summer, but elk had shifted their winter range to irrigated fields outside the park, as well as institutionalized winter feeding subsidies. This resulted in elk populations no longer being limited by natural carrying capacity, so neither wolf nor elk were limited in the summer by elk calf availability (Elbroch et al. 2015).

Atwood et al. (2007) found that cougars and wolves ate the same prey (elk) but in different habitats. Female cougars select habitat based on opportunities for hunting more than male cougars do. Lendrum et al. (2014) suggest that competition with reintroduced wolves in Yellowstone NP caused cougars to select habitat removed from known wolf pack territories and with buffers to reduce the potential for interactions with wolves. Avoiding wolves may result in use of less optimal habitat, especially for female cougars, which may have implications for survival of dispersing juvenile cougars and overall cougar dynamics.

Swift and kit foxes, closely related foxes that are much smaller than coyotes, are often killed by coyotes in areas where their home ranges overlap (Kamler et al. 2003, Moehrenschlager et al. 2007, Kozlowski et al. 2008); however, fox populations having higher survival rates tended to use portions of the overlapping home ranges that had more heterogenity, especially areas providing burrow and den refugia that allow rapid escape from coyotes. Home range sizes decreased as the availability of burrows increased, as it did in areas with lower shrub densities in which predators can be readily viewed and escaped more quickly (Moehrenschlager et al. 2007, Kozlowski et al. 2008).

More than body size and behavior, especially in non-canid mammalian predators, may cause resource partitioning. Even when raccoon and coyote home ranges overlapped, researchers found little evidence of coyotes killing raccoons, and little evidence that raccoons avoided coyotes. Since raccoons are opportunistic omnivores, there is little potential for direct competition. Raccoons also climb trees, which may provide a structural habitat partitioning (Gehrt and Prange 2007). Skunks avoid direct predation by larger carnivores through distinctive coloration and toxic emissions (Hunter and Caro 2008, Ritchie and Johnson 2009).

Human influence on habitat use, especially habitat fragmentation, human activity, and human food subsidies, is an important consideration for how individuals and populations interact and thrive (Litvaitis and Villafuerte 1996, Palomares et al. 1996, Fedriani et al. 2001, Fischer et al. 2012).

8.3 Human Food Subsidies

A review of the literature by Newsome et al. (2015b) found that 36 terrestrial species in 34 countries used food provided by humans, such as discarded food, livestock carcasses, crops, and landscaping. With such subsidies, predator abundance increased (no longer limited by resources), diets were altered to include human-provided food, survival increased, and social interactions shifted to either the benefit or disadvantage of the predator. Predators also changed their home ranges, activity, and movements. Subsidies can result in induced behavioral or population changes and may result in trophic cascades, causing predator populations to no longer cycle with prey cycles. Top predators used primarily livestock, mesopredators used livestock carcasses and waste food, cats continued to use live prey, and bears mostly used crops, waste foods, and carcasses. Prey also used human presence and activities as shields from predators in some cases.

Fedriani et al. (2001) found that areas in southern California with high and patchy human residential development provided sufficient human food subsidies through trash, landfills, livestock, and domestic fruit, as well as providing subsidized habitat for rabbits. The study also found that coyote densities were eight times higher than in more natural areas (also, Fischer et al. 2012). As predator size increases, human tolerance tends to decrease (Fischer et al. 2012).

In urban areas, coyotes tended to avoid urban and crop areas, using safer corridors between patches of forest areas used for cover during the day and hunting (Arim and Marquet 2004, Gehrt et al. 2009). Gehrt et al. (2009) found mostly “invisible” coyotes avoiding humans and human-provided food in core areas of downtown Chicago and at O’Hare International Airport (similar to Wallach et al. 2009a, Wallach et al. 2009b). Raccoons, however, heavily used dumpsters and trashcans at night in areas with high human activity during the day (Gehrt et al. 2009). Bino et al. (2010) found that foxes, when human food subsidies were rapidly removed, responded by increasing or shifting their home ranges or dispersing from the area, and that fox densities in the urban area decreased substantially within a year.

9 How Do Predator Population and Social Dynamics Affect Ecosystem Structure and Function?

The territory of an animal has been defined as the area that an animal will defend against individuals of the same species (Mech 1970). Since the Knowlton and Stoddart (1983a) study (and further clarified by Gese 1998), it is clear that the territorial alpha pair is the basic unit of wolf and coyote populations. According to Gese (1998), the alpha pair is responsible for monitoring and defending the territory and its resources from other conspecific predators from adjacent packs through patrolling and scent marking. Pack size varies geographically, with wolf packs more commonly composed of more individuals than coyote groups. Ecologically, the socially intact and operating wolf pack, not individual animals or even the alpha pair, is the unit that appears to control the structure and function of the ecological system (Wallach et al. 2009b).

Maintaining the structure of the pack is critical for ensuring that the pack has the needed resources through shared hunting strategies and scavenging, collaborative care of the alpha pair’s young, and learned behavior of the young for hunting efficiency and wariness of novel changes in the territory. In coyotes, only the alpha pair breeds and only 10% of the young from a given pair need to survive and reproduce to replace the pair. The remaining 90% of the beta (subdominant) and transient animals either stay in the pack without reproducing, die, or disperse, and often die before establishment in a new territory (Knowlton et al. 1999). Therefore, in the absence of human hunting, territories and associated population densities tend to remain relatively stable over time.

Population control of socially complex species like wolves may have profound ecological impacts that remain largely invisible if only abundance is considered. Heavy predator control (in this case intensive aerial baiting of dingoes with 1080) can seriously fracture pack social structure, leading to changes in age composition, group size, survival rates, hunting abilities, territory size and stability, social behavior, genetic identify, and diversity. Controlled populations tend to have a higher proportion of young breeding pairs and litters due to loss of dominant adults in the pack structure controlling access to breeding. Packs may disperse after the loss of the breeding pair and territory boundaries may weaken or dissolve, creating transient individuals that are more vulnerable to predation. The pack may also shift to another area under heavy exploitation and breakup of territories. Learned and practiced coordinated hunting behaviors within packs may be lost due to loss of social structure and changes to social traditions. A symptom of pack disintegration may be a decreased ability to take down larger prey and predators may shift to smaller and or more vulnerable prey. Smaller packs may reduce success at scavenging in the winter due to competition from larger predators. Intensive human removals may teach remaining animals to be highly secretive (Wallach et al. 2009b).

Studies suggest that coyote territories do not remain vacant for very long after members are removed. Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area within a few weeks, despite removal of breeding coyotes. Blejwas et al. (2002b) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following the removal of the alpha territorial pair. Williams et al. (2003) suggested that temporal genetic variation in coyote populations experiencing high predator removal indicated that localized removal did not negatively impact population size. Gese (2005) found that after heavy removal rates (populations reduced between 44% and 61% over two years) there was a younger age structure in packs and increased reproduction by yearlings, with pack size and density rebounding to pre-removal levels within eight months post-removal. The author attributed some of the response to immigration of animals from outside the territory and increased lagomorph prey availability that apparently increased mean litter size in both the removal and control areas. Young animals, which are low in the social structure and subjected to lower resource accessibility, and some betas with no potential for becoming breeding alpha members of the pack, generally disperse (Gese et al. 1996b), which may also keep genetic diversity high as dispersing animals fill vacated openings within another pack.

While it is true that wolf removal can have a short-term disruptive impact on pack structure, that disruption does not appear to result in adverse impact on the overall wolf population (Nadeau et al. 2008, Nadeau et al. 2009, Mack et al. 2010). Pack resilience to mortality is inherent in wolf behavioral adaptation and reproductive capabilities (Brainerd et al. 2008). Based on mean pack size of eight, mean litter size of five, and 38% pups in packs, Boertje and Stephenson (1992) suggested 42% of juveniles and 36% of adults must be removed annually to achieve population stability. Researchers have indicated declines may occur with human-caused mortality at 40% or less of autumn wolf populations (Peterson et al. 1984, Ballard et al. 1997).

The data on wolf mortality rates suggest some wolf populations tend to compensate for losses and return to pre-removal levels rapidly, potentially within a year. Wolf populations have sustained human-caused mortality rates of 30% to 50% without experiencing declines in abundance (Fuller et al. 2003). In addition, Brainerd et al. (2008) found that 62% of packs in recovering populations retained territories despite breeder loss. Furthermore, pup survival was primarily dependent on size of pack and age of pup because multiple pack members feed pups despite loss of an alpha breeder. Pup survival in 84% of packs with breeder loss was similar or higher than packs without breeder loss (Mech and Boitani 2003).

Wolves and coyotes with strong social structures can be resilient in the face of moderate levels of exploitation, and can recover abundance relatively rapidly. However it is not known at what population densities these species can exert top-down control through the ecosystem. Many populations are simply too small to actually cause top-down trophic cascades (Ray et al. 2005a, Letnic et al. 2011, Ripple et al. 2013).

10 What is the Relationship of Trophic Cascades to Ecological Biodiversity and Ecosystem Function?

Humans are the top predator in all systems, but the roles humans play as predator in trophic cascades, biodiversity, and ecosystem function are rarely considered (Ray et al. 2005a). Most predators cannot directly and intentionally change their habitats and condition to serve their own purposes; only humans can do that.

Humans are altering the composition, ecosystem structures, and impacted diversity of biological communities through a variety of activities, such as logging, agriculture, grazing, development, climate change, loss of native species and additions of exotic or invasive species, with new functions that increase the rates of species invasions and extinctions, at all scales. Many human-altered ecosystems are difficult and expensive to recover, or may be impossible to reverse (Hooper et al. 2005, Ritchie et al. 2012). Biodiversity is declining a thousand times faster now than at rates found in the fossil record, and is becoming increasingly confined to formally protected areas, which may fail to function as intended due to size and lack of connectivity to other protected areas (Balvanera et al. 2006, Estes et al. 2011). Concern is growing that the loss of ecosystem services provided by biodiversity are adversely impacting human well-being (Hooper et al. 2005, Balvanera et al. 2006, Cleland 2011).

