Galbreath Special Status Species Assessment - Methods

This study was conducted as a cross-disciplinary project by Preserve staff and students in the summer and fall of 2010. Students Neal Ramus (Business), Emily Harvey (Biology), Kandis Gilmore (Biology), Linden Schneider (Biology), Christoph Schopfer (Geography), and James Sherwood (Geography) undertook the analyses under the guidance of Preserve Director Claudia Luke and Preserve Coordinator Suzanne DeCoursey. Initial input was provided by faculty Nathan Rank (Biology), Derek Girman (Biology), and Rich Whitkus (Biology).

1.0 Study Area Description

The Study Area was determined by establishing the minimum-bounding rectangle encompassing an approximate 1000-m buffer surrounding the Galbreath Wildlands Preserve and the adjacent California Department of Fish and Game Yorkville Ecological Reserve. Study area easting ranges from 473630.564 – 480864.927; area northing ranges from 4298577.957 – 4307576.927 and lay within four USGS 7.5 minute quads: Ornbaun Valley (536A), Yorkville (535B), Big Foot Mountain (535C), and Gube Mountain (536D).

2.0 Special Status Species with Potential to Occur in the Study Area

2.1 Special Status Species Included: Because the intent of this project is to create an informational resource for long-term management and planning, we were as inclusive as possible in identifying special status species and included species listed by international, federal, state, and non-governmental organizations. We targeted all species that were in some way imperiled (Table 2-1). We did not include species listed as apparently secure. Abbreviations in Table 2-1 are used in resulting documents.

Table 2-1. Categories of special status species included in the target list for the Study Area.

	Source for Listed Species	**Species Not Included**
International		
International Union for Conservation of Nature (IUCN)	IUCN 2010	Least Concern
Federal		
Endangered Species Act (ESA)	CNDDB 2010 a,b	--
Migratory Bird Treaty Act (MBTA)	CNDDB 2010 a,b	--
Bald Eagle Protection Act (BEPA)	CNDDB 2010 a,b	--
US Forest Service (CDF)	CNDDB 2010 a,b	--
US Bureau of Land Management (BLM)	CNDDB 2010 a,b	--

State		
California Endangered Species Act (CESA)	CNDDB 2010 a,b	--
Department of Fish and Game (DFG)	CNDDB 2010 a,b	--
Dept of Forestry and Fire Protection (CalFire)	CNDDB 2010 a,b	--
NatureServe/Natural Heritage Network and California Native Diversity Database (CNDDB)	CNDDB 2010 a,b	G-,N-, or S-Ranks 4,5
Non-Governmental Organizations		
California Native Plant Society	CNPS 2001, CalFlora 2010	List 4
Xerces Society	Xerces 2010, CNDDB 2010a	--

2.2 Identification of Target List: The list of special status species with potential to occur in the Study Area was compiled by searching:

- Species occurrences on-line databases. Because our Study Area overlapped four adjacent 7.5 minute USGS quads (Gube Mountain, Ornbaun Valley, Yorkville, and Big Foot Mountain), we conducted a 16 quad search (i.e., 4 quads containing the Study Area and the 12 adjacent quads). Databases used to search USGS quads were:
    - US Fish and Wildlife Service Species List (updated February 2, 2010)
    - DFG California Native Diversity Database (CNDDB, updated May 4, 2010),
    - CNPS Inventory of Rare and Endangered Plants (7th Edition, April 21, 2010)
    - CalFlora Rare Species (accessed June 14, 2010)

- Special status species lists: We reviewed state and federal lists for special status species with potential to occur in the North Coast region (Table 2-1). Each species was cross-checked with available range maps from a diversity of sources.

Sixty two species were eliminated from the target list because further evaluation indicated no likelihood of occurrence in the Study Area. Reasons for removal from the list fell into five categories:

- Elevation: Species were excluded on elevational grounds were those restricted to the immediate coastline that were not known to occur further inland.
- Specifics of Local Range: We removed species that are not documented as occurring in Mendocino County or northern Sonoma County; are known only from the Inner Coast Ranges; the Study Area occurs in the Outer Coast Ranges which are strongly influenced by marine climate; or are restricted to localized areas of Mendocino County distant from the Study Area (e.g., restricted to Red Mountain). When occurrence records conflicted between CNPS and Calflora, the Jepson

Manual (Hickman 1993) and the Consortium of California Herbaria (CCH 2010) records were used to verify listings.

