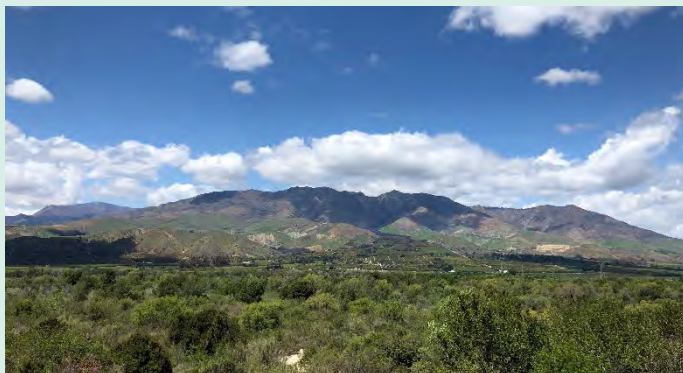


TECHNICAL MEMORANDUM • APRIL 2019

Vegetation Mapping of the Santa Clara River, Ventura County and Los Angeles County, California



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1 INTRODUCTION

The 116-mile-long Santa Clara River flows in a westerly direction from headwaters on the northern slopes of the San Gabriel Mountains in Los Angeles County, through the Santa Clara River Valley and the Oxnard Plain in Ventura County, and empties into the Pacific Ocean near the City of Ventura (Figure 1). Many large coastal southern California rivers (i.e., the Los Angeles, Santa Ana, and San Gabriel rivers) have largely been confined to concrete channels in their lower reaches to provide flood protection for surrounding urban areas, dramatically reducing (or eliminating) riparian vegetation and the fluvial geomorphic processes that maintain functioning ecological systems in river corridors. The Santa Clara River riparian corridor, however, has retained a significant amount of high-quality riparian habitat that supports a diversity of native wildlife, including threatened and endangered species such as least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), and yellow-billed cuckoo (*Coccyzus americanus*).

The present-day Santa Clara River is a dynamic semi-arid ecological system driven primarily by periodic short duration, high intensity flood events (Stillwater Sciences 2005). The channel borders between meandering and braided river forms, as defined by the gradient, discharge, and bed material grain size. Where natural processes prevail, the result is an unusual compound channel morphology that is braided at lower flows but more akin to a low sinuosity meandering channel during large flood events. The channel morphology is affected primarily by large flood flows rather than by the moderate discharges frequently used to characterize channel form response in temperate climates. These factors result in a mosaic of riparian vegetation that shifts in extent, structure, and composition in response to deposition, scour, and inundation by large flood flows (Stillwater Sciences 2007, Orr et al. 2011, Beller et al. 2015).

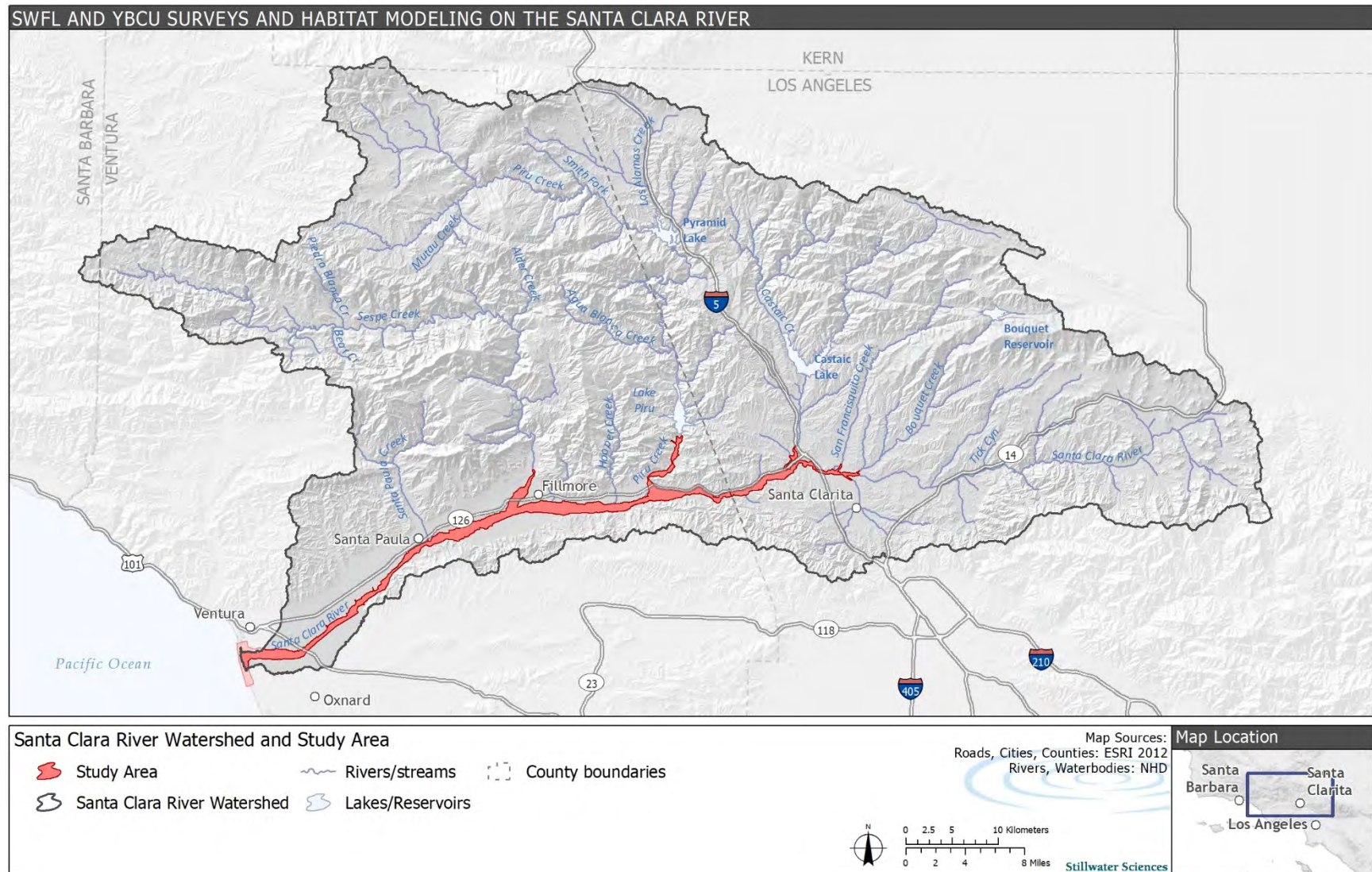


Figure 1. Location of the Santa Clara River watershed and Study Area.

Although the Santa Clara River riparian corridor is relatively intact, flood protection infrastructure, diversions, roads, agriculture, and urbanization have constrained or disrupted natural geomorphic and hydrologic processes, causing riparian and aquatic habitat degradation. As native riparian vegetation provides critical ecosystem services such as improved flood control, water quality, and terrestrial and aquatic habitat quality as well as increased local biodiversity, managing for healthy riparian vegetation is a central to river management and restoration. The replacement of native scrub and mature forest communities by dense stands of *Arundo donax* (giant reed), which does not provide many of the key habitat elements required by most riparian birds and other native wildlife, is prevalent throughout the Santa Clara River. *A. donax* populations are being managed through control and removal programs throughout the watershed. In addition, climate change and the associated periods of prolonged and severe drought (e.g., 2014–2018) have negatively affected the native riparian forest and shrub habitats that provide breeding habitat for southwestern willow flycatcher, yellow-billed cuckoo, and least Bell's vireo.

This project addresses the need for detailed up-to-date vegetation information in support of identifying and modeling habitat for southwestern willow flycatcher, yellow-billed cuckoo, and least Bell's vireo. Funding for the project was provided by an Endangered Species Act Section 6 grant from the United States Fish and Wildlife Service to the California Department of Fish and Wildlife. This project updates and builds upon prior vegetation mapping along the river in Ventura conducted by Stillwater Sciences and URS (2007), which was funded through matching grants from the California State Coastal Conservancy and The Santa Clara River Trustee Council, plus other more recent mapping efforts listed below (Section 2.2).

1.1 Objectives

The primary objective of this project is to provide a preliminary vegetation classification and detailed vegetation map for the mainstem Santa Clara River riparian corridor and its major tributaries within Ventura and Los Angeles Counties, from Bouquet Canyon to the estuary.

1.2 Study Area

The project Study Area (16,370 acres [ac]) encompasses the extent of riparian vegetation along the lower mainstem Santa Clara River in Ventura County, a reach of approximately 51 mi. The project also includes portions of the four largest tributaries to the mainstem Santa Clara River in Ventura and Los Angeles counties (Sespe, Piru, Castaic, and San Francisquito creeks), extending from their confluence with the Santa Clara River upstream between one and five miles (Figure 1). The Study Area was determined using the Federal Emergency Management Agency (FEMA) 100-year floodplain boundary and extent of the 2005 Stillwater Sciences vegetation map (Stillwater Sciences and URS 2007) (Figures 1 and 2). Elevations in the Study Area range from 0 to 1,165 feet above sea level.

1.3 Reaches

To better assess longitudinal shifts in vegetation throughout the Study Area, the river was divided into 17 project reaches (Table 1, Figure 2). The extent of these reaches, which are adapted from three previous studies (Stillwater Sciences and URS 2007; Stillwater Sciences 2011a, 2016), is presented in Figure 2. The table below shows the length of each reach.

Table 1. Reaches within the Study Area from downstream to upstream.

