A Range Wide Map of Least Bell's Vireo Nesting Vegetation: Mapping Protocol

Casey A. Lott[1], Edward Reyes[2], Arin Glass[2], Deborah Johnson[2],

[1] Conservation Science and Data Visualization, LLC
1209 Shenandoah Drive
Boise, ID 83712
caseylott@ymail.com**, corresponding author**

[2]Aerial Information Systems, Inc.
112 First Street
Redlands, CA 92373, mapping contractors

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Prepared by:

Primary Authors
Casey A. Lott[1]
Edward Reyes[2]
Arin Glass[2]
Deborah Johnson[2]
Report Graphics
Ben Johnson[2]

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Ground View Photo Credits:
Google Earth Street View

[1]Conservation Science and Data Visualization, LLC
1209 Shenandoah Drive
Boise, ID 83712
caseylott@ymail.com
208-629-8705

in collaboration with:

[2]Aerial Information Systems, Inc.
112 First Street
Redlands, CA 92373
(909) 793-9493
ais@aisgis.com

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ABSTRACT

Least Bell's Vireos (LBVI) are a state and federally listed endangered species that nests exclusively in riparian areas in California. Despite being listed for ~40 years, there has never been a single map, with high thematic resolution, of riparian vegetation covering the entire breeding range of this species. Conservation Science and Data Visualization and Aerial Information Systems co-developed a standardized mapping protocol, called VireoVegMap, with the objective of providing a comprehensive map of potential LBVI nesting habitat. Dominant vegetation map units and secondary map attributes were chosen to provide specific information relevant to LBVI ecology, conservation, and management. We then applied this protocol, using 2020 aerial imagery, to create a baseline map of riparian vegetation to support vireo recovery planning and status evaluation.

The overall study area consists of twenty-eight USGS Hydrologic Unit Code (HUC) 8 subbasins in Central and Southern Coastal California and Southern California Deserts. This study area is represented by a polygon feature class in the project geodatabase called "Total Study Extent". Within this large study area, a Focused Mapping Area was developed to ensure near-complete coverage of all riparian vegetation within active channels and floodplains of Level 1 stream networks (e.g., streams that terminate in the Pacific Ocean) within each HUC8 subbasin. Similar protocols were developed to cover active channels and floodplains of desert streams that flow eastward from Peninsular Ranges and terminate in playa lakes. Work was performed on the project between 2021 and 2023.

Project data was produced applying heads-up digitizing techniques in an Esri ArcMap environment using 2020 National Agricultural Imagery Program (NAIP) imagery (60-centimeter base; true-color and color infrared). Ancillary imagery and data sources provided context during mapping. Each map polygon was assessed for 6 attributes:

- Dominant vegetation map unit type (defined as the vegetation type with >50% relative cover, regardless of total percent vegetation).

- Tree Willow Cover (absolute percent cover of all species of willow trees combined). This ensures that all mapped stands include information on this primary tree nesting habitat type for LBVI.

- Shrub Willow/Mulefat Cover (absolute percent cover of all shrub willow species and mulefat, *Baccharis salicifolia*). This ensures that all mapped stands include information on this primary shrub nesting habitat type for LBVI.

- Arundo Cover (absolute percent cover of *Arundo donax*). This ensures that all mapped stands include information on this invasive exotic species, which degrades LBVI habitat and in some cases, replaces it.

- Tamarisk Cover (absolute percent cover of *Tamarix* spp*.).* This ensures that all mapped stands include information on this invasive exotic species.

- Dieback Index (absolute percent cover of all trees and/or shrubs within a mapped polygon that show signs of dieback). This provides useful information about vegetation condition and potential drought effects on vireo habitat.

For all but one map unit, the minimum mapping unit (MMU) polygon size was 1 acre. Due to importance of early detection of Arundo, in order to plan for its removal, smaller *Arundo donax* stands were mapped, with polygons as small as a half-acre.

This report describes all VireoVegMap mapping protocols and provides high-level summaries of acreage for dominant vegetation map units and secondary attributes. A detailed appendix provides detailed descriptions of each map unit, listing plant species compositions and ecological settings where each is found. Representative aerial images and ground photographs are provided for each of the major map units and common combinations of secondary attributes associated with each dominant map unit. The 2020 VireoVegMap is freely available for download as an ESRI file geodatabase at: VireoVegMapDownload**.**

Keywords: Habitat Mapping, Recovery Planning, Least Bell's Vireo, Central California, Southern California, California Desert, Vegetation Classification, Aerial Photography Interpretation, Riparian Vegetation, Endangered Species.

