Guidelines for Mapping Rare Vegetation

CNPS, January 2011

In California, vegetation types are designated as 'rare' or 'special status' by both the California Native Plant Society (CNPS) and the Department of Fish and Game (DFG) based on their degree of imperilment (measured by their rarity, trends, and threats) following NatureServe's Methodology for Assigning Ranks. Vegetation types are listed with a G (global) and S (state) ranks, and those that are S3 and below are designated as rare. When encountering rare vegetation types (or high priority natural community elements), it is important for biologists to identify their existence and to identify any potential impacts to them (see other pertinent information from DFG about addressing high priority vegetation).

These guidelines were prepared by the CNPS Vegetation Program to assist in the development and standardization of rare plant community mapping throughout the state. Mapped vegetation should be classified in accordance with the Manual of California Vegetation (MCV, 2nd edition) and the National Vegetation Classification System (NVCS). These guidelines establish the mapping process in three distinct steps, which are explained in detail below:

1. Compilation of existing data and analysis of distributions,
2. Vegetation mapping using photo interpretation and current CNPS/DFG classifications (i.e., alliance and association level mapping), and
3. Field mapping and sampling.

Vegetation mapping can be either focused or comprehensive, depending on the resources available. In focused mapping, the rare vegetation types of interest are the target for the mapping effort. Potential or known locations are identified, and the target vegetation types are mapped. Focused mapping is useful to inventory a specific vegetation community if resources are limited or if the survey area is large.

Comprehensive mapping results in the identification and mapping of all plant communities in a defined area. Comprehensive mapping is used to prepare vegetation maps that can be used in managing large areas (e.g., areas managed by public agencies, mitigation banks, conservancies), and in inventorying a site when planning for development that would potentially result in disturbance or reduction in vegetation coverage.

The methods used depend on the mapping goals as well as the availability of equipment, labor, and time. Skills needed to successfully conduct accurate vegetation mapping include the ability to identify plants and conduct sampling and the ability to identify and field-map vegetation. Access to ArcGIS is extremely useful, but mapping can be done successfully using Google Earth or other tools.

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1. Compilation of Existing Data and Analysis of Distributions

The first step in mapping vegetation, rare or otherwise, requires identification of the target vegetation type/s, gathering existing information on their current distribution, and determining where they are most likely to occur but are not yet recorded. After determining what and where to map, an approach to mapping can be formulated.

1A. Identify vegetation types that are rare or that are associated with rare elements, including the following:

- Vegetation associations that provide habitat for rare plant and/or animal species
- Vegetation associations or habitats that are rare (i.e., rare natural communities)
    - Vegetation alliances or associations that are statewide rare (i.e., with a state rank of S3 or below, or of special concern and noted as high priority)
    - See additional information from DFG about addressing high priority vegetation
    - Most types of wetland and riparian are considered rare (or special status natural communities) due to their limited distribution and threats. These include desert wash and groundwater-dependent communities.

1B. Determine the general distribution and any known locations of rare vegetation, including vegetation types associated with rare elements. Sources of this information may include:

- The Jepson Online Interchange (ucjeps.berkeley.edu/interchange.html) and Calflora (www.calflora.org)
- CNDDB GIS maps (including species and natural communities layers)
- GAP analysis maps
- County/City/Project level maps
- Local (CNPS, consulting biologist, and other) data and knowledge
- DFG's VegCAMP and CNPS vegetation maps

Existing maps may require processing and/or potential transfer into a digital form (e.g., converting hard-copy maps to Geographic Information System (GIS) by digitizing them, etc.). Other existing maps may already be digitally usable. See http://www.dfg.ca.gov/biogeodata/vegcamp/veg_classification_reports_maps.asp and http://www.dfg.ca.gov/biogeodata/gis/veg.asp for digital maps available online.

1C. Identify areas where rare vegetation types, or those associated with rare elements, are known or likely to occur but where they are not mapped or otherwise recorded. Define mapping needs and approach.

- Identify areas most likely to support the rare vegetation community through analysis of existing maps and survey data.
- Determine mapping/staff/equipment needs based on complexity of mapping area, complexity of vegetation, and partners involved.
- Identify best method(s) for mapping (i.e., aerial photo and/or field mapping) based on the ability to accurately identify both understory or overstory plants from aerial photos versus in the field.