Reach	Length (miles)
0	0.7
1	4.1
2a	4.8
2b	1.7
3	3.1
4	2.3
5	1.8
6	4.5
7	3.4
Sespe Creek	4.0
8	3.7
9	3.0
10	2.9
Piru Creek	4.9
11a	3.8
11b	1.5
12	2.5
13	5.5
Castaic Creek	2.0
14a	1.1
Total	61.3

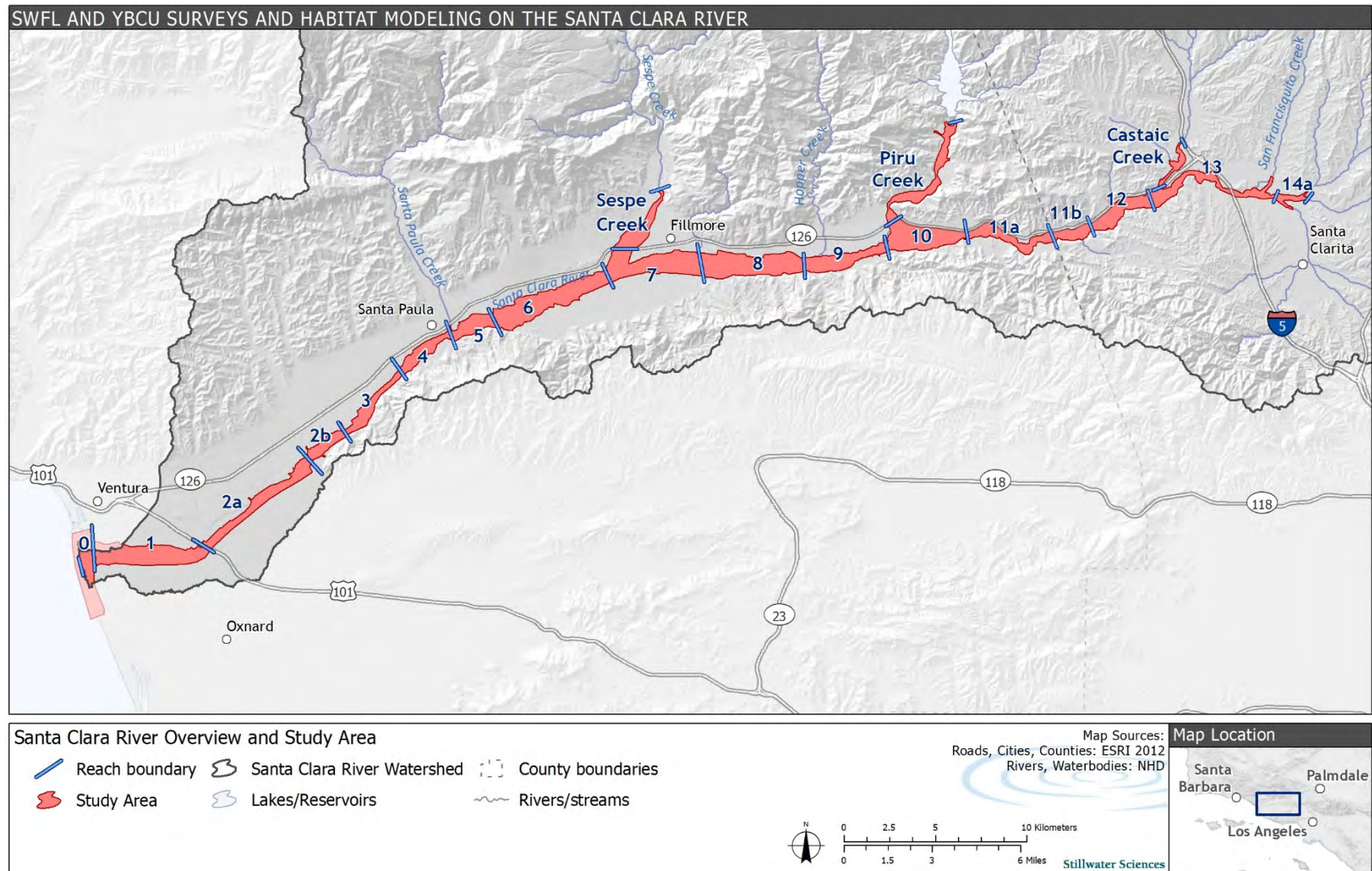


Figure 2. Reach boundaries within the Study Area.

2 METHODS

This project utilized a combination of field-based vegetation classification and mapping, and traditional photo-interpretive techniques, as described below. The vegetation classification follows the State of California standard vegetation classification system described in *A Manual of California Vegetation* (MCV; CNPS 2019a).

2.1 Base Map Imagery and Minimum Mapping Unit

Digital aerial imagery (natural color, 2-foot resolution) from the National Agricultural Imagery Program (NAIP) (USDA-FSA 2016) flown in May, June, and July 2016 served as the primary data source for onscreen photointerpretation using ESRI ArcGIS (see Section 2.2 and 2.5). Based on the Study Area size, resolution of the available imagery, and standard mapping approaches, a minimum mapping unit (MMU) was applied to both field-based and photointerpretation efforts for each vegetation type. The desired target was a 0.5-ac MMU for most types, with finer resolution (0.1-ac MMU) for more unusual types that were discernable from the aerial photography and/or documented in the field.

2.2 Preliminary Map Development

Existing information relevant to vegetation and land cover classification and mapping in the region were gathered and reviewed, then used to generate an initial list of vegetation types (alliances) that were likely to occur in the Study Area. The primary data source was a 2005 vegetation map (Stillwater Sciences and URS 2007).

A preliminary vegetation map was prepared in GIS using available imagery and existing vegetation map datasets. Using heads up digitizing techniques, a photo interpreter delineated and classified each identifiable vegetation stand or land cover area using the MMU and MCV classification procedures. In addition to the 2016 NAIP, 2014 NAIP imagery (USDA-FSA 2014) was used during photointerpretation of vegetation types as a reference for less severe drought conditions, and to identify areas where *Arundo donax* had been removed. Other data sources, including a hillshade generated from the National Center for Airborne Laser Mapping 2015 LiDAR (NCALM 2015) data, and base features such as roads and levees, were used to aid the photo interpretation and classification process. Delineation of vegetation boundaries was conducted at on-screen scales between 1:1,200 and 1:5,000.

Spatial data from the following existing vegetation map datasets that covered portions of the Study Area were incorporated into this preliminary mapping effort, after consideration of temporal changes and checks for consistency with the MMU and MCV classification rules:

- Stillwater Sciences 2005 vegetation map (Stillwater Sciences and URS 2007)
- Freeman Diversion area vegetation map (Rincon 2014)
- TNC parcels vegetation mapping (Rancho Santa Ana Botanic Garden 2015, unpubl. data)
- Newhall Ranch 2012 vegetation map (USFWS 2012, unpubl. data)
- Stillwater Sciences riparian vegetation transects (Stillwater Sciences 2016)
- Arundo mapping for the Santa Clara River (RSABG 2015, unpubl. data)

2.3 Field-based Mapping

The field mapping effort took place during the summer and fall of 2018 and provided a detailed characterization of the vegetation for a majority of the Study Area. Information collected during this field effort was used to refine vegetation type definitions and to modify the initial classification key (see Section 2.4) to ensure the photo interpretation process could proceed more accurately. At each field verified location, a modified CNPS vegetation rapid assessment field data form (CNPS 2018) was used to document the occurrence, percent cover and strata of dominant and characteristic plant species present, as well as the vegetative cover across six height strata (<0.5 m, 0.5–1 m, 1–2 m, 2–5 m, 5–10 m, and > 5 m)¹. A total of approximately 125 sites were sampled using the modified rapid assessment protocol.

In addition, a more streamlined data form, modified from the CNPS vegetation reconnaissance field data form (versus the modified CNPS rapid assessment protocol used for the 125 sites described above) was used to document dominant and characteristic plant species at an additional approximate 130 stands (polygons). This effort provided more accurate vegetation data than could be obtained through photo-interpretation, reduced the amount of area that had to be mapped only by photo-interpretation, and supported further refinement of the classification system. In total, field data on percent cover of dominant and characteristic species were collected for nearly 255 stands of vegetation.

Field crews used the ArcGIS Collector application on handheld tablets (Samsung Galaxy Tablet) to review the preliminary vegetation map and assess the accuracy of the preliminary polygon boundaries and classification. Crews collected GPS data on the tablet to record changes to preliminary mapped polygons. For locations where a modified CNPS rapid assessment was collected, electronic PDF data forms were completed; the CNPS reconnaissance field data forms were completed with the ArcGIS Collector application.

2.4 Vegetation Classification Determination

Species composition data collected in the field was compiled and reviewed in the office to assign the appropriate MCV alliance to each sampled location. In cases where the species present were best described by an MCV association (a sub-category of the broader MCV alliance), one was assigned. For field sampled locations with unique species composition not currently represented by an existing MCV alliance or association, a provisional alliance or association was created. In addition, some areas were classified into broader land cover types (e.g., agriculture, developed, riverwash).

2.5 Final Map Development

Final vegetation type classifications were appended to the spatial data collected in the field and used in combination with the 2016 NAIP base map imagery to refine the preliminary vegetation map using ESRI ArcGIS. This field-based data aided in photointerpretation and extrapolation in areas that were inaccessible to field crews during the field mapping effort.

The complex and dynamic nature of vegetation communities present within the lower Santa Clara River corridor presents temporal challenges for vegetation mapping. Large flows, drought effects,

¹ Metric units were used in the field to collect vegetation structure data; results are presented in standard units.

human disturbance, and active *Arundo donax* removal efforts results in discrepancies between the NAIP base map imagery and on the ground conditions observed in the field. In some cases, field data was disregarded to ensure that unit boundaries match the 2016 NAIP imagery and ensure consistency with the final classification scheme presented in this report. This effort was necessary to ensure that the final vegetation map represents an accurate “snapshot” of the dynamic vegetation mosaic as of 2016 and provides the foundation to detect future changes in riparian vegetation.

After the extent of mapped stands were finalized, *Arundo donax* cover classes were assigned using visual photointerpretation combined with existing *Arundo donax* mapping conducted by RSABG (RSABG 2015). Cover classes were assigned using modified Daubenmire classes (<1, 1–5, 5–10, 10–25, 25–50, 50–75, 75–95, and >95% cover).

Plant species nomenclature followed *The Jepson eFlora* (Jepson Flora Project 2019), except where MCV vegetation alliance names referenced older nomenclature. In such instances, the nomenclature used in MCV was retained for the name of the vegetation alliance only, species associates listed within the alliance description followed *Jepson eFlora* nomenclature. Vegetation alliances that were defined as sensitive natural communities—natural community types with a state ranking of S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable) on CDFW’s *California Sensitive Natural Communities* (CDFW 2018)—were also noted. Where the eponymous species of an alliance was classified by the California Invasive Plant Council (Cal-IPC), the rating of High², Moderate³, or Limited⁴ was noted according to the Cal-IPC inventory (Cal-IPC 2019). Alliance descriptions also note any inclusion of special-status plants, defined as listed, proposed, or candidates for listing as rare, threatened, or endangered by the federal government and/or the state of California; those included on CDFW’s *Special Vascular Plants, Bryophytes, and Lichens List* (CDFW 2019); and those included in California Native Plant Society’s Inventory of Rare and Endangered Plants of California (CNPS 2019b) with a California Rare Plant Rank (CRPR).

