Accuracy Assessment Report

for the 2012 Orange County Vegetation Map

By

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Abstract

The California Native Plant Society (CNPS) Vegetation Program conducted an independent accuracy assessment of a new vegetation map completed for the natural lands of Orange County in collaboration with Aerial Information Systems (AIS), the California Department of Fish and Wildlife (CDFW), and the Nature Reserve of Orange County (NROC). This report provides a summary of the accuracy assessment allocation, field sampling methods, and analysis results; it also provides an in-depth crosswalk and comparison between the new map and the existing 1992 vegetation map. California state standards (CDFW 2007) require that a vegetation map should achieve an overall accuracy of 80%. After final scoring, the new Orange County vegetation map received an overall user's accuracy of 87%. The new fine-scale vegetation map and supporting field survey data provide baseline information for long-term land management and conservation within the remaining natural lands of Orange County.

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Introduction

The California Native Plant Society (CNPS) conducted an independent, third-party accuracy assessment of a new vegetation map in Orange County. This area includes a biologically diverse mix of habitats, including open grasslands, coastal sage scrub, chaparral, and coast live oak woodlands. Accuracy of the new vegetation map was assessed, using a field-based sampling approach of collecting basic vegetation data pertaining to specific map polygons and map units. An accuracy assessment analysis helps map users determine how much confidence can be assigned to each of the map units, and it provides an understanding of the map's appropriateness for various applications, such as species habitat modeling and other uses. CNPS has also compared the new vegetation map to an existing vegetation map from 20 years prior to provide insight on some of the similarities and differences in the two maps' approaches and results.

Methods

Project Location

An accuracy assessment was conducted within the footprint of the new vegetation map created by Aerial Information Systems (AIS) using imagery from 2012; for more information, see the separate AIS Vegetation Mapping Report (AIS 2015). The new vegetation map focused on the natural lands within Orange County and covers approximately 85,000 acres.

Accuracy Assessment Data Collection

To validate the vegetation map, an accuracy assessment (AA) effort was conducted through sample allocation, field data collection, and analysis. CNPS, in consultation with Todd Keeler-Wolf at the California Department of Fish and Wildlife (CDFW), estimated that at least 420 accuracy assessment surveys would be needed to test the accuracy of the mapped units. This number was determined through consideration of the size of the map area (85,000 acres), the number of vegetation types described in the vegetation classification report (AECOM 2013, 72 types), and previous mapping efforts in the south coastal region of California.

A stratified random sampling design was employed (Cochran 1977, Thompson 2002) to obtain a proportional number of surveys within each vegetation type (map unit), i.e., depending on how common or rare the vegetation type was, to assess the accuracy of the map. Miscellaneous map units coded under the 9000 series, such as anthropogenic and sparsely vegetated areas, were excluded from the allocation. Polygons were allocated by CNPS and were stratified by vegetation type and distance from roads/trails to ensure efficiency in the field. Any polygon with a pre-existing classification or reconnaissance survey associated with it was excluded from the allocation. Allocated polygons of the same map unit were located at least 1km away from other allocated polygons of the same map unit. The sample allocation occurred across two phases as additional polygons were received from AIS.

Each vegetation type was assigned a priority level (1-3) based on the number of occurrences per vegetation type – with rarer types (<10 polygons) having the highest priority of 1 and the

more common types (>240 polygons) having the lowest priority of 3 for sampling (see Appendix A). The priority levels guided the field staff when they visited areas of allocated polygons. A total of 675 polygons were allocated in Phase 1 and an additional 36 polygons were allocated in Phase 2, for a grand total of 711 allocated polygons across 71 map units. The number of allocated polygons exceeded the targeted goal of 420 to allow for some polygons to be omitted due to access and time constraints. Occasionally, unallocated polygons were opportunistically sampled to maintain crew efficiency in the field.

Property access and permitting were coordinated by Milan Mitrovich (NROC). To prevent bias, CNPS field staff collected AA surveys without knowledge of the mappers' attributes when assessing polygons. Appendix B displays the field form template used in the project and an example of a completed accuracy assessment survey. Staff made use of paper and digital field maps with highlighted priority levels to guide field work and to navigate to allocated polygons. Each survey was stand-based, that is, both the type and the extent of the entire polygon were evaluated when possible. When a mapped polygon could be divided due to the presence of multiple vegetation types within the given minimum map unit (MMU) standards, a separate assessment was done for each type. Some stands were assessed from a distance using binoculars, a compass, and a laser rangefinder, as long as identification of dominant species and stand characteristics was possible. ESRI's ArcPad software, loaded onto Trimble's Juno devices, was used to collect GPS locations, and ArcPad's offset function was used to project survey coordinates from a distance, when necessary.

Previous vegetation surveys in the region resulted in a floristic classification (AECOM 2013). Appendix C presents a field key to vegetation types of Orange County originally developed by CDFW upon interpreting the AECOM classification, and then edited/updated and utilized by CNPS staff to assess and determine the vegetation types of the mapping area.

All field surveys were entered and archived in a custom MS Access database, including forms for entering and viewing data records. Staff performed data quality control prior to the accuracy assessment analysis. A set of digital photographs were taken for each survey and archived in folders by a unique polygon number specifically assigned for AA (AA_UID). Associated survey data, such as plant species, are contained within a series of tables, and other look-up reference tables provide functionality for the forms and data tables. Plant specimens collected through the AA field surveys were deposited at the Rancho Santa Ana Botanic Garden Herbarium.

Accuracy Assessment Analysis

CNPS and CDFW staff compared the field-based versus the photo-interpreter based determinations or "calls" of vegetation type (map unit), and each assessed polygon was given a score for accuracy. All field calls were independently reviewed by CNPS and CDFW, and a "Final call" was recorded in the database. A fuzzy logic method was used, rather than simply denoting whether a sample was correct or incorrect. Each field-verified polygon was ranked according to the set of decision rules along a scoring scale, with a total of 5 possible points for each. The set of database codes used to score each assessed polygon is available in Table 1.

Table 1. Scoring Rationale with Key to Coding Choices

Code	Reason For Score	Score
A	Correct, perfectly meets key definitions for the vegetation type at the Alliance level (or other higher level map unit)	5
B	Correct at secondary level in the classification (e.g. at the Group or next level up in hierarchy)	4
C	Threshold/transition between PI call and Final call.	4
D	Correct at the Macrogroup level OR next level up in hierarchy.	3
E	Based on close ecological similarity.	3
F	Correct at the Division level but not at lower levels in the hierarchy.	2
G	Some floristic/hydrologic similarity.	2
H	Correct only at life form.	1
I	No similarity above Formation and incorrect life form.	0
J	Survey removed because of significant change in polygon (e.g., the stand was burned, developed, or cleared since the date of the base imagery).	N/A
K	Survey removed because it represents ≤ 10 percent of polygon	N/A
L	Survey removed because field data is incomplete, inadequate or confusing.	N/A
M	Supplementary point, not scored.	N/A

Scores were summed for each vegetation type, and then divided by the total possible score, and multiplied by 100 to generate the percent accuracy per type. Two forms of accuracy (users' and producers') can be estimated from the data (Story and Congalton 1986). Users' accuracy is conditional on the mapped classes and is defined as the probability that a location mapped as class i is in fact class I. This provides an estimate of how well spatial mapping data actually represents what is found on the ground; i.e., if the user goes to a location mapped as sagebrush, what is the probability it is in fact sagebrush? Producers' accuracy, on the other hand, is conditional on the true vegetation class in the field. The producers' accuracy for class J is the probability that a location of vegetation class J in the field is mapped as class j. Producers' accuracy may inform the producers of remotely sensed and mapped data how readily a mapping class may be detected by mapping whenever it occurs on the ground (Story and Congalton 1986, Lea and Curtis 2010).

Results

Accuracy Assessment

CNPS staff conducted two phases of accuracy assessment (AA) fieldwork across eight weeks within natural areas of Orange County. Field surveying occurred between March 18 and July 23, 2014, including 543 point locations throughout the mapping area. Figure 1 illustrates locations of AA field surveys across the study area. A total of 34 surveys were removed from the analysis because they had incomplete information, were supplementary points, or had a significant change in the polygon area between the time of the map attribution and the field survey.

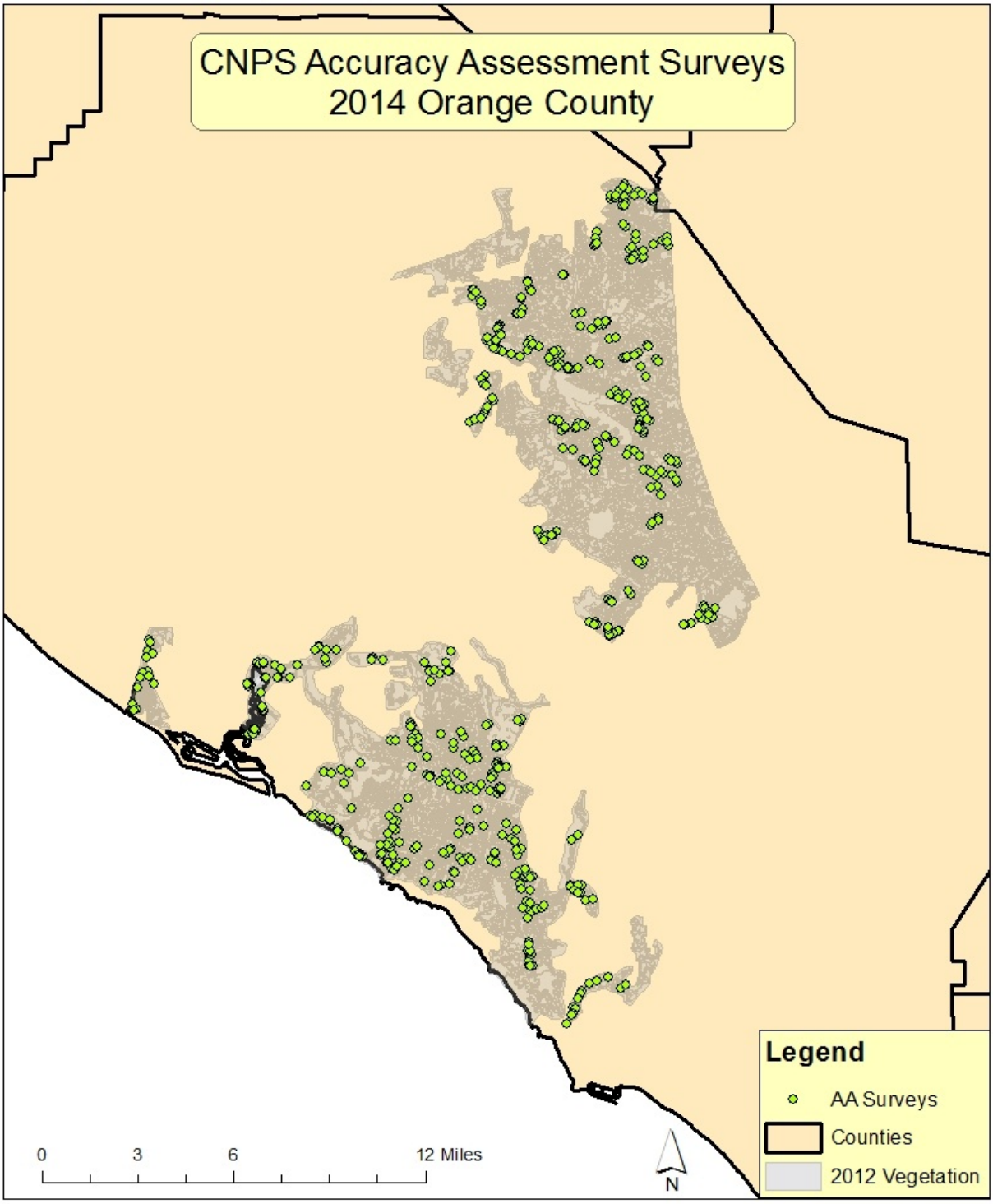


Figure 1. Accuracy Assessment Survey Locations.

Despite attempts to allocate and sample adequate numbers of all mapped types, many map units are relatively rare across the project area (Appendix A). Table 2 provides a summary of all the map units analyzed for accuracy within the map. The user's accuracy (degree of agreement between the map and the reference data) and the producer's accuracy (degree of agreement between the reference data and the map) are also reported.

Table 2. Percent accuracy of vegetation map units with sample size. Numbers in bold signify less than the 80% accuracy threshold with a sample size of ≥ 5; an asterisk (*) means the type was not maintained in the final map.

Map Code	*Map Unit Name*	User's Count	User's Accuracy	Producer's Count	Producer's Accuracy
1120	*Quercus agrifolia* Alliance	23	97	22	100
1210	*Hesperocyparis forbesii* Alliance	3	53	2	70
1410	*Pseudotsuga macrocarpa* Alliance	1	100	1	100
1510	*Eucalyptus (globulus, camaldulensis)* Semi-Natural	10	100	10	100
1610	*Alnus rhombifolia* Alliance	1	100	2	70
1710	*Platanus racemosa* Alliance	7	97	7	86
1720	*Salix gooddingii* Alliance	10	86	12	87
1730	*Salix laevigata* Alliance	5	88	6	**77**
1740	*Populus fremontii* Alliance	4	90	3	93
1810	*Baccharis salicifolia* Alliance	18	91	17	84
1820	*Salix lasiolepis* Alliance	9	84	10	86
1830	*Sambucus nigra* Alliance	5	100	8	85
1910	*Arundo donax* Semi-Natural Stands	3	100	5	92
2001	*A. fasciculatum-A. glandulosa* Mapping Unit*			2	70
2100	California Xeric Chaparral Group			5	**56**
2101	*C. crassifolius - A. fasciculatum* Mapping Unit*			4	80
2110	*Adenostoma fasciculatum* Alliance	14	83	8	93
2120	*Ceanothus crassifolius* Alliance	3	80	1	100
2130	*Ceanothus megacarpus* Alliance	5	84	3	80
2140	*Adenostoma fasciculata - Salvia mellifera* Alliance	4	85	5	80
2210	*Malosma laurina* Alliance	2	70	11	**73**
2220	*Rhus integrifolia* Alliance	20	87	13	95
2230	*Quercus dumosa Association*	1	100	4	75
2300	Californian mesic chaparral Group	1	40	1	60
2310	*Ceanothus tomentosus* Alliance	5	**72**	3	73
2330	*Heteromeles arbutifolia* Alliance	3	73	4	75
2340	*Quercus berberidifolia* Alliance	8	88	9	84
2350	*Quercus berberidifolia - Adenostoma fasciculatum*	1	40	4	55
2410	*Arctostaphylos glandulosa* Alliance	1	80	1	60
3100	Central & South Coastal Californian CSS Group	1	60	8	**73**
3110	*Artemisia californica* Alliance	39	**79**	22	93
3120	*Artemisia californica - Eriogonum fasciculatum*	37	81	28	88

Map Code	*Map Unit Name*	User's Count	User's Accuracy	Producer's Count	Producer's Accuracy
3130	*Artemisia californica - Salvia mellifera* Alliance	13	85	21	84
3140	*Encelia californica* Alliance	10	80	7	89
3150	*Eriogonum fasciculatum* Alliance	12	83	14	90
3160	*Eriogonum fasciculatum - Salvia apiana* Alliance	1	80		
3170	*Keckiella antirrhinoides* Alliance	1	40	1	40
3180	*Salvia apiana* Alliance	5	96	11	87
3190	*Salvia leucophylla* Alliance	9	89	6	93
3210	*Salvia mellifera* Alliance	31	**79**	10	94
3220	*Mimulus aurantiacus* Alliance	5	100	6	97
3300	Central and South Coastal Californian Seral Scrub Group	2	90	6	**67**
3310	*Ericameria palmeri* Alliance	8	95	6	100
3330	*Isocoma menziesii* Alliance	6	87	6	87
3340	*Acmispon glaber* Alliance	3	87	6	83
3350	*Malacothamnus fasciculatus* Alliance	3	87	4	85
3410	*Acacia (cyclops)* Semi-Natural Stands	5	100	5	100
4000	California Annual and Perennial Grassland Macrogroup	6	100		
4100	California Perennial Grassland Group	1	100		
4110	*Leymus condensatus* Alliance	1	100	2	90
4120	*Stipa lepida* Alliance	1	100	5	92
4130	*Stipa pulchra* Alliance	6	100	9	91
4200	Mediterranean CA Naturalized Annual and Perennial Grassland Group	10	100	40	94
4210	*Avena (barbata, fatua)* Semi-Natural Stands	4	100		
4220	*Brassica nigra* and other mustards Semi-Natural Stands	13	95	13	98
4230	*Bromus (diandrus, hordeaceus) - Brachypodium distachyon* Semi-Natural Stands	20	100		
4250	*Cynara cardunculus* Provisional Semi-Natural Stands	3	100	6	100
4260	*Cortaderia (jubata, selloana)* Semi-Natural Stands	1	100	3	80
4280	*Lolium perenne* Semi-Natural Stands	1	100		
5210	*Toxicodendron diversilobum* Alliance	5	**72**	4	85
5310	*Baccharis pilularis* Alliance	22	84	14	96
6100	Arid West Freshwater Emergent Marsh Group	2	70		
6110	*Schoenoplectus acutus* Association	2	100	5	96
6120	*Typha (angustifolia, domingensis, latifolia)* Alliance	10	90	7	97
6130	*Schoenoplectus californicus* Association	10	94	10	88
6140	*Scirpus robustus* Provisional Association	1	100	1	100
7100	Temperate Pacific Tidal Salt & Brackish Meadow Group	2	90	3	80
7110	*Sarcocornia pacifica (Salicornia depressa)* Alliance	7	86	4	95
7120	*Spartina foliosa* Alliance	4	95	4	95

Map Code	*Map Unit Name*	User's Count	User's Accuracy	Producer's Count	Producer's Accuracy
7130	*Bolboschoenus maritimus* Association			5	**76**
7140	*Distichlis spicata* Alliance	1	80	1	40
7210	*Atriplex lentiformis* Alliance	5	100	6	90
8100	Coastal Baja California Norte maritime succulent scrub Group	3	73		
8110	*Lycium californicum* Provisional Alliance*	1	60	3	73
8120	*Opuntia littoralis* Alliance	7	91	8	93
8210	*Lepidospartum squamatum* Alliance	1	100	5	**52**
8220	*Bebbia juncea* Association	1	80		
9420	Cliff, bluffs, scree, and rock outcrop			1	0
	Total Number of Samples and Average Score	**509**	**86.7%**	**509**	**82.4%**

The broad distribution of AA surveys across the map area and resulting accuracy scores are strong indicators of the final map's validity. For the assessed map units, the overall users' accuracy averaged 86.7% and producers' accuracy averaged 82.4%. Since California state standards (CDFW 2007) require that a vegetation map should achieve an overall accuracy of 80%, the map met or exceeded these expectations across most vegetation types. A contingency table (Appendix D) displays the resulting vegetation calls for the field surveyors (user's final field calls) along rows and photo interpreters (producer's map classes) in columns. The numbers along the diagonal record the correctly matched calls between the map photo interpretation and field surveys.