2. Vegetation Mapping Methods through Aerial Photo Interpretation

Mapping by photo interpretation is a useful (and less expensive) precursor to field mapping. It is sometimes done by comparing an existing aerial photo and map of the target vegetation type(s) to an aerial photo of the target mapping area. Depending on the quality of the aerials and the experience of the person mapping, it may be possible to map the vegetation onto the aerial of the target area, by comparing the signatures (colors, patterns and hues) of the vegetation shown on the existing map. Although this section discusses the use of ArcGIS, photo interpretation can also be done using Google Earth, which is easy to access and use. ***Please note:*** some vegetation associations or special features may be too hard to discern on aerial photos (i.e., no distinct signatures are perceptible or acreage of the type is too small to observe on the photos), in which case mapping on the ground must be conducted first.

2A. Acquire existing maps of the target rare vegetation types and/or plant species (using above sources)

2B. Acquire aerial photos and other GIS layers of study area (if mapping in ArcGIS)

- Digital photos/orthophotos for use in GIS
  - 2010 National Agriculture Imagery Program (NAIP) photos from http://gis.ca.gov (1 meter, true color)
  - Regional/local aerial photos (e.g., 1 ft. true color) – depending on availability
- Non-georeferenced photos (hard-copy prints) for map areas (which could be georeferenced later)
- Topography (e.g., digital raster graphs or topographic maps)
- Slope and aspect through Digital Elevation Models (DEMs)
- Geologic, soils, and/or geomorphology data
- Precipitation, temperature, fog and/or humidity data
- Rare species data (e.g., California Natural Diversity Database element occurrences of rare species)
- Other layers/data pertinent to the vegetation mapping area of interest

2C. Map vegetation types (and/or rare species) onto aerial photos

2C-1. Identify known occurrences using

- Documented occurrences from existing maps
- Known occurrences from local/regional experts
- Previously conducted field surveys or reconnaissance to locate occurrences

2C-2. Identify additional potential occurrences by extrapolation

- Identify the color and texture signature of the target vegetation/species
- Utilize the biogeophysical factors that correlate with the target vegetation/species (e.g., hydrology, slope position, aspect, geology or soils, precipitation, disturbance, strongly associated species) using (2B) above and any existing literature.

2C-3. Create an aerial photo interpretation guide (especially when mapping multiple vegetation types)

(Please see for example guides)

- List vegetation mapping units (and codes), including association and alliance names, and higher level groups (or habitat names)
- Document color, shape and texture of photo images distinguishing the rare associations (or plants)
- Identify clear transitions, environmental contexts, barriers, and site history
- Establish vegetation descriptions, including information on vegetation composition/ structure/ species abundance, environmental/ geographic settings, and other notations

2C-4. Delineate vegetation using ArcGIS (or other tools*)

*If GIS technology is not available to you, mapping can also be done using Google Earth. Google Earth is a free virtual globe, map, and geographical information program. Using their "polygon" feature, you can create and save vegetation polygons.

(Please see pages 7 and 8 for examples of delineating vegetation)

- Define the minimum mapping unit (mmu), in which vegetation can be mapped repeatedly (e.g., mmu at ½ acre if using NAIP, or ¼ acre or below if using higher resolution air photos)
- Digitize at consistent scales (e.g., 1:2,000 scale)
- Create point locations and/or delineate polygon areas
- Utilize defining boundaries and barriers between vegetation patches
- Define the separation distance to determine when the vegetation should be split into separate polygons or combined into one polygon. Separation distances are typically defined for:
    - Adjacent patches of the same vegetation type
    - Vegetated vs. non-vegetated breaks (clearing, other urban features, height)
    - Breaks in understory vegetation
    - Breaks in overstory vegetation

  Examples of defined separation distances for creating separate polygons for vegetation stands are a 5-acre mmu for non-floristic and non-cover breaks (e.g., clearing, other urban features, height); a 3-acre mmu for polygon break in understory cover (e.g., grass understory changes in a serpentine chaparral stand); and a 1-acre mmu for polygon break in overstory cover (including herb layer for herbaceous types). Additionally, adjacent patches of the same vegetation that are less than some determined distance away could be included in the same occurrence.