Despite compelling experimental evidence, the relationship of biodiversity to ecosystem functioning and provision of ecological services has great uncertainty and is still contentious among researchers because the differences in experimental design, the results obtained, and interpretations of those results have not been consistent or universally accepted among the research community (Hooper et al. 2005, Balvanera et al. 2006).

Biodiversity can be described at many scales, from genetic to global (Hooper et al. 2005, Cleland 2011). Biodiversity can be measured in many ways as well, including **species richness** (the number of species in a system), richness of functional groups (the number of ecological functions performed by groups of species in a system), **evenness** (the distribution of species or functional groups across the system), species composition (the identity of species occurring in the system), and diversity indices (comparative measures, using whatever factors are measured). Typically, biodiversity is measured in terms of species richness, because it can be readily measured and compared, but that measurement ignores the complex interactions among species, population, communities, and abiotic factors (Ray et al. 2005a, Balvanera et al. 2006, Cleland 2011).

The five top reasons for losses of biodiversity are human-caused habitat loss, fragmentation, and conversion; climate change; introduction of invasive and exotic species; pollution and nutrient enrichment (such as additions of farm fertilizers to aquatic systems); and overharvesting (Srivastava and Vellend 2005). However, these effects can be mediated to a degree by immigration and dispersal (France and Duffy 2006). The effects of biodiversity change in ecosystem processes are weaker at the ecosystem level than at the community level, and have a negative correlation at the population level (Balvanera et al. 2006).

Four mechanisms that account for biodiversity can influence the combined densities of predators and prey and their resources: sampling effects; resource partitioning; indirect effects caused by IGP, including diverse ecosystems with multi-trophic levels and multiple indirect effects; and non-additive effects resulting from consumers with non-linear complex functional responses (Ives et al. 2005).

Biodiversity can enhance the reliability and stability of ecosystem services and functions through more diverse communities and spatial heterogeneity (France and Duffy 2006). **Ecosystem stability** is defined as a system that changes little, even when disturbed; **ecological resilience** is defined as a system that, when perturbed, can recover to its original stasis (Cleland 2011). Ecosystems with low biodiversity have low resilience and are sensitive to disruptions, including perturbations caused by humans (Ritchie et al. 2012). Having a variety of species, including top predators, which responds differently to environmental perturbations can stabilize ecosystem processes (Hooper et al. 2005, Duffy et al. 2007).

Ecosystem functioning is a broad term that encompasses a variety of processes and reflects how the interrelated ecosystems involving biotic and abiotic factors work together. It depends on biodiversity and is the basis of the capability of the ecosystem to provide ecological services of value to humans (Hooper et al. 2005). Variation in ecosystem functions and processes can result from natural annual environmental fluctuations, directional correlational changes in conditions, and abiotic and biotic disturbances (Hooper et al. 2005).

Functional redundancy of species refers to the degree to which organisms do similar things within a system and that one species can potentially compensate for the loss of another (Hooper et al. 2005, Casula et al. 2006, Cleland 2011). A relevant example of lack of functional redundancy involves human hunting (with human as the top predator) and natural predation. Human hunting cannot replace the roles that top predators play because the timing and intensity of predation is different; different age and sex classes are targeted; hunting does not generally result in impacts to mesopredators; trapping can result in take of non-target animals; hunting requires infrastructure such as roads that have effects on animals and vegetation (such as mortality caused by collisions with vehicles). In many cases, human hunting and poaching are unsustainable in many parts of the world (Ray et al. 2005a).

It is suspected that greater variations in response to changes in biodiversity occur than is reported in the literature, based on inherent complexities associated with variations in prey use patterns, prey use rates by predators, predator abundance, and predator-prey distributions and interactions. This complexity results in many plausible theoretical explanations for results obtained by modeling biodiversity (Casula et al. 2006), none of which are certain. Studies incorporating multi-trophic levels that more realistically reflect nature and that consider interrelationships are still rare in this discipline (Hooper et al. 2005).

Ecosystem services are the conditions and processes through which natural ecosystems and the species that comprise them sustain and fulfill human life, including purification of air and water, support of soil fertility, decomposing waste, climate regulation, pollination, regulation of pests and human diseases, creating conditions of aesthetic beauty, and maintenance of biodiversity (Srivastava and Vellend 2005, Balvanera et al. 2006). As human populations increase and human domination of the biosphere expands, managing ecosystems for human services will become increasingly important to prevent shortages of water, energy, and food, while attempting to decrease disease and war (Kremen 2005).

Substantial theoretical and empirical evidence exists that biodiversity is able to effect ecosystem function for plant communities, but it is not clear if these patterns hold for conditions involving large predator extinctions, multi-trophic communities, or larger spatial scales (Loreau et al. 2001, Ray et al. 2005a, Srivastava and Vellend 2005). The major challenge is to determine how the dynamics of biodiversity, ecosystem function, and abiotic factors interact, especially with steadily increasing human-caused ecosystem degradations. Considering factors other than species abundance and richness (the number of species occurring in an ecosystem and the number of animals in each species), a more predictive science might be achieved if researchers developed an appropriate classification of ecosystem function integrating changes in biodiversity, ecosystem function, and abiotic factors into a single, unified theory that can be empirically tested (Loreau et al. 2001). This is extremely difficult to develop.

Understanding how biodiversity affects ecosystem function requires integrating diversity within trophic levels horizontally and across trophic levels vertically. Multi-trophic interactions may produce a richer variety of diversity and functioning relationships, depending on the degree of dietary generalization and specialization, trade-offs between competitive ability and resistance to predation, IGP, and immigration/dispersal. Little is known about how reducing the number of trophic levels or species or removing predator species affects ecosystem processes. Integrating more mobile large carnivores into research is an especially difficult challenge empirically (Duffy et al. 2007).

Experiments are often conducted at small scales with insufficient duration to account for turnover of the components in order to provide evidence for true change (as opposed to inherent natural variation), and biodiversity often includes exotic and invasive species. The effects of biodiversity on ecosystem function depend on the system being studied and the functions that are sampled and measured. Few studies have been conducted considering interactive effects of extinctions between two trophic levels, and those studies have mixed results (Srivastava and Vellend 2005).

Srivastava and Vellend (2005) conclude that biodiversity is declining at global scales, but the scales at which empirical studies are being conducted are not scaled up to appropriate levels to reflect nature. The results of studies are inconsistent on whether biodiversity has positive effects on ecosystem function, especially because it is not known how these studies are being scaled up; ecosystem effects of extinctions in multi-trophic food webs are difficult to predict because of numerous and complex indirect effects and the likelihood of simultaneous or cascading extinctions through the trophic levels; and human-caused drivers of extinction effect ecosystem function to a large magnitude directly and indirectly.

Decreases in biodiversity often lead to reductions in ecosystem functions, then in the resultant ecosystem services. Declines in providing services are initially slow, but become more rapid as species from higher trophic levels are lost at faster rates. Different ecosystem services respond differently to losses of habitat and biodiversity, introductions of exotic or invasive species, and the variety of interactions among species within and between trophic levels. Because different ecosystem services tend to be performed by species at different trophic levels, and trophic webs tend to first thin before collapsing from top to bottom, the processes should be predictable and foreseeable. The best way to address biodiversity and ecosystem function is to ensure that the ecosystems remain viable for species with larger area requirements that tend to have less readily identifiable economic value, such as large carnivores (Dobson et al. 2006).

Sustainable and healthy populations of large predators have the potential to restore ecosystem stability and confer resiliency against global processes, including climate change and biological invasions (Duffy et al. 2007). Because the roles of predators are dependent on their context, the emphasis of research must be more focused on predator functions in ecosystems, including the importance of social structures and adaptive behaviors in influencing the dynamics of trophic interactions, and less on the identities and abundance of species. There is great variability and uncertainty surrounding the ecological functions of predators, including unpredictable and even counter-intuitive outcomes that may be caused by species interactions such as IGP and mesopredator release (Ritchie et al. 2012). However, it is inappropriate to assume that the mere presence of large carnivores ensures persistence of biodiversity (Ray et al. 2005a).

The first species that tends to be lost or rendered ecologically extinct in both terrestrial and marine systems is almost invariably the large carnivorous predator, primarily due to their intrinsic rarity at the top of the trophic web, small population sizes, restricted geographic ranges, generally slow population growth rates, and specialized ecological habits. Top predators are especially vulnerable to human-caused habitat destruction and fragmentation, as well as exploitation and persecution due to conflicts with humans (Duffy 2003). Humans, as the top predator, have eliminated the largest predators from over 90% of the Earth, globally extinguishing ecological functions (Pace et al. 1999, Ray et al. 2005a).

Evidence suggests that the loss of one or more large carnivorous predator species often has impacts comparable in magnitude to impacts associated with a large reduction in plant diversity. This results in large changes in community organization, ecosystem properties and system functions (Duffy 2003). Apex predators tend to be the determinants of biodiversity structure and function, and the most challenging to conserve (Ray et al. 2005a). Studying the results of the impacts of the loss of large carnivores on the structure and function of ecosystems is extremely difficult because of a complexity in trophic interactions. Evidence from ecological studies indicate that the largest contribution of changes in biodiversity on ecosystem function occurs when humans introduce exotic or invasive plant and/or animal species, which may increase the number of species in a system (species richness), while reducing ecosystem functions. Biodiversity will continue to erode under human influence (Duffy 2003).