After the map accuracy scoring was complete, AIS staff reviewed all assessed polygons in order to address issues in photo interpretation and attribution. Updates were made to the map, and each polygon that differed in vegetation type was edited as needed. After the assessment review and polygon updates, the mappers evaluated the results of the AA to conduct an overall quality control of the map, so that the final map accuracy is higher than reported in Table 2. The majority of the map units that came in at users or producers accuracy below 80% were types that were not sampled sufficiently to generate a statistically significant sample size, however general trends can be noted.

The *Hesperocyparis forbesii* alliance fell below the accuracy threshold due to early seral patterns of regenerating cypress following fire, and often *H. forbesii* was present but not a dominant tree in areas mapped as that alliance but that had chaparral shrubs as dominant. Other fine scale types that didn't meet the 80% accuracy goal were lumped within a broader Group of the National Vegetation Classification Hierarchy such as semi-natural grasslands (*Brassica, Cynara*), which were lumped into the Mediterranean Naturalized Grassland Group and other types within the Arid Freshwater Marsh Group. Types mapped within some of the broader groups, such as the Coastal Baja California Norte Maritime Succulent Scrub Group (e.g. *Lycium californicum*), were not easily identifiable in the accuracy assessment field effort

due to extreme drought conditions; many stands were decadent and were thus assigned to the broader group-level mapping unit.

Map Comparison (1992 v. 2012)

CNPS compared the existing Orange County vegetation map produced in 1992 (Jones & Stokes 1993) to the new vegetation map produced using 2012 NAIP imagery (AIS 2015). The objective of this comparison was to identify and interpret differences between the two maps in order to guide future analyses and interpretations.

Classification Systems

In California, ecologists have developed numerous vegetation classification systems that reflect a variety of descriptive scales, philosophies, and purposes. When comparing the two mapping efforts in Orange County, it is important to understand the general differences between the classification systems used. The 1992 map used a modified version of the Holland (1986) classification with customized habitat descriptions available from two reports submitted to the County of Orange, Environmental Management Agency (Gray & Bramlet 1992, Jones & Stokes 1993). The habitat types used in the 1992 map were established using the existing understanding of natural vegetation in California and the extensive field experience of local botanists; however, these types were not developed from quantitatively-based analysis techniques (Jones & Stokes 1993). The 2012 map utilized the current state standard classification which has been developed over the past 20 years. Specifically, the 2012 map used vegetation alliances or associations defined using the Manual of California Vegetation (Sawyer et al. 2009) standard and augmented through the comprehensive sampling and classification project conducted in Orange County (AECOM 2013).

The Manual of California Vegetation (MCV) was developed to describe vegetation across California in a consistent way. It comes from a synthesis of quantitative vegetation sampling and is the product of a multi-year collaboration of a committee of state experts brought together by CNPS. The MCV fits within the National Vegetation Classification system (NVC) and uses defensible quantitative definitions of vegetation placed within a hierarchy of eight levels (see http://usnvc.org/explore-classification/ or http://host.appgeo.com/NVCHierarchyBrowser/). Assemblages of vegetation are surveyed to describe species composition (species presence and cover), structure (plant cover, height, etc.), and environmental conditions (elevation, local topography, soil characters, etc.) for fixed areas (variously referred to as samples, plots, relevés, polygons, etc.). This sampling is repeated throughout the landscape to represent the diversity of vegetation present. The field data are subjected to statistical analyses, which quantify the repeating patterns in species composition and correlate them with vegetation structure and environmental data. These analyses define a set of vegetation types that best describe and encapsulate the landscape's vegetation in an empirical way.

Appendix E displays a conceptual crosswalk between the classification system used in 1992 and the system used in 2012. The relationships within the crosswalk are complex and while some types directly relate one-to-one, other types have one-to-many or even many-many relationships between the two classification systems. In order to spatially compare vegetation types and acreages, the two maps were clipped to each other's boundaries – removing portions that did not overlap (e.g. the 1992 map spanned the entire county while the 2012 map focused on the natural areas).

Some map units were described in similar ways across both the 1992 and the 2012 map efforts, such as the treatment of sumac, *Malosma laurina*. In the 1993 report, Jones & Stokes state that "Occurrences of *Malosma laurina* proved problematic in assigning sites to habitat types because it occurs in a variety of habitats" thus the species was not used to classify shrub or chaparral communities (although, if it was the dominant species in a survey area, then the area was identified as Laurel Sumac Savannah or Toyon Sumac Chaparral). A similar caveat is given in the new key to Orange County vegetation (Appendix C) where *Rhus integrifolia* and/or *Malosma laurina* may be present with the highest cover in shrub stands, but neither species is considered a useful diagnostic species, as they are both ubiquitous across chaparral and coastal scrub settings. *Rhus integrifolia* and *Malosma laurina* Alliances are distinguished only when either species is strongly dominant and other shrub species are trace or strongly sub-dominant.

However, other map units were characterized differently across the two maps. In 1992, the presence of *Artemisia californica* was considered an important parameter for distinguishing shrub types (due to an interest in identifying suitable habitat for California Gnatcatcher); thus, its presence was heavily weighted when defining subtypes and ecotones of scrub and coastal scrub habitat types. Mixed types were created from this weighting when shrub species were co-dominant, and pure types when a scrub species exceeded 80% relative cover. While the 2012 map also recognizes both pure and mixed *Artemisia californica* types, such as *Artemisia californica* - *Eriogonum fasciculatum* and *Artemisia californica* - *Salvia mellifera* Alliances, mismatches may occur in types. For example, the 1992 Sagebrush-Coyote bush map unit equates in 2012 to a mixed association under the Coyote bush (*Baccharis pilularis*) Alliance. Also, the 1992 Chamise-Sagebrush unit equates in 2012 to a mixed association under the Chamise (*Adenostoma fasciculatum*) Alliance.

Additional complexity exists with the 1992 Southern cactus scrub type, which was used when >20% of the shrub cover contained a cacti species. In 2012, stands of cactus that were dominated by *Artemisia californica* or *Eriogonum fasciculatum* are mapped to the respective alliances, unless the cover of cacti species was >30% relative cover. Nolina Chaparral (mapped in 1992) is not pulled out in the 2012 map, but was noted as a dominant in three polygons typed to Xeromorphic Scrub & Herb Vegetation. While the presence of *Nolina cismontana* is important due to its rarity within California (1B.2), it occurs across multiple vegetation types and thus is better tracked using species level or population mapping, such as through occurrence records found in the California Natural Diversity Database (CNDDB). Across 23 field surveys, *Nolina cismontana* was found with high cover (≥ 10% absolute cover) in *Artemisia californica*, *Acmispon glaber*, and *Adenostoma fasciculatum* Alliances; and with lower cover within

Arctostaphylos glandulosa, *Ceanothus* spp., *Malacothamnus fasciculatus*, *Quercus berberidifolia - Adenostoma fasciculatum*, *Salvia leucophylla*, and *Salvia mellifera* Alliances.

In 1992, stands of Coast Live Oak that occurred along rivers, streams, creeks, and drainages were mapped as oak riparian, whereas stands situated away from watercourses were labeled either oak woodland or oak forest. However, there was an acknowledged lack of consistency when distinguishing between oak riparian, oak woodland and oak forest during field surveys of the 1992 map. Across the 2012 map, all *Quercus agrifolia* stands were assigned initially to the *Quercus agrifolia* Alliance and each polygon contains an attribute for percent cover/density of hardwoods (AIS 2015). In order to compare acreages between these types across the different maps, the four separate 1992 Coast Live Oak units would need to be merged as shown in the table below. However, to rectify some of the differences, the 2012 map has now been updated to separate out *Quercus agrifolia* Alliance in riparian settings versus uplands settings.

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
80100	Coast live oak woodland	1559	*Quercus agrifolia* Alliance	1120	3428
40500	Coast live oak savanna	228	*Quercus agrifolia* Alliance	1120	
90100	Coast live oak forest	14	*Quercus agrifolia* Alliance	1120	
70500	Southern coast live oak riparian forest	1063	*Quercus agrifolia* Alliance	1120	
	Total Acres	**2864**	**Total Acres**		**3428**

A broader Habitat Class was attributed within the 1992 map to categorize the 102 units into 15 general classes. In 2012, each map unit fits within the National Vegetation Classification (NVC) Hierarchy, which enables map users to combine units from the Alliance level to Subclass through six successively broader units. There are a number of notable differences between the 1992 Habitat Classes and the NVC Hierarchy. The broad Riparian Habitat Class from 1992 contains trees, shrubs and herb types while equivalent stands in 2012 are split by life form in the upper levels of the hierarchy. Other differences include the 1992 Sage Scrub-Grassland Ecotone and Buckwheat Grass that are found in the Scrub Habitat Class, while the Coast Live Oak Savannah and Sumac Savannah are found under the Grassland Class; in contrast, the related 2012 types are split into Forest and Shrub Formations based on their dominant life form. In 1992, Elderberry was treated in the Woodland Class, but it is placed in a Riparian Shrub Group in the 2012 hierarchy.

In 2012, each polygon was mapped to the finest level possible (with a focus on Alliance), using the supporting imagery and ground-based data. However, all vegetation types are hierarchically associated with coarser Group and/or Macrogroup levels of the NVC hierarchy. Some users of the map may be interested in interpreting the map at the Macrogroup level to depict certain habitats, (e.g. Coastal Sage Scrub) for wildlife or plant species that do not differentiate between the finer floristic or structural levels of the vegetation. This flexibility in the coarser and finer levels of the classification will be advantageous for different applications of the map.

Aerial Cover Estimates

At the broadest scale, habitat types are separated by life form (tree, shrub, and herb) and rules to separate these levels were defined differently across the two maps. Table 3 summarizes the cover break rules defined within each of the maps. The different cut-off values used to characterize the dominant life form may result in differences between the two map products (e.g. vegetation with 10-20% cover of shrubs was mapped as Shrub-Overstory in 2012, but was mapped as Grassland in 1992).

In 1992, sites supporting grassland with scattered shrubs between 5% and 20% cover were sometimes mapped as Sage Scrub-Grassland Ecotone/Sere and sometimes identified as grassland habitat (the 1993 Jones & Stokes report indicates this was not consistently mapped across the study area). For example, the shrub-grassland ecotone was mapped on County properties, but not on the Irvine Company Property (which corresponds to the current-day Central-Coastal NCCP/HCP subregions). In general, the 2012 map used a general 10% relative cover rule to separate and delineate tree stands and shrublands versus grasslands.

For the 2012 mapping effort, the Irvine Ranch Conservancy contributed spatial data marking locations of native grasslands. Aerial Information Systems incorporated and modified grassland polygons based on this supplementary data in order to represent native grasslands, which are notoriously difficult to detect using aerial imagery (AIS 2015). The 1992 map also included polygons mapped as Southern coastal needlegrass grassland based on field surveys.

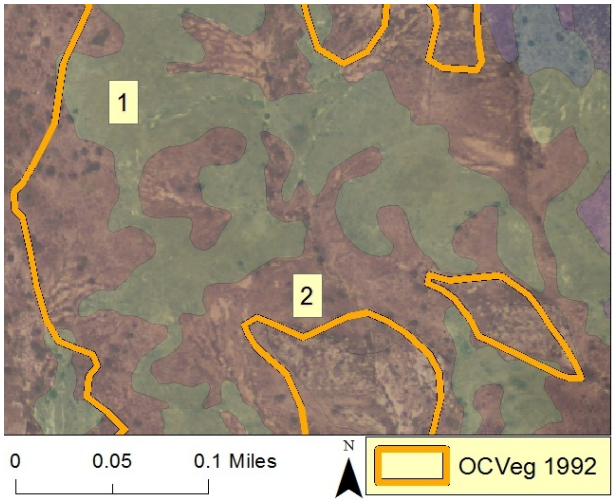
Table 3. Comparison of 1992 v. 2012 Cover Breaks

1992 Orange County Vegetation Classification System (Jones & Stokes 1993)	2012 Orange County Vegetation Classification System (MCV/AECOM 2013)
TREES	
If between 20% and 80% tree cover, then mapped as Woodland Habitats	If >10% Tree Cover, then mapped as Tree-Overstory Vegetation
If >80% tree cover, then mapped as Forest Habitats	If >10% Tree Cover, then mapped as Tree-Overstory Vegetation
SHRUBS	
If between 5% and 20% shrub cover, then mapped as a Sage Scrub-Grassland Ecotone [County of Orange Property]	If >10% shrub cover and <10% tree cover, then mapped as Shrub-Overstory Vegetation
If >20% shrub cover with >80% relative cover from species characterized as scrub, then mapped as Scrub Habitats	If >10% shrub cover of scrub species, then mapped to alliances within the Central & Southern California Coastal Sage Scrub Group
If >20% shrub cover, with >20% relative cover by cacti species, then mapped as Southern Cactus Scrub	If >10% shrub cover and >30% relative cover of cacti species, then mapped as *Opuntia littoralis* Alliance
If >20% shrub cover, with between 20% and 50% relative cover from species characterized as chaparral, then mapped as Coastal Sage-Chaparral Ecotone	Mixed types were not mapped in 2012. The 1992 types fit into the broad NVC Division “California Scrub” which encompasses chaparral and coastal scrub habitats.
If >20% shrub cover, with >50% shrub cover from species characterized as chaparral species, then mapped as Chaparral Habitats	If >10% shrub cover and >30% relative cover of chaparral species, then mapped to alliances within the California Chaparral Macrogroup
HERBACEOUS	
If <20% shrub and/or tree cover, then mapped as a Grassland Habitat [Irvine Co. Property]	If <10% shrub and/or tree cover, then mapped as Herbaceous Vegetation
If <5% shrub cover, then mapped as Grassland Habitats [County of Orange Property]	If <10% shrub and/or tree cover, then mapped as Herbaceous Vegetation
If >10% *Stipa* spp. cover, then classified as a Native Grassland	If >10% native perennial grass cover, then mapped to alliances within the California Native Perennial Grassland Group

Additional aerial cover comparisons through text and map display (and corresponding numbers for specific 2012 map units) are provided below.

A screenshot from Fremont Canyon displays a large polygon of Sage Scrub-Grassland Ecotone/Sere as delineated in 1992 with an orange line. Within the orange-lined footprint are interdigitating polygons of grassland (1, gray) separated from the open shrublands (2, red) as delineated in the 2012 map.

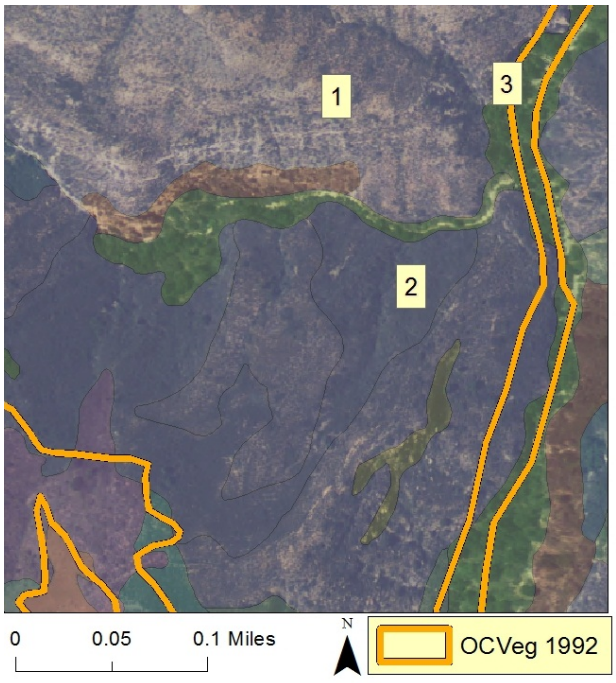
1) Annual & Perennial Grassland Group
2) *Artemisia californica – Eriogonum fasciculatum* Alliance



In addition to vegetation information, the 2012 vegetation maps provides important structural and human impact information that extends well beyond a simple map with vegetation type labels. The new map contains attributes such as separate estimates of density for conifer, hardwood, shrub, and herb vegetation layers, as well as codes for disturbance, exotics and land-use (AIS 2015); these attributes are not available in the1992 map. The additional attributes greatly expand the ability to analyze the map in broader ways such as modeling for wildlife habitat. For example, the 2012 map may be used to identify gnatcatcher habitat by selecting for the suite of appropriate habitat types, screening by preferred shrub density, and/or selecting for sagebrush adjacent to grassland as targets.