- Attribute data for each polygon or point
    - Vegetation alliance and association name using the CNPS/DFG state classification system

    - Use scientific names and codes as attributes (e.g., 1110 *Quercus durata* alliance and 1111 *Quercus durata - Arctostaphylos glauca* association within the higher level of 1100 Serpentine chaparral group)
  - Percent cover by stratum/layer of vegetation – see below for complete explanation
  - Main indicator species (x 4) – when identifying associations (if possible)
  - Height of overstory vegetation in classes (e.g., 1 = <1m, 2 = 1-5m, 3 = 5-20m, 4 = 20-50m, 5 = >50m)
  - Tree size in classes when trees are >10% cover (size classes for diameter at breast height (dbh) per the California Wildlife Habitat Relationships (CWHR) categories are 1=seedlings 0-1 in., 2=saplings 1-6 in., 3=pole 6-11 in., 4=small 11-24 in., 5=medium to large > 24 in., and 6=multilayered with trees >24 in. dbh over 11-24 in.) – see below for additional details
  - Vegetation condition or site quality (high/medium/low) – which can be assigned as an overall condition, or as specified site impact fields (e.g. intensity of clearing, roads/trails, invasive exotics, or other impacts)
  - Confidence (high/medium/low) in delineation of the vegetation type
  - Notes (particular to that polygon or point)
  - Other polygon features (e.g., polygon ID code, shape/length, shape/area)

Percent cover of vegetation by stratum/layer (using % actual cover or cover classes1[1], whereby the maximum value of trees, shrubs and herbs is equal or less than 100%)

  - Birdseye total cover[2] by all vegetation
  - Percent of birdseye total cover by trees (canopy closure - sum of conifers and hardwoods % cover)
  - Percent of birdseye total cover by conifers
  - Percent of birdseye total cover by hardwoods (and not covered by overstory conifer trees[3])
  - Percent of birdseye total cover by shrubs (and not covered by trees)
  - Percent of birdseye total cover by herbaceous (and not covered by trees or shrubs)

CWHR category attributes	**Conifer crown diameter**	**Hardwood crown diameter**
1 = Seedlings (< 1")	n/a	n/a
2 = Saplings (1-6")	n/a	<15'
3 = Pole (6-11")	<12'	15-29.9'
4 = Small (11-24")	12-24'	30-45'
5 = Medium to Large (> 24")	>24'	>45'
6 = Multi Layered Medium to Large (Canopy trees over smaller trees in Cover/Densities >60%)	Size class 5 trees over a distinct layer of size class 4 or 3 trees. Total tree canopy exceeds 60% closure. Layers must have ≥10.0% canopy cover and distinct height separation)	
0 = Not Determined / Not Applicable	I.e., tree cover is <10% cover	
***used when tree cover is ≥10.0% canopy cover**		

[1] Cover classes can be in increments of 5%'s, 10%'s, or through use of the California Wildlife Habitat Relations (CWHR) cover class values of <2%, 2-9%, 10-24%, 25-59%, 60-100%.
[2] "Birdseye" total cover is apparent vegetation cover visible on an air photo, i.e., cover of overlapping, understory layers covered by overstory layers is not counted, and total cover is no greater than 100%.
[3] This refers to the situation when hardwoods are essentially in the same layer as the conifers or visible outside of the conifer canopy cover. If hardwoods are understory trees beneath a taller conifer canopy >50 % cover, then this attribute is not recorded. Likewise, if any other layer obscures the layer beneath it at >50 % cover, the understory layer cover attribute is not recorded.

3. Field Mapping Methods

Field mapping can be conducted for two purposes: 1) to map vegetation in the field using aerial photographs, and 2) to ground truth and assess the accuracy of any mapping done in the office using the photo-interpretation techniques discussed above.

3A. Identify sites for field mapping (unless conducting ground truthing)

- Utilize aerial photos, existing plant distribution maps, and expert knowledge of plant locations to identify sites
- Obtain knowledge of local CNPS staff, volunteers, consultants, or local land managers who are familiar with the plants/area

3B. Map locations of plant associations using field maps and/or GPS

Once the rare plant association is identified in the field, a field crew should either decide to map a) vegetation stands as *polygons*, or b) map special features, individual plants, or stands as *points*.

Polygons are preferred when mapping rare plant associations or alliances that meet the minimum mapping unit (mmu) designations. *Points* can be created in a separate map for special features (e.g., a small wetland or spring) or for vegetation stands that are below mmu.

If polygons are chosen, the field crew could walk through the stand (from one boundary to the opposite boundary if possible) to characterize the vegetation (see attributes below). The stand can be delineated by either a) walking the perimeter of the stand with a GPS unit (or PDA), or b) delineating the stand directly only an aerial photograph or digital image, or c) creating a single point feature (using a GPS unit or directly placing point onto an aerial photo) that is located near the center of the stand.