- Habitat: Species restricted to habitats that do not occur in the Study Area, such as bogs, fens, marshes, and large water bodies, were removed.
- Taxonomic Revision: In some cases, recent taxonomic revision indicated that species occurring within the Study Area are now identified as a separate taxonomic group from the special status taxa.
- Regulatory Specificity: For some species regulatory protection only pertains to certain activities, such as breeding. If a species is not known to breed in the region, the species was removed from the list.

3.0 Likelihood of Occurrence Analysis

A likelihood of occurrence analysis was conducted for 110 special status species. Species listed only in the Migratory Bird Treaty Act (MBTA) and the American Bird Conservatory Watch List (ABC) were not included. The analysis was conducted in three stages:

- compilation of species-specific habitat information
- spatial mapping of species-specific habitat
- likelihood analysis (based on mapping and available biological information, and field observations)

3.1 Compilation of Species-Specific Habitat Information: We conducted a literature search to identify information on about each special status species (description, taxonomy, ecology, conservation concern) and its habitat (aquatic habitat, terrestrial habitat, soils, geology, species association, elevation, etc.). As much as possible, we used on-line resources and databases for the survey. We specifically did not try to recreate the extensive and very useful information available in on-line databases. Instead, information was cut and pasted from these sites with full credit given to the authors and source.

3.2 Spatial Mapping of Species-Specific Habitat: We clipped available spatial data (Table 2-2) to the boundaries of the Study Area and projected in WGS 1984 Zone 10 N (NAD datum 1983).

Table 2-2. Data Sources for Spatial Analysis. Details on manipulations and creation of data layers are included in the text.

Available Data Layers	**Data Source**
Vegetation, Tree Diameter, Canopy Cover	USFS 2007a
Digital Elevation Model (DEM)	USGS du
Soils (Eastern Study Area)	NRCS 1991
Soils (Western Study Area)	NRCS 2001
High Resolution Satellite Imagery	NAIP 2009
Roads	USCB 2010

Parcel Boundaries	Mendocino County du.

Additional data layers were created by gathering field data or manipulating the existing data layers using GPS tracking, aerial imagery interpretation, and some modeling (further described below). New data layers created were: elevation, slope, aspect, riparian woodland/scrub vegetation, redwood vegetation, watercourses (seasonal and perennial), ponds (seasonal and perennial), ridgelines, cliffs, roads, and buildings.

Elevation: We used the USGS DEM to create elevational models of the Study Area which was found to range from 240 m to 774 m. Many plant species are known from only a few occurrences. We added a 30 m buffer to either end of the elevations of documented occurrences when projecting possible elevational distribution in the Study Area.

Slope and Aspect: We used the USGS DEM to create slope and aspect data layers of the Study Area. Slope categories used were default categories using the "Natural Breaks (Jenks)" for slope analysis in ArcMap (Version 9.3.1, ESRI).

Table 2-3. Degrees and percent slope breaks based on natural breaks used in the slope map.

Degrees	Slope
0-7	0-12%
8-13	13-23%
14-17	24-31%
18-22	32-40%
23-25	41-47%
26-29	48-55%
30-32	56-62%
33-37	63-75%
38-54	76-1.38%

Some species are described in the literature as being associated with "gentle", "moderate" or "steep" slopes. In the literature, slope categories are generally defined relative to the process being studied (e.g., construction, erosion, farming, drainage, etc.) and no standard categories exist that identify "gentle," "moderate," or "steep" slopes relative to species needs. Previous studies have categorized gentle slopes as anywhere from 0-15%, moderate slopes from 5-25%, and steep slopes > 10-30% (Cahill 2001, Rutgers 2010, Hasse 2010, Ovuka and Ekbom 2001). For this study, we divided the ArcMap categories into gentle, moderate and steep slope categories as follows:

- flat or very gentle slope – 0 to 7 degrees (0-12%)
- moderate slope – 8 to 17 degrees (13-31%)
- steep slope > 18 degrees (> 32%)

We identify dry and wet slopes as:

- dry slopes – >8 deg slopes facing S, SE, or SW
- wet slopes: > 8 deg slopes facing N, NE, or NW

Vegetation Type: Calveg (USFWS 2007a) provides both Calveg Alliance classifications and California Wildlife Habitat Relationships (WHR) habitat classification. We chose to use Calveg data as the primary vegetation layer because it includes a greater diversity of vegetation types, particularly with regards to dominant hardwood species. Sixteen vegetation types (Table 2-4) are documented to occur in the Study Area. In addition to the Calveg layers we created two additional vegetation layers to enhance accuracy of the assessment:

- Riparian Woodland and Scrub **:** Riparian vegetation along Rancheria Creek is not extensive enough to register in the Calveg layer (minimum mapping unit for Calveg is 2.5 acres). Because some species may be able to use and reproduce in riparian vegetation that occurs in small patches, we estimated a zone of patchy riparian woodland and scrub by placing a 130 meter buffer around the Rancheria Creek polyline feature in the Galbreath Preserve hydrology data layer. Buffer width was determined by identifying a section of Rancheria Creek with little cover and determining the width of Rancheria Creek—including stream, alluvial terraces, and riparian vegetation—at its widest point utilizing high-resolution aerial imagery.
- Redwoods *:* Based in field reconnaissance, redwoods were underestimated in the Calveg data, especially along drainages and north slopes. Potential redwood extent for these areas was estimated by modeling steep-walled drainages: all flat areas (0-7 degrees slope) within 100 m of steep slope (> 30 degrees). Most ridges were removed from the model by only selecting areas below 350 m in elevation. Areas without redwoods in the resulting model were identified by local expert Charlie Hiatt. Generally redwoods are absent from the Preserve south of 38 deg 52 min 0 sec North, and the model was clipped to remove polygons below this latitude.

Vegetation, canopy cover, and tree size are the most common types of information used in descriptions of species habitat. To provide descriptions that would allow these three types of Calveg data to be applied to species habitat descriptions, we cross-walked Calveg vegetation types to CNPS (2010) habitat descriptions (Table 2-4). Open and closed canopy cover are translated to < 40% cover and $\geq$ 40% cover (see section on Canopy Cover for more details). "Large" trees are categorized as > 61 cm DBH (see section on Tree Size for more details).

Note that differentiation between North Coast Coniferous Forest and Lower Montane Coniferous Forest is based on tree density and size. CNPS 2001 describes North Coast Coniferous Forest as conifers occurring in "usually quite dense stands that may attain impressive heights." Similarly, Riparian Forest vs Riparian Woodland and Cismontane Woodland vs Broadleaved Upland Forest: are differentiated based solely upon an "open" or "closed" canopy. For discussion of "open" and "closed" definitions see section on Tree Crown Closure below.

Tree Size: We used WHR categories for Diameter at Breast Height (DBH). Size categories in the Study Area are:

Centimeters	Inches
2.54 – 15.24	1 – 6
15.24 – 27.94	6-11
27.94 – 60.96	11 -24
> 60.96	> 24

Most of the large trees in the Study Area were logged during the last century. Timber harvest plans between 1988 and 2000 indicate that both clear cut and selection cut methods were used to harvest Redwood, Douglas Fir, and hardwoods. Despite a history of logging, some areas still support isolated redwood trees over 4 feet in diameter. The largest DBH category in the WHR data in the Study Area is > 61 cm DBH (24 in). While this category is not large enough to be considered old growth (a DBH of 102 cm (40 in) or more (Giusti 2007)), we mapped this size class as North Coast Coniferous Forest to indicate the best remaining habitat for these species.

Canopy: Single story vs multi-storied canopy were differentiated in available data.

Tree Crown Closure: Calveg defines 10 size classes for canopy cover: 0-9%, 10-19%. 20-29%, 30-39%, 40-49%, 50-59%, 60-69%, 70-79%, 80-89%, 90-100%. Canopy categories relevant to biological processes depends on whether a researcher is examining the abiotic forest environment (e.g. Anderson 1964; Federer and Tanner 1966; Jennings, Brown and Sheil 1999; Reid 1962; Voigt 1960) or biotic response to any number of physical factors (e.g. Strothmann 1967; Skelley at al. 1999; Verner et al. 1980). For example, Anderson and Loucks (1969) find that throughfall precipitation diminishes quickly when canopy closure approaches 85%, while a canopy closure of below 60% allows for near-total throughfall. "Snow water equivalent measurements," on the other hand, show that the highest net snow amounts occur when canopy cover is below 40% (although they decrease when canopy cover is below 25% due to rapid melting) (Veatch et al. 2010).

Canopy effects can also be species specific. Exotic herbaceous species in some forest areas increase dramatically once canopy cover falls to 50% (Charbonneau et al. 2004). Avian responses to canopy closure vary with species, behavior (nesting versus foraging, for example), and other factors (e.g. Anderson and Shugart 1974; Beedy 1981; Saab 1999). For anuran reproductive success, a 25% canopy cover can be "low" and 75% "high" (Skelley et al. 2002).