3 VEGETATION CLASSIFICATION

The final vegetation map includes 45 vegetation alliances, seven of which were further classified into 38 associations, and ten broad land cover types (Table 2). Three vegetation alliances and 15 associations are provisional types not described in MCV (CNPS 2019a). Eighteen of the vegetation alliances are considered sensitive natural communities (CDFW 2018), covering a total of 4,750.5 ac (27.8%) of the Study Area (see Table 2 for the state rankings of these eighteen sensitive natural communities). Ten vegetation alliances are dominated by naturalized non-native

² High – These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.

³ Moderate – These species have substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.

⁴ Limited – These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.

species (semi-natural stands), covering a total of 1,072.7 ac (6.6%) of the Study Area. The vegetation alliances and land cover types are summarized in Table 2 and described in the sections below; for a summary of the mapped vegetation types by reach, see Appendix A.

Table 2. Vegetation alliances and land cover types in the Study Area.

Type	Sensitive natural community ¹	Acres	Percent total
Vegetation Alliance			
Forest and Woodlands			
<i>Eucalyptus</i> spp. - <i>Ailanthus altissima</i> - <i>Robinia pseudoacacia</i> Woodland Semi-Natural Alliance	–	74.4	0.5%
<i>Juglans californica</i> Woodland Alliance	S3.2	6.0	0.0%
<i>Olea europaea</i> Woodland Semi-Natural Alliance [Provisional]	–	2.7	0.0%
<i>Platanus racemosa</i> Woodland Alliance	S3	4.6	0.0%
<i>Populus fremontii</i> Forest Alliance	S3.2	807.9	4.9%
<i>Populus trichocarpa</i> Forest Alliance	S3	431.9	2.6%
<i>Quercus agrifolia</i> Woodland Alliance	–	58.5	0.4%
<i>Quercus lobata</i> Woodland Alliance	S3	6.0	0.0%
<i>Salix laevigata</i> Woodland Alliance	S3	1,800.7	11.0%
<i>Salix lucida</i> Woodland Alliance	S3.2	27.2	0.2%
<i>Schinus (molle, terebinthifolius)</i> - <i>Myoporum laetum</i> Woodland Semi-Natural Alliance	–	42.3	0.3%
Shrublands			
<i>Artemisia californica</i> Shrubland Alliance	–	110.1	0.7%
<i>Artemisia californica</i> - <i>Salvia mellifera</i> Shrubland Alliance	–	6.7	0.0%
<i>Artemisia tridentata</i> Shrubland Alliance	–	87.6	0.5%
<i>Atriplex canescens</i> Shrubland Alliance	–	2.2	0.0%
<i>Atriplex lentiformis</i> Shrubland Alliance	–	33.9	0.2%
<i>Baccharis pilularis</i> Shrubland Alliance	–	77.2	0.5%
<i>Baccharis salicifolia</i> Shrubland Alliance	–	3,260.2	19.9%
<i>Encelia californica</i> - <i>Eriogonum cinereum</i> Shrubland Alliance	S3	51.1	0.3%
<i>Eriogonum fasciculatum</i> Shrubland Alliance	– ²	41.6	0.3%
<i>Lepidospartum squamatum</i> Shrubland Alliance	S3	439.1	2.7%
<i>Lotus scoparius</i> Shrubland Alliance	–	6.5	0.0%
<i>Pluchea sericea</i> Shrubland Alliance	S3.3	79.7	0.5%
<i>Ricinus communis</i> Shrubland Semi-Natural Alliance [Provisional]	–	2.2	0.0%
<i>Salix exigua</i> Shrubland Alliance	–	207.5	1.3%
<i>Salix lasiolepis</i> Shrubland Alliance	–	486.7	3.0%
<i>Salvia apiana</i> Shrubland Alliance	S3	4.9	0.0%
<i>Salvia leucophylla</i> Shrubland Alliance	–	1.1	0.0%
<i>Sambucus nigra</i> Shrubland Alliance	S3	41.4	0.3%
<i>Tamarix</i> spp. Shrubland Semi-Natural Alliance	–	54.6	0.3%
Herbaceous			
<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous Alliance	S3	103.5	0.6%
<i>Brassica nigra</i> - <i>Raphanus</i> spp. Herbaceous Semi-Natural Alliance	–	12.1	0.1%
<i>Bromus (diandrus, hordeaceus)</i> - <i>Brachypodium distachyon</i> Herbaceous Semi-Natural Alliance	–	104.4	0.6%

Type	Sensitive natural community ¹	Acres	Percent total
<i>Bromus rubens</i> - <i>Schismus (arabicus, barbatus)</i> Herbaceous Semi-Natural Alliance	–	2.3	0.0%
<i>Corethrogyne filaginifolia</i> - <i>Eriogonum (elongatum, nudum)</i> Herbaceous Alliance	–	9.6	0.1%
<i>Cressa truxillensis</i> - <i>Distichlis spicata</i> Herbaceous Alliance	S2	4.2	0.0%
<i>Distichlis spicata</i> Herbaceous Alliance	–	2.1	0.0%
<i>Heterotheca (oregona, sessiliflora)</i> Herbaceous Alliance	S3	678.3	4.1%
<i>Leymus cinereus</i> - <i>Leymus triticoides</i> Herbaceous Alliance	S3	0.9	0.0%
<i>Mesembryanthemum</i> spp. - <i>Carpobrotus</i> spp. Herbaceous Semi-Natural Alliance	–	73.9	0.5%
<i>Phragmites australis</i> - <i>Arundo donax</i> Herbaceous Semi-Natural Alliance	–	703.8	4.3%
<i>Pseudognaphalium leucocephalum</i> Herbaceous Alliance [Provisional]	–	0.2	0.0%
<i>Sarcocornia pacifica (Salicornia depressa)</i> Herbaceous Alliance	S3	4.9	0.0%
<i>Schoenoplectus (acutus, californicus)</i> Herbaceous Alliance	S3	64.3	0.4%
<i>Typha (angustifolia, domingensis, latifolia)</i> Herbaceous Alliance	–	5.5	0.0%
Land Cover Type			
Agriculture		4,061.6	24.8%
Beach		93.3	0.6%
Developed		791.6	4.8%
Developed - park/open space		140.4	0.9%
Disturbed		386.5	2.4%
Non-native Grass and Forb Mapping Unit		128.6	0.8%
Ocean		253.2	1.5%
Riverwash		294.1	1.8%
Riverwash herbaceous		66.3	0.4%
Water		127.9	0.8%
Total		16,369.9	100.0%

¹ State Ranks:

S3 = Vulnerable. Vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation from the state.

0.2 = threatened

0.3 = no current threat known

-- = not considered a sensitive natural community

² Contains 13.9 ac of *Eriogonum fasciculatum* – *Artemisia tridentata* Association, a sensitive association (CDFW 2018).

3.1 Vegetation Alliance Descriptions

3.1.1 Forest and Woodland Alliances

3.1.1.1 *Eucalyptus* spp. - *Ailanthus altissima* - *Robinia pseudoacacia* Woodland Semi-Natural Alliance (Eucalyptus - tree of heaven - black locust groves)

In the Study Area, this alliance includes at least one species of eucalyptus (*Eucalyptus globulus* [blue gum] or *Eucalyptus camaldulensis* [red gum]) in the tree layer (5–85% cover) and is typically moderately to densely vegetated (40–100% total cover). Other tree species may be present in low cover, including *Juglans californica* (Southern California black walnut) and

Quercus agrifolia (coast live oak). *Arundo donax* is generally present and is occasionally the dominant understory species in terms of percent cover (which can reach 60–70%). Shrub species present at low cover may include *Artemisia californica* (California sagebrush), *Eriogonum fasciculatum* (California buckwheat), and *Toxicodendron diversilobum* (western poison oak).

Eucalyptus globulus and *Eucalyptus camaldulensis* both have a Cal-IPC rating of Limited (Cal-IPC 2019).

This alliance includes the following association that was identified in the Study Area:

- *Eucalyptus (globulus, camaldulensis)* Association.

3.1.1.2 *Juglans californica* Woodland Alliance (California walnut groves)

This alliance is generally moderately vegetated (55% cover), with a mix of tree, shrub, and herbaceous species. The *Juglans californica* alliance generally occurs on slopes in canyons and valleys, and along riparian corridors in the outer coast zone of southern Central California and Southern California. In the Study Area, the tree layer is generally dominated by *Juglans californica*, with *Salix laevigata* (red willow) as a co-dominant and *Populus fremontii* subsp. *fremontii* (Fremont cottonwood) generally present at low cover. The shrub layer is sparse to moderate (about 15% cover) and can commonly include *Baccharis salicifolia* (mule fat), *Atriplex lentiformis* (big saltbush), and *Sambucus nigra* subsp. *caerulea* (blue elderberry). *Arundo donax* may be present but at low (1%) cover. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following associations that were identified in the Study Area:

- *Juglans californica* Association; and
- *Juglans californica* – *Salix laevigata* Provisional Association.

3.1.1.3 *Olea europaea* Woodland Semi-Natural Alliance (olive) [Provisional]

This alliance typically has moderate to dense cover with a mix of shrubs and herbaceous species. It is characterized by the dominance of *Olea europaea* (olive) in the tree layer, generally with 20–30% cover. *Hirschfeldia incana* (shortpod mustard) and grasses are common co-occurring species (with <20% cover). *Tamarix ramosissima* (saltcedar) may be present at low cover.

Although not listed as an alliance in MCV, *Olea europaea* is naturalized in California (Jepson Flora Project 2019), where it has invaded areas in southern California and the Central Valley (Cal-IPC 2019). It has a Cal-IPC rating of Limited (Cal-IPC 2019).

3.1.1.4 *Platanus racemosa* Woodland Alliance (California sycamore woodlands)

This alliance typically has moderate to high vegetative cover (50–95% cover) in the tree layer with generally 10% cover from *Platanus racemosa* (western sycamore). This alliance generally occurs along streams and canyon bottoms. *Juglans californica* and *Schinus molle* (pepper tree) are common co-occurring tree species. Common species in the shrub layer include *Baccharis salicifolia* and *Salix laevigata*. *Arundo donax* may be found at low densities (<15% cover). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following vegetation types that were identified in the Study Area:

- *Platanus racemosa* Alliance;

- *Platanus racemosa* – *Quercus agrifolia* Association; and
- *Platanus racemosa* – *Quercus agrifolia* – *Populus fremontii* – *Salix laevigata* Association.