Recommended Equipment	
GPS unit (set to UTM and NAD83)	Clipboard
Aerial photograph (digital and/or hard-copy	Compass (with clinometer if possible)
CNPS survey form (see 3C below)	Tape measure (50 m)
Pens and pencils	Range finder (if possible)
Digital camera	Binoculars

3C. Survey the vegetation stand

A CNPS Combined Vegetation Rapid Assessment and Relevé Form (and *CNDDB* species form) should be the basis for data collection. A simple reconnaissance may suffice, although a standardized CNPS form is strongly recommended where surveys may be tied to financial or legal issues. The following data could be collected at each site:

- Date and observer name
- GPS location (using UTM coordinates in datum NAD83)
- Vegetation alliance and association name (using scientific names)
- Vegetation description (standardized and simple) – including phenology, regeneration (saplings/seedlings), site history, and condition information
- % cover of vegetation strata (conifer and hardwood (tree), shrub, and herb layers)
- Indicator species (using scientific names)
- % cover (or cover class) of indicator species
- Size of stand (e.g., classes of <1/2 acre, 1/2-1 acre, 1-2 acres, 2-5 acres, >5 acres)
- Adjacent vegetation (with compass bearing and distance away)
- Site conditions (based on list)

If possible, also record the following:

- Soil type and geologic substrate
- Slope steepness (using a clinometer)
- Aspect (needs compass)
- Hydrology or other apparent environmental correlate
- Ground photos in the four cardinal directions

Note: Minimum numbers of field forms for documenting a rare vegetation type (e.g., types that you are newly proposing as rare) are at least 10 samples for an alliance and 5 for an association.

3D. Ground-truthing to assure accuracy of a comprehensive map

Ground-truthing of the core map attributes for each project area is useful to verify a map's accuracy and value. This is done through a field assessment of all polygons (in small areas with full access) or of a subset of polygons (in large areas with varied access to public and private lands) mapped using a modified version of the Vegetation Rapid Assessment protocol. Projects should independently account for a minimum accuracy of 80% for each type of vegetation mapped, and at a minimum, verify specific types in the field (including rare types and those regionally important types to the user). The assessment could also include cover by layer, overstory height, and tree size of each vegetation type mapped (if feasible).

Additional Protocols/Criteria to Note:

Additional vegetation classification, ranking and mapping standards are summarized by the California Department of Fish and Game's Vegetation Classification and Mapping Program including the following links:
http://www.dfg.ca.gov/biogeodata/vegcamp/natural_comm_background.asp
http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/Final_SB_85_Report.pdf.

Special status natural communities are covered under both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). These acts require disclosure of impacts of proposed projects and to greater or lesser extent may result in mitigation for significant adverse impacts. Wagner (2006)[4] discusses seven instances in which CEQA provisions can be used to address potential adverse impacts of a project to a rare community. These are when projects may affect:

1) Plant communities that support rare, threatened or endangered species (§15065 of the CEQA Guidelines);

2) Plant communities that could be completely eliminated by the project (also §15065 of the CEQA Guidelines);

3) Riparian plant communities [Appendix G of the CEQA Guidelines, sample question IV(b)];

4) Wetland communities [Appendix G, IV(c)];

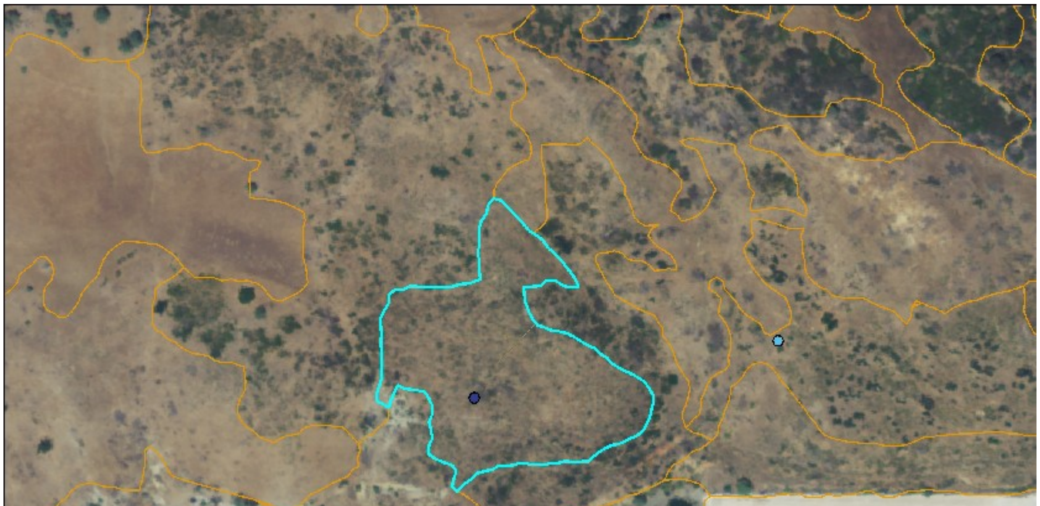
5) Sensitive natural communities that have been identified in local or regional plans or policies [Appendix G, IV(b) and (e)];