This screenshot from Fremont Canyon centers upon a large Chamise polygon delineated in 1992 with an orange line, which contains numerous purple-tinted polygons of *Adenostoma fasciculatum* Alliance delineated based on shrub density in the 2012 map (1, 2). The separate polygons of canopy density can allow map analyses beyond the focus of vegetation type (e.g. fuel loading). Also, a long narrow orange polygon depicts a riparian corridor delineated as Coast Live Oak in both 1992 and 2012 (3, green) though the alignment differs slightly.

1) ***Adenostoma fasciculatum* Alliance at 25-39% cover**
2) ***Adenostoma fasciculatum* Alliance at >60% cover**
3) ***Quercus agrifolia* Alliance**

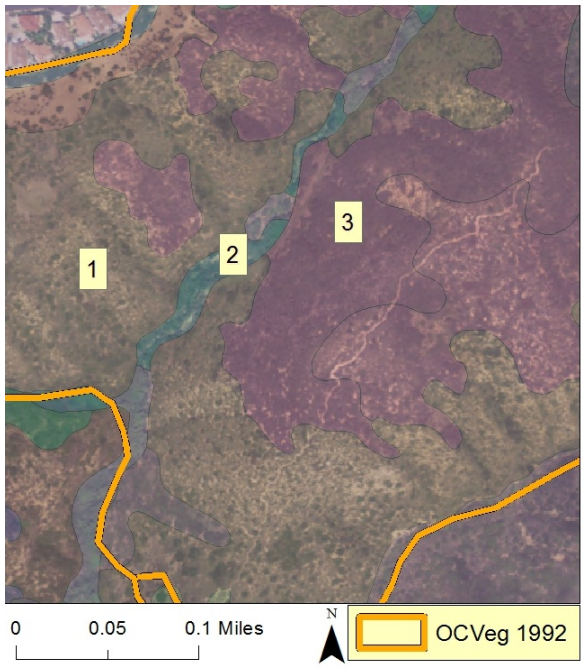


Scale and minimum mapping unit

In any vegetation map, the matter of scale is always compromised in map interpretation. A cartographer cannot represent all vegetation units, especially those that are smaller than the project's minimum mapping unit (mmu), which in 2012 was 1 acre. The 1992 map was drawn at a minimum scale of 1"=500', which likely correlates to a mmu of 5–10 acres. Additional complexity exists in the 1992 map, which originally had multiple habitat designations assigned to certain polygons. These were ultimately simplified into a single category to reflect the more common/important habitat. Thus, many vegetation types are included within other potentially unrelated and more extensive vegetation units. In addition to scale and habitat designations, different species that appear similar in aerial photographs were sometimes merged into a single map unit, potentially obliterating important ecological differences. In 2012, it was possible to delineate individual types reflecting a finer scale product. This difference is particularly visible through fine-scale delineation of riparian habitats, while in 1992 was largely determined via geographic location (i.e. proximity to already mapped watercourses).

This screenshot from Laguna Coast displays a large Black Sage polygon delineated in 1992 with an orange line. The 2012 map includes a linear strip of alternating *Platanus racemosa* and *Salix lasiolepis* Alliances (2, blue, purple). While portions of the large Black Sage polygon match between the two maps (1, brown), large inclusions of Bigpod Ceanothus (3, pink) were delineated in 2012. A fire occurred in this region in the early 1990's and differences between the two maps may reflect change over time (regeneration) as well as finer-scale delineation in 2012.

1) ***Salvia mellifera* Alliance**
2) **Riparian polygons of alternating *Platanus racemosa* & *Salix lasiolepis* Alliances**
3) ***Ceanothus megacarpus* Alliance**



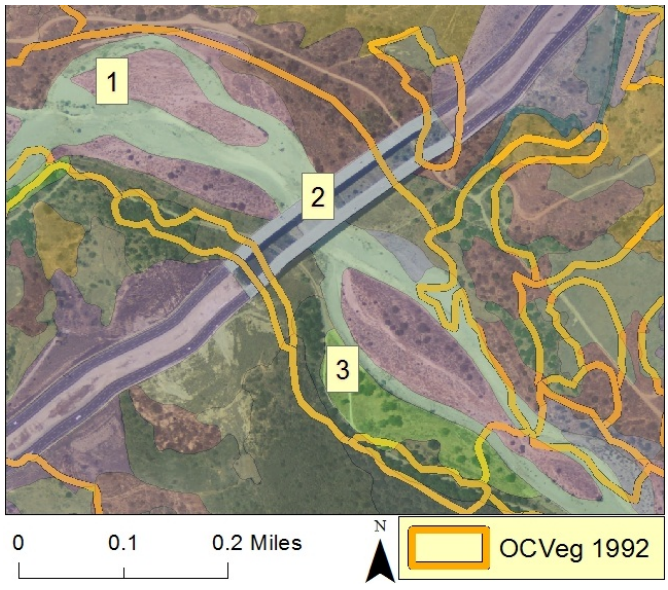
When directly comparing acreage of non-oak riparian habitat, the 1992 effort mapped 2,315 acres of riparian vegetation, while the 2012 mapped 3,334 acres (see excerpted table from Appendix E below). The new map represents an additional 1,000 acres of riparian vegetation, likely through finer-scale delineation. Additionally, the 2012 map had a finer resolution of map units, recognizing 10 alliances and 3 groups, as compared to the 1992 map of 9 riparian types.

1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
			SW N. Amer. Rip. evergreen and deciduous woodland Group	1700	124
			Alnus rhombifolia Alliance	1610	22
70400	Southern sycamore riparian woodland	392	*Platanus racemosa* Alliance	1710	459
70700	Southern black willow forest	424	*Salix gooddingii* Alliance	1720	647
			Salix laevigata Alliance	1730	94
70800	Southern cottonwood-Willow riparian forest	24	*Populus fremontii* Alliance	1740	26
70200	Southern willow scrub	440	SW North American riparian/wash scrub Group	1800	25
71100	Bramble thicket	1			
70300	Mulefat scrub	537	*Baccharis salicifolia* Alliance	1810	780
70600	Southern arroyo willow forest	195	*Salix lasiolepis* Alliance	1820	679
80400, 80401	Mexican elderberry woodland	7	*Sambucus nigra* Alliance	1830	393
			Arundo donax Semi-Natural	1910	79
70100	Riparian herb	295	Temperate and Boreal Freshwater Marsh Formation	6000	6
	Total Acres	**2,315**	**Total Acres**		**3,334**

It is important to note that the 1992 map unit for Southern coast live oak riparian forest (1,063 acres) was not separated in the first draft map from 2012, and is not included in the Table above. Also not included in the above riparian acreage calculation is Floodplain Sage Scrub, which was mapped in 1992. This type is difficult to relate to current vegetation definitions, though it crosswalks directly to two vegetation types mapped in 2012 including *Lepidospartum squamatum* and *Bebbia juncea* Alliances. There is a marked decrease (172 acres less) between the 2012 map when compared to the 1992 map (see excerpted table from Appendix E below).

In this screenshot from Weir and Fremont Canyons, a large Floodplain Sage Scrub polygon delineated in 1992 (the center orange line boundary) was split in 2012 into finer scale polygons. The difference in acreage between the two maps is likely a combination of finer scale mapping and interpretation, as well as potential change (loss) of shrub and herb cover over time.

1) ***Lepidospartum squamatum* Alliance**
2) **Streambed Mapping Unit**
3) ***Platanus racemosa* Alliance**



1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
20600	Floodplain sage scrub	284	(Warm Semi-Desert Shrub & Herb Dry Wash Group)		
			Lepidospartum squamatum Alliance	8210	110
			Bebbia juncea Association	8220	2
	Total Acres	**284**	**Total Acres**		**112**

Polygons mapped as Floodplain Sage Scrub in 1992 intersect with more than 30 types used in 2012 including *Artemisia californica - Eriogonum fasciculatum*, *Quercus agrifolia, Baccharis salicifolia,* and many others. The table below lists 20 of the intersecting vegetation types from 2012 that overlap with at least 1% of the previously mapped Floodplain Sage Scrub habitat.

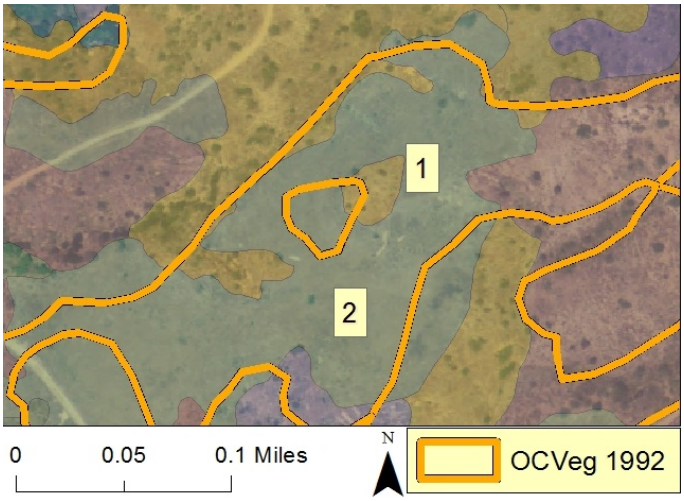
2012 Code	Vegetation Name	Percent
9431	Streambed Mapping Unit	18
3120	*Artemisia californica - Eriogonum fasciculatum* Alliance	15
8210	*Lepidospartum squamatum* Alliance	14
1710	*Platanus racemosa* Alliance	7
3110	*Artemisia californica* Alliance	7
1120	*Quercus agrifolia* Alliance	6
4200	Mediterranean CA Naturalized Annual and Perennial Grassland Group	5
9100	Introduced Trees, Shrubs (not in hierarchy)	5
1810	*Baccharis salicifolia* Alliance	4
3210	*Salvia mellifera* Alliance	3
3130	*Artemisia californica - Salvia mellifera* Alliance	3
9300	Urban/disturbed Mapping Unit	2
9310	Special Linkage Area	2
1730	*Salix laevigata* Alliance	2
1830	*Sambucus nigra* Alliance	1
3100	Central & South Coastal Californian CSS Group	1
3340	*Acmispon glaber* Alliance	1
8220	*Bebbia juncea* Alliance	1
2210	*Malosma laurina* Alliance	1
	13 additional map units with a small amount of overlap	2
	Total	**100%**

The largest component represented in 2012 is the Streambed Mapping Unit which reflects habitat with less than 2% cover of plant species (see AIS 2015), this type was lumped within the Floodplain Sage Scrub acreage in 1992. Finer scale mapping can allow a more accurate assessment of vegetation extent and can assist in tracking change over time, especially in this rare plant community which has an S3 rank, meaning it is vulnerable to extirpation or extinction (CDFW 2010).

Alignment Issues

Image registration is a process of transforming multiple data sources into one coordinate system. Registration errors commonly occur when data obtained from different sources are integrated together. Many polygons within the 1992 map have registration errors (misalignment) within the current ArcGIS map workspace; likely from the translation between acetate topographic overlays, aerial images, and digitization into GIS. The misalignments are not consistent across the map which makes them difficult to identify and rectify.

This screenshot from Fremont Canyon is centered on an Annual Grassland polygon from 1992 with a small inclusion of Purple Sage delineated with orange lines. The same inclusion of *Salvia leucophylla* Alliance is delineated in the 2012 map, shown as transparent tan (1) within a larger *Stipa lepida* Alliance (perennial grassland) polygon in gray (2). The two sage polygons are offset from each other while in other areas the map boundaries seem more aligned.



1) *Salvia leucophylla* Alliance
2) *Stipa lepida* Alliance

A timeline of aerial imagery currently available online (Google Earth 2014) reaches back to 1994 and allows users to view the landscape as it looked just a few years after the 1992 map. From this imagery, it is possible to confirm that this inclusion of sage has remained stable over the past 20 years. Alignment errors make intersect analyses between the two maps difficult and results could include false differences between types due to spatial issues.

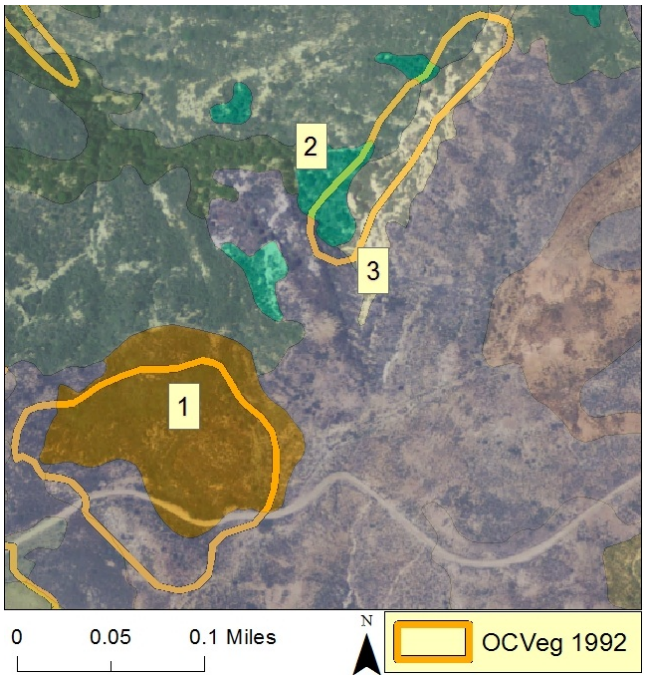
Change over time

It is well known that fire has a strong influence on plant community composition and species distribution within California (Sugihara et al. 2006). The Fire and Resource Assessment Program (FRAP) publishes a statewide geodatabase of fire perimeters that includes wildfire history, prescribed burns, and other fuel modification projects. This resource will allow users to better understand and interpret potential landscape-scale vegetation change between the two vegetation maps in Orange County. Within the 20 year span between the two mapping efforts, numerous fires have occurred mainly located in the foothill and montane zones of the Santa Ana Mountains. Variations in the frequency, intensity, and scale of these fires can significantly alter the patterns plant community regeneration.

One important, rare vegetation type in this region is the *Hesperocyparis forbesii* Alliance (Tecate Cypress), which forms stands along dry, exposed hillsides and ridgetops, stream banks, and arroyos. The species has a California Rare Plant Rank of 1B.1 (CNPS 2015) and is threatened by a short fire return interval, which destroys young trees before they are able to reproduce and/or build up adequate seed reserves. In 2006, a large fire swept over the northern-most population of Tecate cypress, damaging the majority of the mature individuals. The new 2012 map delineates only 38 acres of *Hesperocyparis forbesii* Alliance compared to 196 acres delineated in 1992 (<20% of the 1992 extent). Much of the area previously mapped as Tecate Cypress is now dominated by various shrub species. However, significant regeneration of the cypress has been observed, and this regeneration is documented in the 2012 map within the conifer density attribute (usually at low levels 2 -10%). The supplementary attributes for each polygon allow users to identify and quantify more than the existing vegetation type. In this case, visible cover of conifer is estimated regardless of the overall vegetation type.

In this screenshot from Gypsum Canyon, a small blobby stand of Southern Interior Cypress Forest was delineated in the 1992 map by the orange lines. In 2012, a similar polygon now denotes the stand as *Ceanothus tomentosus* (1, gold). Remaining patches of *Hesperocyparis forbesii* Alliance mapped in 2012 (2, teal) are embedded within a large Chamise polygon from 1992. Both maps recognize and delineate a similar linear un-vegetated polygon mapped as Xeric-Vascular Plant in 1992 and as Cliffs, Bluffs, etc. in 2012 (3, off-white).