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1 Introduction

1.1 Background

The Least Bell's Vireo (LBVI) is a state and federally listed endangered species that nests exclusively in low-slope riparian areas with dense shrub understory in California (Kus et al. 2022). Due to extreme loss and degradation of riparian habitat from development and expansion of agricultural land use into riparian zones in the 1900's, the LBVI was listed as a state endangered species in California in 1980 (Goldwasser et al. 1980). On May 2, 1986, the U.S. Fish and Wildlife Service (USFWS) added the LBVI to its list of endangered species because of these factors, evidence of regional extirpations, significant declines in pair numbers, and invasion of many riparian areas by the invasive exotic grass, *Arundo donax* (USFWS 1986). The LBVI population has slowly increased over the past 3+ decades, mainly due to federal listing, which helped curb the loss of riparian habitat; encouraged invasive exotic plant removal and habitat restoration; and resulted in efforts to control brown-headed cowbirds, a widespread brood parasite across the geographic range of LBVI that was also implicated in population declines (USFWS 1998). These actions have led to population growth and partial recolonization of former breeding areas due to increased vireo reproductive success (Griffith and Griffith 2000, Kus and Whitfield 2005, Zembal et al. 2022). An accurate map of potential habitat across the current and formerly occupied range of LBVI will aid in recovery planning to help maintain viable populations for this species in its current range (mostly in Southern California) and to help this species recolonize parts of its former range to the north (specifically, the Central California Coast, where this recolonization appears to be happening currently).

Concerns remain about the sustainability of the groundwater-dependent riparian vegetation that vireos favor for nesting, as California faces potential reductions in water supply brought on by more frequent drought conditions caused by climate change, increases in demand for water due to continued urban growth and other intensive water uses, and ongoing problems with Arundo and other exotic plant species. In addition, the invasion of the shot-hole borer, an exotic wood boring beetle, which introduces a fungal pathogen that causes significant dieback of riparian nesting vegetation, may be an emerging threat (Lynch 2019). Conservation Science and Data Visualization (CSDV) was asked by the US Army Engineer Research and Development Center to provide an assessment of the current state of range-wide LBVI habitat to help inform collaborative recovery planning among federal action agencies and USFWS. To facilitate this assessment, the US Department of Defense, Marine Corps, funded the development of this comprehensive vegetation map, based on recent aerial imagery.

CSDV contracted Aerial Information Systems (AIS) to produce a range-wide map of LBVI riparian nesting habitat using imagery from the 2020 growing season. This was the most current National Agricultural Imagery Program (NAIP) imagery at the time of the project start date. The main objective of the project was to produce riparian vegetation

data specific to, and in context of, potential LBVI nesting habitat that can be used to support vireo status assessment, research, population modeling, and recovery planning.

1.2 Potential applied uses of the 2020 Vireo Vegetation Map

Mapping of 2020 riparian vegetation establishes a baseline for range-wide LBVI nesting habitat conditions that can be used to:

- Evaluate the range-wide status and distribution of riparian vegetation that LBVI may use for nesting.
- Develop cowbird control plans at the scale of HUC8 subbasins within recovery units that will be sufficient to maintain existing populations and facilitate the expansion of LBVI into suitable habitat within their former range.
- Develop A*rundo donax* (Giant Reed) removal strategies at the scale of HUC8 subbasins that will maintain or expand existing areas of native riparian vegetation nesting habitat. These areas, with follow-up management, will help LVBI reoccupy formerly suitable nesting habitat that has been lost to Arundo*.*
- Understand the extent of the threat to riparian vegetation that is imposed by the emerging stressor of shot-hole borer invasion and develop potential management strategies.
- Evaluate the potential impacts of groundwater management issues on vireo habitat across the species' potential breeding range.
- Evaluate the potential impacts of wastewater management issues on vireo habitat across the species' potential breeding range.
- Develop habitat-based metapopulation models to explore how LBVI may respond to alternative future climate or vegetation management strategies.