6) Sensitive natural communities identified by resources agencies [Appendix G, IV(b)]; and

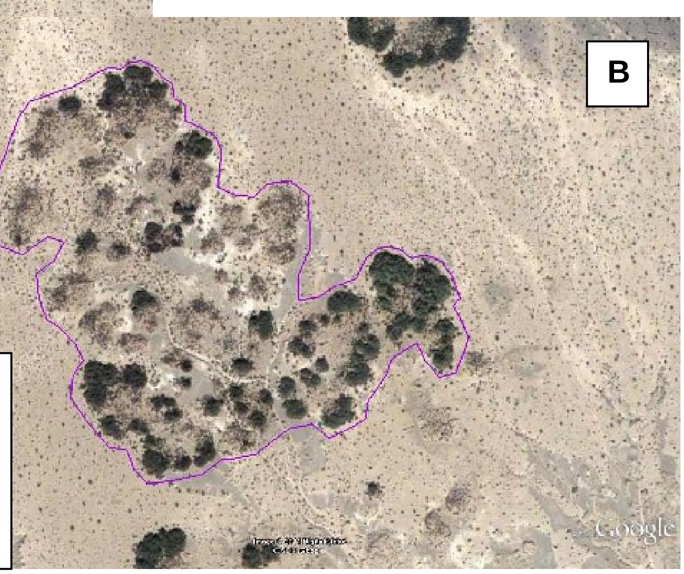
7) Communities for which substantial evidence exists to show they are rare and adverse impacts may be significant.

The California Coastal Act is another regional act that covers the coastal zone and provides even greater protections to rare communities. This act requires that "environmentally sensitive areas" [ESHA's] *shall* be protected against any significant disruption of habitat values; and that adjacent development *shall* be sited and designed to prevent impacts which would significantly degrade ESHAs. ESHAs are defined in Local Coastal Plans or by the Coastal Commission in areas without accepted LCPs.

[4] *Wagner, K.G. 2006. Protecting rare plant communities using the California Environmental Quality Act (CEQA. *Fremontia* 34: 11-15.