1) ***Ceanothus tomentosus* Alliance**
2) ***Hesperocyparis forbesii* Alliance**
3) **Cliffs, Bluffs, Scree and Rock Outcrops**



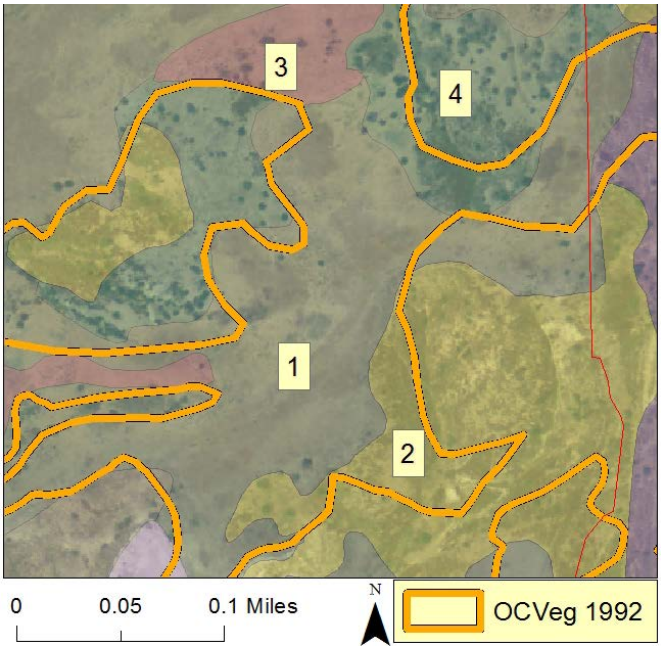
When directly comparing acreage of grasslands, the 1992 effort mapped 13,162 acres of grassland types, while the 2012 map totals 10,752 acres (see excerpted table from Appendix E below); i.e., the new map depicts approximately 2,400 fewer acres of grassland vegetation. Potential factors to explain these differences include finer-scale delineation in 2012, the use of different mapping rules between shrub and (ecotonal) grassland habitats between the maps, as well as an increase in shrub cover over time, especially post-fire. The 2012 map had a finer resolution of map units, recognizing three perennial alliances under two Groups, and seven Semi-Natural stand types, compared to the 1992 map which recognized five types.

1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
40000, 41200	Grassland Habitats	15	California Annual and Perennial Grassland MG	4000	7
40100	Annual grassland	11,843	California Annual and Perennial Grassland MG	4000	
40200	Elymus grassland	2	California perennial grassland Group	4100	59
40300	Southern coastal needlegrass grassland	180	California perennial grassland Group	4100	
			Stipa pulchra Alliance	4130	597
			Stipa lepida Alliance	4120	85
			Leymus condensatus Alliance	4110	2
40600	Ruderal	1,122	Mediterranean CA Naturalized Annual and Perennial Grassland Group	4200	8,775
			Avena (barbata, fatua) Semi-Natural Stands	4210	9
			Brassica nigra and other mustards Semi-Natural	4220	513
			Bromus (diandrus, hordeaceus) - Brachypodium distachyon Semi-Natural Stands	4230	84
			Cynara cardunculus Provisional Semi-Natural	4250	504
			Cortaderia (jubata, selloana) Semi-Natural	4260	16
			Lolium perenne Semi-Natural Stands	4280	2
			Erodium spp. Mapping Unit	4290	99
	Total Acres	**13,162**	**Total Acres**		**10,752**

Note: the completed 2015 map product has merged the Alliance level Semi-natural types into the Mediterranean Naturalized Grassland group, because the AA sampling and analysis found that these naturalized types change in dominant non-native species from year to year.

This screenshot in Irvine Q is centered upon a large Annual Grassland polygon delineated in 1992 with orange lines, which corresponds to a Mediterranean Grassland Group (tan, 1) mapped in 2012. On the eastern edges, a polygon of *Malosma laurina* (light green, 4) and a polygon of *Acmispon glaber* (yellow, 2) in 2012 overlap with the previous grassland polygon, reducing the original acreage. Also, insets of *Stipa pulchra* (pink, 3) show the finer scale distinctions between annual and perennial types in the 2012 map.

1) **Mediterranean Grassland Group**
2) ***Acmispon glaber* Alliance**
3) ***Stipa pulchra* Alliance**
4) ***Malosma laurina* Alliance**



While grassland acreage was less in 2012 than previously mapped, the Central and South Coastal Californian Seral Scrub Group shows a large increase in acreage between the two map efforts. The excerpted table from Appendix E below shows 179 acres mapped in 1992 as compared to more than 2,000 acres mapped in 2012. This Group includes drought-deciduous and evergreen shrubs that proliferate after disturbance, including alluvial processes, clearing, grazing, and fire. However, with a typical lifespan of 10-25 years, seral scrub stands often are replaced post-disturbance by other coastal and chaparral shrubs and trees that are longer-lived, including *Adenostoma fasciculatum*, *Artemisia californica*, *Eriogonum fasciculata*, and *Quercus agrifolia*. It is likely that the recent increases in fire frequency across Orange County has converted large acreages of habitat to seral scrub stands or to other non-native and ruderal types.

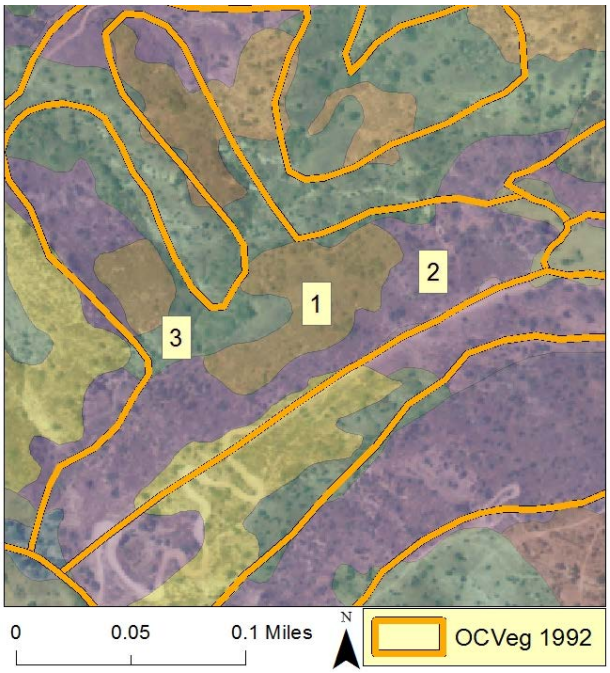
1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
			Central and South Coastal Californian seral scrub Group	3300	87
20804	Box springs goldenbrush-Grassland	15	*Ericameria palmeri* Alliance	3310	51
20803	Coastal goldenbush-Grassland	79	*Isocoma menziesii* Alliance	3330	38
			Acmispon glaber Alliance	3340	1,540
20311	Bush mallow sage scrub	85	*Malacothamnus fasciculatus* Alliance	3350	319
	Total Acres	**179**	**Total Acres**		**2,035**

Differences between seral scrub types across the two mapping efforts are likely a combination of factors including finer-scale delineation in 2012, classification differences, and change (gain or loss) over time due to fire and/or other disturbances and/or recovery from past disturbances. The classification differences are significant, especially within the *Acmispon glaber* (*Lotus scoparius*) Alliance (1,540 acres mapped in 2012), which was not recognized in 1992. This widespread species is a common component of different habitats. In the Jones & Stokes (1993) report it was recorded across Sage scrub-Grassland ecotone, Sagebrush-Buckwheat, White Sage, and Scalebroom types. In 2012 effort, the *Acmispon glaber* Alliance was mapped separately when it was the dominant shrub species (>60% relative cover).

Areas mapped in 1992 as Bush Mallow Sage Scrub included types co-dominated by *Salvia mellifera,* yet in 2012 mixed stands were classified and mapped under the *Salvia mellifera* Alliance. This and other complex relationships between the two mapping classifications make direct comparisons difficult.

This screenshot from Santiago Oaks Regional Park centers upon a Bush Mallow Sage Scrub polygon in 1992 with the orange lines. The 2012 map shows numerous patches of *Malacothamnus fasciculatus* (brown, 1) that correspond with the previous 1992 polygon. However, there are two other types delineated in 2012 including *Artemisia californica – Salvia mellifera* (purple, 2) and *Malosma laurina* (green, 3).

1) ***Malacothamnus fasciculatus*** **Alliance**
2) ***Artemisia californica – Salvia mellifera*** **Alliance**
3) ***Malosma laurina*** **Alliance**



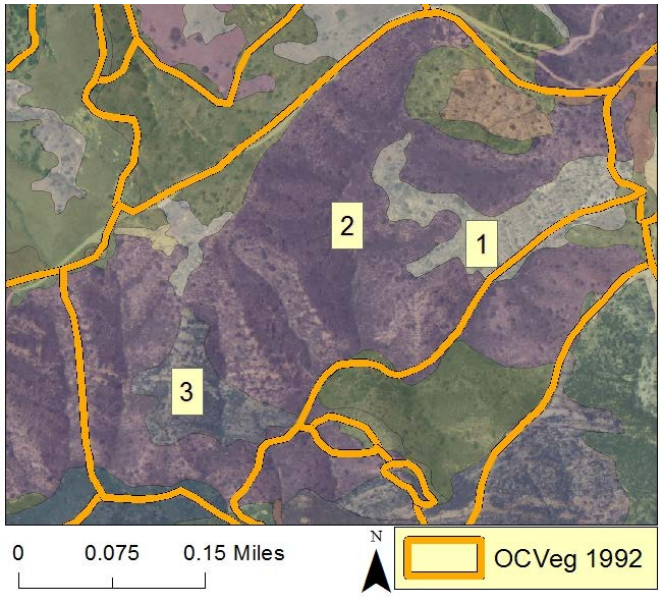
The most diverse and complex Group mapped in Orange County is the Coastal Sage Scrub Group which maintained equivalent acreage across the two mapping efforts. The crosswalk between map types is not a direct match; many types used in 1992 intersect with multiple alliances in the 2012 map and are thus best related at the NVC Group level (see excerpted table from Appendix E below). The hierarchical nature of the NVC allows the 2012 map to be displayed at both broad and fine scales which increases the uses and application of the map.

1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
20000, 20900	Scrub Habitats	70	Central & South Coastal Californian CSS Group	3100	1,085
20300	Venturan-Diegan transitional coastal sage scrub	1,941	Central & South Coastal Californian CSS Group	3100	
20500, 20505	Riversidian coastal sage scrub	317	Central & South Coastal Californian CSS Group	3100	
20310	Mixed sage scrub	2,644	Central & South Coastal Californian CSS Group	3100	
20800	Sage scrub-Grassland ecotone	487	Central & South Coastal Californian CSS Group	3100	
20306	Sagebrush scrub	2,863	*Artemisia californica* Alliance	3110	4,521
20801	Sagebrush-Grassland	434	*Artemisia californica* Alliance	3110	
20302	CA sagebrush-Orangebush monkey flower scrub	138	*Artemisia californica* Alliance	3110	
			Mimulus aurantiacus Alliance	3220	103
20301	CA sagebrush-CA buckwheat scrub	8,883	*Artemisia californica - Eriogonum fasciculatum* Alliance	3120	9,028
20308	Sagebrush-black sage	6,800	*Artemisia californica - Salvia mellifera* Alliance	3130	8,067
			Encelia californica Alliance	3140	200
20307	Buckwheat	111	*Eriogonum fasciculatum* Alliance	3150	934

1992 Code	1992 Vegetation Name	Acres	2012 Vegetation Name	2012 Code	Acres
20802	Buckwheat-Grassland	21	*Eriogonum fasciculatum* Alliance	3150	
			Eriogonum fasciculatum - Salvia apiana Alliance	3160	2
			Keckiella antirrhinoides Alliance	3170	17
20305	White sage	573	*Salvia apiana* Alliance	3180	215
20303	Purple sage	540	*Salvia leucophylla* Alliance	3190	409
20304	Black sage	1,347	*Salvia mellifera* Alliance	3210	2,171
	Total Acres	**27,169**	**Total Acres**		**26,752**

One type within the Coast Sage Scrub group that is easily recognizable using high-resolution aerial imagery is White Sage (*Salvia apiana* Alliance). The type had 573 acres delineated in 1992 and only 215 acres in 2012. The difference in acreage between the two maps is likely due to finer scale delineation in 2012 as illustrated below.

This screenshot from Fremont Canyon centers upon a White Sage polygon in 1992 with orange lines. The 2012 map shows small patches of *Salvia apiana* Alliance (white, 1) that correspond with the previous 1992 polygon. However, the majority of the polygon includes other types delineated in 2012 including a large acreage of *Artemisia californica – Salvia mellifera* (purple, 2) and *Adenostoma fasciculatum* (darker purple blue, 3), among others.



1) ***Salvia apiana* Alliance**
2) ***Artemisia californica – Salvia mellifera* Alliance**
3) ***Adenostoma fasciculatum* Alliance**

Polygons mapped as White Sage in 1992 intersect with more than 30 types used in 2012 consisting mostly of *Artemisia californica* and other mixed sagebrush Alliances. The table below lists 15 of the intersecting vegetation types from 2012 that overlap with at least 1% of the previously mapped White Sage habitat.

2012 Code	Vegetation Name	Percent
3110	*Artemisia californica* Alliance	27
3130	*Artemisia californica – Salvia mellifera* Alliance	23
3120	*Artemisia californica – Eriogonum fasciculatum* Alliance	19
3180	*Salvia apiana* Alliance	9
2210	*Malosma laurina* Alliance	5
2110	*Adenostoma fasciculatum* Alliance	4
1120	*Quercus agrifolia* Alliance	3
4200	Mediterranean CA Naturalized Annual and Perennial Grassland Group	2
4130	*Stipa pulchra* Alliance	1
3100	Central & South Coastal Californian CSS Group	1
2340	*Quercus berberidifolia* Alliance	1
9420	Cliff, bluffs, scree, and rock outcrop	1
2310	*Ceanothus tomentosus* Alliance	1
4120	*Stipa lepida* Alliance	1
	20 additional map units with a small overlap	3
	Total	**100%**

Differences in map classification, cover breaks, alignment, and scale of delineation make comparisons between the 1992 and 2012 maps difficult.

Discussion

The vegetation map based on 2012 imagery provides a new baseline for natural areas within Orange County. Accuracy assessment is an integral part of fine-scale mapping and the new map generally exceeded the accuracy standards set by the California state standards. The 2012 map units are based on the *Manual of California Vegetation* (MCV), which quantitatively summarizes local and regional studies into one source. Standardized definitions of vegetation types, which were interpreted and mapped for Orange County in 2012, are now comparable across numerous other standardized mapping projects in California that use the MCV classification, including Western Riverside County, Santa Monica Mountains, Palos Verdes peninsula, among others. Currently, about 1/3 of the state is mapped using these standards (CDFW 2015). The MCV also relates to the National Vegetation Classification Standards (NVC) with a goal that vegetation types and maps will be comparable across the nation.

The new vegetation map attempts to represent dominant vegetation, plant cover, and disturbance factors across the landscape. Eleven of the 80+ vegetation types were mapped without representative classification field surveys, including alliance or association level map units of *Adenostoma fasciculatum - Salvia mellifera*, *Arundo donax*, *Bebbia juncea*, *Bolboschoenus maritimus*, *Distichlis spicata*, *Erodium* spp., *Lepidium latifolium*, *Populus fremontii*, *Quercus dumosa*, *Schoenoplectus californicus*, and *Scirpus robustus*. Though some

of these types have been sampled in other regions of the state, these types could be prioritized for additional sampling to capture and confirm their variation within Orange County.

Conversely, about 14 vegetation types were not represented in the 2012 map, though they were recognized through recent classification surveys (AECOM, 2013). These include types that may only occur in small patches below the map's set minimum mapping unit (~1 acre), such as *Lycium californicum* and *Muhlenbergia rigens* Alliances. These finer scale patterns of plants as well as rare species such as *Nolina cismontana* will need additional surveying and/or monitoring methods to track change over time as they are not represented in the current map.

A preliminary comparison of the new 2012 vegetation map to the existing 1992 vegetation map is presented in the results section. Both of the mapping efforts represent single snapshots in time with unique interpretations of the distribution of vegetation in the County. These two map resources allow users to better understand and interpret vegetation patterns across the region. However, differences between the two maps are not straightforward. Careful map interpretation will be needed to differentiate actual changes in vegetation composition from differences in classification, map scale, and resolution of delineation.

Some important vegetation types, such as the *Hesperocyparis forbesii* Alliance, will need additional research and analyses to better understand spatial turnover. The availability of two vegetation maps and the accessibility of a timeline for aerial imagery online (Google Earth 2014) make these types of study more feasible. A regular interval (e.g., decadal) of re-mapping in Orange County, using standardized mapping and classification methodologies, will allow direct comparisons of change over time. Additional attributes assigned to each polygon within the 2012 map add value for additional analyses, including the ability to analyze change in vegetative cover over time or to analyze habitat characteristics for specific wildlife species.