In most published descriptions of species habitat associations, percent canopy cover of "closed" and "open" canopy are not defined. In these cases, we used the following categories:

- open: 10-39% canopy cover
- closed: $\geq$ 40% canopy cover. If further delineation is indicated, we used:
  - moderately closed: 40-69%
  - fully closed: $\geq$70%

During a one-day field reconnaissance on Preserve lands, we confirmed that canopies < 39% visually appeared "open" and those with > 70% coverage appeared "fully closed."

Canopy Gaps: Some habitat descriptions for special status plants mention "canopy gaps" as a key habitat feature. During a one-day field reconnaissance, we confirmed that canopy gaps as large as 15 square meters were not indicated in the Calveg data. The only canopy gap surrogate available for mapping was that created by roads.

Soils: The Study Area lies at the intersection of two soil surveys (Mendocino County, Western Part [USDA 2006] and Mendocino County, Eastern Part and Southwestern Part of Trinity County [USDA 1991]). We merged the two datalayers and clipped the resulting data to the Study Area. We then created a common attribute table using the data available the two reports (i.e., USDA 2006 and USDA 1991). Characteristics identified in complexes and other mixed types were included in the attribute table if they comprised 20% or more of the overall soil volume. The resulting soils data layer provided the following information on

soil characteristics in the Study Area. Definitions for soils below are from NRCS 2010 unless otherwise noted.

Parent Material: Parent material is the unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of soils is developed by pedogenic processes (SSSA 2008). The six types of parent material in the Study Area are either sedimentary or metamorphic:

Sedimentary

- *Sandstone:* sedimentary rock containing dominantly sand-sized particles.
- *Graywacke*: any of various dark gray, coarse-grained sandstones that contain abundant feldspar and rock fragments and often have a clay-rich matrix. (American Heritage Science Dictionary 2010).
- *Siltstone*: an indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.
- *Shale*: sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Metamorphic

- Schist: A highly foliated, medium-grained metamorphic rock that splits easily into flakes or slabs along well-defined planes of mica. The mineral composition of schist is varied and is often reflected in the name given to the rock. For example, a schist that contains garnet is called a garnet schist. A schist containing chlorite is called a chlorite schist. (American Heritage Science Dictionary 2002).
- Mica Schist: a rock composed essentially of mica and quartz, and having a thin parallel-banded or foliated structure, with lamellae rich in mica alternating with others which are principally quartz (Encyclopedia Britannica 2010)

Soils data do not indicate that mafic or ultramafic soils occur in the Study Area. Serpentine soils, while common regionally, are not indicated by the GIS soil data as occurring in the Study Area. To verify the GIS information, we identified all areas (11 sites) of exposed rocky soils from high-resolution satellite imagery. During site visits to these areas, the only serpentine found were rocks exposed by road maintenance activity at a waterbar.

Soil Texture (SSSA 2008): The following soil texture occurred in the Study Area:

Soil Textures

- *Clay Loam*: Soil material that contains 27 to 40% clay and 20 to 45% sand.
- Loam: Soil material that contains 7 to 27% clay, 28 to 50% silt, and <52% sand.
- Sandy Loam: Soil material that contains 7 to 20% clay, more than 52% sand, and the percentage of silt plus twice the percentage of clay is 30 or more; or less than 7% clay, less than 50% silt, and more than 43% sand.

Modified Textural Classes

- Cobbly Loam – We defined “cobbly loam” as areas labeled cobbly loam or very cobbly loam.
- Gravelly Loam – We defined “gravelly loam” as areas labeled “gravelly loam” or “very gravelly loam”

We described rocky soils as any soil texture with gravel, cobble or alluvium. No soil type within the study area included rock outcrops.

Soil Wetness: We identified areas a likely to have prolonged moist soils as areas with high Available Water Capacity (AWC) and poor drainage. AWC is loosely defined as the amount of water available for plants to use. Specifically, the volume of water released from soil between the time the soil is at field capacity (the maximum water held in soil against the pull of gravity) until the time it is at the wilting point (the amount of water held too tightly in soil for commonly grown crops to extract). Loamy soils and soils high in organic matter have the highest AWC (from NRCS 2010). In the Study Area, AWC was classified in the spatial data layer as very low, low, moderate, or high. We classified soils in the Study Area as low (very low or low AWC) or high (moderate or high AWC).