Despite increasing research on the tangled complexity of food webs and trophic interactions, we have no better understanding of how to apply the results to conserving biodiversity and ecosystem function. Marine ecosystem cascades are generally caused by overexploitation of species eaten by humans; in terrestrial ecosystems, changes in biodiversity are generally caused by human-caused habitat destruction, fragmentation, and conversion. Large carnivores are generally not specialized in function or diet, so pristine conditions are not needed for survival; large carnivores are mostly resilient in the face of human perturbations, provided they have their basic baseline conditions. The primary problem with restoring large carnivores is competition with humans for space, resources, and property such as livestock (Ray et al. 2005a), which can often lead to legal and illegal removals, concerns with human health and safety, and further pressures on endangered species (Ritchie et al. 2012).

Biodiversity, broadly defined, and the roles of large predators potentially contributing to biodiversity, clearly has strong effects on ecosystem functioning and provision of ecosystem services, which must be communicated to those charged with economic and policy decision-making to avoid ineffective and costly management actions (Hooper et al. 2005).

However, researchers have identified the need for consideration of ecological complexities in study designs for better determining true levels of biodiversity and their roles within ecosystems, including factors such as resource partitioning, indirect and additive effects (including IGP and MPR), multiple effects, social stability of packs of socially complex top predators, and multi-trophic systems. Studies must also be upscaled to more realistically represent larger systems, the results of which may then overturn the more general findings of the current studies of simplified systems (Ives et al. 2005, Srivastava and Vellend 2005, Wallach et al. 2009b). More studies are also needed on the sequence of system collapse and replacement of ecosystem services as systems are further degraded (Dobson et al. 2006). The ecological roles of predators in supporting ecosystem biodiversity and functions and providing ecosystem services to humans are substantially unknown.

What Should Be the Role of Top Predators in Conservation Plans?

Predator management is characterized by complex ecological, economic, and social tradeoffs that are often not readily apparent or mutually exclusive, as well as being very expensive. Large carnivore conservation is impeded because much of the habitat is already destroyed or has uses that conflict with predators, they can be perceived to be threatening to human safety, and they kill game species and livestock (Prugh et al. 2009, McShane et al. 2011, Ritchie et al. 2012). Replicating the full suite of influences provided by apex predators is exceptionally challenging if not impossible.

The ability to better predict mesopredator responses to reintroduction or gradual recolonization of apex predators would enhance effectiveness of management efforts. The daunting task of conservation of top predators requires substantial habitat restoration, greater public acceptance of large carnivores, and compromises among people most directly affected by these predators (Prugh et al. 2009). Also, little is known about the impact of trophic interactions, particularly predator-prey and predator-predator interactions on the relationship of biodiversity and ecosystem functioning in natural systems. Increasing predator diversity could promote trophic cascades if predator species act additively or hide trophic cascades if IGP is likely to occur in diverse predator assemblages (Finke and Denno 2005).

Because top predators need lots of room, have symbolic value, and can structure ecosystems under certain circumstances, they have the potential to gain public support for conservation programs to achieve higher scale conservation goals to restore degraded ecosystems. Large scale conservation should not be confused with the ecological roles and importance of apex predators to conservation. In areas where top predators were extirpated but the system was protected, such as in national parks, top predators may be effective in improving biodiversity and ecosystem function.

In areas with high levels of human-caused habitat change, development, and relatively unlimited prey (large populations of deer), gradual recolonization by top predators, such as by wolves in the northern Midwestern US, often increase the potential for conflicts with humans. The ability of top predators to reach a threshold density to play an ecological role for conservation may be limited by population reductions in response to human conflicts, including in areas surrounding reserves. The conservation goal must focus on reaching population levels and distribution of top predators that the threshold for creating ecological structure is reached and sustained (Ray et al. 2005a, Letnic et al. 2011, Ripple et al. 2013).

The best chances for using top predators for conservation purposes is where the extirpation of predators has been clearly shown to result in adverse ecosystem impacts and where the system has not been degraded by other factors. In terrestrial systems, where habitat conversion has created so many changes to biodiversity, the return of top predators may require long periods of time to reach conservation objectives, if recovery can be achieved at all (Ray et al. 2005a).

The precautionary principle when designing conservation plans is important, shifting the burden of proof to those who discount the ecological role of predation, because thresholds of change may result in large and sudden phase shifts that may be impossible to reverse (Ray et al. 2005a, Estes et al. 2011).

The most important questions regarding conservation of large predators, biodiversity, and ecosystem function remain unanswered:

1. In what locations and under what conditions to large carnivores play an ecologically significant role?
2. In what locations and under what conditions would restoration of large carnivores result in restoration of biodiversity?
3. What densities of large carnivores are necessary to produce the desired restoration of biodiversity?
4. What are the interactions between hunting by carnivores and hunting by humans? (Ray et al. 2005a).

11 What are the Challenges Associated with Interpreting and Applying the Results from Studies Conducted in Different Ecosystems?

Regardless of the context, Litvaitis and Villafuerte (1996) warn researchers not to confuse declines in apex predators and changes in lower trophic level species abundance as a cause-and-effect relationship, as both are likely a response to human activity, including collisions with vehicles, legal and illegal take, habitat fragmentation, development, and/or human subsidies. Interpretations of results must look for factors beyond those naturally occurring in the study area.

A primary challenge to testing the presence and strength of a trophic cascade involves removing predators from systems in which they are abundant or adding them to systems where they are absent, creating an intended perturbation that can be tested statistically (Estes et al. 2011, Ripple et al. 2016). With large free-ranging carnivores, intended removal of predators as part of a study is typically socially, ethically, and politically challenging or impossible (Ray et al. 2005a, Estes et al. 2011). Therefore, many studies rely on areas in which large apex predators were extirpated and either reintroduced or rapidly recolonized the area, while the original conditions remain substantially the same, such as in older national parks, including Yellowstone National Park, Zion NP, and Banff NP (e.g., Hebblewhite et al. 2005, Ripple and Beschta 2006a, Berger et al. 2008, Estes et al. 2011, Beschta and Ripple 2012, Ripple et al. 2015).

Another challenge involved with conducting studies that provide statistically-strong results involves the temporal scale of the study, which must be of sufficient duration to incorporate the generation times of the component species, especially plants. While predator impacts have been observed over weeks and months in lakes, streams, and nearshore marine systems, decades or even centuries may be required for terrestrial systems where the base autotrophs may be shrubs or trees (Duffy 2003, Schmitz et al. 2004, Briggs and Borer 2005, Ripple et al. 2016, Engeman et al. 2017).

11.1 Relevant Publications Outlining Challenges

Ecosystems are more complex than first thought: Pace et al. (1999) suggested that cascades are more likely to be non-linear and food webs to be probabilistic due to highly variable conditions that promote and inhibit the transmission of the effects of predators on food webs (called trophic dynamics), including complicating and confounding factors such as differences in inherent primary productivity (the nutrition provided by the plant communities), adaptive predator-avoidance behavior, the potential for ecological compensation, and the availability of anti-predator refugia for prey. In other words, researchers began to understand that ecological interrelationships among biotic and abiotic components of ecosystems had blurred what had appeared to be clear boundaries and interconnections.

Top-down effects appear to dissipate faster on terrestrial ecosystems than in freshwater ecosystems: Polis et al. (2000) suggest that this may be the result of aquatic systems better fitting the simplifying assumptions of trophic cascade models (such as incorporating discrete homogeneous environments and short regeneration periods for predators, and simple and trophically-stratified systems with strong and clearly identifiable interactions among species). They also suggest that most terrestrial systems are more complex and heterogeneous, with fuzzy boundaries between trophic levels, having variable prey and predator dynamics, and weak and diffuse interactions between species (except in human-designed agricultural systems). Species that have greater defenses against predation or herbivory tend to become dominant, weakening the link between predators and prey. The authors argue that, even at the species level, support for the presence of trophic cascades is limited in terrestrial systems (also, Halaj and Wise 2001). Conclusions about the strength of top-down effects may be an artifact of the plant-response being measured, not a response that actually exists in the environment. Schmitz et al. (2004), based on a meta-analysis, reports that a conclusion that a cascading effect may be weak or non-existent or existent and strong may be an artifact of the was the species in a system are categorized and aggregated by the researcher (for example, whether a species is a mesopredator or an apex predator, or which predator species feeds on which prey species), and the conclusion may be dependent on the system topology as conceptualized for the specific web.

Certain ecological dynamics that occur in terrestrial ecosystems may not occur in aquatic ecosystems: The additions of the concepts of IGP (Section 8.1) and mesopredator release (MPR; Section 8.2), in addition to non-consumptive factors such as adaptive anti-predator behavior and beneficial foraging behavior (Section 9) in the face of differing predation risk based on the type of predator hunting behavior (“coursing” compared to “sit-and-wait”), further complicate the concept of trophic cascades in heterogeneric terrestrial ecosystems with socially complex and wide-ranging predators and prey (Ripple et al. 2016).

Some effects, though appearing in both ecosystems, may be weaker in terrestrial ecosystems: A meta-analysis of research papers conducted by Halaj and Wise (2001) related to terrestrial arthropod-dominated food webs found extensive support for the presence of trophic cascades in terrestrial communities, but that the effects on biomass of primary producers are weaker in terrestrial communities than in aquatic food webs. A meta-analysis of 102 scientific publications across different types of ecosystems (lakes/ponds, marine, stream, lentic and marine plankton, and terrestrial agricultural and old fields) conducted by Shurin et al. (2005) reported high variability among ecological systems, and that predator effects were apparently strongest in benthic communities in lakes, ponds and marine ecosystems, and weakest in marine plankton and terrestrial food webs (also Borer et al. 2005). The complexity of terrestrial food webs within which large wide-ranging and adaptable carnivores are at the top of the web may further weaken the statistically observable presence of predator-driven effects (Halaj and Wise 2001).