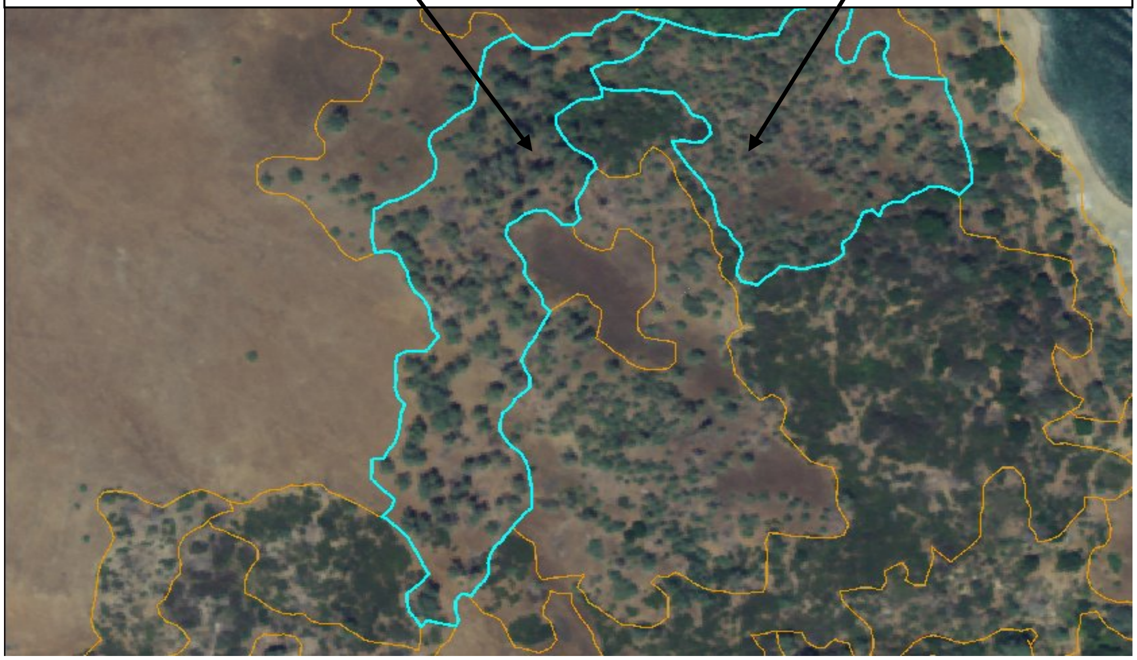


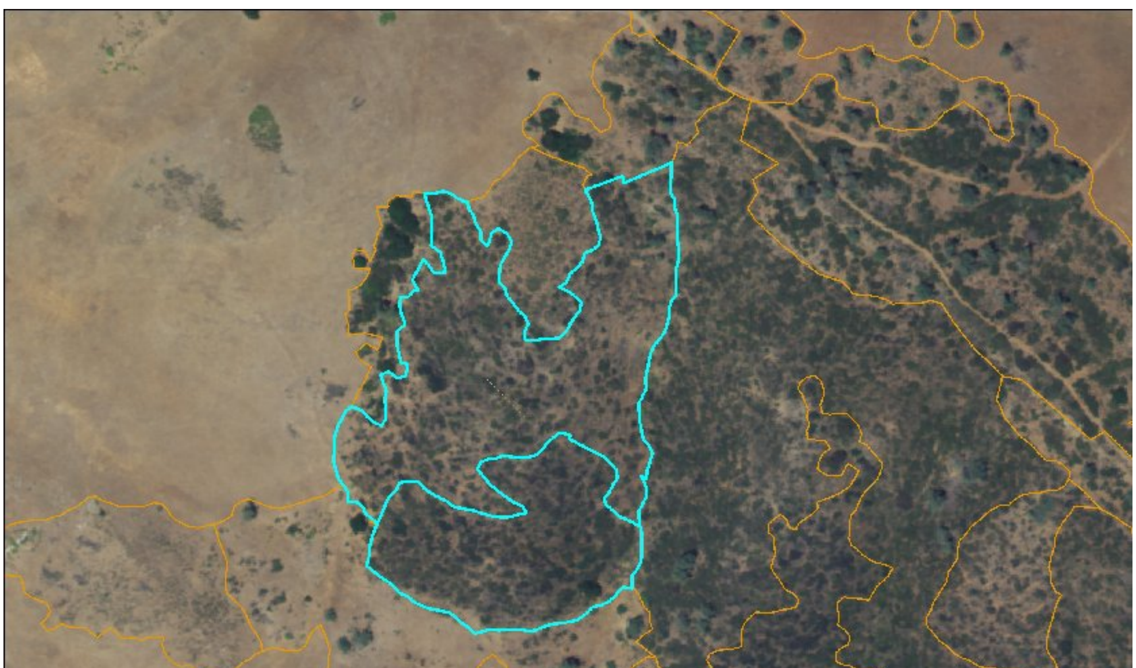
A stand of ***Artemisia californica* shrubland alliance**. This stand was mapped in the field as the rare ***Artemisia californica - Ceanothus ferrisiae - Heteromeles arbutifolia* association**. *Ceanothus ferrisiae* is federally endangered and a California Rare Plant Rank (CRPR) 1B.1 species. This illustrates the need to map to the association level wherever possible. It also highlights the importance of understanding what alliances may harbor rare species and the importance conducting field surveys of these alliances when possible.



An example of mapping vegetation using Google Earth. Image **A** shows creation of a polygon in progress and image **B** the final polygon.

Adjacent stands of ***Pinus sabiniana* alliance** separated by differences in the **tree size** per the California Wildlife Habitat Relationships size categories of medium/large (>24 in. diameter at breast height) versus small (11-24 in. diameter at breast height).





Adjacent stands of the rare ***Quercus durata* alliance** with different **shrub layer cover classes** (20-30% vs 30-40%). Separation is consistent with mapping rules established for the project (5-acre mmu for differences in understory density).