3.1.1.5 *Populus fremontii* Forest Alliance (Fremont cottonwood forest)

This alliance is generally moderately to densely vegetated (50–90% cover), with an open to dense tree canopy. This alliance typically occurs in riparian areas along streams and rivers with fairly reliable groundwater available year-round at depths of less than 10–13 feet. *Populus fremontii* subsp. *fremontii* is the sole dominant or co-dominant, with 10–50% cover. Co-dominant and subdominant tree species vary widely between stands and can include *Quercus agrifolia*, *Eucalyptus* spp., *Juglans californica*, *Salix laevigata*, and *Populus trichocarpa* (black cottonwood). The shrub layer is typically sparse to dense, with *Salix exigua* (narrowleaf willow), *Salix lasiolepis* (arroyo willow) and *Salix lasiandra* (Pacific willow), *Sambucus nigra* subsp. *caerulea*, and *Baccharis salicifolia*. *Tamarix* spp. (tamarisk) may occur at low to moderate cover. *Arundo donax* is often present up to 50% cover, but otherwise herbaceous species generally have low cover. This alliance can be found at warmer, drier reaches when compared to the distribution of *Populus trichocarpa* stands that occur in lower, cooler reaches. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following associations that were identified in the Study Area:

- *Populus fremontii* Association
- *Populus fremontii* subsp. *fremontii* – *Juglans californica* Association
- *Populus fremontii* subsp. *fremontii* – *Quercus agrifolia* Association
- *Populus fremontii* subsp. *fremontii* – *Salix laevigata* Association;
- *Populus fremontii* subsp. *fremontii* – *Salix laevigata*/*Arundo donax* Provisional Association;
- *Populus fremontii* subsp. *fremontii* – *Salix lasiolepis* Association; and
- *Populus fremontii* subsp. *fremontii*/*Arundo donax* Provisional Association.

3.1.1.6 *Populus trichocarpa* Alliance (Black cottonwood forest)

This alliance has an open to dense tree canopy (10–90% cover) and is typically found along streams and in alluvial floodplain areas closer to the coast where summer maritime fog moderates temperatures, compared to the *Populus fremontii* subsp. *fremontii* stands that occur inland at warmer, drier reaches. *Populus trichocarpa* is generally the sole dominant or co-dominant (up to 50% total cover) in the tree layer. Co-dominant tree species can include *Salix laevigata* and *Populus fremontii* subsp. *fremontii*. The shrub layer is typically sparse to dense and commonly includes *Salix exigua* and *Baccharis salicifolia*. *Arundo donax* is often present up to 50% cover, but otherwise herbaceous species are generally not present. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following associations that were identified in the Study Area:

- *Populus trichocarpa* – *Salix laevigata* Association
- *Populus trichocarpa* – *Salix laevigata*/*Arundo donax* Provisional Association
- *Populus trichocarpa* – *Salix lasiolepis* Association; and
- *Populus trichocarpa*/*Arundo donax* Provisional Association.

3.1.1.7 *Quercus agrifolia* Woodland Alliance (Coast live oak woodland)

This alliance generally has high vegetative cover (75–90%) and is found on terraces, valleys, riparian areas. *Quercus agrifolia* is the dominant or co-dominant species (5–80% cover); co-dominant tree species may include *Schinus molle*, *Salix laevigata*, *Platanus racemosa*, *Populus fremontii* subsp. *fremontii*, and *Juglans californica*. Cover in the shrub layer is generally low to moderate (1–25%) and often includes *Sambucus nigra*. *Arundo donax* is nearly always present with low percent cover (<1–2% cover). Non-native herbs and grasses dominate the herbaceous understory.

3.1.1.8 *Quercus lobata* Woodland Alliance (Valley oak woodland)

This alliance generally has high vegetative cover (90%) and is generally found in valley bottoms that experience intermittent flooding. The tree layer may be open to moderate, with *Quercus lobata* (valley oak) as the dominant tree species, often with *Quercus agrifolia* as a co-dominant. The shrub layer is typically sparse and may include *Artemisia tridentata* subsp. *parishii* (big sagebrush), *Sambucus nigra*, and *Datura wrightii* (sacred thorn-apple). The herbaceous layer generally is dense with non-native grasses such as *Bromus diandrus* (ripgut brome). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.1.9 *Salix laevigata* Woodland Alliance (Red willow thickets)

The *Salix laevigata* alliance is found along streams, seeps, and riparian areas and is typically densely vegetated (60–90% total cover), although total vegetative cover is occasionally open to moderate (15–50% cover). *Salix laevigata* is the dominant or co-dominant species (10–60% cover) in the tree layer, which is typically 15–30 feet high. *Populus fremontii* subsp. *fremontii* is often represented in the tree layer at low cover. The shrub layer is generally moderate and is dominated by *Baccharis salicifolia* and *Salix exigua*. *Tamarix* spp. and *Arundo donax* are often present but at low cover. In several occurrences, the *Salix laevigata* alliance appears to represent an earlier successional stage of the *Populus fremontii* and/or *Populus trichocarpa* alliances, with *Populus* spp. (cottonwood) seedlings and saplings prevalent in the shrub layer. The composition and structure of the understory is highly variable, with some stands sparsely vegetated and other with a diverse mix of species. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following associations that were identified in the Study Area:

- *Salix laevigata* Association;
- *Salix laevigata* – *Salix lasiolepis* Association;
- *Salix laevigata* – *Salix lasiandra* Provisional Association;
- *Salix laevigata*/*Arundo donax* Provisional Association;
- *Salix laevigata*/*Baccharis salicifolia* Provisional Association; and
- *Salix laevigata*/*Salix exigua* Provisional Association.

3.1.1.10 *Salix lucida* Woodland Alliance (Shining willow groves)

This alliance can have highly variable vegetative cover and is usually found in wet places. *Salix lasiandra* is the dominant species (20–75% cover). *Salix lasiolepis* and *Salix exigua* are common associates in the shrub layer. *Arundo donax* is often present but at low cover. The herbaceous layer is typically lacking or sparse (<5% cover), but in wetter sites, *Typha* spp. (cattails) may

dominate the understory (20–50% cover). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.1.11 *Schinus (molle, terebinthifolius) - Myoporum laetum* Woodland Semi-Natural Alliance (Pepper tree or Myoporum groves)

This alliance generally has a moderate level of vegetative cover (30–75% total cover). *Schinus molle* generally composes at least 10% cover, and dominates the tree layer. Native species, such as *Baccharis salicifolia*, *Artemisia californica*, *Encelia californica* (California brittlebush), and *Salvia mellifera* (black sage) often dominate the shrub layer, while non-native herbs and grasses dominate the understory.

Schinus molle has a Cal-IPC rating of Limited, having escaped cultivation and generally invading sites that have already experienced disturbance (Cal-IPC 2019).

This alliance includes the following associations that were identified in the Study Area:

- *Myoporum laetum* Association;
- *Schinus molle* Association; and
- *Schinus molle*/*Lepidospartum squamatum* Association.

3.1.2 Shrubland Alliances

3.1.2.1 *Artemisia californica* Shrubland Alliance (California sagebrush)

This shrub-dominated alliance has open to dense cover (40–80% total cover), with *Artemisia californica* (10–75% cover) as the dominant or co-dominant shrub. Other co-dominant shrubs may include *Atriplex lentiformis*, *Baccharis pilularis* (coyote brush), and *Baccharis salicifolia*. *Eriogonum fasciculatum* is a fairly common sub-dominant species and scattered emergent trees are present in some stands. The herbaceous layer varies from sparse to dense, and is generally dominated by non-native grasses and forbs, especially *Hirschfeldia incana*.

This alliance includes the following associations that were identified in the Study Area:

- *Artemisia californica* Association; and
- *Artemisia californica* – *Eriogonum cinereum* Association.

3.1.2.2 *Artemisia californica - Salvia mellifera* Shrubland Alliance (California sagebrush - black sage scrub)

This shrub-dominated alliance has intermittent to dense canopy cover, with *Artemisia californica* and *Salvia mellifera* as co-dominants (CNPS 2019a). Other shrubs represented may include *Adenostoma fasciculatum* (chamise), *Diplacus aurantiacus* (orange bush monkeyflower), *Encelia californica*, *Eriogonum fasciculatum*, *Hesperoyucca whipplei* (chaparral yucca), *Acmispon glaber* (deerweed), *Malosma laurina* (laurel sumac), *Rhus integrifolia* (lemonade berry), *Rhus ovata* (sugar bush), and *Salvia apiana* (white sage), with taller emergent shrubs (>2m) present at low cover (CNPS 2019a). This is the only alliance in which *Baccharis sarothroides* (broom baccharis) was observed in the study area (one stand containing *Baccharis sarothroides* was mapped along the South Fork Santa Clara River in Reach 14a)

This alliance includes the following association that was identified in the Study Area:

- *Artemisia californica* – *Salvia mellifera* - *Baccharis sarothroides* Association.

3.1.2.3 *Artemisia tridentata* Shrubland Alliance (Big sagebrush)

Within the Study Area, one subspecies of *Artemisia tridentata* subsp. *parishii* is dominant or co-dominant with *Atriplex canescens* (four-wing saltbush), *Baccharis salicifolia*, *Eriogonum fasciculatum*, and/or *Salvia mellifera*. Emergent trees may occasionally be present. Shrub canopy of < 7 feet in height varied from continuous to intermittent or open, with *Artemisia tridentata* subsp. *parishii* cover typically around 10–15% (ranging from 5–40%). The herbaceous understory layer is sparse to intermittent or grassy, with *Bromus diandrus*, *Hirschfeldia incana*, and *Melilotus albus* (yellow sweetclover) as the most common associates.

This alliance includes the following associations that were identified in the Study Area

- *Artemisia tridentata* subsp. *parishii* Association;
- *Artemisia tridentata* subsp. *parishii* – *Atriplex canescens* Provisional Association;
- *Artemisia tridentata* subsp. *parishii* – *Eriogonum fasciculatum* Association; and
- *Artemisia tridentata* subsp. *parishii* – *Salvia mellifera* Provisional Association.

3.1.2.4 *Atriplex canescens* Shrubland Alliance (Fourwing saltbush scrub)

This alliance is shrub-dominated (50–75% cover), with a moderate herbaceous understory (25–50% cover). The shrub canopy is intermittent to continuous, and <7 feet in height. In the Study Area, *Atriplex canescens* is dominant and typically has 50–75% cover. Other shrubs commonly represented with low cover include *Sambucus nigra* subsp. *caerulea*, *Isocoma menziesii* (coastal goldenbush), *Artemisia tridentata* subsp. *parishii*, *Baccharis salicifolia*, and *Salvia leucophylla* (purple sage).

This alliance includes the following association that was identified in the Study Area:

- *Atriplex canescens* Association.