Tradeoff behavior may be specific to the type of ecosystem and may contribute to the variability in the nature and strength of cascading effects: Schmitz et al. (2004) conducted a meta-analysis of 41 studies conducted in aquatic and terrestrial ecosystems that indicated that one mechanism addressing the uncertainty about the ultimate mechanisms driving trophic cascades may be the trade-off behavior associated with prey avoiding the risk of predation while also attempting to forage optimally. Knowing the habitat and resource use by prey with regard to the presence of one or more predators, and the hunting mode of the predator (“coursing/patrolling” compared to “sit-and-wait”) may help explain the considerable variability on the nature and strength of cascading effects among systems. Different hunting modes force prey to balance the energetic effects of reacting through vigilance, ceasing foraging and moving away, or exhibiting aggression. Prey responding to active, coursing predators may be the least risk averse, determining that foraging is more important than maintaining constant vigilance, especially later in the winter, when fitness is inherently reduced. Different predators apply different rules of engagement based on hunting mode and habitat use, which then drive adaptive behavioral responses and associated trophic effects (Schmitz et al. 2004, Peckarsky et al. 2008).

Studies may study small subsets of communities for short periods of time, making interpreting results difficult. Borer et al. (2005) conducted a meta-analysis of 114 studies in terrestrial agricultural and grassland/shrub ecosystems mainly involving arthropods, lake, marine, and stream benthic communities. Of all the studies reviewed, only the marine benthic and grassland studies involved warm-blooded predators, and only one included a warm-blooded herbivore. The authors found evidence that the strongest cascades involved warm-blooded vertebrates (otters and humans), but these communities were primarily in marine environments. However, the authors reported that most studies only evaluate interactions within a small subset of a community, potentially resulting in too little variability in the species manipulated to detect relationships between diversity and the strength of cascades. Most studies were also of insufficient duration and study area size to actually detect ecological impacts that could be suggested to be different from inherent natural variability.

11.2 Challenges to Conducting and Interpreting Research and Modeling on Complex and Dynamic Ecological Systems

Many researchers and theoretical ecologists have identified the challenges associated with attempting to study and reach conclusions about very complex and interrelated systems. Ray et al. (2005a) finds that determining the ecological effects of large carnivores on the biodiversity, structure, function, and dynamics of ecological systems and any associated ecosystem services may be highly challenging or even impossible to discern. Reasons provided by various researchers include:

It is difficult to design suitable experiments with spatial and temporal dimensions that are appropriate for the species, populations, communities, and systems involved. This is especially difficult for large carnivore species that are wide-ranging and socially and behaviorally complex, and that use large heterogeneous integrated habitats that may change seasonally (Ray et al. 2005a, Ripple and Beschta 2006a, Vance-Chalcraft et al. 2007, Engeman et al. 2017).

Determining change in systems requires that perturbations be created and the results tested, with replications, which may be socially, morally, ethically, and politically impossible with systems involving large carnivores (Ray et al. 2005a, Estes et al. 2011).

Baselines on which to compare changes to determine causal relationships are often already damaged or eliminated, with no remaining or known natural benchmarks against which to measure effects, restricting the ability to discern short-term and long-term equilibrium states with and without predators (Ray et al. 2005a, Kozlowski et al. 2008, Estes et al. 2011).

Finding matched comparison study areas that are sufficiently similar over large spatial areas and over a sufficiently large temporal duration may be difficult and costly at best, and realistically impossible (Ray et al. 2005a).

The existence of many confounding factors can make strong predictions about effects and causation impossible, including abiotic factors such as climate change; weather; differences in site and area productivity; naturally occurring environmental oscillations and “noise”; soil mineralization; and surface and subsurface hydrological dynamics (e.g., Ray et al. 2005a, Ripple and Beschta 2006a, Kauffman et al. 2010, Orrock et al. 2010, Miller et al. 2012, Ripple et al. 2013, Allen et al. 2014, Engeman et al. 2017).

Human impacts are often discounted or are considered tangentially, despite their often dominant and pervasive influence (Vitousek et al. 1997, Estes et al. 2011), and can confound the ability to experimentally discern functional roles of predators, such as: human actions that have historical caused extirpations or extinctions; habitat fragmentation, especially by development and agriculture; introduction of livestock and/or exotic and invasive species into systems; hunting, poaching, persecution, and roadkill; human intolerance, especially of larger predators; human competition for prey of predators; depletion of prey needed by predators; providing food and structural subsidies; creating predator guilds made up of free-ranging carnivorous pets (cats and dogs) that are subsidized, are recreational killers, and often live in developments bordering large fragmented habitats with already stressed prey populations; and large-scale resource exploitation (e.g., Litvaitis and Villafuerte 1996, Palomares et al. 1996, Fedriani et al. 2001, Ray et al. 2005a, Estes et al. 2011, Fischer et al. 2012, Allen et al. 2017, Haswell et al. 2017).

Some potentially strong and important correlations related to non-consumptive factors that are in the same statistical direction as commonly recognized correlations may be masked and not considered in interpretation of study results (Peckarsky et al. 2008).

Valid comparisons of studies evaluated in meta-analyses of multiple studies (where researchers review and reconsider the results of many studies to look for patterns and problems) have been difficult to make because of differences in spatial and/or temporal scale, differences in factors measured, differences in statistical methods and assumptions, and differences in study methodologies, among other reasons (Briggs and Borer 2005, Hooper et al. 2005, Vance-Chalcraft et al. 2007, Brashares et al. 2010).

Most models are oversimplifications of natural systems, and do not include complexities such as anti-predator behavior, more multi-trophic community models, and richer webs of interacting species across heterogeneous landscapes (e.g., Holt and Huxel 2007).

Much of the research related to trophic cascades is often conducted at a small scale and is of short duration in relation to the inherent biological characteristics of the species, communities, and populations (such as reproduction, immigration, generational turnover, or developing ecologically meaningful changes in abundance), and on species that are small, sessile, or localized and easily manipulated (adding or removing individual predator species or guilds), such as invertebrates, arthropods, localized fish populations, and plankton, and are typically in high productivity systems such as streams, lakes, and marine intertidal ecosystems (e.g., Duffy 2003, Schmitz et al. 2004, Briggs and Borer 2005, Ray et al. 2005a, Beschta and Ripple 2006, Brashares et al. 2010, Estes et al. 2011, Ritchie et al. 2012).

Research conducted in small temporal and/or geographic scales is difficult or inappropriate to scale up or apply generally to large marine or terrestrial systems, especially for guilds involving wide-ranging, often socially complex predators (for example, bluefin tuna (*Thunnus thunnus*), sharks, wolves, dingoes, or coyotes) (e.g., Schmitz et al. 2004, Ripple and Beschta 2006a, Brashares et al. 2010, Engeman et al. 2017).

Research in various systems is being published so rapidly in the last 20 years that it is difficult for researchers to be aware, let alone familiar with, that level of new research results ("information avalanche"), especially if the research is conducted on systems outside of their own disciplinary area (Sergio et al. 2014).

Statistical analyses, assumptions, and interpretations of results are often appropriately re-evaluated and challenged by other researchers, yet the original papers are cited by other researchers without recognizing these challenges (e.g., Litvaitis and Villafuerte 1996, Palomares et al. 1996, Hooper et al. 2005, Balvanera et al. 2006, Ripple and Beschta 2006a;2007, Kauffman et al. 2010, Wielgus and Peebles 2014, Painter et al. 2015, Poudyal et al. 2016).

The role of outbreaks of parasites and pathogens in ecosystem function is often ignored, although they may be strong mediators of trophic competition and, in some systems, keystone species for driving ecological structure and/or function through acting as a small biomass predator on other larger predatory species within the food web (for example, canine parvovirus in wolves on Isle Royale) (e.g., Ray et al. 2005a).

Several studies identify that predator population must reach a certain threshold level at which they become ecologically effective at creating trophic and ecosystem changes, but no one is attempting to determine the threshold level and its effect on humans and livestock (Ray et al. 2005a, Estes et al. 2011, Letnic et al. 2011, Ripple et al. 2013).

Researchers even disagree on the appropriate definitions of and factors involved in ecological functions, trophic cascades, and intraguild predation causing miscommunication among researchers, sampling of inappropriate factors, and misinterpretation of and challenges to cited correlations (Ray et al. 2005a, Ripple et al. 2016).

Poor population sampling to reflect true presence/absence and abundance, resulting in misinterpretations of results, and differences in sampling protocols among studies, making comparisons difficult (e.g., Vance-Chalcraft et al. 2007, Wallach et al. 2009a, Allen et al. 2014).

Publication bias, where only positive results are published, may result in important information being withheld that could provide insight into the findings of other studies (Polis et al. 2000, Brashares et al. 2010).

Not considering adaptive behavior for predator avoidance (for example, changing circadian patterns of activity or habitats used or climbing trees) or increasing predator efficiencies (for example, scavenging), and morphological and biological traits (such as toxic chemicals used by brightly patterned skunks) (e.g., Schmitz et al. 2004, Peckarsky et al. 2008, Berger-Tal et al. 2011).

Many papers repeatedly use the same few examples of trophic cascades, such as studies conducted in Yellowstone NP, Isle Royale, orca-otters-urchins-kelp (e.g., Ray et al. 2005a, Peckarsky et al. 2008, Estes et al. 2011, Allen et al. 2014, Allen et al. 2017).

Confusing the roles of, failing to consider, or making inappropriate interpretations of immigration and emigration to account for changes in consumer, competitor or prey abundance; the levels and rates of immigration is very difficult to measure (e.g., Duffy 2003, Briggs and Borer 2005, Ray et al. 2005a).