Drainage capacity was identified in 4 categories in the available data: poor, moderate, good, and very good. High drainage was categorized as "very good" if the plurality of soil volume in a complex was described as "excessively drained" or "somewhat excessively drained" in the survey report. For our study, we categorized soils as poorly drained (poor or moderate) or well-drained (good or very good).

Buildings**:** Known structures were added to a data layer (e.g., Galbreath family sheep barns) and GPS'd locations of structures located during targeted surveys (feeding shed). Additional abandoned structures may exist in the study area but the resolution of aerial imagery prevents estimating their location.

Permanent Stream*:* Sections of creeks with perennial water were mapped based on information provided by local expert Charlie Hiatt. Although Charlie is one of the most knowledgeable living people with regard to the Preserve his suggestions were not ground-truthed and remain estimates.

Ridgelines**:** Ridgelines were modeled as areas were slopes ranged from 0-13 degrees and elevation is greater than 425 m. Results were visually inspected for accuracy.

Perennial Ponds: Except for two GPS ponds, permanent water sources were located via aerial imagery. Other ponds such as those below a closed forest canopy may need to be located via on the ground surveys. We assumed that all ponds we could see in the NAIP imagery were perennial since the imagery was taken in the summer.

Cliffs**:** Cliff locations were based primarily on estimate provided by local expert Charlie Hiatt. Although Charlie is one of the most knowledgeable living people with regard to the Preserve his suggestions were not ground-truthed and remain estimates with one exception. FID 6 was GPS'd by a field crew during targeted surveys. Most of the cliffs identified are small or not steeply sloped.

Roads**:** Roads are from the TIGER/line database supplemented with GPS data on Preserve roads.

Common Habitat Features for Which Spatial Information Are Unavailable:

- *Springs, Seeps, and Wet Meadow:* Information on springs and seeps was not available in spatial data layers. To estimate the general abundance of seeps, springs, and wet meadows, we identified possible wet areas from high-resolution aerial images. Three 2-person field crews visited the target sites in August 2010 and recorded occurrences of seeps, springs and wet meadows at each sites and on the way to and from the site. All field crews reported wet areas as occurring in a variety of habitat types. Based on these surveys, we assumed that wet and moist areas are common in the Preserve. Seeps typically occur in open grassy areas and are dominated by rushes

(*Juncus* spp.), sedge (*Cyperus eragrostis*), mint (*Menthe puleglum)*, bracken ferns (*Pteridium aquilium)*. Springs, sites with surface water, occur in many habitat types and vary in species composition.

- *Tree Height:* Some special status species co-occur with trees of particular height. Tree height is not available in spatial data. Because the relationship of DBH to tree height varies with tree species, growing conditions, stand density and other factors, we did not attempt to project DBH data to tree height.
- *Friable Soil:* Some plant prefer soils that is crumbly and easily broken into small fragments or reduced to powder. Soils of any type can be friable, including clay loam, which is common throughout the Study Area, but is not available in spatial data sets.
- *Snags:* Snags are present on the Preserve but are not available in the GIS database. Logging on the Galbreath Wildlands Preserve was discontinued in 2000 and a one-day field reconnaissance found that large snags are common in the Study Area.
- *Rock Outcrops* – Some species as associated with rock outcrops. Information on the location of these sites is not available in spatial data layers, although all soil types are recorded as having up to 5% rocky outcrops present. To confirm the general abundance of rocky outcrops, we identified possible rocky areas from high-resolution aerial images. Three 2-person field crews visited the target sites in August 2010 and recorded occurrences of rocky areas on the way to and from the site. All field crews reported rock outcrops as occurring in a variety of habitat types. Based on these surveys, we assumed that rock outcrops are common in the Preserve. Small rocky areas are common, and boulder grouping with sufficient for the development crevices and cracks are less abundant.
- *Caves*: Caves have not been mapped in the Study Area. Large rocky outcrops and cliffs are the most likely areas for caves to occur. Based on initial field surveys, extensive boulder outcrops are not common in the Study Area.

Data Layer Creation and Display: To enhance map readability, the map display area is slightly smaller than total Study Area. All potential-habitat shapefiles, however, include data for the total study area.
Potential habitats for all special status species were saved as new data layers. If a species uses multiple habitats (e.g., nesting, foraging and wintering), or prefers one habitat type over another, these were saved as separate layers. Once created, these shape files are available for all future research, education and land management projects. Habitats comprised of entire existing data layers (such as the layer representing all drainages in the study area) were *not* saved as separate shape files. Please note that future use of habitat spatial data will require this addition.