3.1.2.5 *Atriplex lentiformis* Shrubland Alliance (Quailbush scrub)

This alliance is shrub-dominated (30–50% cover), with a sparse herbaceous understory (0–20% cover). In the Study Area, *Atriplex lentiformis* typically has 20–30% cover with *Hirschfeldia incana* as a frequently co-occurring species (3–28% cover) in the herbaceous understory. Other common species in the alliance include *Baccharis salicifolia* and *Baccharis pilularis*.

This alliance includes the following association that was identified in the Study Area:

- *Atriplex lentiformis* Association.

3.1.2.6 *Baccharis pilularis* Shrubland Alliance (Coyote brush scrub)

This alliance has a moderate cover of shrubs (30–50% cover), dominated by *Baccharis pilularis* (5–50% cover), with a generally sparse herbaceous understory (0–19% cover). *Baccharis salicifolia* may also be present and is occasionally co-dominant (0–20% cover). *Arundo donax* is generally found at low cover (3–10% cover).

This alliance includes the following associations that were identified in the Study Area:

- *Baccharis pilularis* Association; and
- *Baccharis pilularis*-*Artemisia californica* Association.

3.1.2.7 *Baccharis salicifolia* Shrubland Alliance (Mulefat thickets)

This alliance typically has moderate to dense cover of shrubs (20–60% cover), is dominated by *Baccharis salicifolia*, and has low to moderate herbaceous cover (3–45% cover). Trees are only rarely present in the alliance. In the Study Area, this alliance often occurs as thickets in canyon bottoms, seasonally inundated floodplains and stream channels, and in irrigation ditches. In addition to *Baccharis salicifolia*, *Arundo donax* is frequently found in the alliance, although with variable cover when present (1–40% cover). *Salix exigua*, *Artemisia californica*, *Tamarix ramosissima*, *Pluchea sericea* (arrow-weed), and *Nicotiana glauca* (tree tobacco) are occasionally present in the shrub layer. In the understory, *Distichlis spicata* (salt grass), *Hirschfeldia incana*, *Bromus diandrus*, and *Silybum marianum* (blessed milkthistle) are common species.

This alliance includes the following associations that were identified in the Study Area:

- *Baccharis salicifolia* – *Artemisia californica* Provisional Association;
- *Baccharis salicifolia* – *Artemisia tridentata* Provisional Association; and
- *Baccharis salicifolia* – *Sambucus nigra* Association.

3.1.2.8 *Encelia californica* - *Eriogonum cinereum* (California bruttle bush - Ashy buckwheat scrub) Shrubland Alliance

The *Encelia californica* alliance in the Study Area is typically dominated by *Encelia californica* (20–50% cover), with other shrubs including *Artemisia californica* and *Eriogonum fasciculatum*. In the Study Area, this alliance is generally found in upland coastal scrub habitats. *Malosma laurina*, *Baccharis pilularis*, *Salvia leucophylla*, and *Salvia mellifera* are also typically present in the shrub layer at low densities (<5% cover). Mature tree species are occasionally present but in very low cover. The herbaceous layer typically included *Elymus condensatus* (giant wild-rye) (20% cover). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following association that was identified in the Study Area:

- *Encelia californica* Association.

3.1.2.9 *Eriogonum fasciculatum* Shrubland Alliance (California buckwheat scrub)

The *Eriogonum fasciculatum* alliance in the Study Area is characterized by a sparse to dense shrub canopy (20–70% cover) and a typically sparse herbaceous layer (10–25%). *Eriogonum fasciculatum* is dominant (generally 10–40% cover), with *Artemisia tridentata* subsp. *parishii*, *Encelia californica*, *Sambucus nigra* subsp. *caerulea*, and *Ribes* spp. (currant or gooseberry) commonly co-occurring. Tree species may be present but at low cover, including *Populus fremontii* subsp. *fremontii*. *Hirschfeldia incana* is common in the herbaceous layer.

This alliance includes the following associations that were identified in the Study Area:

- *Eriogonum fasciculatum* Association; and
- *Eriogonum fasciculatum* – *Artemisia tridentata* Association (sensitive; CDFW 2018).

3.1.2.10 *Lepidospartum squamatum* Shrubland Alliance (Scale broom scrub)

This alliance typically has a mix of shrubs and herbaceous understory species, with a wide range of total cover (15–80% cover). This alliance generally occurs on sandy and gravelly washes and

on stream terraces in arid and semi-arid regions and is characterized by the presence of *Lepidospartum squamatum* (California broomsage), although it is not always abundant (generally >10% cover, ranging from 2–30% cover). Dominant and co-dominant shrub species can include *Baccharis salicifolia*, *Salvia mellifera*, and *Eriogonum fasciculatum*. Other commonly associated sub-dominant shrubs can include *Salix exigua*, *Nicotiana glauca*, *Hesperoyucca whipplei*, and *Tamarix* spp. The herbaceous layer varies from very sparse to moderate cover, often with *Hirschfeldia incana* as the most abundant herbaceous species, followed by *Bromus diandrus*, *Bromus madritensis* subsp. *rubens* (red brome), and *Heterotheca sessiliflora* (sessileflower goldenaster). *Arundo donax* can be present, but typically at low densities. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following vegetation types that were identified in the Study Area:

- *Lepidospartum squamatum* Alliance;
- *Lepidospartum squamatum* – *Baccharis salicifolia* Association; and
- *Lepidospartum squamatum* – *Salvia mellifera* Provisional Association.

3.1.2.11 *Lotus scoparius* Shrubland Alliance (Deer weed scrub)

This alliance typically has a moderate cover of shrubs (50–55% cover) with a sparse herbaceous layer (5–15% cover). This alliance generally occurs in chaparral habitats, along roadsides and other disturbed sites, and in coastal scrub, desert slopes, and flat washes. The dominant species is common deerweed (*Acmispon glaber*), generally with 40% cover. Co-occurring species are variable by site and may include *Corethrogyne filaginifolia* (common sandaster), *Baccharis pilularis*, or *Hirschfeldia incana*.

3.1.2.12 *Pluchea sericea* Shrubland Alliance (Arrow weed thickets)

This alliance typically has a moderate to densely vegetated shrub layer (60–95% cover), with occasional shrubs. This alliance typically occurs as thickets in stream bottoms, washes, canyons, and around springs, occasionally in saline areas. *Pluchea sericea* is dominant with 40–85% cover. Other species that may be present at low levels (< 10% cover) include *Salix exigua*, *Baccharis salicifolia*, and *Arundo donax*. Tree species, if present, are generally no larger than saplings and may include *Populus trichocarpa*. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.2.13 *Ricinus communis* Shrubland Semi-Natural Alliance (castorbean) [Provisional]

This alliance is generally found in disturbed sites and is dominated by naturalized *Ricinus communis* (castor bean). *Ricinus communis* is rated by Cal-IPC as Limited and with a widespread distribution in coastal scrub and riparian habitats (Cal-IPC 2019). *Hirschfeldia incana* and *Bromus diandrus* are common co-occurring species in the understory. *Arundo donax* is uncommon (0–1% cover).

Although not listed as an alliance in MCV, *Ricinus communis* is naturalized in California, where it has invaded the Central Valley and coastal areas of Central and Southern California (Jepson Flora Project 2019). It has a Cal-IPC rating of Limited (Cal-IPC 2019).

3.1.2.14 *Salix exigua* Shrubland Alliance (Sandbar willow thickets)

This alliance is characterized by a moderate shrub layer (generally 25–75% cover) and is found along streams and in washes. *Salix exigua* is the dominant shrub species, often with *Baccharis salicifolia* as a co-dominant shrub. *Tamarix* spp. and *Arundo donax* are typically present but at low cover. The tree layer is generally lacking, and the herbaceous layer is sparse to moderate with *Bromus diandrus* and other non-native grasses and forbs.

This alliance includes the following associations that were identified in the Study Area:

- *Salix exigua* Association;
- *Salix exigua* – *Baccharis salicifolia* Provisional Association; and
- *Salix exigua*/*Arundo donax* Association.

3.1.2.15 *Salix lasiolepis* Shrubland Alliance (Arroyo willow thickets)

This alliance has vegetation coverage that ranges from sparse to dense, and is generally found in moist meadows, seeps, and marshes. The shrub layer is dominated by *Salix lasiolepis*, often with *Salix exigua* as a co-dominant species. Other common shrubs include *Toxicodendron diversilobum*, *Baccharis salicifolia*, and *Sambucus nigra*. The tree layer is generally sparse and can include *Quercus agrifolia* and *Populus trichocarpa*. *Arundo donax* is a common associate at low to moderate cover, but other herbaceous species are lacking or sparse.

This alliance includes the following associations that were identified in the Study Area:

- *Salix lasiolepis* Association; and
- *Salix laevigata*/*Arundo donax* Provisional Association.

3.1.2.16 *Salvia apiana* Shrubland Alliance (White sage scrub)

This alliance generally has a moderate to continuous shrub canopy and is found on dry, coastal mountain slopes and high benches along streams that rarely flood (CNPS 2019a). *Salvia apiana* is dominant or co-dominant, often with *Artemisia californica*, *Diplacus aurantiacus*, and *Eriogonum fasciculatum*, among other shrub species (CNPS 2019a). The tree layer is generally lacking and the herbaceous layer is variable (CNPS 2019a). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.2.17 *Salvia leucophylla* Shrubland Alliance (Purple sage scrub)

This alliance generally has an intermittent to continuous canopy and is usually found on steep upland slopes (CNPS 2019a). *Salvia leucophylla* is dominant or co-dominant in the shrub layer, often with *Artemisia californica*, *Diplacus aurantiacus*, *Eriogonum cinereum* (coastal wild buckwheat), *Eriogonum fasciculatum*, *Hesperoyucca whipplei*, *Acmispon glaber*, *Salvia apiana*, and *Salvia mellifera*, among other shrubs (CNPS 2019a). The tree layer is generally sparse and if present consists of scattered emergent trees including *Juglans californica* and *Quercus agrifolia*; the herbaceous layer is variable (CNPS 2019a).

3.1.2.18 *Sambucus nigra* Shrubland Alliance (Blue elderberry stands)

This alliance typically has moderate to very dense (33–97%) vegetative cover and is found along stream banks and in open areas in woodlands where groundwater is accessible. *Sambucus nigra* is consistently present (10–25% cover) and dominant in the shrub or tree layers. *Salix exigua* and

Pluchea sericea are commonly represented in the shrub layer, and the tree layer may contain low cover of *Populus fremontii* subsp. *fremontii* and *Salix laevigata*. In more disturbed sites, *Schinus molle* is often present. The herbaceous layer is generally dense and dominated by non-native grasses and forbs, including *Bromus diandrus*, *Carduus pycnocephalus* subsp. *pycnocephalus* (Italian thistle), and *Hirschfeldia incana*. *Arundo donax* may comprise up to 10% of the vegetative cover. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.2.19 *Tamarix* spp. Shrubland Semi-Natural Alliance (Tamarisk thickets)

This alliance typically has a dense shrub layer (70–100% cover), with little understory, and is found along riparian areas and washes. *Tamarix ramosissima* is the dominant species (70–80% cover), with *Arundo donax* typically present but not abundant (<15% cover). *Baccharis salicifolia* and *Salix lasiolepis* may also compose a small amount (<10% cover) of the shrub layer. Cover in the tree layer is low and limited to a few emergent trees.