Few studies have attempted to evaluate or quantify the short term and long terms costs of loss of apex predators and mesopredator release (Brashares et al. 2010).

Confusing and misinterpreting the trophic level and functions that a particular predator plays in a specific food web that may poorly reflect on actual roles in nature (Polis et al. 1989, Ray et al. 2005a, Ripple et al. 2016).

The differences in studying large carnivore-driven system structure and function in relatively unchanging and protected areas in which they were previously extirpated and rapidly reintroduced for management purposes (for example, wolves in Yellowstone National Park), areas in which large carnivores gradually immigrated that are dynamic and largely impacted by humans (for example, wolves in Wisconsin and Minnesota immigrating into areas with high levels of habitat fragmentation and human and livestock densities), urban areas with high levels of human-provided subsidies and habitats, human persecution, intense levels of habitat fragmentation, and/or high levels of subsidized carnivorous pets exist, and neotropical islands (e.g., Ripple and Beschta 2007, Berger et al. 2008, Beschta and Ripple 2012, Fischer et al. 2012, Newsome et al. 2015b).

The repeated citation of a few studies as examples throughout the literature, some of which have been challenged regarding validity of interpretations of results or factors considered (Peckarsky et al. 2008, Prugh et al. 2009, Allen et al. 2017).

Consideration of whether ecological change to system structure and function occur in a smooth dynamic way or reach thresholds at which major, and possibly irreversible, shifts and perturbations occur (e.g., Ray et al. 2005a, Estes et al. 2011, Ripple et al. 2016).

12 What Relevant Commonly Cited Articles Are Not Included in Summary Because of Study Discrepancies?

Several commonly cited papers in support of the occurrence of trophic cascades in terrestrial systems have serious discrepancies that create problems with the use of their results.

Clark (1972): This early study collected field data on coyote densities, food habits, fecundity, and population growth in relation to prey densities. Documented limitations of the study included inconsistent time spent looking for dens between year, and small sample sizes for the size of the breeding female cohort and litter sizes. Despite these methodology weaknesses, this paper is often cited for its conclusion that long term coyote densities in the Great Basin of Utah appeared to be partly a function of food base, in this case jackrabbits. The study suggests that coyotes did not control jackrabbit populations.

Henke and Bryant (1999): This study conducted in Texas involved heavy removal of coyotes with between 26 and 55 coyotes removed every third month between 1990 and 1992, reducing coyote density from approximately 0.12 coyotes/km^2 to 0.001 coyotes/km^2 (coyote density on untreated control area was 0.14 coyotes/km^2). In addition to such heavy and chronic removals, the authors suggest caution should be used in interpreting the results reported of a substantial decrease in rodent prey richness within nine months of coyote removals. A drought occurred in 1989 through 1990, which decreased forage and may have facilitated dominance of the highly competitive Ord’s kangaroo rat over other species present before treatment began. Also, the authors state that logistical and financial constraints limited the number of replications performed, resulting in a low statistical power associated with the results. However, they state that the “weight of evidence” suggested that coyotes exerted top-down influence on the prey community with only weak empirical evidence. The authors also stated that, to consistently lower coyote densities, an annual removal rate of at least 75% is needed.

Mezquida et al. (2006): This paper discusses a potential negative effect of coyote control on sage grouse conservation through release of mesopredators (foxes, badgers, and ravens) that prey on sage grouse and eggs, depending heavily on Henke and Bryant (1999) and an internal unpublished report prepared by the wildlife biologist at a large private ranch in Utah (Danvir 2002). Rather than coyote predation being either directly or indirectly involved in adversely or positively affecting sage grouse, Danvir (2002) actually places the primary concern with heavy jackrabbit browsing in sagebrush habitat. Golden eagles, another predator of sage grouse, and coyote abundance seemingly increased in response to variability of jackrabbits and ground squirrels. His final conclusion is that he did not consider predator-prey interactions to be the cause of the increase in sage grouse, instead emphasizing the habitat manipulations that had been performed on the ranch to benefit sage grouse was the primary factor. Danvir (2002) suggests that weather drives sage grouse population dynamics relating to vulnerability to predators, especially in winters with deep snow and during spring nesting season, and that the way sagebrush steppe ecosystems are managed related to the quality of sage grouse habitat can magnify or minimize the effects of severe droughts, severe winters, and predation.

Atwood and Gese (2008): In Yellowstone NP after wolf reintroduction, socially dominant coyotes (alpha and beta) responded to wolf presence by increasing the proportion of time spent vigilant while scavenging, with alphas more diligent than betas. Alphas fed first on carcasses, then betas, then others. Increased vigilance, reduced foraging time, changes in group size and configuration, pre-emptive aggression, and retreat to refugia are crucial behaviors to mediating interspecific interactions. Coyotes would aggressively confront wolves, with numerical advantage by coyotes and the stage of carcass consumption influencing whether coyotes were able to displace wolves. In confrontation bouts that coyotes won, both alpha coyotes were present, there were more coyotes than wolves, and wolves were not very invested in winning. These observations are on one wolf pack and should not be generalized to coyote-wolf interactions at a broader scale without further study.

Miller et al. (2012): This paper suggested that coyotes avoided a wolf den, and that coyote predation on rodents away from the wolf den indicated a top-down effect by wolves on coyotes and subsequently on rodents, claiming that restoration of wolves could be a powerful tool for regulating predation at lower trophic levels. The authors argue that making comparisons over time as wolf numbers increase, especially when coupled with spatial comparisons in the study area, can provide evidence that the changes are due to the treatment, and not another confounding factor. These conclusions are based on studying coyote interactions with one wolf den in Grand Teton NP, which is not a sufficient sample size for making conclusions with any correlational strength.

Allen et al. (2014): In Australia, three particular published case studies are commonly cited in support of the mesopredator release theory. Problems exist in each study, including use of circumstantial evidence for MPR of introduced red fox or feral cat coinciding with dingo control. The authors conclude that an absence of reliable evidence that top predator control induced MPR. In the last 10 years, 22 literature reviews and extended opinion pieces were published. Only three of the 22 discussed caveats or methodological limitations of these three case studies, while other call them anecdotal or circumstantial. Pettigrew (1993) concluded that shooting dingoes increased abundance of feral cats. Abundance sampling was imprecise (800 cats removed from trees, but only 229 observed in sampling surveys), and large bursts of cat abundance occurred in years following rainfall-induced increases in prey availability. Cats shot were prime adults, indicating a large-scale immigration of nonresident cats rather than increased rapid reproduction. Lundi-Jenkins et al. (1993) stated that dingo control resulted in fox detection and extinction of a protected species after dingo control. The study was small scale and the experimental design insufficient for inferring changes in predator population abundance. To suggest that lethal dingo control caused a MPR of foxes from a single opportunistic observation of fox tracks is to extend inferences far beyond the limitations of the data. To infer from the data that dingo control caused the local extinction of the protected species does not recognize the persistence of a nearby colony that did not go extinct in response to baiting but was destroyed by wildfire. Christensen and Burrows (1995) stated that dingo and fox poisoning resulting in an increase in feral cat abundance. The experimental design (imprecise sampling of predator populations) precludes reliable inference because increases in cat abundance coincided with the beginning of 1080 baiting (which does not target cats) after cessation of cyanide baiting (which targets cats, dingoes, and foxes), substantial rainfall events increasing prey densities, and a change in the physical location of the unbaited treatment area, all confounding the results.

The three case studies provide no reliable evidence of MPR because of little reliable evidence that dingo populations were affected by the control to any substantial degree, limitations to the experimental designs and predator sampling methods meant that the studies were incapable of reliably evaluating predator responses to dingo control, and MPR remains only one of several plausible explanations for the observations. Although broad patterns among top predator, mesopredators, and their prey have been demonstrated in some contexts and there are good reasons to suspect that these processes also occur for dingoes, MPR cannot be reliably separated from other equally plausible alternative explanations for the suggested interrelationships among dingoes, foxes, and cats. The authors advocate for evidence-based wildlife management approaches that do not unduly risk valuable environmental and economic resources, such as threatened species and livestock.

13 Literature Cited

Allen, B. L., L. R. Allen, H. Andrén, G. Ballard, L. Boitani, R. M. Engeman, P. J. S. Fleming, A. T. Ford, P.
M. Haswell, R. Kowalczyk, J. D. C. Linnell, D. L. Mech, and D. M. Parker. 2017. Can we save large carnivores without losing large carnivore science? Food Webs. 12: 64-75.

Allen, B. L., L. R. Allen, R. M. Engeman, and L. K.-P. Leung. 2013. Intraguild relationships between sympatric predators exposed to lethal control: Predator manipulation experiments. Frontiers in Zoology. 10(39): 1-18.

Allen, B. L., A. Fawcett, A. Anker, R. M. Engeman, S. Lisle, and L. K. P. Leung. 2018. Environmental effects are stronger than human effects on mammalian predator-prey relationships in arid Australian ecosystems. Science of the Total Environment. 610-611: 451-461.

Allen, B. L., G. Lundie-Jenkins, N. D. Burrows, R. M. Engeman, and P. Fleming. 2014. Does lethal control of top-predators release mesopredators? A re-evaluation of three Australian case studies. Ecological Management & Restoration. 15(3): 191-195.

Arim, M., and P. Marquet. 2004. Intraguild predation: A widespread interaction related to species biology. Ecology Letters. 7: 557-564.

Arjo, W. M., D. H. Pletscher, and R. R. Ream. 2002. Dietary overlap between wolves and coyotes in northwestern Montana. Journal of Mammalogy. 83(3): 754-766.

Atwood, T. C., and E. M. Gese. 2008. Coyotes and recolonizing wolves: Social rank mediates risk-conditional behaviour at ungulate carcasses. Animal Behavior. 75: 753-762.