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Appendix A

Allocation Table

Veg Code	Polygon Count	Goal	Priority Rank	Number Allocated	Vegetation Name
1120	791	20	3	29	*Quercus agrifolia* Alliance
1210	46	5	2	5	*Hesperocyparis forbesii* Alliance
1410	2	2	1	2	*Pseudotsuga macrocarpa* Alliance
1510	55	5	2	14	*Eucalyptus (globulus, camaldulensis)* Semi-Natural
1610	4	3	1	3	*Alnus rhombifolia* Alliance
1710	151	5	2	10	*Platanus racemosa* Alliance
1720	67	5	2	15	*Salix gooddingii* Alliance
1730	27	5	2	9	*Salix laevigata* Alliance
1740	8	2	1	2	*Populus fremontii* Alliance
1810	311	10	3	17	*Baccharis salicifolia* Alliance
1820	250	5	2	10	*Salix lasiolepis* Alliance
1830	124	5	2	12	*Sambucus nigra* Alliance
1910	45	5	2	12	*Arundo donax* Alliance
2001	13	3	2	3	*A. fasciculatum-A. glandulosa* Mapping Unit
2100	25	5	2	9	California Xeric Chaparral Group
2101	80	5	2	10	*C. crassifolius - A. fasciculatum* Mapping Unit
2110	277	10	3	15	*Adenostoma fasciculatum* Alliance
2120	3	3	1	2	*Ceanothus crassifolius* Alliance
2130	67	5	2	7	*Ceanothus megacarpus* Alliance
2140	133	5	2	10	*Adenostoma fasciculata - Salvia mellifera* Alliance
2210	518	10	3	16	*Malosma laurina* Alliance
2220	256	10	3	17	*Rhus integrifolia* Alliance
2230	44	5	2	10	*Quercus dumosa* Association
2300	10	5	2	6	Californian mesic chaparral Group
2310	20	5	2	7	*Ceanothus tomentosus* Alliance
2320	1	1	1	1	*Cercocarpus montanus* Alliance
2330	55	5	2	9	*Heteromeles arbutifolia* Alliance
2340	292	10	3	15	*Quercus berberidifolia* Alliance
2350	29	5	2	10	*Quercus berberidifolia - Adenostoma fasciculatum*
2410	1	1	1	1	*Arctostaphylos glandulosa* Alliance
3100	162	5	2	10	Central & South Coastal Californian CSS Group
3110	783	20	3	28	*Artemisia californica* Alliance
3120	1033	30	3	37	*Artemisia californica - Eriogonum fasciculatum* Alliance
3130	806	20	3	27	*Artemisia californica - Salvia mellifera* Alliance
3140	55	5	2	8	*Encelia californica* Alliance
3150	225	5	2	11	*Eriogonum fasciculatum* Alliance
3170	7	1	1	1	*Keckiella antirrhinoides* Alliance
3180	69	5	2	17	*Salvia apiana* Alliance
3190	51	5	2	8	*Salvia leucophylla* Alliance
3210	297	10	3	15	*Salvia mellifera* Alliance

Veg Code	Polygon Count	Goal	Priority Rank	Number Allocated	Vegetation Name
3220	29	5	2	8	*Mimulus aurantiacus* Alliance
3300	17	5	2	12	Central and South Coastal Californian seral scrub Group
3310	22	5	2	7	*Ericameria palmeri* Alliance
3330	10	5	1	6	*Isocoma menziesii* Alliance
3340	181	10	2	13	*Acmispon glaber* Alliance
3350	87	5	2	10	*Malacothamnus fasciculatus* Alliance
3410	51	5	2	8	*Acacia (cyclops)* Semi-Natural Stands
4110	3	3	1	3	*Leymus condensatus* Alliance
4120	24	5	2	9	*Stipa lepida* Alliance
4130	196	5	2	10	*Stipa pulchra* Alliance
4200	1229	30	3	40	Mediterranean CA Naturalized Annual and Perennial Grassland Group
4220	98	5	2	14	*Brassica nigra* and other mustards Semi-Natural Stands
4250	53	5	2	8	*Cynara cardunculus* Provisional Semi-Natural Stands
4260	15	4	1	4	*Cortaderia (jubata, selloana)* Semi-Natural Stands
5210	26	5	2	8	*Toxicodendron diversilobum* Alliance
5310	83	10	2	22	*Baccharis pilularis* Alliance
5410	13	3	1	3	*Carpobrotus edulis* or other Ice Plant Semi-Natural Stands
6110	10	5	1	5	*Schoenoplectus acutus* Alliance
6120	34	5	2	9	*Typha (angustifolia, domingensis, latifolia)* Alliance
6130	50	5	2	9	*Schoenoplectus californicus* Alliance
6140	1	1	1	1	*Scirpus robustus* Association
6310	13	3	1	3	*Lepidium latifolium* Semi-Natural Stands
7100	35	4	2	4	Temperate Pacific Tidal Salt & Brackish Meadow GP
7110	68	5	2	5	*Sarcocornia pacifica (Salicornia depressa)* Alliance
7120	93	5	2	5	*Spartina foliosa* Alliance
7130	31	5	2	6	*Bolboschoenus maritimus* Association
7140	2	2	1	2	*Distichlis spicata* Alliance
7210	8	5	1	5	*Atriplex lentiformis* Alliance
8110	9	3	1	3	*Lycium californicum* Provisional Alliance
8120	146	5	2	10	*Opuntia littoralis* Alliance
8210	28	5	2	9	*Lepidospartum squamatum* Alliance
SUM		**449**		**711**	

Appendix B

CNPS Accuracy Assessment Field Form

Field Verification Form: Orange County Vegetation Mapping (2/25/2014)

Surveyors (circle recorder):	**Date:**
Base Waypoint ID: **Polygon UID:**	**GPS name:** **Projected? Yes / No** **Bearing: _____(degrees) Distance: _____ (meters) Inclination:_____ (degrees)** Base UTMs UTME_____ UTMN _____ Projected UTMs UTME _____ UTMN _____ PDOP: +/-

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover

Notes: (including # and type of roads, recommendations for line-work revision, state of veg. "discernability" based on season and topography, classification interpretation, homogeneity and unusual sightings of plants or animals)	
Map Unit (code and name)	
Camera Name/Photo #s	
Conifer Cover	None >0-1% 2-9% 10-24% 25-39% 40-59% >60% NA
Hardwood Cover	None >0-1% 2-9% 10-24% 25-39% 40-59% >60% NA
Total Tree Cover	None >0-1% 2-9% 10-24% 25-39% 40-59% >60% NA
Shrub Cover	None >0-1% 2-9% 10-24% 25-39% 40-59% >60% NA
Herb Cover	<20% >20-40% >40% NA
Exotics	None or not visible Low (<33%) Medium (33-66%) High (>66%) Not Applicable
Human Disturbance/Roadedness (not fire)	None or not visible Low (<33%) Medium (33-66%) High (>66%) Not Applicable
Percent of delineated poly viewed	rough % of polygon viewed from this point _____
% of the delineated polygon occupied by stand?	rough % of polygon covered by type _____; Denote any other types in notes above
Is this a "multiple" point assessment?	NO YES if yes: _____ of ____ points for this polygon
If 'multiple point', what is est. % viewed total for this stand?	_____% Is/are the other point(s) a different veg type? Yes No

Field Verification Form: Orange County Vegetation Mapping

(2/04/2014)

Surveyors (circle recorder): (TJB), SMT — **Date:** 3/18/14

Base Waypoint ID: 1095

Projected Waypoint ID: ———

Polygon UID: 1095

GPSname: 5 **Projected? Yes / No**

Bearing: ____ (degrees) **Distance:** ____ (meters) **Inclination:** ____ (degrees)

Base UTMs UTME 435354 UTMN 3725675

Projected UTMs UTME ———— UTMN ———— PDOP: +/- 2.7

Strata	Species	% cover	Strata	Species	% cover	Strata	Species	% cover
S	Baccharis salicifolia	15	T	Salix (goodingii)	+			
S	Sambucus nigra	18	T	Eucalyptus sp.	+			
S	Toxicodendron div.	2	S	Croton calif.	+			
T	Platanus racemo	+	H	Brassicaceae	4			

Notes: (including # and type of roads, recommendations for line-work revision, state of veg. "discernability" based on season and topography, classification interpretation, homogeneity and unusual sightings of plants or animals)

Long, narrow riparian shrub stand. Mixed composition but regular occurrence of BASAf co-dominance w/large Sambucus. Individuals of Sycamore, Salix + Eucalyptus. Other shrubs @ low cover. Stand next to an active sandy channel.

Map Unit (code and name)	1610 Baccharis salicifolia - Sambucus nigra
Camera Name/Photo #s	CAM2; 3539-3542 (NJ)
Conifer Cover	(None) >0-1% 2-9% 10-24% 25-39% 40-59% >60% NA
Hardwood Cover	None (>0-1%) 2-9% 10-24% 25-39% 40-59% >60% NA
Total Tree Cover	None (>0-1%) 2-9% 10-24% 25-39% 40-59% >60% NA
Shrub Cover	None >0-1% 2-9% 10-24% (25-39%) 40-59% >60% NA
Herb Cover	(≤20%) >20-40% >40% NA
Exotics	None or not visible (Low (<33%)) Medium (33-66%) High (>66%) Not Applicable
Disturbance/Roadedness	(None or not visible) Low (<33%) Medium (33-66%) High (>66%) Not Applicable
Percent of delineated poly viewed	rough % of polygon viewed from this point 100
% of the delineated polygon occupied by stand?	rough % of polygon covered by type 100 ; Denote any other types in notes above —
Is this a "multiple" point assessment?	(NO) YES if yes: ____ of ____ points for this polygon
If 'multiple point', what is est. % viewed total for this stand?	____ % Is/are the other point(s) a different veg type? Yes No

Appendix C

Hierarchical Vegetation Field and Mapping Key

Orange County Vegetation Classification

Example Terms and Concepts Used Throughout the Key:

Dominance by layer: Tree, shrub, and herbaceous layers are considered physiognomically distinct. A vegetation type is considered to belong to a certain physiognomic group if it is dominated by one layer. Layers are prioritized in order of height when naming the type.

Dominant: Dominance refers to the preponderance of vegetation cover in a stand of uniform composition and site history. It may refer to cover of an individual species (as in "dominated by *Quercus agrifolia*"), or it may refer to dominance by a physiognomic group, as in "dominated by shrubs." Dominance refers to the relative cover of one species or physiognomic group as compared to another species or physiognomic group.

Co-dominant: Co-dominance refers to two or more species in a stand that share dominance and have between 30 and 60 percent relative cover each.

Cover: The primary metric used to quantify the importance/abundance of a particular species or a particular vegetation layer within a stand. It is measured by estimating the aerial extent of the living plants, or the bird's-eye view looking from above, for each category. Cover in this project uses the concept of "porosity" or foliar cover rather than "opacity" or crown cover.

Relative cover: Refers to the amount of the surface of the plot or stand sampled that is covered by one species (or physiognomic group) as compared to (relative to) the amount of surface of the plot or stand covered by all species (in that group). Thus, 50 percent relative cover means that half of the total cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are proportional numbers and, if added, total 100 percent for each stand (sample).

Absolute cover: Refers to the actual percentage of the ground (surface of the plot or stand) that is covered by a species or group of species. For example, *Artemisia californica* covers between 5 percent and 10 percent of the stand. Absolute cover of all species or groups if added in a stand or plot may total greater or less than 100 percent because it is not a proportional number.

Characteristic/Diagnostic species: Must be present in at least 80 percent of the classification samples, with no restriction on cover.

Often/Usually occurring species: Must be present in at least 50 percent of the classification samples, with no restriction on cover.

( ): The use of ( ) in an Alliance or Association name denotes that the species in parentheses may or may not be present, if present it may act as merely an indicator with low cover (e.g. *Adenostoma fasciculatum* – (*Ceanothus crassifolius*))

Sparse: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is less than 8 percent absolute cover.

Trace: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is less than 5 percent absolute cover.

Open: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is generally less than 33 percent absolute cover.

Stand: Is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small such as wetland seeps, and some may be several square kilometers in size such as desert or forest types. A stand is defined by two main unifying characteristics:

a. It has *compositional* integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or gradual.

b. It has *structural* integrity. It has a similar history or environmental setting, affording relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest formerly dominated by the same species but has burned on the upper part of the slope and not the lower is divided into two stands. Likewise, a sparse woodland occupying a slope with shallow rocky soils is considered a different stand from an adjacent slope of a denser woodland/forest with deep, moister soil and the same species.

Tree: Is a one-stemmed woody plant that normally grows to be greater than 5 meters tall. In some cases, trees may be multiple stemmed following a fire or other disturbance, but the size of mature plants is typically greater than 5 meters. Undisturbed individuals of these species are usually single stemmed.

Shrub: Is normally a multi-stemmed woody plant that is usually between 0.2 meters and 5 meters tall. Definitions are blurred at the low and high ends of the height scales. At the tall end, shrubs may approach trees based on disturbance frequencies (e.g., old-growth re-sprouting chaparral species such as *Cercocarpus betuloides, Fraxinus dipetala, Heteromeles arbutifolia, Prunus ilicifolia,* and so forth, may frequently attain "tree size"). At the short end, woody perennial herbs or subshrubs of various species are often difficult to categorize into a consistent life-form.

Herbaceous plant: Is any species of plant that has no main woody stem development and includes grasses, forbs, and dieback perennial species.

Key to vegetation types in Orange County, California

Class A. Vegetation characterized by an even distribution of overstory trees. Tree canopy is generally greater than 10%, but occasionally may be less than 10% over a denser understory of shrub and/or herbaceous species = **Tree-Overstory (Woodland / Forest Vegetation)**

Class B. Vegetation characterized by woody shrubs in the canopy. Shrubs are usually at least 10% cover. Tree species, if present, generally total less than 10% absolute cover and herbaceous species may total higher cover than shrubs = **Shrubland Vegetation**

Class C. Vegetation characterized by non-woody, herbaceous species in the canopy including grass, graminoid, and broad-leaved herbaceous species. Shrubs, if present, usually comprise <10% of the vegetation. Trees, if present, generally compose <10% cover **= Herbaceous Vegetation**

Class A. Tree-Overstory (Woodland / Forest Vegetation)

Section I: Woodlands and forests characterized by needle or scale-leaved conifer trees.

1. Vegetation dominated or co-dominated by a species of *Pinus*.

1a. *Pinus coulteri* is co-dominant to dominant in the tree overstory, sometimes with well-developed understory shrub layers.

***Pinus coulteri* Alliance (1230)**
Pinus coulteri / *Arctostaphylos glandulosa* – *Quercus wislizeni* Association
Pinus coulteri – *Quercus wislizeni* Association

1b. *Pinus attenuata* is co-dominant to dominant in the tree overstory. *Pinus coulteri* may be present and sub-dominant.

***Pinus attenuata* Alliance (1220)**
Pinus attenuata / Arctostaphylos glandulosa Association

2. Vegetation dominated or co-dominated by *Hesperocyparis* or *Pseudotsuga*, sometimes with co-dominant *Quercus* spp.

2a. *Pseudotsuga macrocarpa* is co-dominant to dominant in the tree overstory, usually with >30% relative cover. In Orange County, *Quercus agrifolia*, *Q. chrysolepis*, and *Q. wislizeni* may be found intermixing as co-dominant trees.

***Pseudotsuga macrocarpa* Alliance (1410)**
Pseudotsuga macrocarpa – *Quercus agrifolia* Association
Pseudotsuga macrocarpa – *Quercus chrysolepis* Association

2b. *Hesperocyparis forbesii* has >30% relative cover in the tree overstory or is emergent above a shrub canopy, typically with at least 5% cover.

***Hesperocyparis forbesii* Alliance (1210)**
Hesperocyparis forbesii Association

Section II. Woodlands, forests, and riparian shrublands characterized mainly by native and non-native broad-leaved evergreen and deciduous trees, as well as riparian shrub species. Includes *Acer*, *Alnus*, *Baccharis salicifolia, Eucalyptus, Juglans, Platanus, Quercus*, *Salix*, *Sambucus*, *Schinus*, and *Myoporum*.

3. Stands characterized by a species of *Acer, Juglans*, and/or *Quercus*.

3a. *Acer macrophyllum* is co-dominant or dominant in the tree overstory, occurring alone or with *Quercus chrysolepis.*

***Acer macrophyllum* Alliance (1310)**
Acer macrophyllum Association

3b. *Juglans californica* dominates in the tree overstory or co-dominates with *Quercus agrifolia*.

***Juglans californica* Alliance (1110)**
Juglans californica / annual herbaceous Association

3c. Stands not as above and with a species of *Quercus* dominating or co-dominating in the tree canopy.

3a1. *Quercus chrysolepis* dominates in the tree overstory, often with >50% relative cover. If present, *Pseudotsuga macrocarpa* is sub-dominant.

***Quercus chrysolepis* tree Alliance (1130)**
Quercus chrysolepis Association

3a2. *Quercus agrifolia* dominates in the tree overstory, usually with >50% relative cover and >10% absolute cover.

***Quercus agrifolia* Alliance (1120)**
Quercus agrifolia / Artemisia californica Association
Quercus agrifolia / grass Association
Quercus agrifolia / Quercus (berberidifolia, x *acutidens*) Association
Quercus agrifolia / *Salix lasiolepis* Association
Quercus agrifolia / *Toxicodendron diversilobum* / grass Association

4. Stands characterized by native riparian/wash trees and tall shrubs, including *Alnus, Platanus, Salix, Baccharis salicifolia*, and *Sambucus*. *Quercus agrifolia* may intermix as a sub- to co-dominant tree.

4a. Riparian/wash vegetation with an overstory characterized by trees.

4a1. *Alnus rhombifolia* dominates or co-dominates in the tree overstory. In Orange County, *Acer macrophyllum* and *Platanus racemosa* are two of the more common tree species that intermix as sub-dominant trees.

***Alnus rhombifolia* Alliance (1610)**
Alnus rhombifolia – Acer macrophyllum Association
Alnus rhombifolia – Platanus racemosa Association

4a2. *Salix gooddingii* dominates or co-dominates in the tree overstory as the sole dominant or with other tree species of *Salix*.