Tamarix ramosissima has a Cal-IPC rating of High, being one of the most invasive and widespread wildland pest plants (Cal-IPC 2019). Its extent in the upper Santa Clara River watershed, rate of spread and impacts to the ecology of riparian areas have made it the focus of a large-scale eradication effort, along with *Arundo donax*, in the upper watershed (VCRCD 2006a,b).

3.1.3 Herbaceous Alliances

3.1.3.1 *Abronia latifolia*-*Ambrosia chamissonis* Herbaceous Alliance (Dune mat)

This alliance typically has a sparse to moderate cover of perennial forbs in the ground layer and may occur with grasses and occasional emergent shrubs. It occurs in sandy coastal foredune areas. In the survey area, the common species include *Ambrosia chamissonis* (beach bur-sage), *Abronia maritima* (red sand-verbena; California Rare Plant Rant (CRPR) 4.2⁵ (CNPS 2019b)), *Abronia umbellata* (pink sand verbena), *Eriogonum parvifolium* (seacliff wild buckwheat), *Camissoniopsis cheiranthifolia* subsp. *suffruticosa* (beach suncup), *Cakile maritima* (European searocket), and *Acmispon junceus* (rush broom). Co-dominant and common associates in McGrath State Beach include *Carpobrotus edulis* (freeway iceplant), *Carpobrotus chilensis* (sea fig), and *Mesembryanthemum crystallinum* (crystalline iceplant). The description of this alliance is based on the information provided in ESA (2003). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.3.2 *Brassica nigra* - *Raphanus* spp. Herbaceous Semi-Natural Alliance (Upland mustards and other ruderal forbs)

This alliance is dominated by ruderal forbs in the herbaceous layer. In the Study Area, this alliance typically has high herbaceous cover (50–95%); common species associates include *Hirschfeldia incana*, *Brassica nigra* (black mustard), and *Arundo donax*. Shrubs may be present at low cover, including *Sambucus nigra* subsp. *caerulea*, *Eriodictyon crassifolium* (thickleaf yerba santa), and *Baccharis pilularis*.

Brassica nigra has a Cal-IPC rating of Moderate (Cal-IPC 2019).

⁵ Plants of limited distribution, a watch list; threat rank of fairly threatened in California (moderate degree/immediacy of threat).

3.1.3.3 *Bromus (diandrus, hordeaceus) - Brachypodium distachyon* Herbaceous Semi-Natural Alliance (Annual brome grasslands)

This alliance is dominated by non-native annual grasses in the herbaceous layer. In the Study Area, this alliance typically has high herbaceous cover (up to 90%); common species associates include *Bromus diandrus* and *Bromus madritensis*. Shrubs may be present at low cover, including *Sambucus nigra* subsp. *caerulea*, *Datura wrightii*, and *Artemisia californica*.

Bromus diandrus has a Cal-IPC rating of Moderate (Cal-IPC 2019).

3.1.3.4 *Bromus rubens - Schismus (arabicus, barbatus)* Herbaceous Semi-Natural Alliance (Red brome or Mediterranean grass grasslands)

This alliance is dominated by non-native annual grasses in the herbaceous layer. Dominant grasses may include *Bromus madritensis* subsp. *rubens*, *Schismus arabicus* (Arabian schismus), and *Schismus barbatus* (common Mediterranean grass), with other non-native grasses and forbs present at lower cover and low cover of shrubs (CNPS 2019a). In the Study Area, this alliance is generally dominated by *Bromus madritensis* subsp. *rubens*.

Bromus madritensis subsp. *rubens* has a Cal-IPC rating of High; *Schismus arabicus* and *Schismus barbatus* are both rated Limited (Cal-IPC 2019).

3.1.3.5 *Corethrogyne filaginifolia - Eriogonum (elongatum, nudum)* Herbaceous Alliance (Sand-aster and perennial buckwheat fields)

This alliance is generally open, with low cover of low-growing herbaceous and shrub species. In the Study Area, this alliance is generally open (25% cover); *Corethrogyne filaginifolia* has the highest cover in the herbaceous layer. Shrubs are present at low cover, including *Eriogonum fasciculatum* and *Lepidospartum squamatum*. Exposed mineral surface cover of gravel, rock, fines, and cobble is generally high due to occasional flood scour.

3.1.3.6 *Cressa truxillensis - Distichlis spicata* Herbaceous Alliance (Alkali weed - salt grass playas and sinks)

This alliance is dominated by the low-stature perennial herbs *Cressa truxillensis* (alkali weed), *Crypsis schoenoides* (swamp pickle grass) and/or *Distichlis spicata*, and can have an herbaceous canopy that is open to continuous (CNPS 2019a). Soils that support this alliance are generally saline alluvial deposits that experience seasonal inundation and evaporation, forming alkaline or saline vernal playas or alkali sinks flats and sinks (CNPS 2019a). This alliance has a State sensitive natural community rank of S2 (CDFW 2018).

3.1.3.7 *Distichlis spicata* Herbaceous Alliance (Salt grass flats)

This alliance is dominated by the perennial grass *Distichlis spicata* and may occur in areas subject extended periods of inundation by brackish water and in saline soils. In the Study Area, the *Distichlis spicata* alliance typically has dense herbaceous layer (70% cover), although shrubs occasionally occur. The dominant species is *Distichlis spicata* (35% cover), with *Rumex crispus* (curly dock) (20% cover), and *Xanthium strumarium* (cocklebur) (20% cover) as common co-occurring species. *Baccharis salicifolia* seedlings and saplings can occur but are not common.

3.1.3.8 *Heterotheca (oregona, sessiliflora)* Herbaceous Alliance (Goldenaster patches)

This alliance is generally found on seasonally disturbed areas, especially riparian terraces, on floodplains with sand and cobble substrates, or coastal dunes and headlands (CNPS 2019a). In the Study Area, this alliance is generally sparsely vegetated, although with more cover (>10%) than the riverwash herbaceous cover type. *Heterotheca sessiliflora* is the dominant species, with low cover of shrubs and trees, if any. Given that photointerpretation is challenging for herbaceous species that lack unique visual signatures, this alliance may represent a variety of sparsely vegetated herbaceous types. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.3.9 *Leymus cinereus* - *Leymus triticoides* Herbaceous Alliance (Ashy ryegrass - creeping ryegrass turfs)

This herbaceous alliance is densely vegetated (>90% cover) with grasses and forbs and is generally found in moist or seasonally inundated sites; shrubs are occasionally present but at low cover (<5% cover). In the Study Area, *Elymus triticoides* (beardless wild rye) is the dominant species in this alliance, sometimes occurring as a nearly mono-specific stand while other sites contain a rich diversity of species. *Ambrosia psilostachya* (western ragweed) and *Anemopsis californica* (yerba mansa) are common co-dominant or sub-dominant species in the Study Area. This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

This alliance includes the following association that was identified in the Study Area:

- *Leymus triticoides* Association.

3.1.3.10 *Mesembryanthemum* spp. - *Carpobrotus* spp. Herbaceous Semi-Natural Alliance (Ice plant mats)

This alliance is typically found on sand dunes at the immediate coastline, on bluffs or within disturbed areas. In the Study Area, total vegetative cover is moderate (45%) and dominated by *Carpobrotus* spp. Shrubs may be present in low cover, including *Baccharis salicifolia*. Other herbaceous species include *Bromus* spp. and *Hirschfeldia incana*.

Cal-IPC rates *Carpobrotus edulis* as High; *Carpobrotus chilensis* and *Mesembryanthemum crystallinum* are rated Moderate (Cal-IPC 2019).

3.1.3.11 *Phragmites australis* - *Arundo donax* Herbaceous Semi-Natural Alliance (Common and giant reed marshes)

This alliance typically has a continuous herbaceous layer (60–95% cover). In the Study Area, *Arundo donax* is the dominant species in stands of this alliance, generally with >50% relative cover and often >50% total cover. Although *Arundo donax* is herbaceous, it commonly reaches heights of 12–15 feet along the Santa Clara River (and occasionally extends up to 20 feet). Because of its height, dense growth pattern, and general physical structure, it commonly dominates the middle stratum (0.5–5 m, also known as the shrub stratum), or co-dominates with woody shrubs. Shrub species are often present at highly variable cover and commonly include *Baccharis salicifolia*, *Salix exigua*, *Salix lasiolepis*, *Sambucus nigra*, and *Toxicodendron diversilobum*. Trees may occur at low cover, including *Populus fremontii* subsp. *fremontii*, *Populus trichocarpa*, and *Salix laevigata*.

This alliance includes the following association that was identified in the Study Area:

- *Arundo donax* Association.

Phragmites australis has been reported from the study area, but no patches of sufficient size to classify and map as the *Phragmites australis* Association were observed.

Arundo donax has a Cal-IPC rating of High and is one of the most invasive and widespread wildland pest plants in California (Cal-IPC 2019). Its great extent in the Santa Clara River watershed, rate of spread and impacts to the ecology of riparian areas have made it the focus of a large-scale eradication effort in the upper watershed (VCRC 2006a,b). In addition to mapped stands of this semi-natural alliance described above, *Arundo donax* also occurs as an invasive component in many other vegetation types. Further information on the distribution and abundance (percent cover) of *Arundo donax* throughout the study area is provided below in Section 3.3.

3.1.3.12 *Pseudognaphalium leucocephalum* Herbaceous Alliance (White rabbit-tobacco) [Provisional]

This alliance is characterized by the presence of *Pseudognaphalium leucocephalum* (white rabbit-tobacco), which has a CRPR of 2B.2⁶. One small stand was previously mapped in the study area (RSABG 2015). More stands may be present, but given the small scale and lack of clear signature in aerial photographs additional mapping of this alliance would require extensive field surveys.