Atwood, T. C., E. M. Gese, and K. E. Kunkel. 2007. Comparative patterns of predation by cougars and recolonizing wolves in Montana's Madison Range. Journal of Wildlife Management. 71(4): 1098-1106.

Australian Bureau of Statistics. 2013. Statistical language: Correlation and causation. Australian Bureau of Statistics. 11-28-2017.

Ballard, W. B., L. A. Ayres, P. R. Krausman, D. J. Reed, and S. G. Fancy. 1997. Ecology of wolves in relation to a migratory caribou herd in northwest Alaska. Wildlife Monographs. 135: 45.

Balvanera, P., A. B. Pfisterer, N. Buchmann, J.-S. He, T. Nakashizuka, D. Raffaelli, and B. Schmid. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology Letters. 9(10): 1146-1156.

Benson, J. F., K. M. Loveless, L. Y. Rutledge, and B. R. Patterson. 2017. Ungulate predation and ecological roles of wolves and coyotes in eastern North America. Ecological Applications. 27(3): 718-733.

Berger-Tal, O., T. Polak, Oron A., Y. Lubin, B. P. Kotler, and D. Saltz. 2011. Integrating animal behavior and conservation biology: A conceptual framework. Behavioral Ecology. 236-239

Berger, K. M., and E. M. Gese. 2007. Does interference competition with wolves limit the distribution and abundance of coyotes? Journal of Animal Ecology. 76: 1075-1085.

Berger, K. M., E. M. Gese, and J. Berger. 2008. Indirect effects and traditonal trophic cascades: A test
involving wolves, coyotes and pronghorn. Ecology. 89(3): 818-828.

Bergstrom, D. M., A. Lucieer, K. Kiefer, J. Wasley, L. Belbin, T. K. Pedersen, and S. L. Chown. 2009. Indirect effects of invasive species removal devastate World Heritage Island. Journal of Applied Ecology. 46(1): 73–81.

Beschta, R. L., and W. J. Ripple. 2006. River channel dynamics following extirpation of wolves in northwestern Yellowstone National Park, USA. Earth Surface Processes and Landfroms. 31(12): 1525-1539.

Beschta, R. L., and W. J. Ripple. 2012. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology. 157-158: 88-98.

Bino, G., A. Dolev, D. Yosha, A. Guter, R. King, D. Saltz, and S. Kark. 2010. Abrupt spatial and numerical responses of overabundant foxes to a reduction in anthropogenic resources. Journal of Applied Ecology. 47(6): 1262–1271.

Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The Effectiveness of Selective
Removal of Breeding Coyotes in Reducing Sheep Predation. Journal of Wildlife Management. 66(2): 451-462.

Boertje, R. D., and R. O. Stephenson. 1992. Effects of ungulate availability on wolf reproduction potential in Alaska. Canadian Journal of Zoology. 70: 441-443.

Borer, E. T., J. B. Shurin, C. Blanchette, and S. Cooper. 2005. What determines the strength of a tropic cascade? Ecology. 86(2): 528-537.

Brainerd, S. M., H. Andrén, E. E. Bangs, E. Bradley, J. A. Fontaine, W. Hall, Y. Iliopulos, M. D. Jimenez, E. A. Jozwiak, O. Liberg, C. M. Mack, T. J. Meier, C. C. Niemeyer, H. C. Pederson, H. K. Sand, R. N. Schultz, D. W. Smith, P. Wabakken, and A. P. Wydeven. 2008. The effects of breeder loss on wolves. Journal of Wildlife Management. 72: 89-98.

Brashares, J. S., L. R. Prugh, C. J. Stoner, and C. W. Epps. 2010. Ecological and conservation implications of mesopredator release. 221-240 *in* J. Terborgh, andJ. A. Estes. Trophic Cascades. Island Press, Washington, D.C., USA.

Briggs, C. L., and E. T. Borer. 2005. Why short-term experiments may not allow long-term predictions about intraguild predation. Ecological Applications. 15(4): 1111–1117.

Brook, L. A., C. N. Johnson, and E. G. Ritchie. 2012. Effects of predator control on behaviour of an apex predator and indirect consequences for mesopredator suppression. Journal of Applied Ecology. 49: 1278–1286.

Brooks, J. L., and S. I. Dodson. 1965. Predation, body size and composition of plankton. Science. 150(3692): 28-35.

Brown, D. E., and M. R. Conover. 2011. Effects of large-scale removal of coyotes on pronghorn and mule deer productivity and abundance. Journal of Wildlife Management. 75(4): 876-882.

Callan, R., N. P. Nibbelink, T. P. Rooney, J. E. Wiedenhoeft, and A. P. Wydeven. 2013. Recolonizing wolves trigger a tropic cascade in Wisconsin (USA). Journal of Ecology. 101: 837-845.

Casanovas, J. G., J. Barrull, I. Mate, J. M. Zorrilla, J. Ruiz-Olmo, J. Gosàlbez, and M. Salicrú. 2012. Shaping carnivore communities by predator control: Competitor release revisited. Ecological Research. 27(3): 603–614.

Casula, P., A. Wilby, and M. B. Thomas. 2006. Understanding biodiversity effects on prey in multi-enemy systems. Ecology Letters. 9: 995-1004.

Christensen, P., and N. D. Burrows. 1995. Project Desert Dreaming: The reintroduction of mammals to the Gibson Desert. 199-207 *in* M. Serena. Reintroduction Biology of Australian and New Zealand Fauna. Surrey Beatty and Sons, Sydney, Australia.

Clark, F. W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management. 36(2): 343-356.

Cleland, E. E. 2011. Biodiversity and ecosystem stability. Nature Education Knowledge. 3(10): 1-7.

Cote, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology. 11(2): 395-405.

Courchamp, F., M. Langlais, and G. Sugihara. 1999. Cats protecting birds: Modelling the mesopredator release effect. Journal of Animal Ecology. 68: 282-292.

Creel, S., and J. A. Winnie Jr. 2005. Responses of elk herd size to fine-scale spatial and temporal variation in the risk of predation by wolves. Animal Behavior. 69: 1181-1189.

Crooks, K. R., and M. E. Soule. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Letters to Nature. 400: 563-566.

Danvir, R. E. 2002. Sage grouse ecology and management in morthern Utah sagebrush-steppe. Deseret Land and Livestock Ranch and The Foundation for Quality Resource Management, Woodruff, Utah, USA.

Darwin, C. 1859. On the origin of species by means of natural selection; or, the preservation of favoured races in the struggle for life. 6. John Murray, London, United Kingdom.

Daugherty, M. P., J. P. Harmon, and C. J. Briggs. 2007. Trophic supplements to intraguild predation. Oikos. 116(4): 662–677.

Dobson, A., D. Lodge, J. Alder, G. S. Cumming, J. Keymer, J. McGlade, H. Monney, J. A. Rusak, O. Sala,
V. Wolters, D. Wall, R. Winfree, and M. A. Xenopoulos. 2006. Habitat loss, trophic collapse, and the decline of ecoystem services. Ecology. 87(8): 1915–1924.

Duffy, J. E. 2003. Biodiversity loss, trophic skew and ecosystem functioning. Ecology Letters. 6: 680–687.

Duffy, J. E., B. J. Cardinale, K. E. France, P. B. McIntyre, E. Thebault, and M. Loreau. 2007. The functional role of biodiversity in ecosystems: Incorporating trophic complexity. Ecology Letters. 10: 522–538.

Elbroch, L. M., P. E. Lendrum, J. Newby, H. Quigley, and D. J. Thompson. 2015. Recolonizing wolves influence the realized niche of resident cougars. Zoological Studies. 54(41): 12.

Elmhagen, B., G. Ludwig, S. P. Rushton, P. Helle, and H. Linden. 2010. Top predators, mesopredators and their prey: Interference ecosystems along bioclimatic productivity gradients. Journal of Animal Ecology. 79: 785–794.

Engeman, R. M., L. R. Allen, and B. L. Allen. 2017. Study design concepts for inferring functional roles of mammalian top predators. Food Webs. 12: 56-63.

Estes, J. A., and J. F. Palmisano. 1974. Sea Otters: Their role in structuring nearshore communities. Science. 185(4156): 1058-1060.

Estes, J. A., J. Terborgh, J. S. Brashares, M. E. Power, J. Berger, W. J. Bond, S. R. Carpenter, T. E. Essingtom, R. D. Holt, J. B. C. Jackson, R. J. Marrquis, L. Oksanen, T. Oksanen, R. T. Paine, E. K.
Pikitch, W. J. Ripple, S. A. Sandin, M. Scheffer, T. W. Schoener, J. B. Shurin, A. R. E. Sinclair, M.
E. Soulé, R. Virtanen, and D. A. Wardle. 2011. Trophic downgrading of planet Earth. Science. 333(6040): 301-306.

Estes, J. A., M. T. Tinker, T. M. Williams, and D. F. Doak. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science. 282: 473-475.

Fedriani, J. M., T. K. Fuller, and R. M. Sauvajot. 2001. Does availability of anthropogenic food enhance densities of omnivorous mammals? An example with coyotes in southern California. Ecography. 23(3): 325–331.

Finke, D. L., and R. F. Denno. 2005. Predator diversity and the functioning of ecosystems: The role of intraguild predation in dampening trophic cascades. Ecology Letters,. 8: 1299–1306.

Fischer, J. D., S. H. Cleeton, T. P. Lyons, and J. B. Miller. 2012. Urbanization and the predation paradox: The role of trophic dynamics in structuring vertebrate communities. BioScience. 62(9): 809-818.

France, K. E., and J. E. Duffy. 2006. Diversity and dispersal interactively affect predictability of ecosystem function. Nature. 441: 1139-1143.