***Salix gooddingii* Alliance (1720)**

Salix gooddingii Association

4a3. *Salix laevigata* dominates in the tree overstory. *Salix lasiolepis* may intermix in the sub-canopy and sometimes exceeds *S. laevigata* in cover.

***Salix laevigata* Alliance (1730)**
Salix laevigata Association
Salix laevigata – Salix lasiolepis Association

4a4. *Platanus racemosa* dominates or co-dominates in the tree overstory as the sole dominant or with *Quercus agrifolia, Salix* spp., or *Populus fremontii* intermixing as co-dominants in the canopy.

***Platanus racemosa* Alliance (1710)**
Platanus racemosa / annual grass Association
Platanus racemosa – Quercus agrifolia Association

4a5. *Populus fremontii* dominates or co-dominates in the tree overstory with *Salix* spp., if *Platanus racemosa* is present it has <30% relative cover in the overstory.

***Populus fremontii* Alliance (1740)**

4b. Riparian/wash vegetation with an overstory characterized by tall shrubs.

4b1. *Salix lasiolepis* dominates or co-dominates with *Baccharis salicifolia* in the shrub/tree canopy.

***Salix lasiolepis* Alliance (1820)**
Salix lasiolepis Association
Salix lasiolepis / Baccharis salicifolia Association

4b2. *Baccharis salicifolia* dominates or co-dominates with *Sambucus nigra* in the shrub overstory.

***Baccharis salicifolia* Alliance (1810)**
Baccharis salicifolia Association
Baccharis salicifolia – Sambucus nigra Association (not yet observed)

4b3. *Sambucus nigra* dominates or co-dominates with *Baccharis pilularis* in the shrub overstory.

***Sambucus nigra* Alliance (1830)**
Sambucus nigra Association

5. Stands are characterized by high relative cover of non-native trees, including species of *Acacia, Eucalyptus, Schinus*, and *Myoporum*.

5a. A species of *Eucalyptus* dominates in the tree overstory.

***Eucalyptus* (*globulus, camaldulensis*) Semi-Natural Stands (1510)**

5b. A species of *Schinus* or *Myoporum laetum* dominates in the tree/shrub overstory, usually with >60% relative cover.

***Schinus* (*molle, terebinthifolius*) – *Myoporum laetum* Semi-Natural Stands (1520)**

5c. A species of *Acacia* dominates stands, with no other native tree/shrub species having significant cover.

***Acacia cyclops* (or other *Acacias*) Semi-Natural Stands (3410)**

Class B. Shrubland Vegetation

Section III. Shrublands dominated by sclerophyllous, evergreen shrubs in upland settings.
[Note: Throughout the study area, *Rhus integrifolia* and/or *Malosma laurina* may be present with the highest cover in shrub stands, but neither species is considered a useful diagnostic species, as they are both ubiquitous across chaparral and coastal scrub settings. *Rhus integrifolia* and *Malosma laurina* Alliances are distinguished only when either species is strongly dominant and other shrub species are trace or strongly sub-dominant.]

6. A species of scrub oak, *Quercus berberidifolia, Q. dumosa* or *Q. wislizeni*, dominates or shares dominance with other chaparral species in the shrub overstory.

6a. *Quercus berberidifolia* and *Adenostoma fasciculatum* share dominance in the shrub overstory, often co-occurring with a variety of sub-dominant chaparral and/or coastal scrub species. If either *Q. berberidifolia* or *A. fasciculatum* is sub-dominant to the other species, key to the alliance of the dominant species.

***Quercus berberidifolia – Adenostoma fasciculatum* Alliance (2350)**
Quercus berberidifolia – Adenostoma fasciculatum Association

6b. *Quercus berberidifolia* and/or *Quercus dumosa* intermix with a variety of shrubs as either the dominant species or sharing dominance with *Cercocarpus montanus*, *Ceanothus* spp., *Fraxinus dipetala* or *Arctostaphylos glandulosa*. [Note: *Fraxinus dipetala* may occasionally be dominant to *Q. berberidifolia* in this alliance].

***Quercus berberidifolia* Alliance (2340)**
Quercus berberidifolia Association
Quercus berberidifolia – Ceanothus tomentosus Association
Quercus berberidifolia – Fraxinus dipetala – Heteromeles arbutifolia Association
Quercus dumosa Association (2230)

6c. *Quercus wislizeni* occurs as the dominant shrub or may be co-dominant with *Arctostaphylos glandulosa* or *Fraxinus dipetala* in the overstory [Note: *Fraxinus dipetala* may occasionally be dominant to *Q. wislizeni* in this alliance].

***Quercus wislizeni* shrub Alliance (2420)**
Quercus wislizeni – Arctostaphylos glandulosa Association

7. Vegetation not as in 6 and with a species of *Ceanothus* dominating or sharing dominance with other chaparral or disturbance following species in the shrub overstory.

7a. *Ceanothus megacarpus* is dominant in the shrub overstory (Note: Some *Ceanothus* individuals in these stands may bear similarities with *C. verrucosus* of coastal San Diego Co.).

***Ceanothus megacarpus* Alliance (2130)**
Ceanothus megacarpus Association

7b. *Ceanothus tomentosus* intermixes with a variety of shrubs as either the dominant species or sharing dominance with disturbance following species such as *Helianthemum scoparium* or *Eriodictyon crassifolium* in the overstory.

***Ceanothus* (*oliganthus*, *tomentosus*) Alliance (2310)**
Ceanothus tomentosus Association

7c. *Ceanothus crassifolius* is the dominant shrub species or may be co-dominant with *Adenostoma fasciculatum* in the overstory.

***Ceanothus crassifolius* Alliance (2120)**
Ceanothus crassifolius Association
Ceanothus crassifolius – Adenostoma fasciculatum – Malosma laurina Association (2101)

8. Vegetation not as in 6 and 7 and with *Adenostoma fasciculatum* and/or *Arctostaphylos glandulosa* characterizing the shrub overstory, sometimes sharing dominance with disturbance following species.

8a. *Arctostaphylos glandulosa* is the dominant shrub species or may be co-dominant with *Adenostoma fasciculatum* in the overstory.

***Arctostaphylos glandulosa* Alliance (2410)**
Arctostaphylos glandulosa Association
Arctostaphylos glandulosa – Adenostoma fasciculatum Association **(2001)**

8b. *Adenostoma fasciculatum* is co-dominant with *Salvia mellifera* in the shrub canopy where both species have between 30% and 60% relative cover.

***Adenostoma fasciculatum – Salvia mellifera* Alliance (2140)**

8c. *Adenostoma fasciculatum* intermixes with a variety of shrubs as either the dominant species or it shares dominance disturbance following species such as *Helianthemum scoparium*, *Acmispon glaber* (*Lotus scoparius*), and *Eriodictyon crassifolium*. Sub-dominant shrubs may include *Arctostaphylos glandulosa, Eriogonum fasciculatum*, *Artemisia californica*, *Salvia mellifera*, *Quercus berberidifolia*, *Ceanothus crassifolius*, and others.

***Adenostoma fasciculatum* Alliance (2110)**
Adenostoma fasciculatum Association
Adenostoma fasciculatum – (*Arctostaphylos glandulosa*) Association
Adenostoma fasciculatum – (*Eriogonum fasciculatum*, *Artemisia californica*, *Salvia mellifera*) Association
Adenostoma fasciculatum – (*Ceanothus crassifolius*) Association
Adenostoma fasciculatum – Acmispon glaber Association
Adenostoma fasciculatum – Malosma laurina – Eriodictyon crassifolium Association

9. Stands not as above in 6-8 and characterized by *Cercocarpus montanus*, *Fraxinus dipetala*, *Heteromeles arbutifolia*, *Malosma laurina* or *Rhus integrifolia*.

9a. *Heteromeles arbutifolia* intermixes with a variety of shrubs as either the dominant species or it shares dominance with *Baccharis pilularis*, *Encelia californica*, *Fraxinus dipetala,* or *Rhus integrifolia.* [Note: *F. dipetala* may occasionally be dominant to *H. arbutifolia* in this alliance].

***Heteromeles arbutifolia* Alliance (2330)**

9b. *Cercocarpus montanus* is the dominant shrub species or may be co-dominant with *Eriogonum fasciculatum* or *Fraxinus dipetala* in the overstory. [Note: *Fraxinus dipetala* may occasionally be dominant to *C. montanus* in this alliance].

***Cercocarpus montanus* Alliance (2320)**
Cercocarpus montanus var. *glaber* Association

9c. *Malosma laurina* is strongly dominant or may share dominance with *Acmispon glaber*. Please see note under Section III description.

***Malosma laurina* Alliance (2210)**
Malosma laurina Association
Malosma laurina – Acmispon glaber Association

9d. *Rhus integrifolia* is strongly dominant, usually with >50% relative cover. If *Heteromeles arbutifolia* is present as a co-dominant shrub, key to the *Heteromeles arbutifolia* Alliance. See note under the Section III description for guidelines on mapping the *Rhus integrifolia* Alliance.

***Rhus integrifolia* Alliance (2220)**
Rhus integrifolia Association

9e. If *Fraxinus dipetala* is dominant or co-dominant with *Heteromeles arbutifolia, Cercocarpus montanus* var. *glaber, Quercus berberidifolia* or *Q. wislizeni*, key to the most appropriate alliance of the four latter species by following the appropriate key steps above. A *Fraxinus dipetala* Alliance is not supported by data collected to date in Southern California.

Section IV. Shrublands dominated mainly by soft-leaved, deciduous, or succulent shrubs that are microphyllous or broad-leaved. This vegetation is generally considered to be part of coastal sage scrub or other more soft-leaved shrub habitats. Chaparral species may be present, but are not dominant. [Please see note regarding *Malosma laurina* and *Rhus integrifolia* under Section III description].

10. Stands characterized by *Bebbia juncea, Eriodictyon crassifolium,* or *Lepidospartum squamatum*. The latter two species may be sub-dominant to other shrubs.

10a. *Lepidospartum squamatum* is characteristically present (may be low cover) to dominant along washes, intermixing with variable cover (sometimes much higher) of species such as *Eriogonum fasciculatum, Artemisia californica, Baccharis salicifolia, Brickellia californica*, and others.

***Lepidospartum squamatum* Alliance (8210)**
Lepidospartum squamatum – Eriogonum fasciculatum Association

10b. *Bebbia juncea* dominates in the shrub overstory along washes or on south-facing slopes with rocky substrate. *Pennisetum setaceum* had similar cover to *Bebbia* in the one stand encountered in the study area.

***Ambrosia salsola* Alliance**
Bebbia juncea Provisional Association (8220)

10c. *Eriodictyon crassifolium* dominates in the shrub overstory along alluvial washes or in post-burn areas.

***Eriodictyon crassifolium* Provisional Alliance (no MU)**
Eriodictyon crassifolium Provisional Association

11. Stands with *Atriplex lentiformis, Baccharis pilularis*, or *Toxicodendron diversilobum* as dominant or co-dominant species.

11a. *Baccharis pilularis* is dominant or may share dominance with *Artemisia californica* or *Isocoma menziesii*.

***Baccharis pilularis* Alliance (5310)**
Baccharis pilularis/Herbaceous Association
Baccharis pilularis – Artemisia californica Association

11b. *Atriplex lentiformis* is dominant in the shrub canopy.

***Atriplex lentiformis* Alliance (7210)**
Atriplex lentiformis Association

11c. *Toxicodendron diversilobum* is dominant or co-dominant with *Artemisia californica* and *Leymus condensatus*. If *Rhus integrifolia* and *Heteromeles arbutifolia* intermix with moderate cover, key to this alliance.

***Toxicodendron diversilobum* Alliance (5210)**
Toxicodendron diversilobum – Artemisia californica / *Leymus condensatus* Association

12. A shrub species of *Salvia* is dominant or co-dominant with *Artemisia californica* or *Eriogonum fasciculatum* in the shrub overstory.

12a. *Salvia apiana* is dominant or co-dominant with *Artemisia californica* or *Diplacus aurantiacus* in the overstory.

***Salvia apiana* Alliance (3180)**
Salvia apiana Association
Salvia apiana – Artemisia californica Association

12b. *Salvia leucophylla* is dominant or co-dominant with *Artemisia californica* in the overstory.

***Salvia leucophylla* Alliance (3190)**
Salvia leucophylla Association
Salvia leucophylla – Artemisia californica Association

12c. *Salvia mellifera* occurs is dominant or co-dominant with *Eriogonum fasciculatum* in the overstory. A variety of sub-dominant shrubs may intermix, including *Artemisia californica, Malacothamnus fasciculatus*, and others.

***Salvia mellifera* Alliance (3210)**
Salvia mellifera Association
Salvia mellifera – Eriogonum fasciculatum Association
Salvia mellifera – Malosma laurina Association

12d. *Salvia mellifera* is co-dominant with *Adenostoma fasciculatum* in the shrub canopy where both species have between 30% and 60% relative cover.

***Adenostoma fasciculatum – Salvia mellifera* Alliance (2140)**

12e. *Artemisia californica* and *Salvia mellifera* occur as co-dominants in the overstory, co-occurring with a variety of sub-dominant shrubs. *Rhus integrifolia* and/or *Malosma laurina* may be present

with the highest cover, but neither species is considered a useful diagnostic species, being that they are both ubiquitous across the study area, occupying both chaparral and coastal sage settings. Such stands should be types to this alliance.

Artemisia californica – Salvia mellifera **Alliance (3130)**
Artemisia californica – Salvia mellifera Association

12f. *Eriogonum fasciculatum* and *Salvia apiana* share dominance, often intermixing with other shrub species such as *Artemisia californica*.

Eriogonum fasciculatum – Salvia apiana **Alliance (3160)**
Eriogonum fasciculatum – Salvia apiana Association

13. Stands dominated by either *Keckiella antirrhinoides* or *Encelia californica* or with either species co-dominant with *Artemisia californica*.

13a. *Keckiella antirrhinoides* is dominant or co-dominant with *Artemisia californica.*

Keckiella antirrhinoides **Alliance (3170)**
Keckiella antirrhinoides – Artemisia californica Association

13b. *Encelia californica* is dominant or co-dominant with *Artemisia californica*.

Encelia californica **Alliance (3140)**
Encelia californica Association
Encelia californica – Artemisia californica Association

14. Vegetation not as above and characterized by *Artemisia californica*, *Diplacus aurantiacus*, *Eriogonum fasciculatum, Lycium californicum, Opuntia littoralis, Opuntia oricola*, and/or *Salvia mellifera*. If *Mirabilis laevis* and/or *Salvia columbariae* characterize open stands with *E. fasciculatum*, skip to 14g below. (Note: These are south facing hotter and well drained rocky or gravelly slopes usually inland.)

14a. *Lycium californicum* is dominant, co-dominant or characteristically present with a mixture of other shrubs and herbs, including *Suaeda taxifolia, Cylindropuntia prolifera, Atriplex* spp., and others. Even if *Rhus integrifolia* has significantly higher cover than *L. californicum*, key to this alliance.

Lycium californicum **Alliance (8110)**
Lycium californicum Association

14b. *Opuntia littoralis* OR *Opuntia oricola* occurs as the dominant shrub or co-dominates with *Eriogonum fasciculatum*, which is characteristically present. If *Artemisia californica* is present, it has trace cover or is clearly sub-dominant [contrast with the similar *Artemisia californica – Eriogonum fasciculatum – Opuntia littoralis/Dudleya* (*edulis*) Association described in lead 14c below]. High cover by *Malosma laurina*, *Rhus integrifolia*, or disturbance following species such as *Acmispon glaber* should be disregarded as these species are not diagnostic in the study area unless they are sole dominants.

Opuntia littoralis **Alliance (8120)**
Opuntia littoralis – Eriogonum fasciculatum – Malosma laurina Association

14c. *Artemisia californica* and *Eriogonum fasciculatum* characterize stands, either as co-dominant species, or in combination with a variety of coastal succulent species such as *Opuntia littoralis*,

Cylindropuntia prolifera or a species of *Dudleya*. In the latter case, the combined cover of *Artemisia californica* and *E. fasciculatum* exceeds that of succulents (e.g. *Opuntia littoralis*), though succulents are clearly diagnostic. When *O. littoralis* is dominant or co-dominant with *E. fasciculatum* and *A. californica* is absent or sub-dominant, key to the *Opuntia littoralis* Alliance above.

***Artemisia californica – Eriogonum fasciculatum* Alliance (3120)**
Artemisia californica – Eriogonum fasciculatum – Malosma laurina Association
Artemisia californica – Eriogonum fasciculatum – Opuntia littoralis/*Dudleya* (*edulis*) Association

14d. *Artemisia californica* occurs as the dominant, or it is co-dominant with *Diplacus aurantiacus* in the overstory (*D. aurantiacus* may occasionally be dominant to *A. californica*). A variety of sub-dominant shrubs may intermix, including *Eriogonum fasciculatum*, *Acmispon glaber, Salvia mellifera, Baccharis pilularis, Toxicodendron diversilobum, Opuntia littoralis*, and others. *Nolina cismontana*, a CNPS list 1B species, has been found in stands dominated by *A. californica* in Orange County.