2 Methods and Protocols

AIS and CSDV collaborated to develop a new mapping protocol, unique to this effort, that is designed to facilitate quantitative analysis of vegetation types that are commonly used for nesting by LBVI. This mapping protocol, which we refer to as "VireoVegMap" is described herein. This protocol includes:

- Methods for locating riparian vegetation patches across the entire study extent, ensuring near-comprehensive coverage of potential range-wide vireo nesting habitat.
- A classification scheme for assigning vegetation polygons to a standardized list of primary map units based on dominant vegetation types.
- Rules for assigning 5 secondary map attributes to each polygon, describing vegetation characteristics that may affect vireo habitat quality in addition to dominant vegetation type.

2.1 Defining the Range-wide LBVI Vegetation Map Project Boundary

The range-wide LBVI habitat study area consists of 28 selected HUC8 subbasins, 24 of which are in Central California Coastal and Southern California Coastal HUC6 basins, 3 of which are in desert areas east of the Peninsular Ranges, and one in the southeastern Sierra Nevada Mountains (Figure 1). HUC8 subbasins were used for boundary definition, since this was the hierarchical level of USGS' Watershed Boundary Dataset (WBD) that most closely corresponds to prior narrative definitions of USFWS recovery units (USFWS 1998). The WBD is part of USGS' National Hydrography Dataset (NHD), which is a standardized spatial framework for research and analysis involving streams in the United States (McKay et al. 2017). The Seal Beach and Carrizo Plains HUC8 subbasins, although within this larger geographic area, did not contain any potential LBVI nesting habitat and were therefore not included. WBD HUC8 boundaries were adjusted, as necessary, if their extent presented a mismatch with observed vegetation. For example, some coastal HUC8 boundaries fell short of the current coastline due to recent deposition at river mouths. In these areas, HUC8 boundaries were extended downstream to encompass all land at river mouths.

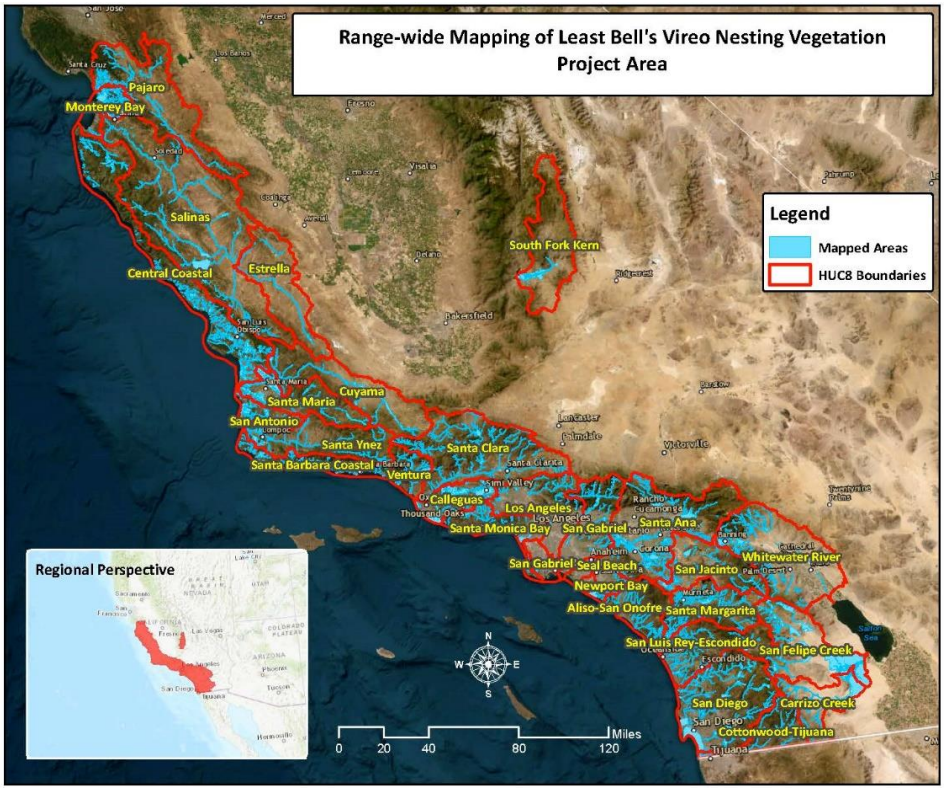

Figure 1: Range-wide study area boundaries, defined by WBD HUC8 subbasins, are shown in red. The Focused Mapping Area, which covers all riparian areas within the project boundary, is shown in blue. The south fork of the Kern River was added to this study opportunistically, since this area supports a small population of nesting vireos and it was not mapped during previous mapping efforts for the Central Valley or Sierra Nevada Mountains.