3.1.3.13 *Sarcocornia pacifica* (*Salicornia depressa*) Herbaceous Alliance (Pickleweed mats)

The *Salicornia pacifica* (*Salicornia depressa*) alliance is a low-growing (<1.5 feet), densely vegetated (typically 90–100% cover) herbaceous vegetation type that is associated with estuaries and tidal marshes, and is tolerant of tidal inundation and moderately saline water. *Salicornia pacifica* (Pacific swampfire) is the dominant—and often only—species in the alliance, with percent cover typically >90%. Common associated species can include *Distichlis spicata*, *Jaumea carnosa* (marsh jaumea), and *Frankenia salina* (alkali heath). The description of this alliance is based on the information provided in ESA (2003). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

3.1.3.14 *Schoenoplectus (acutus, californicus)* Herbaceous Alliance (Hardstem and California bulrush marshes)

This alliance is densely vegetated with emergent species and typically occurs in tidal marshes that experience extended periods of inundation by fresh or brackish water. This alliance is dominated by any of several bulrush species (*Schoenoplectus acutus* var. *occidentalis* [common tule], *S. americanus* [Olney's three-square bulrush], and/or *S. californicus* [southern bulrush]), often with 47–99% cover. The tree layer is absent and the lower herbaceous understory (<1.5 feet) is generally sparse (<5% cover). A variety of other species, including *Arundo donax*, can be present but are generally low in abundance (<5% cover). This alliance has a State sensitive natural community rank of S3 (CDFW 2018).

⁶ Plants are rare, threatened, or endangered in California, but more common elsewhere; threat rank of fairly threatened in California (moderate degree/immediacy of threat).

3.1.3.15 *Typha* (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance (Cattail marshes)

This alliance is generally intermittently to densely vegetated with emergent species and typically occurs on silty alluvial deposits in semi-permanently flooded freshwater and brackish marshes (CNPS 2019a). This alliance is dominated by any of several cattail species (*Typha angustifolia* [narrow-leaved cattail], *T. domingensis* [southern cattail], and/or *T. latifolia* [broad-leaved cattail]), with a wide variety of associated species that may be represented. The tree and shrub layers are generally lacking or—if sparse—consist of scattered emergent *Salix* (willow) species.

3.2 Land Cover Type Descriptions

3.2.1 Agriculture

Agriculture, including orchards (primarily avocado and citrus), irrigated row-crops, and pasture, covers over 4,000 ac, and makes up nearly 25% of the Study Area.

3.2.2 Beach

The beach land cover type is found at the downstream end of the Study Area, at the Santa Clara River estuary and covers unvegetated coastal beach. It occupies 93 ac, 0.6% of the Study Area.

3.2.3 Developed

Developed areas, including golf courses, infrastructure, parks, municipal facilities, and other types of industrial or residential development cover 792 ac, under 5% of the Study Area.

3.2.4 Disturbed

Disturbed areas are those areas that experience high levels of human disturbance, particularly those exhibiting a substantial amount of bare earth or trash and debris accumulation. Disturbed areas make up 387 ac, over 2% of the Study Area.

3.2.5 Non-native grass and forb mapping unit

It was not feasible to collect field verification data for all stands of herbaceous vegetation throughout the Study Area. Because photointerpretation of herbaceous species is challenging for many species that don't have unique visual signatures, unverified herbaceous stands were categorized into this broader type, which may include a variety of herbaceous semi-natural alliances such as *Avena* (*barbata*, *fatua*), *Brassica nigra* – *Raphanus* spp., *Bromus* (*diandrus*, *hordeaceus*) – *Brachypodium distachyon*, *Bromus rubens* – *Schismus* (*arabicus*, *barbatus*), and *Centaurea* (*solstitialis*, *melitensis*). This classification type covers 129 ac, or less than 1% of the Study Area.

3.2.6 Ocean

The Pacific Ocean was included in the Study Area, and occupies 253 ac, over 1% of the Study Area.

3.2.7 Riverwash

High flows and scour events can clear out entire riparian communities. Riverwash captures these unvegetated river bottom and floodplain areas subject to fluvial disturbance (i.e. scour and deposition). Riverwash covers 294 ac, just under 2% of the Study Area.

3.2.8 Riverwash herbaceous

The riverwash herbaceous category captures areas that have experienced scour and deposition, but where herbaceous vegetation is recolonizing. These areas have less than 10% herbaceous vegetative cover, as visible in the 2016 aerial imagery. This type makes up 66 ac, less than 1% of the Study Area.

3.2.9 Water

The water land cover type includes all open water visible in imagery, both riverine or lacustrine. This type makes up 130 ac, less than 1% of the Study Area.

3.3 *Arundo donax* Distribution and Abundance

In addition to mapped stands of this semi-natural alliance described above, *Arundo donax* (giant reed) also occurs as an invasive component in many other vegetation types. To help characterize the distribution and relative abundance of *Arundo donax* throughout the study area we estimated the percent cover (by cover class) of this species in each mapped polygon. As can be seen in Table 3 and Figure 3, this nonnative invasive species occurs throughout the study area. The largest infestations generally occur in reaches with perennial surface water and shallow groundwater. Removal and control of *Arundo donax* is a major natural resource management challenge along the Santa Clara River (Orr et al. 2011, Stillwater Sciences 2011b).

Table 3. Summary statistics of acres of *Arundo donax* cover by reach in the Study Area.

Reach	Percent <i>Arundo donax</i> cover								Total acres
	<1	1–5	5–10	10–25	25–50	50–75	75–95	>95	
0	899.3	68.2	70.5	30.3	21.7	1.8	5.7	4.1	1,101.8
1	910.3	126.8	79.8	135.1	221.5	37.7	35.4	1.1	1,547.7
2a	286.9	149.1	326.4	34.6	81.1	2.7	55.5		936.3
2b	74.4	96.6	65.0	80.5	2.4	5.9	20.4		345.2
3	51.0	105.3	175.7	23.5	111.1	18.3	5.9		490.9
4	134.9	113.4	36.3	93.8	11.4	37.3	29.4		456.5
5	136.3	84.2	56.1	96.5	55.3	42.7	10.5		481.6
6	455.7	205.5	650.1	115.3	137.9	65.9	48.1	32.8	1,711.3
7	647.0	88.7	71.0	101.3	526.8	28.5	23.2	0.0	1,486.7
Sespe Creek	467.3	28.7	87.5	1.2	2.6	0.6			587.9
8	869.7	165.7	117.9	205.8	75.1	53.2	119.3	4.2	1,610.9
9	216.5	359.7	9.4	175.6	17.1	2.9	1.1		782.2
10	636.3	345.2	0.9	12.2	134.6	70.0	27.3		1,226.6
Piru Creek	729.9	24.9							754.7
11a	290.3	81.2	63.1	47.3	68.9	82.3	26.2		659.2
11b	115.0	39.7	85.1	36.5	48.3				324.6
12	394.8	44.0	1.7	155.2	73.3				669.0

Reach	Percent <i>Arundo donax</i> cover								Total acres
	<1	1–5	5–10	10–25	25–50	50–75	75–95	>95	
13	265.0	93.4	72.9	87.4	311.3	11.8			841.9
Castaic Creek	53.4	50.0	40.4	46.4			0.8		191.0
14a	83.3	37.8	42.2	0.4					163.8
Total	7,717.4	2,308.0	2,052.1	1,478.9	1,900.5	461.8	409.0	42.2	16,369.9

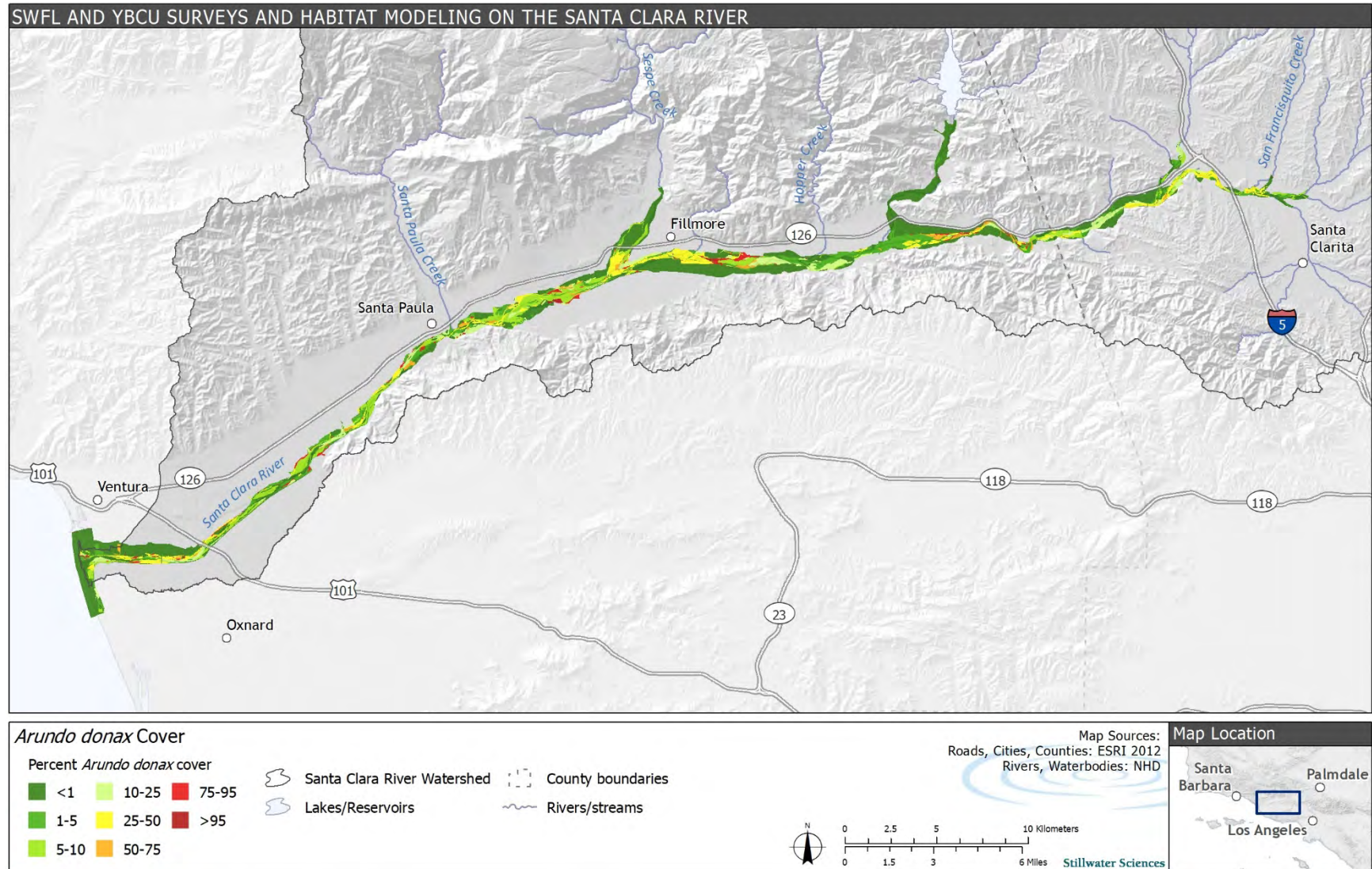


Figure 3. Percent *Arundo donax* cover in the Study Area.