Fuller, T. K., L. D. Mech, and J. F. Cochrane. 2003. Wolf population dynamics. 161-191 *in* L. D. Mech,
andL. Boitani. Wolves: Behavior, ecology, and conservation. University of Chicago Press, Chicago, Illinois, USA.

Gehrt, S. D., C. Anchor, and L. A. White. 2009. Home range and landscape use of coyotes in a metropolitan landscape: Conflict or coexistence? Journal of Mammalogy. 90(5): 1045-1057.

Gehrt, S. D., and S. Prange. 2006. Interference competition between coyotes and raccoons: A test of the mesopredator release hypothesis. Behavioral Ecology. 28: 11.

Gese, E. M. 1998. Response of neighboring coyotes (*Canis latrans*) to social distruption in an adjacent pack. Canadian Journal of Zoology. 76(10): 1960-1963.

Gese, E. M. 1999. Threat of predation: Do ungulates behave aggressively towards different members of a coyote pack? Canadian Journal of Zoology. 77: 499-503.

Gese, E. M. 2005. Demographic and spatial responses of coyotes to changes in food and exploitation. *in* Wildlife Damage Management Conference, Traverse City, Michigan, USA. 11:

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996a. Foraging ecology of coyotes (*Canis latrans*): The influence of extrinsic factors and a dominance hierarchy. Canadian Journal of Zoology. 74: 769-783.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996b. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behavior. 52(5): 1025-1043.

Halaj, J., and D. H. Wise. 2001. Terrestrial trophic cascades: How much do they trickle? American Naturalist,. 157(3): 262-281.

Haswell, P. M., J. Kusak, and M. W. Hayward. 2017. Large carnivore impacts are context-dependent. Food Webs. 12: 3-13.

Hebblewhite, M., and D. H. Pletscher. 2002. Effects of elk group size on predation by wolves. Canadian Journal of Zoology. 80(5): 800-809.

Hebblewhite, M., C. A. White, C. G. Nietvelt, J. A. McKenzie, T. E. Hurd, J. M. Fryxell, S. E. Bayley, and P. C. Paquet. 2005. Human activity mediates a trophic cascade caused by wolves. Ecology. 86(8): 2135–2144.

Henke, S. E., and F. C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. Journal of Wildlife Management. 63(4): 1066-1081.

Holt, R. D., and G. R. Huxel. 2007. Alternative prey and the dynamics of intraguild predation: Theoretical perspectives Ecology. 88(11): 2706–2712.

Hooper, D. U., F. S. Chapin III, J. J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J. H. Lawton, D. M. Lodge, M. Loreau, S. Naeem, B. Schmid, H. Setälä, A. J. Symstad, J. Vandermeer, and D. A. Wardle. 2005. Effects of biodiversity on ecosystem fuctioning: A consensus of current knowledge. Ecological Monographs. 75(1): 3-35.

Hrbáček, J., and M. Straškraba. 1966. Horizontal and vertical distribution of temperature, oxygen, pH and water movements in Slapy Reservoir (1958-1960). 7-40 *in* J. Hrbáček. Hydrobiological Studies 1. Academia Publishing House of the Czechoslovak Academy of Sciences, Prague, Czechoslavakia.

Hunter, J., and T. Caro. 2008. Interspecific competition and predation in American carnivore families. Ethology Ecology & Evolution. 20: 295-324.

Ives, A. R., B. J. Cardinale, and W. E. Snyder. 2005. A synthesis of subdisciplines: Predator–prey interactions, and biodiversity and ecosystem functioning. Ecology Letters,. 8: 102–116.

Kamler, J. F., W. B. Ballard, R. L. Gilliland, P. R. Lemons, and K. Mote. 2003. Impacts of coyotes on swift foxes in northwestern Texas. Journal of Wildlife Management. 67(2): 317-323.

Kauffman, M. J., J. F. Brodie, and E. S. Jules. 2010. Are wolves saving Yellowstone's aspen? A landscape-level test of a behaviorally mediated trophic cascade. Ecology. 91(9): 2742–2755.

Kitchen, A. M., E. M. Gese, and E. R. Schauster. 2000. Changes in coyote activity patterns due to reduced exposure to human persecution. Canadian Journal of Zoology. 78: 853-857.

Knowlton, F. F., E. M. Gese, and M. M. Jaeger. 1999. Coyote depredation control: An interface between biology and management. Journal of Range Management. 52(5): 398-412.

Knowlton, F. F., and L. C. Stoddart. 1983. Coyote population mechanics: Another look. *in* Symposium on Natural Regulation of Wildlife Populations, Moscow, Idaho, USA. 83-111.

Kozlowski, A. J., E. M. Gese, and W. M. Arjo. 2008. Niche overlap and resource partitioning between sympatric kit foxes and coyotes in the Great Basin Desert of western Utah. American Midland Naturalist. 160: 191–208.

Kremen, C. 2005. Managing ecosystem services: What do we need to know about their ecology? Ecology Letters. 8: 468–479.

Lendrum, P. E., L. M. Elbroch, H. Quigley, D. J. Thompson, M. Jimenez, and D. Craighead. 2014. Home range characteristics of a subordinate predator: selection for refugia or hunt opportunity? Journal of Zoology. 294(1): 59-67.

Letnic, M., A. Greenville, E. Denny, C. R. Dickman, M. Tischler, C. Gordon, and F. Koch. 2011. Does a top predator suppress the abundance of an invasive mesopredator at a continental scale? Global Ecology and Biogeography. 20: 343–353.

Levi, T., and C. C. Wilmers. 2012. Wolves-coyotes-foxes: A cascade among carnivores. Ecology. 93(4): 921-929.

Litvaitis, J. A., and R. Villafuerte. 1996. Intraguild predation, mesopredator release, and prey stability. Conservation Biology. 10(2): 676-677.

Loreau, M., S. Naeem, P. Inchausti, J. Bengtsson, J. P. Grime, A. Hector, D. U. Hooper, M. A. Huston, D.
Raffaelli, B. Schmid, D. Tilman, and D. A. Wardle. 2001. Biodiversity and ecosystem functioning: Current knowledge and future challenges. Science. 294(5543): 804-808.

Mack, C., J. Rachael, J. Holyan, J. Husseman, M. Lucid, and B. Thomas. 2010. Wolf conservation and management in Idaho: Progress Report 2009. Idaho Department of Fish and Game. Boise, Idaho, USA.

Marshall, K. N., N. T. Hobbs, and D. J. Cooper. 2013. Stream hydrology limits recovery of riparian ecosystems after wolf reintroduction. Proceedings of the Royal Society B. 280(1756): 1-7.

McShane, T. O., P. D. Hirsch, T. C. Trung, A. N. Songorwa, A. Kinzig, B. Monteferri, D. Mutekanga, H. V. Thang, J. L. Dammert, M. Pulgar-Vidal, M. Welch-Devine, J. P. Brosius, P. Coppolillo, and S. O'Connor. 2011. Hard choices: Making trade-offs between biodiversity conservation and human well-being. Biological Conservation. 144(3): 966–972.

Mech, L. D. 1970. The wolf: The ecology and behavior of an endangered species. University of Minnesota Press, Minneapolis, Minnesota, USA.

Mech, L. D., and L. Boitani. 2003. Wolf social ecology. *in* L. D. Mech, andL. Boitani. Wolves: Behavior, ecology and conservation. University of Chicago Press, Chicago, Illinois, USA.

Mezquida, E. T., S. J. Slater, and C. Benkman. 2006. Sage-grouse and indirect interactions: Potential implications of coyote control on sage-grouse populations. Condor. 108(4): 747-759.

Miller, B. J., H. J. Harlow, T. S. Harlow, D. Biggins, and W. J. Ripple. 2012. Trophic cascades linking wolves (*Canis lupus*), coyotes (*Canis latrans*), and small mammals. Canadian Journal of Zoology. 90(1): 70-78.

Moehrenschlager, A., R. List, and D. W. Macdonald. 2007. Escaping intraguild predation: Mexican kit foxes survive while coyotes and golden eagles kill Canadian swift foxes. Journal of Mammalogy. 88(4): 1029–1039.

Nadeau, M. S., C. Mack, J. Holyan, J. Husseman, M. Lucid, D. Spicer, and B. Thomas. 2009. Wolf conservation and management in Idaho: Progress report 2008. Idaho Department of Fish and Game. Boise, Idaho, USA.

Nadeau, M. S., C. Mack, J. Holyan, J. Husseman, M. Lucid, and B. Thomas. 2008. Wolf conservation and management in Idaho: Progress report 2007. Idaho Department of Fish and Game. Boise, Idaho, USA.

Newsome, T. M., J. A. Dellinger, C. R. Pavey, W. J. Ripple, C. R. Shores, A. J. Wirsing, and C. R. Dickman. 2015. The ecological effects of providing resource subsidies to predators. Global Ecology and Biogeography. 24(1): 1-11.

Newsome, T. M., A. C. Greenville, D. Cirovic, C. R. Dickman, C. N. Johnson, M. Krofel, M. Letnic, W. J. Ripple, E. G. Ritchie, S. Stoyanov, and A. J. Wirsing. 2017. Top predators constrain mesopredator distributions. Nature Communications. 23(8): 7.

Orrock, J. L., L. M. Dill, A. Sih, J. H. Grabowski, S. D. Peacor, B. L. Peckarsky, E. L. Preisser, J. R. Vonesh, and E. E. Werner. 2010. Predator effects in predator-free space: The remote effects of predators on prey. Open Ecology Journal. 3: 22-30.

Pace, M. L., J. L. Cole, S. R. Carpenter, and J. F. Kitchell. 1999. Trophic cascades revealed in diverse ecosystems. Tree. 14(12): 483-488.