***Artemisia californica* Alliance (3110)**
Artemisia californica Association
Artemisia californica – Diplacus aurantiacus Association
Artemisia californica – Opuntia littoralis Association

14e. *Diplacus aurantiacus* is dominant (>50% relative cover) in the shrub canopy; if *Artemisia californica* or *Adenostoma fasciculatum* are present as co-dominant species, then key stands to those alliances.

***Diplacus aurantiacus* Alliance (3220)**

14f. *Artemisia californica* and *Salvia mellifera* occur as co-dominant species in the overstory, co-occurring with a variety of sub-dominant shrubs. *Rhus integrifolia* and/or *Malosma laurina* may be present with the highest cover, but neither species is considered a useful diagnostic species, being that they are both ubiquitous across the study area, occupying both chaparral and coastal sage settings.

***Artemisia californica – Salvia mellifera* Alliance (3120)**

14g. *Eriogonum fasciculatum* and *Salvia apiana* occur as co-dominants, often intermixing with other shrub species such as *Artemisia californica*.

***Eriogonum fasciculatum – Salvia apiana* Alliance (3160)**
Eriogonum fasciculatum – Salvia apiana Association

14g. *Eriogonum fasciculatum* characterizes stands by being the sole dominant shrub, and understory may include *Mirabilis laevis* and/or *Salvia columbariae* in open shrub stands.

***Eriogonum fasciculatum* Alliance (3150)**
Eriogonum fasciculatum Association
Eriogonum fasciculatum / *Salvia columbariae – Mirabilis laevis* Association

15. Stands are dominated by *Ericameria palmeri*, *Isocoma menziesii*, *Hazardia squarrosa*, *Malacothamnus fasciculatus*, or *Acmispon glaber*. Vegetation cover can be open and/or with recent evidence of fire or other disturbance. (Note: Often higher herb than shrub cover is present during peak phenology, with the look of open shrublands or grassy shrublands.)

15a. *Ericameria palmeri* is dominant in the shrub overstory, with *Stipa pulchra* occurring as a characteristic grass.

***Ericameria palmeri* Alliance (3310)**
Ericameria palmeri Association

15b. *Isocoma menziesii* is dominant in the shrub overstory, usually over a mixture of forbs and grasses.

***Isocoma menziesii* Alliance (3330)**
Isocoma menziesii Association

15c. *Hazardia squarrosa* is the dominant shrub usually over a mixture of forbs and grasses.
***Hazardia squarrosa* Alliance (3320)**

15d. *Malacothamnus fasciculatus* is dominant in the shrub overstory, with any co-occurring chaparral or coastal scrub species being clearly sub-dominant. *Acmispon glaber* may occasionally be present with similar cover to *M. fasciculatus*.

***Malacothamnus fasciculatus* Alliance (3350)**
Malacothamnus fasciculatus Association

15e. *Acmispon glaber* (*Lotus scoparius*) is dominant in the shrub overstory, with any co-occurring chaparral or coastal scrub species being clearly sub-dominant.

***Acmispon glaber* Alliance (3340)**
Acmispon glaber Association

16. *Malosma laurina* or *Rhus integrifolia* display strong dominance in the shrub overstory. If coastal scrub or other soft-leaved, deciduous shrubs are present, they are insignificant. See note under Section III description.

16a. *Malosma laurina* is strongly dominant or may share dominance with *Acmispon glaber*.
***Malosma laurina* Alliance (2210)**
Malosma laurina Association
Malosma laurina – Acmispon glaber Association

16b. *Rhus integrifolia* is strongly dominant, usually with >50% relative cover.
***Rhus integrifolia* Alliance (2220)**
Rhus integrifolia Association

17. A species of *Acacia* dominates stands, with no other native shrub species having significant cover.
***Acacia cyclops* (or other *Acacias*) Semi-Natural Stands (3410)**

18. A species of *Schinus* or *Myoporum laetum* dominates in the tree/shrub overstory, usually with >60% relative cover.
***Schinus (molle, terebinthifolius) – Myoporum laetum* Semi-Natural Stands (1520)**

Class C. Herbaceous Vegetation

Section V. Herbaceous Vegetation

19. Vegetation is dominated or characterized by a mixture of native perennial grasses and annuals in upland settings, with the native grasses and forbs usually making up >10% relative cover of the herbaceous layer. Non-native herbaceous species may have a significant presence, but are not considered diagnostic as they are ubiquitous across the study area.

19a. *Stipa pulchra* characterizes stands alone or in shared dominance with other native and non-native grasses and forbs. A variety of emergent shrubs may be present.

***Stipa pulchra* Alliance (4130)**
Stipa pulchra Association

19b. *Stipa lepida* characterizes stands alone or in shared dominance with other native and non-native grasses and forbs. A variety of emergent shrubs may be present.

***Stipa lepida* Alliance (4120)**
Stipa pulchra Association

19c. *Leymus condensatus* dominates herbaceous stands that may be associated with scrub or woodland vegetation.

***Leymus condensatus* Alliance (4110)**
Leymus condensatus Association

19d. *Muhlenbergia rigens*, a mid-sized tufted perennial grass, is dominant, co-dominant or characteristically present with other native and non-native grasses and forbs in moist settings. A variety of emergent shrubs may be present.

***Muhlenbergia rigens* Alliance (6210)**
Muhlenbergia rigens Association

20. Vegetation dominated by non-native perennial or annual grasses and forbs in upland settings, with native herbaceous species being absent, having trace cover, and/or with uneven distribution.

20a. Vegetation strongly dominated by non-native annual grasses and forbs, including *Avena* spp., *Brassica nigra* and other mustards, *Bromus* spp., *Lolium perenne*, *Schismus* spp., and others:

Mediterranean California naturalized annual and perennial grassland Group (4200)
Specific types key as follows:

***Avena (barbata, fatua*) Semi-Natural Stands (4210)**
Avena barbata Semi-Natural Stands
Avena barbata–Avena fatua Semi-Natural Stands

***Brassica nigra* and other mustards Semi-Natural Stands (4220)**
Brassica nigra – Bromus diandrus Semi-Natural Stands

***Bromus (diandrus, hordeaceus*) – *Brachypodium distachyon* Semi-Natural Stands (4230)**
Bromus diandrus Semi-Natural Stands
Bromus diandrus – Avena spp. Semi-Natural Stands

***Bromus rubens – Schismus* (*arabicus, barbatus*) Semi-Natural Stands (4240)**

***Lolium perenne* Semi-Natural Stands (4280)**

20b. Vegetation dominated by medium to tall introduced perennial herbs, including *Cortaderia, Cynara cardunculus, Euphorbia terracina*, *Foeniculum vulgare* and *Phalaris aquatica*:

***Cortaderia* (*jubata, selloana*) Semi-Natural Stands (4260)**

***Cynara cardunculus* Provisional Semi-Natural Stands (4250)**

***Euphorbia terracina* Semi-Natural Stands**

***Foeniculum vulgare* Semi-Natural Stands (4270)**

***Phalaris aquatica* Semi-Natural Stands (5110)**

21. Vegetation dominated by herbs, grasses, and graminoids in wet to moist meadows, seasonal ponds, in regularly to episodically flooded bottomlands or depressions, or in tidal/intertidal aquatic environments. Stands are characterized by species of *Bolboschoenus, Distichlis*, *Muhlenbergia*, *Sarcocornia*, *Schoenoplectus*, *Spartina*, or *Typha*.

21a. Vegetation characterized by halophytic species such as *Spartina foliolosa*, *Batis maritima*, *Sarcocornia pacifica*, *Distichlis spicata*, *Bolboschoenus maritimus* and *Frankenia salina*.

21a1. *Spartina foliolosa* is dominant or co-dominant with *Batis maritima* or *Sarcocornia pacifica*.

***Spartina foliosa* Alliance (7120)**
Spartina foliosa Association

21a2. *Sarcocornia pacifica* characterizes stands as a dominant or co-dominant, though sometimes with much less cover than associated species *Frankenia salina*.

***Sarcocornia pacifica* (*Salicornia depressa*) Alliance (7110)**
Sarcocornia pacifica – Frankenia salina Association

21a3. *Bolboschoenus maritimus* or *Scirpus robustus* is dominant or co-dominant with other halophytic species.

***Bolboschoenus maritimus* Alliance (7130)**
Bolboschoenus maritimus Association
Scirpus robustus Provisional Association

21a4. *Distichlis spicata* is dominant in the herbaceous layer.

***Distichlis spicata* Alliance (7140)**
Distichlis spicata Association

21b. Vegetation dominated by moderately tall, emergent, wetland perennial graminoids.

Arid West interior freshwater emergent marsh Group (6100)
Specific types key as follows:

21b1. One or more species of *Schoenoplectus* dominates in the herbaceous layer.

***Schoenoplectus (acutus, californicus*) Alliance**
Schoenoplectus acutus Association (6110)
Schoenoplectus californicus Association (6130)

21b2. One or more species of *Typha* dominates in the herbaceous layer. If a species of *Schoenoplectus* is co-dominant, key to the appropriate *Schoenoplectus* type.

***Typha (angustifolia, domingensis, latifolia*) Alliance (6120)**
Typha domingensis Association

21c. *Muhlenbergia rigens*, the mid-sized tufted perennial grass, is dominant, co-dominant or characteristically present with other native and non-native grasses and forbs in moist settings. A variety of emergent shrubs may be present.

***Muhlenbergia rigens* Alliance (6210)**
Muhlenbergia rigens Association

21d. *Arundo donax* dominates, often with >60% relative cover in the herbaceous and shrub layers.

***Arundo donax* Semi-Natural Stands (1910)**

21e. *Lepidium latifolium* dominates the herbaceous layer.

***Lepidium latifolium* Semi-Natural Stands (6310)**

22. Vegetation dominated mainly by herbs of coastal environments, including sea cliffs, dunes, rocky outcrops, and bluffs. Stands in such settings may have relatively low total vegetation cover.

22a. *Carpobrotus edulis* dominates stands, often found spreading on bluffs or dunes adjacent to the ocean.

***Carpobrotus edulis* (or other iceplants) Semi-Natural Stands (5410)**

22b. Various annuals and perennials (grasses, forbs, succulents), including *Dudleya* spp., as well as shrub species (i.e. *Atriplex* spp., *Lycium californicum*) occur along steep coastal bluffs, slopes, or cliffs, usually with sparse cover (<10% total cover) or low cover (<25%).

Coastal Baja California Norte maritime succulent scrub Group (8100)
Specific types key as follows:

22b1. *Dudleya edulis* or other *Dudleya* sp. present and dominant or co-dominant with other herbs, often at low cover.

Dudleya greenei - *Dudleya* spp. Succulent Scrub Alliance

Appendix D

Contingency Table

Map Unit #	Map Unit Name (from Map); Sorted by Map Unit #	Quercus agrifolia Alliance	Hesperocyparis forbesii Alliance	Pseudotsuga macrocarpa Alliance	Eucalyptus spp. Semi-Natural Stands	Alnus rhombifolia Alliance	Platanus racemosa Alliance	Salix gooddingii Alliance	Salix laevigata Alliance	Populus fremontii Alliance	Baccharis salicifolia Alliance	Salix lasiolepis Alliance	Sambucus nigra Alliance	Arundo donax Alliance	A. fasciculatum-A. glandulosa Mapping Unit	California Xeric Chaparral Group	C. crassifolius - A. fasciculatum Mapping Unit	Adenostoma fasciculatum Alliance	Ceanothus crassifolius Alliance	Ceanothus megacarpus Alliance	Adenostoma fasciculata - Salvia mellifera Alliance	Malosma laurina Alliance	Rhus integrifolia Alliance	Quercus dumosa Association	California Mesic Chaparral Group	Ceanothus tomentosus Association	Heteromeles arbutifolia Alliance	Quercus berberidifolia Alliance	Quercus berberidifolia - A. fasciculatum Alliance	Arctostaphylos glandulosa Alliance	Central & South Coastal Californian Coastal Scrub Group	Artemisia californica Alliance	Artemisia californica - Eriogonum fasciculatum Alliance	Artemisia californica - Salvia mellifera Alliance	Encelia californica Alliance	Eriogonum fasciculatum Alliance	Eriogonum fasciculatum-Salvia apiana	Keckiella antirrhinoides Alliance	Salvia apiana Alliance	Salvia leucophylla Alliance	Salvia mellifera Alliance	Mimulus aurantiacus Alliance	Central and South Coastal CA Seral Scrub Group	Ericameria palmeri Alliance	Isocoma menziesii Alliance	Acmispon glaber Alliance	Malacothamnus fasciculatus Alliance	Acacia (cyclops) Semi-Natural Stands	California Annual and Perennial Grassland Macrogroup	California perennial grassland Group	Leymus condensatus Alliance	Nassella lepida Alliance	Nassella pulchra Alliance	Mediterranean CA Naturalized A. & P. Grassland Group	Avena spp. Semi-natural Stands	Brassica nigra and other mustards Semi-natural Stands	Bromus spp. - Brachypodium distachyon Semi-Natural Stands	Cynara cardunculus Prov. Semi-Natural Stands	Cortaderia (jubata, selloana) Semi-natural Stands	Lolium perenne Alliance	Toxicodendron diversilobum Alliance	Baccharis pilularis Alliance	Arid West Freshwater Emergent Marsh Group	Schoenoplectus acutus Association	Typha (angustifolia, domingensis, latifolia) Alliance	Schoenoplectus californicus Association	Bolboschoenus maritimus - Scirpus robustus Alliance	Temperate Pacific Tidal Salt & Brackish Meadow Group	Sarcocornia pacifica (Sarcocornia depressa) Alliance	Spartina foliosa Alliance	Distichlis spicata Alliance	Atriplex lentiformis Alliance	Coastal Baja Calif Norte maritime succulent scrub Group	Lycium californicum Provisional Alliance	Opuntia littoralis Alliance	Lepidospartum squamatum Alliance	Bebbia juncea Association	**Grand Total**
1120	Quercus agrifolia Alliance	22																																																																													22
1210	Hesperocyparis forbesii Alliance		1																						1																																																					2
1410	Pseudotsuga macrocarpa Alliance			1																																																																										1
1510	Eucalyptus (globulus, camaldulensis) Semi-Natural Stands				10																																																																										10
1610	Alnus rhombifolia Alliance					1						1																																																																	2
1710	Platanus racemosa Alliance						6																																																																							6
1720	Salix gooddingii Alliance							6	2	2	1	1																																																																			12
1730	Salix laevigata Alliance							1	2		2	1																																																																		6
1740	Populus fremontii Alliance						1			2																																																																				3
1810	Baccharis salicifolia Alliance										13																					1			1						1																					1																17
1820	Salix lasiolepis Alliance							3			1	6																																																																10
1830	Sambucus nigra Alliance												5																			2			1																																											8
1910	Arundo donax Alliance								1					3																																																1																5
2001	A. fasciculatum-A. glandulosa Mapping Unit																	1												1																																																2
2100	California Xeric Chaparral Group		1															1								2							1																																													5
2101	C. crassifolius - A. fasciculatum Mapping Unit																	2	1		1																																																									4
2110	Adenostoma fasciculatum Alliance																	6		1						1																																																				8
2120	Ceanothus crassifolius Alliance																		1																																																											1
2130	Ceanothus megacarpus Alliance																			2		1																																																								3
2140	Adenostoma fasciculata - Salvia mellifera Alliance																			1	2													1							1																																					5
2210	Malosma laurina Alliance	1																				1	4				2	1				2																																														11
2220	Rhus integrifolia Alliance																						11					1					1																																													13
2230	Querecus dumosa Association																						2	1								1																																														4
2300	California Mesic Chaparral Group																																1																																													1
2310	Ceanothus tomentosus Association																	1		1						1																																																				3
2330	Heteromeles arbutifolia Alliance																						1				1	1				1																																														4
2340	Quercus berberidifolia Alliance																		1		1		1			1		5																																																		9
2350	Quercus berberidifolia - Adenostoma fasciculatum Alliance																	2																				1			1																																					4
2410	Arctostaphylos glandulosa Alliance																	1																																																												1
3100	Central & South Coastal Californian Coastal Scrub Group																															1	2	1					1																						1	1													1			8
3110	Artemisia californica Alliance																															15	3	2							1																					1																22
3120	Artemisia californica - Eriogonum fasciculatum Alliance																															3	13	4	1	2					2				1		1															1																28
3130	Artemisia californica - Salvia mellifera Alliance																															4	4	4						1	8																																					21
3140	Encelia californica Alliance																																		4						1				1																													1				7
3150	Eriogonum fasciculatum Alliance																																3		1	7					3																																					14
3160	Eriogonum fasciculatum-Salvia apiana																																																																														0
3170	Keckiella antirrhinoides Alliance																												1																																																	1
3180	Salvia apiana Alliance																															1					1		4	4	1																																					11
3190	Salvia leucophylla Alliance																															1	1							4																																						6
3210	Salvia mellifera Alliance																																	1							8					1																																10
3220	Mimulus aurantiacus Alliance																															1										5																																						6
3300	Central and South Coastal Californian Seral Scrub Group																														1				2	1					1		1																																			6
3310	Ericameria palmeri Alliance																																											6																																		6
3330	Isocoma menziesii Alliance										1																					1												1	3																																	6
3340	Acmispon glaber Alliance																																1										1		1	2																												1			6
3350	Malacothamnus fasciculatus Alliance																																								2						2																															4
3410	Acacia (cyclops) Semi-Natural Stands																																															5																														5
4000	California Annual and Perennial Grassland Macrogroup																																																																														0
4100	California perennial grassland Group																																																																															0
4110	Leymus condensatus Alliance																															1																			1																											2
4120	Nassella lepida Alliance																																1																	1			1		2																							5
4130	Nassella pulchra Alliance																																1											1									3			1	2			1																		9
4200	Mediterranean CA Naturalized Annual & Perennial Grassland Group																															3	1			1													5			1	1	8		3	16					1																40
4210	Avena (barbata, fatua) Semi-natural Stands																																																																													0
4220	Brassica nigra and other mustards Semi-natural Stands																																																1				1	1		7	2					1																13
4230	Bromus (diandrus, hordeaceus) - Brachypodium distachyon Semi-natural Stands																																																																													0
4250	Cynara cardunculus Provisional Semi-natural Stands																																																						2	1		3																				6
4260	Cortaderia (jubata, selloana) Semi-natural Stands																																																					1					1			1																3
4280	Lolium perenne Semi-natural Stands																																																																													0
5210	Toxicodendron diversilobum Alliance																						1																																						3																	4
5310	Baccharis pilularis Alliance																																								1																					13																14
6100	Arid West Freshwater Emergent Marsh Group																																																																													0
6110	Schoenoplectus acutus Association																																																															2	1	2													5
6120	Typha (angustifolia, domingensis, latifolia) Alliance																																																																6	1												7
6130	Schoenoplectus californicus Association																																																														1		2	6			1										10
7130	Bolboschoenus maritimus - Scirpus robustus Alliance																																																														1		1	1	1	1	1										6
7100	Temperate Pacific Tidal Salt & Brackish Meadow Group																																																																				2	1									3
7110	Sarcocornia pacifica (Sarcocornia depressa) Alliance																																																																			3		1								4
7120	Spartina foliosa Alliance																																																																		1		3									4
7140	Distichlis spicata Alliance																																																							1																						1
7210	Atriplex lentiformis Alliance																																																													1										5						6
8100	Coastal Baja Calif Norte maritime succulent scrub Group																																																																													0
8110	Lycium californicum Provisional Alliance																																																																								3					3
8120	Opuntia littoralis Alliance																																																																										8			8
8210	Lepidospartum squamatum Alliance																															1	1			1																																								1	1	5
8220	Bebbia juncea Association																																																																													0
	Grand Total	23	2	1	10	1	7	10	5	4	18	9	5	3	0	0	0	14	3	5	4	2	20	1	1	5	3	8	1	1	1	39	34	13	10	12	1	1	5	9	31	5	2	8	6	3	3	5	6	1	1	1	6	10	4	13	20	3	1	1	4	22	2	2	10	10	1	2	7	4	1	5	3	1	10	1	1	507