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Appendices

Appendix A

Summary of Vegetation Mapping in Study Area

Table A-1. Summary statistics of acres of vegetation classes mapped by reach in the Study Area.

	Reach																				Total acres
	0	1	2a	2b	3	4	5	6	7	8	9	10	11a	11b	12	13	14a	Castaic Creek	Piru Creek	Sespe Creek	
Alliance																					
<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous Alliance	103.5																				103.5
<i>Artemisia californica</i> - <i>Salvia mellifera</i> Shrubland Alliance																	6.7				6.7
<i>Artemisia californica</i> Shrubland Alliance			15.5	24.5	0.9			19.4		2.0	10.6		1.6	1.0		0.7	7.8	9.7	8.2	8.1	110.1
<i>Artemisia tridentata</i> Shrubland Alliance									4.0		50.4	3.7					29.0	0.6			87.6
<i>Atriplex canescens</i> Shrubland Alliance																2.2					2.2
<i>Atriplex lentiformis</i> Shrubland Alliance			1.6		0.4	9.0					21.3	1.0							0.6		33.9
<i>Baccharis pilularis</i> Shrubland Alliance	4.4	50.4	3.0										0.9			3.0	15.5				77.2
<i>Baccharis salicifolia</i> Shrubland Alliance		57.0	417.6	74.0	157.4	171.0	59.7	493.0	545.6	402.1	202.8	290.4	22.7	25.8	23.1	76.4	32.2	50.2	123.3	36.1	3260.2
<i>Brassica nigra</i> - <i>Raphanus</i> spp. Herbaceous Semi-Natural Alliance	1.6	2.3							8.2												12.1
<i>Bromus (diandrus, hordeaceus)</i> - <i>Brachypodium distachyon</i> Herbaceous Semi-Natural Alliance					59.6		2.1								0.6	42.0					104.4
<i>Bromus rubens</i> - <i>Schismus (arabicus, barbatus)</i> Herbaceous Semi-Natural Alliance					2.3																2.3
<i>Corethrogyne filaginifolia</i> - <i>Eriogonum (elongatum, nudum)</i> Herbaceous Alliance		2.1	1.4																	6.0	9.6
<i>Cressa truxillensis</i> - <i>Distichlis spicata</i> Herbaceous Alliance	2.0																		2.2		4.2
<i>Distichlis spicata</i> Herbaceous Alliance	2.1																				2.1
<i>Encelia californica</i> - <i>Eriogonum cinereum</i> Shrubland Alliance																				51.1	51.1
<i>Eriogonum fasciculatum</i> Shrubland Alliance									1.3			11.4				5.5	4.2		16.1	3.1	41.6
<i>Eucalyptus</i> spp. - <i>Ailanthus altissima</i> - <i>Robinia pseudoacacia</i> Woodland Semi-Natural Alliance		1.2	0.5		3.5		2.8	21.6	19.7	1.2	0.8	0.4	1.4						0.2	21.2	74.4
<i>Heterotheca (oregona, sessiliflora)</i> Herbaceous Alliance		1.9	34.6	4.4	18.4	12.5	26.0	5.4	47.0	43.8	258.8	192.0				8.1		18.4	7.0		678.3
<i>Juglans californica</i> Woodland Alliance								4.8												1.1	6.0
<i>Lepidospartum squamatum</i> Shrubland Alliance								63.9	41.9		3.2	67.3				22.6	1.1		47.1	192.0	439.1
<i>Leymus cinereus</i> - <i>Leymus triticoides</i> Herbaceous Alliance		0.5						0.3													0.9
<i>Lotus scoparius</i> Shrubland Alliance			4.8			1.6															6.5
<i>Mesembryanthemum</i> spp. - <i>Carpobrotus</i> spp. Herbaceous Semi-Natural Alliance	73.9																				73.9
<i>Olea europaea</i> Woodland Semi-Natural Alliance [Provisional]																			2.7		2.7
<i>Phragmites australis</i> - <i>Arundo donax</i> Herbaceous Semi-Natural Alliance	9.9	36.5	52.1	19.3	24.3	66.7	35.8	118.8	54.3	159.9	4.0	69.7	26.2			25.0		0.8		0.6	703.8

	Reach																				Total acres
	0	1	2a	2b	3	4	5	6	7	8	9	10	11a	11b	12	13	14a	Castaic Creek	Piru Creek	Sespe Creek	
<i>Platanus racemosa</i> Woodland Alliance																			4.6		4.6
<i>Pluchea sericea</i> Shrubland Alliance													37.2	33.9	8.6						79.7
<i>Populus fremontii</i> Forest Alliance							0.6				9.7	14.6	125.6	57.4	87.7	291.3	55.0	68.9	96.4	0.7	807.9
<i>Populus trichocarpa</i> Forest Alliance	24.9	60.3	3.2		22.2	0.9	32.4	284.3		2.9										1.0	431.9
<i>Pseudognaphalium leucocephalum</i> Herbaceous Alliance [Provisional]												0.2									0.2
<i>Quercus agrifolia</i> Woodland Alliance		0.5				1.9	18.8		0.7			5.6	6.2	1.0		1.3			15.7	7.0	58.5
<i>Quercus lobata</i> Woodland Alliance																6.0					6.0
<i>Ricinus communis</i> Shrubland Semi- Natural Alliance [Provisional]											2.2										2.2
<i>Salix exigua</i> Shrubland Alliance		2.8	17.2	4.0	16.6		50.8	52.5	22.2	1.0	27.7		1.3			2.5				9.0	207.5
<i>Salix laevigata</i> Woodland Alliance	0.0	203.4	114.3	117.7	70.8	51.8	133.1	278.0	11.2	59.8	8.6	8.6	128.6	124.7	176.2	213.0		6.7	81.8	12.3	1800.6
<i>Salix lasiolepis</i> Shrubland Alliance	81.0	265.3	12.4	5.8	94.6	17.7	3.6	4.5								1.8					486.7
<i>Salix lucida</i> Woodland Alliance		17.8						9.3													27.2
<i>Salvia apiana</i> Shrubland Alliance											4.9										4.9
<i>Salvia leucophylla</i> Shrubland Alliance					1.1																1.1
<i>Sambucus nigra</i> Shrubland Alliance							27.0	0.8								9.4	1.4			2.9	41.4
<i>Sarcocornia pacifica</i> (<i>Salicornia depressa</i>) Herbaceous Alliance	4.9																				4.9
<i>Schinus</i> (<i>molle</i> , <i>terebinthifolius</i>) - <i>Myoporum laetum</i> Woodland Semi- Natural Alliance	1.3																		20.2	20.8	42.3
<i>Schoenoplectus</i> (<i>acutus</i> , <i>californicus</i>) Herbaceous Alliance	50.3	5.8						8.1													64.3
<i>Tamarix</i> spp. Shrubland Semi-Natural Alliance	1.7												41.3	9.7		1.8					54.6
<i>Typha</i> (<i>angustifolia</i> , <i>domingensis</i> , <i>latifolia</i>) Herbaceous Alliance					0.9												1.3		3.3		5.5
Land Cover Type																					
Agriculture		406.0	24.0	79.4		52.2	83.4	253.5	546.6	876.1	94.9	546.3	240.8	25.1	332.7	53.0			276.7	170.9	4061.6
Beach	93.3																				93.3
Developed	283.9	284.9	65.4	1.1	1.8	13.0	3.3		41.1		3.6	2.3	2.6			36.8		3.4	30.2	18.1	791.6
Developed - park/open space		104.5				30.1			5.8												140.4
Disturbed		27.9	14.8	0.5	10.3	11.1	2.3	15.3	101.4	35.0	10.6	12.2	1.8	41.7	36.1	21.5		31.5	11.0	1.6	386.5
Non-native Grass and Forb Mapping Unit			2.8	3.2	2.1	12.7		32.7	2.8		14.1	1.1	19.5	4.4		3.1			6.2	23.8	128.6
Ocean	253.2																				253.2
Riverwash		3.6	151.0	9.7		2.7			27.3	27.1	48.9				0.1	14.9	8.0	0.8			294.1
Riverwash herbaceous				1.5	3.7			45.1	5.6		5.0				3.8		1.6				66.3
Water	109.8	13.0		0.2		1.5							1.5						1.3	0.5	127.9
Total	1101.8	1547.7	936.3	345.2	490.9	456.5	481.6	1711.3	1486.7	1610.9	782.2	1226.6	659.2	324.6	669.0	841.9	163.8	191.0	754.7	587.9	16369.9

Appendix B

Metadata

An ESRI geodatabase was developed to house the digital spatial data associated with this project. The polygon layer representing the vegetation and land cover mapping data contains several fields, defined below.

- **Alliance:** the alliance, or broader landcover type, of the mapped unit.
- **Association:** where available, the association of the mapped unit.
- **Abbr:** an abbreviation label for each mapped unit based on its classification, generally the four-letter species code.
- **UID:** a unique identifier for each mapped unit.
- **Source2018:** The source from which the mapping unit delineation and classification call were derived. See Sections 2.1 and 2.2 of the report for more detailed information on these sources.
- **QC_type:** the type (or types) of field validation, if applicable:
 - “data form” indicates a CNPS vegetation rapid assessment field data form was used.
 - “recon form” indicates a CNPS vegetation reconnaissance field data form was used. Where these reconnaissance field data forms were collected remotely using binocular based surveys, this was noted.
 - “YBCU” indicates surveys were performed during bird surveys by Western Foundation of Vertebrate Zoology staff.
 - “field data” indicates that field crews took a line or polygon feature to recommend a revised polygon extent.
- **ARDO_cover:** Percent *Arundo donax* cover for the mapped unit.
- **ARDO_class:** *Arundo donax* cover classified into modified Daubenmire bins.
- **Disturbed:** indicates if mapped unit shows visible disturbance in NAIP 2016 imagery, or as noted during field surveys.
- **Acreage:** the acreage of each mapped unit.
- **Shape_Length:** The length of a polygon shape, in feet.
- **Shape_Area:** The area of a polygon shape, in square feet.

The data are projected in California State Plane V, NAD 83, in U.S. feet.