2.2 Defining a Focused Mapping Area within the Project Boundary

The project objective was to document and classify all riparian vegetation that might provide vireo nesting habitat within active channels and floodplains along any of the streams located within our broader study region. Given the incomplete coverage of our study area by prior vegetation maps, and an absence of vireo surveys in many areas, we followed the steps below to ensure near-complete coverage of potential LBVI nesting habitat within the broad project area boundaries defined by HUC8 subbasins. First, CSDV used the combination of prior vireo nesting locations and a large number of vegetation maps with partial coverage of our study area (https://wildlife.ca.gov/Data/VegCAMP/Reports-and-Maps) to preselect stream segments from the NHD's hydrography layer within each HUC8 that may contain potential vireo nesting habitat. This initial set of stream lines was then buffered by 250 meters (a very rough approximation of average channel widths within our study area) on each side to generate a draft Focused Mapping Area. This draft focused mapping area polygon was just a starting point.

To ensure near-complete coverage of all streams with vireo habitat, photo interpreters started at the mouth of each selected stream at the Pacific Ocean and mapped entire stream networks while moving upstream, leaving the mainstem to follow each tributary upstream until no more potential nesting habitat occurred, and returning to the mainstem back at the tributary confluence to resume upstream movement on the mainstem. This approach ensured that entire stream networks were covered from their mouths to their headwaters. In desert areas within our study region, streams drain eastward and terminate in inland playas rather than the Pacific Ocean. In these areas, mapping proceeded from inland sinks upstream toward the headwaters to ensure near-complete coverage of desert stream networks.

As the mapping team progressed upstream within each stream network, they extended the draft Focused Mapping Area boundary laterally, beyond initial 250m buffers, whenever this was necessary to capture all potential riparian habitat within and adjacent to active river channels and floodplains. Given large variation in channel, floodplain, and valley widths within and among stream networks across our study extent, this kind of flexible approach was necessary to ensure complete near-complete coverage. The Focused Mapping Area was also expanded to include large waterbodies along river networks, such as reservoirs, with riparian areas on their shorelines. Additional streams with similar ecological contexts to those that were included in the original "StreamsToMap" layer were added to the Focused Mapping Area as they were encountered via visual exploration of aerial imagery for each HUC8 subbasin during map production. This served as an additional check to ensure that no streams were missed by relying solely on the initial "StreamsToMap" layer. Finally, draft Focused Mapping Area boundaries were extended in upper stream reaches and tributaries when the original StreamsToMap database stopped short of capturing all potential nesting vegetation in headwater areas. As tributaries and headwater streams became narrower

and steeper, it was common for primary nesting tree and shrub species to transition to vegetation types where vireos do not regularly nest (e.g., sycamore, oak, or alder-dominated stands on narrow, steep streams with no willow or mulefat component). In this transition zone, photo interpreters only mapped stands where vegetation polygons contained percent cover codes of 1 (>5-15%), 2 (>15-40%), or 3 (>40%) of percent tree willow and/or percent shrub willow/mulefat (see Appendix A for percent cover guidelines). Areas upstream of the last mapped stand on each headwater tributary were assessed for approximately 1 kilometer upstream for additional potential nesting polygons. If none were found, the Focused Mapping Area was terminated at this upstream boundary. Occasionally, isolated stands of potential nesting habitat were found past this 1km threshold in areas where narrow streams widened into higher-elevation valleys. These polygons had to be greater than 5 acres to be considered for mapping. These isolated patches were buffered and included in Focused Mapping Area.

These protocols were designed to ensure that the 2020 VireoVegMap represents as complete of an accounting as possible of riparian vegetation along all streams within the study region with potential vireo habitat, regardless of stream or floodplain width. In the end, the final Focused Mapping Area, which is provided as a polygon feature class in the project geodatabase, covered 2,254,958 acres. We are confident that this robust mapping protocol resulted in a near comprehensive accounting of all potential vireo nesting habitat within our broader study extent as it was defined by HUC8 subbasin boundaries. However, we acknowledge that some isolated patches of riparian vegetation, particularly in headwaters, may have been missed. All portions of the study area within the expanded Focused Mapping Area were assessed for potential habitat. Areas of HUC8 subbasins that were inside the larger study region but outside the Focused Mapping Area were not assessed. See Appendix B for additional methods that were used to delineate Focused Mapping Areas for desert HUC8s.