3.3 Likelihood Analysis

Likelihood of occurrence was evaluated based upon habitat quality and quantity, species distribution, and species commonness or rarity. For birds, we evaluated the potential of occurrence for the protected stage of their life cycle (i.e., only for nesting birds). Species were placed into one of four categories based on habitat quality, habitat quantity, distribution, and commonness:

Known to Occur: Species in this category have been documented to occur in the Preserve.

Likely to Occur: Species in this category were assigned if:

- *Habitat Quality* – the Preserve contains moderate to good potential habitat quality based on literature descriptions and field reconnaissance.

- *Habitat Quantity* – the Preserve contains sufficient habitat to support many individuals
- *Species Distribution Relative to the Preserve* – the Preserve is bracketed to the N-S and E-W by known occurrences or species occurs "nearby" (relative to the distances observed among other documented occurrences).
- *Species Commonness/Rarity* – the species is commonly found in areas throughout its range with appropriate habitat.

Unlikely to Occur: Species in this category were assigned if:

- *Habitat Quality* – the Preserve contains poor to moderate quality habitat based on literature descriptions and field reconnaissance.
- *Habitat Quantity* – the Preserve contains insufficient to support many individuals
- *Species Distribution Relative to the Preserve:* the Preserve is not bracketed to the N-S and E-W by known occurrences and the nearest documented occurrence does not occur "nearby" (relative to distances observed among other documented occurrences).
- *Species Commonness/Rarity* – the species is rarely found in areas throughout its range with appropriate habitat.

Not Expected to Occur: Potential habitat occurs in the Study Area but not within Preserve boundaries.

4.0 Limitations to Study

This study is a first approximation of the likelihood of species occurrence within Preserve boundaries. The best use of these data is to generate a working hypothesis that identifies the most likely areas to observe target species. Limitations of these working hypotheses include:

***Lack of Biological Information*:** Information about species association with habitat is highly variable. For some species, such as the Noyo Snail, habitat information was so poor that even a first approximation of distribution in the Preserve could not be mapped.

Lack of Spatial Data: Some types of habitat information needed for predicting species distribution is unavailable. Examples include the importance of snags for nesting birds, or caves for bat species. Additional field surveys may be able to document these features. Key habitat features of importance to many special status species include: rock outcrops, seeps and springs, and snags. We were able to create new data layers to estimate certain habitat features, such as perennial watercourses.

Weak Associations with Habitat: Species distributions may only be weakly correlated with mapable habitat features and distributions.

Spatial Data Resolution: Calveg minimum mapping unit is 2.5 acres. Habitats in patches smaller than this area will not be identified in this study. We have addressed key weaknesses by creating additional spatial data layers that recognize the occurrence of riparian woodland and scrub, ponds, and redwood stands.

Spatial Data Error: The primary data used to map potential habitat mapping were Calveg data layers for vegetation type, tree size, and canopy cover. USFS (2007b) provides accuracy estimates of the Calveg data that are based on a comparison of Calveg map labels with data collected at reference or 'ground truth" sites. We report here on measures of "accuracy" (the ability of the Calveg data to accurately differentiate among classes) and "confusion" (the degree to which a class is over or underestimated) for cover type,

tree size and canopy closure in the. Northern California Coast Section (Section 263A) where the Study Area is located.

- *Cover Class*: Accurate differentiation between conifer, mixed hardwood, chaparral, and herbaceous cover ranged from 74% (hardwoods) to 94% (conifers) with a weighted average accuracy of all types of 85%. Generally, mixed hardwoods and hardwoods are overestimated and shrubland and herbaceous cover underestimated.
- *Conifer Size Classes*: Ability to accurately differentiate between 5 tree size classes ranged from 14% (class 5) to 77% (class 2) with a weighted average accuracy of 69%. Lower size classes (0-2) tend to be underestimated and the higher size classes (3-5) overestimated.
- *Hardwood Size Classes:* Ability to accurately differentiate between 5 tree size classes ranged from 33% (class 1) to 88% (class 2) with a weighted average accuracy of 69%. Class 3 is overestimated.
- *Tree Crown Closure*: Ability to accurately differentiate between 10 tree cover classes ranged from 33% (classes 2 and 5) to 69% (class 9) with a weighted average accuracy of 62%. Generally the method was more accurate for the higher classes (7-9) than for lower classes (0-6). Class 9 is most overestimated (159/21). Classes 7,8,9 are most often confused with other classes

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