Paine, R. T. 1980. Food webs: Linkage, interaction, strength and community infrastructure. Journal of Animal Ecology. 49(3): 666-685.

Painter, L. E., R. L. Beschta, E. J. Larsen, and W. J. Ripple. 2015. Recovering aspen follow changing elk dynamics in Yellowstone: Evidence of a trophic cascade? Ecology. 96(1): 252–263.

Palomares, F., M. Delibes, P. Ferreras, and P. Gaona. 1996. Mesopredator release and prey abundance: Reply to litvaitis and villafuerte. Conservation Biology. 10(2): 678-679.

Palomares, F., P. Goana, P. Ferreras, and M. Delibes. 1995. Positive effects on game species of top predators by controlling smaller predator populations: An example with lynx, mongooses, and rabbits. Conservation Biology. 9(2): 295-305.

Paquet, P. C. 1992. Prey use strategies of sympatric wolves and coyotes in Riding Mountain National Park, Manitoba. Journal of Mammalogy. 73(2): 337-343.

Peckarsky, B. L., P. A. Abrams, D. I. Bolnick, L. M. Dill, J. H. Grabowski, B. Luttbeg, J. L. Orrock, S. D. Peacor, E. L. Preisser, O. J. Schmitz, and G. C. Trussell. 2008. Revisiting the classics: Considering nonconsumptive effects in textbook examples of predator-prey interactions. Ecology. 89(9): 2416–2425.

Peterson, R. O., J. D. Woolington, and T. N. Bailey. 1984. Wolves of the Kenai Peninsula, Alaska. Wildlife Monographs. 88: 3-52.

Pettigrew, J. D. 1993. A burst of feral cats in the Diamantina - A lesson for the management of pest species? *in* Cat Management Workshop, 24-33.

Polis, G. A., C. A. Myers, and R. D. Holt. 1989. The ecology and evolution of intraguild predation: Potential competitors that eat each other. Annual Review of Ecology and Systematics. 20: 297-330.

Polis, G. A., A. L. W. Sears, G. R. Huxel, D. R. Strong, and J. Maron. 2000. When is a trophic cascade a
trophic cascade? Tree. 15(11): 473-475.

Poudyal, N., N. Baral, and S. T. Asah. 2016. Wolf lethal control and livestock depredations: Counter-evidence from respecified models. PLoS ONE. 11(2): 1-8.

Prugh, L. R., C. J. Stoner, C. W. Epps, W. T. Bean, W. J. Ripple, A. S. Laliberte, and J. S. Brashares. 2009. Rise of the mesopredator. BioScience. 59(9): 779-791.

Ray, J. C., K. H. Redford, and R. Steneck. 2005a. Conclusion: Is large carnivore conservaiton equivalent to biodiversity conservation and how can we achieve both? 400-507 *in* J. C. Ray, K. H. Redford, R. S. Steneck, andJ. Berger. Large Carnivores and the Conservation of Biodiversity. Inland Press, Washington, D.C., USA.

Ray, J. C., K. H. Redford, R. S. Steneck, and J. Berger. 2005b. Large carnivores and the conservation of biodiversity. Island Press, Washington, D.C., USA.

Ripple, W. J., and R. L. Beschta. 2006. Linking a cougar decline, trophic cascade and catastrophic regime shift in Zion National Park. Biological Conservation. 133: 397-408.

Ripple, W. J., and R. L. Beschta. 2007. Restoring Yellowstone's aspen with wolves. Biological Conservation. 138(3/4): 514-519.

Ripple, W. J., and R. L. Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation. 145(1): 205-213.

Ripple, W. J., R. L. Beschta, J. K. Fortin, and C. T. Robbins. 2015. Wolves trigger a trophic cascade to berries as alternative food for grizzly bears. Journal of Animal Ecology. 84: 652–654.

Ripple, W. J., J. A. Estes, R. L. Beschta, C. C. Wilmers, E. G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M. P. Nelson, O. J. Schmitz, D. W. Smith, A. D. Wallach, and A. J. Wirsing.
2014. Status and ecological effects of the world's largest carnivores. Science. 343(6167): 1241484.

Ripple, W. J., J. A. Estes, O. J. Schmitz, J. L. Motley, V. Constant, M. J. Kaylor, A. Lenz, K. E. Self, D. S. Taylor, and C. Wolfe. 2016. What is a trophic cascade? Tree. 31(11): 842–849.

Ripple, W. J., A. J. Wirsing, R. L. Beschta, and S. W. Buskirk. 2011. Can restoring wolves aid in lynx recovery? Wildlife Society Bulletin. 35(4): 514–518.

Ripple, W. J., A. J. Wirsing, C. C. Wilmers, and M. Letnic. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation. 160: 70-79.

Ritchie, E. G., B. Elmhagen, A. S. Glen, M. Letnic, G. Ludwig, and R. A. McDonald. 2012. Ecosystem restoration with teeth: What role for predators? Trends in Ecology and Evolution. 27(5): 265-271.

Ritchie, E. G., and C. N. Johnson. 2009. Predator interactions, mesopredator release and biodiversity conservation. Ecology Letters. 12(9): 982-998.

Roemer, G. W., M. E. Gompper, and B. Van Valenburg. 2009. The ecological role of the mammalian mesocarnivore. BioScience. 59: 165–173.

Russell, J. C., V. Letcomte, Y. Dumont, and M. Le Corre. 2009. Intraguild predation and mesopredator release effect on long-lived prey. Ecological Modelling. 220: 1098–1104.

Schmitz, O. J., K. Vlastimil, and O. Ofer. 2004. Trophic cascades: The primacy of trait-mediated indirect interactions. Ecology Letters. 7: 153-163.

Schwartz, C. C., J. E. Swensen, and S. D. Miller. 2003. Large carnivores, moose, and humans: A changing paradigm of predator management in the 21st century. ALCES. 39: 41-63.

Sergio, F., O. J. Schmitz, C. J. Krebs, R. D. Holt, M. R. Heithaus, A. J. Wirsing, W. J. Ripple, E. G. Ritchie,
D. Ainley, D. Oro, J. Yadvendradev, F. Hiraldo, and E. Korpimaki. 2014. Towards a cohesive, holistic view of top predation: A definition, synthesis and perspective. Oikos. 123: 1234–1243.

Shurin, J. B., E. T. Borer, E. W. Seabloom, K. Anderson, C. A. Blanchette, B. Broitman, S. D. Cooper, and B. S. Halpern. 2005. A cross-ecosystem comparison of the strength of trophic cascades. Ecology Letters. 5: 785–791.

Silva-Rodriguez, E. A., and K. E. Sieving. 2012. Domestic dogs shape the landscape-scale distribution of a threatened forest ungulate. Biological Conservation. 150: 103-110.

Squires, J. R., N. J. DeCesare, M. Hebblewhite, and J. Berger. 2012. Missing lynx and trophic cascades
in food webs: A reply to Ripple et al. Wildlife Society Bulletin. 36(3): 567-571.

Srivastava, D. S., and M. Vellend. 2005. Biodiversity-ecosystem function research: Is it relevant to conservation? Annual Review of Ecology and Systematics. 36: 267–294.

Stenseth, N. C., W. Falck, O. N. Bjornstad, and C. J. Krebs. 1997. Population regulation in snowshoe hare and Canadian lynx: Asymmetric food web configurations between hare and lynx. Proceeding of National Academy of Science. 94: 5147–5152.

Terborgh, J., K. Feeley, M. Silman, P. Nuňez, and B. Bulukjian. 2006. Vegetation dynamics of predator-free land-bridge islands. Journal of Ecology. 94: 253-263.

Terborgh, J., L. Lopez, P. Nunez, M. Rao, G. Shahabuddin, G. Orihuela, M. Riveros, R. Ascanio, G. H. Adler, T. D. Lambert, and L. Balbas. 2001. Ecological meltdown in predator-free forest fragments. Science. 294: 1923-1926.

Thompson, C. M., and E. M. Gese. 2007. Food webs and intraguild predation: Community interactions of a native mesocarnivore. Ecology. 88(2): 334-346.

Vance-Chalcraft, H. D., J. A. Rosenheim, J. R. Vonesh, C. W. Osenberg, and A. Sih. 2007. The influence
of intraguild predation on prey suppression and prey release: A meta-analysis. Ecology. 88(11): 2689–2696.

Vitousek, P. M., H. A. Mooney, J. Lubchenco, and J. M. Melillo. 1997. Human domination of Earth's ecosystems. Science. 277(5325): 494-499.

Wallach, A. D., B. T. Murray, and A. J. O'Neill. 2009a. Can threatened species survive where the top predator is absent? Biological Conservation. 142: 43-52.

Wallach, A. D., E. G. Ritchie, J. Read, and A. J. O'Neill. 2009b. More than mere numbers: the impact of lethal control on the social stability of a top-order predator. PLoS ONE. 4(9): 1-8.

Wielgus, R. B., and K. A. Peebles. 2014. Effects of wolf mortality on livestock depredations. PLoS ONE. 9(12): 1-9.

Williams, C. L., K. M. Blejwas, J. J. Johnston, and M. M. Jaeger. 2003. Temporal genetic variation in a coyote (*Canis latrans*) population experiencing high turnover. Journal of Mammalogy. 84(1): 177-184.

Wilmers, C. C., R. L. Crabtree, D. S. Smith, K. M. Murphey, and W. M. Getz. 2003. Trophic facilitation by introduced top predators: Grey wolf subsidies to scavengers in Yellowstone National Park. Journal of Animal Ecology. 72: 909-916.

Wilson, R. R., T. L. Blankenship, M. B. Hooten, and J. A. Shivik. 2010. Prey-mediated avoidance of an intraguild predator by its intraguild prey. Oecologia. 164: 921-929.