Appendix E

Crosswalk of vegetation mapping units used in 1992 and 2012

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
80000	Woodland Habitats	6	(NVC Subclass: Temperate & Boreal Forest)		
80500	Woodland Habitats?	3	(NVC Subclass: Temperate & Boreal Forest)		
			Juglans californica Alliance	1110	15
80100	Coast live oak woodland	1559	*Quercus agrifolia* Alliance	1120	3428
40500	Coast live oak savanna	228	*Quercus agrifolia* Alliance	1120	
90100	Coast live oak forest	14	*Quercus agrifolia* Alliance	1120	
70500	Southern coast live oak riparian forest	1063	*Quercus agrifolia* Alliance	1120	
			Calif. evergreen coniferous forest and woodland Group	1200	1
90500	Southern interior cypress forest	196	*Hesperocyparis forbesii* Alliance	1210	33
			Pseudotsuga macrocarpa Alliance	1410	4
			Alnus rhombifolia Alliance	1610	22
			SW N. Amer. Rip. evergreen and decid. woodland Group	1700	124
70400	Southern sycamore riparian woodland	392	*Platanus racemosa* Alliance	1710	459
70700	Southern black willow forest	424	*Salix gooddingii* Alliance	1720	647
			Salix laevigata Alliance	1730	94
70800	Southern cottonwood-Willow riparian forest	24	*Populus fremontii* Alliance	1740	26
70200	Southern willow scrub	440	SW North American riparian/wash scrub Group	1800	25
71100	Bramble thicket	1	SW North American riparian/wash scrub Group	1800	
70300	Mulefat scrub	537	*Baccharis salicifolia* Alliance	1810	780
70600	Southern arroyo willow forest	195	*Salix lasiolepis* Alliance	1820	679
80400	Mexican elderberry woodland	4	*Sambucus nigra* Alliance	1830	393
80401	Mexican elderberry woodland?	3	*Sambucus nigra* Alliance	1830	
			Arundo donax Semi-Natural Stands	1910	79
30100	Coastal sage- Chaparral scrub ecotone/sere	613	(NVC Division: California Scrub)		
30105	Maritime Chaparral-Sagebrush	2358	(NVC Division: California Scrub)		
30106	Maritime chaparral-Sage scrub	8	(NVC Division: California Scrub)		
30600	Southern maritime chaparral	288	(NVC Division: California Scrub)		
30200	Southern mixed chaparral	4480	California Chaparral Macrogroup	2000	4
30201	Southern mixed chaparral?	56	California Chaparral Macrogroup	2000	
31100	Nolina chaparral	89	California Chaparral Macrogroup	2000	
30000	Chaparral Habitats	190	California Xeric Chaparral Group	2100	221
30300	Chamise Chaparral	4431	*Adenostoma fasciculatum* Alliance	2110	4492
30101	Chamise-Sagebrush	604	*Adenostoma fasciculatum* Alliance	2110	

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
30400	*Ceanothus crassifolius* chaparral	34	*Ceanothus crassifolius* Alliance	2120	1151
30500	*Ceanothus megacarpus* chaparral	369	*Ceanothus megacarpus* Alliance	2130	1180
30102	Chamise- Sage scrub	1456	*Adenostoma fasciculata - Salvia mellifera* Alliance	2140	1051
			Californian maritime chaparral Group	2200	39
			Californian mesic chaparral Group	2300	43
			Ceanothus tomentosus Alliance	2310	98
			Cercocarpus montanus Alliance	2320	26
40800	Sumac savannah	242	*Malosma laurina* Alliance	2210	2660
			Rhus integrifolia Alliance	2220	1201
31200	Toyon-sumac chaparral	1796	*Heteromeles arbutifolia* Alliance	2330	252
31201	Toyon-sumac chaparral?	27	*Heteromeles arbutifolia* Alliance	2330	
30103	Scrub oak-Sagebrush	3	*Quercus berberidifolia* Alliance	2340	1278
30104	Scrub oak-Sage scrub	3	*Quercus berberidifolia* Alliance	2340	
30700	Scrub oak chaparral	524	*Quercus berberidifolia* Alliance	2340	
30708	Scrub oak chaparral?	4	*Quercus berberidifolia* Alliance	2340	
			Quercus berberidifolia - Adenostoma fasciculatum Alliance	2350	162
			Quercus dumosa Association	2230	122
30900	Manzanita chaparral	16	*Arctostaphylos glandulosa* Alliance	2410	316
20000	Scrub Habitats	11	Central & South Coastal Californian CSS Group	3100	1085
20900	Scrub Habitats?	59	Central & South Coastal Californian CSS Group	3100	
20300	Venturan-Diegan transitional coastal sage scrub	1941	Central & South Coastal Californian CSS Group	3100	
20500	Riversidian coastal sage scrub	10	Central & South Coastal Californian CSS Group	3100	
20505	Riversidian coastal sage scrub?	307	Central & South Coastal Californian CSS Group	3100	
20310	Mixed sage scrub	2644	Central & South Coastal Californian CSS Group	3100	
20800	Sage scrub-Grassland ecotone	487	Central & South Coastal Californian CSS Group	3100	
20306	Sagebrush scrub	2863	*Artemisia californica* Alliance	3110	4521
20801	Sagebrush-Grassland	434	*Artemisia californica* Alliance	3110	
20302	CA sagebrush-Orangebush monkey flower scrub	138	*Artemisia californica* Alliance	3110	
20301	CA sagebrush-CA buckwheat scrub	8883	*Artemisia californica - Eriogonum fasciculatum* Alliance	3120	9028
20308	Sagebrush-black sage	6800	*Artemisia californica - Salvia mellifera* Alliance	3130	8067
			Encelia californica Alliance	3140	200
20307	Buckwheat	111	*Eriogonum fasciculatum* Alliance	3150	934
20802	Buckwheat-Grassland	21	*Eriogonum fasciculatum* Alliance	3150	

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
			Eriogonum fasciculatum - Salvia apiana Alliance	3160	2
			Keckiella antirrhinoides Alliance	3170	17
20305	White sage	573	*Salvia apiana* Alliance	3180	215
20303	Purple sage	540	*Salvia leucophylla* Alliance	3190	409
20304	Black sage	1347	*Salvia mellifera* Alliance	3210	2171
			Mimulus aurantiacus Alliance	3220	103
			Central and South Coastal Californian seral scrub Group	3300	87
20804	Box springs goldenbrush-Grassland	15	*Ericameria palmeri* Alliance	3310	51
20803	Coastal goldenbush-Grassland	79	*Isocoma menziesii* Alliance	3330	38
			Acmispon glaber Alliance	3340	1540
20311	Bush mallow sage scrub	85	*Malacothamnus fasciculatus* Alliance	3350	319
20600	Floodplain sage scrub	284	(Warm Semi-Desert Shrub & Herb Dry Wash Group)		
			Lepidospartum squamatum Alliance	8210	110
			Bebbia juncea Association	8220	2
40000	Grassland Habitats	9	California Annual and Perennial Grassland MG	4000	7
40100	Annual grassland	11843	California Annual and Perennial Grassland MG	4000	
41200	Grassland Habitats?	6	California Annual and Perennial Grassland MG	4000	
40200	Elymus grassland	2	California perennial grassland Group	4100	59
40300	Southern coastal needlegrass grassland	180	California perennial grassland Group	4100	
			Stipa pulchra Alliance	4130	597
			Stipa lepida Alliance	4120	85
			Leymus condensatus Alliance	4110	2
40600	Ruderal	1122	Mediterranean CA Naturalized Annual and Perennial Grassland Group (Weedy)	4200	8775
			Avena (barbata, fatua) Alliance	4210	9
			Brassica nigra and other mustards Alliance	4220	513
			Bromus (diandrus, hordeaceus) - Brachypodium distachyon Alliance	4230	84
			Cynara cardunculus Provisional Semi-Natural Stands	4250	504
			Cortaderia (jubata, selloana) Alliance	4260	16
			Lolium perenne Alliance	4280	2
			Erodium spp. Mapping Unit	4290	99
			Introduced Trees, Shrubs (not in hierarchy)	9100	575
			Acacia (cyclops) Semi-Natural Stands Alliance	3410	285

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
			Eucalyptus (globulus, camaldulensis) Semi-Natural Stands	1510	168
			Toxicodendron diversilobum Alliance	5210	56
20309	Coyote bush	37	*Baccharis pilularis* Alliance	5310	396
20312	Sagebrush-Coyote bush sage	33	*Baccharis pilularis* Alliance	5310	
			Carpobrotus edulis or Other Ice Plants Semi-Natural Stands	5410	11
70100	Riparian herb	295	Temperate and Boreal Freshwater Marsh Formation	6000	6
50000	Vernal pools, seeps & wet meadows	2	Temperate and Boreal Freshwater Marsh Formation	6000	
50300	Freshwater seep	4	Temperate and Boreal Freshwater Marsh Formation	6000	
50400	Freshwater swale	13	Temperate and Boreal Freshwater Marsh Formation	6000	
			Meadow (*Carex - Juncus - Eleocharis*) Mapping Unit	6001	4
			Arid West Freshwater Emergent Marsh Group	6100	3
60400	coastal freshwater marsh	264	Fresh water marsh (bulrush - cattail) MU	6101	32
			Schoenoplectus acutus Alliance	6110	12
			Typha (angustifolia, domingensis, latifolia) Alliance	6120	49
			Schoenoplectus californicus Alliance	6130	69
			Lepidium latifolium Alliance	6310	20
			Scirpus robustus Association	6410	17
60000	Marsh Habitats	3	Temperate Pacific Tidal Salt & Brackish Meadow Group	7100	25
60100	Southern coastal salt marsh	355	Temperate Pacific Tidal Salt & Brackish Meadow Group	7100	
60200	Coastal brackish marsh	15	Temperate Pacific Tidal Salt & Brackish Meadow Group	7100	
60300	Cismontane alkali marsh	3	Temperate Pacific Tidal Salt & Brackish Meadow Group	7100	
			Sarcocornia pacifica (Salicornia depressa) Alliance	7110	263
			Spartina foliosa Alliance	7120	131
			Bolboschoenus maritimus Association	7130	12
			Distichlis spicata Alliance	7140	9
			SW North American Salt Basin & High Marsh Group	7200	32
20700	Chenopod scrub	70	*Atriplex lentiformis* Alliance	7210	31
			XEROMORPHIC SCRUB AND HERB VEGETATION (SEMI-DESERT) CLASS	8000	33
20200	Maritime Succulent Scrub	31	Coastal Baja Calif Norte maritime succulent scrub Group	8100	25
20100	Southern coastal bluff scrub	108	Coastal Baja Calif Norte maritime succulent scrub Group	8100	
20104	Southern coastal bluff scrub?	1	Coastal Baja Calif Norte maritime succulent scrub Group	8100	
20400	Southern cactus scrub	1356	*Opuntia littoralis* Alliance	8120	510

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
140000	Agriculture	3	Agriculture	9200	800
140500	Other Agriculture	17	Agriculture	9200	
140100	Dryland Field Crops	19	Agriculture	9200	
140200	Irrigated Row and Field Crops	393	Agriculture	9200	
140300	Vineyards and Orchards	1200	Agriculture	9200	
140400	Dairies, Stockyards & Stables	2	Agriculture	9200	
140600	Nurseries	9	Agriculture	9200	
150100	Urban	6128	Urban/disturbed Mapping Unit	9300	13715
150000	Developed Areas	15	Urban/disturbed Mapping Unit	9300	
150600	Other Developed Areas	166	Urban/disturbed Mapping Unit	9300	
150200	Rural Residential	213	Urban/disturbed Mapping Unit	9300	
150201	Rural Residential?	1	Urban/disturbed Mapping Unit	9300	
150300	Non-Urban Commercial/Industrial/Institutional	428	Urban/disturbed Mapping Unit	9300	
150400	Transportation	887	Urban/disturbed Mapping Unit	9300	
150500	Parks and Ornamental Plantings	2158	Urban/disturbed Mapping Unit	9300	
160000	Disturbed Areas	84	Urban/disturbed Mapping Unit	9300	
160200	Other disturbed areas	41	Urban/disturbed Mapping Unit	9300	
160100	Cleared or Graded	3629	Anthropogenic Areas of Little or No Vegetation	9330	555
160400	Mined Areas	105	Anthropogenic Areas of Little or No Vegetation	9330	
			Special Linkage Area	9310	821
			Fuel Mod Zone	9320	1158
			Vegetation Restoration Areas	9340	665
			Sparsely vegetated to non-vegetated	9400	2
110300	Rocky Shore & Intertidal Zone	6	Rocky shore Mapping Unit	9411	7
110400	Sandy Beach	60	Beach sand Mapping Unit	9412	59
100000	Cliff & Rock Habitats	7	Cliff, bluffs, scree, and rock outcrop	9420	347
100100	Xeric cliff faces	33	Cliff, bluffs, scree, and rock outcrop	9420	
100101	Xeric-Vascular plant	32	Cliff, bluffs, scree, and rock outcrop	9420	
100102	Xeric-Lichen & moss	16	Cliff, bluffs, scree, and rock outcrop	9420	
100300	Rock outcrops	50	Cliff, bluffs, scree, and rock outcrop	9420	
			Riverine & Lacustrine	9430	3
130200	Intermittent streams & creeks	191	Streambed Mapping Unit	9431	227
130300	Ephemeral drainages & washes	81	Streambed Mapping Unit	9431	

1992 Code	1992 Vegetation Name	1992 Acres	2012 Vegetation Name	2012 Code	2012 Acres
110500	Tidal Flats (Mud)	6	Intertidal mudflat	9440	159
110501	Tidal Flats (Algal)	120	Intertidal mudflat	9440	
110000	Marine & coastal habitats	2	Intertidal mudflat	9440	
110100	Algal	1	Intertidal mudflat	9440	
			Salt panne	9450	9
120100	Open water	942	Water body	9800	517
110200	Estuarine	287	Water body	9800	
130100	Perennial rivers & streams	16	Perennial Stream Channel	9810	31
130400	Flood control channels	66	Perennial Stream Channel	9810	
120300	Spreading grounds & retention basins	12	Ephemeral ponds & reservoirs	9820	888
120200	Fluctuating shorelines	10	Ephemeral ponds & reservoirs	9820	
	SUM ACRES	**83500**	**SUM ACRES**		**83500**

? = A code used in 1992 which did not have a corresponding Vegetation Name. In these cases the name was assigned according to the numbering system (e.g. Mexican elderberry woodland was assigned to 80400 and thus was also used for the unnamed code 80401)