2.3 Imagery Sources and Pre-existing Vegetation Maps

Mapping of vegetation polygons is based on aerial photography interpretation, while gleaning information from ancillary data sources, using mapping criteria as outlined below. The primary imagery source, and the basis of georeference, was 2020 NAIP imagery. NAIP imagery is available in both natural color and color infrared, with sub-meter pixel resolution (USDA 2013). This imagery serves as a consistent snapshot in time and was used to delineated all polygons described herein and analyzed in further detail in Lott et al. (in preparation).

Many prior categorical vegetation maps are available from portions of our study area (https://wildlife.ca.gov/Data/VegCAMP/Reports-and-Maps). However, these maps were created for different purposes, used different classification schemes for primary map units; had different Minimum Mapping Unit (MMU) sizes, mapping criteria, and imagery dates; and were generated by different mapping entities. We used some of these prior vegetation maps as sources for spatial reference or context. However, we created a new, internally consistent classification system and geodatabase structure for the 2020

VireoVegMap, described herein. This classification system was developed specifically to support range-wide mapping of potential nesting habitat for LBVI.

In addition to historic vegetation maps, supplemental imagery sources were used to assist in the interpretation of vegetation, identification of plant species, or other contextual needs for assessing and coding all the attributes in the project schema. Ancillary imagery sources included 2016 and 2018 color and color infrared NAIP imagery, Google Earth multi-year historical imagery with leaf-on and leaf-off conditions, Google Earth multi-year street views with leaf-on and leaf-off conditions, and Bing imagery with birds-eye view and street view.

Note that for small portions the western ends of the Santa Ynez, San Antonio, and Santa Maria subbasins, on Vandenberg Space Force Base, imagery was not available from any of the sources listed above. Instead, for these areas, we used 3-inch resolution 2019 natural color imagery that we acquired via formal request for authorized, restricted-use (e.g., only for this project), directly from the Department of Defense. Collectively, these imagery sources covered the entire project study area with high-resolution imagery from 2020 (NAIP, most of the study area) or 2019 (restricted-use imagery from DOD) for Vandenberg Space Force base.

2.4 Classification of Dominant Map Units and Secondary Attributes in VireoVegMap: Differences from other Classification Schemes

We developed the VireoVegMap protocol largely to overcome a fundamental incompatibility between vegetation classification schemes used in prior mapping projects in California and the delineation of vireo nesting habitat. That is: Least Bell's Vireos are particularly abundant in shrub willow species and/or mulefat, as these shrubs are frequently used for nest placement. California's Vegetation Classification and Mapping Program (VegCAMP) employs a standard vegetation classification scheme that is tied to the National Vegetation Classification Standard (NVCS). Many of the prior, high-resolution vegetation maps for the state of California have used this scheme, which maps vegetation polygons down to alliances or associations (Jennings et al. 2009). While the NVCS is extremely useful for many applications, its rules for the classification of vegetation polygons to map units does not adequately account for the presence of shrub willow/mulefat or tree willow. This is because NVCS membership rules for vegetation types differ from the needs of the LBVI for habitat. For example, willow species, when not strongly dominant, are typically subsumed within other riparian tree map units in the NVCS. Specifically, when tree willow stands are mixed with *Platanus, Populus*, or *Fraxinus,* the non-willow trees take precedence in the classification of stand type to NVCS alliance. Thus, when willow trees or shrubs are mixed with these other tree species, which is a very common occurrence, the presence of willows may not be specifically accounted for. For example, NVCS-based vegetation classification criteria place stands with a co-dominance of *Populus fremontii* and *Salix laevigata* into the *Populus fremontii* Alliance. Similarly, a stand with co-dominance of *Platanus racemosa* and *Salix laevigata* is mapped into the *Platanus racemosa* Alliance or the *Platanus*

racemosa – *Quercus agrifolia* Alliance. Whenever NVCS rules result in the assignment of a polygon to a dominant tree type (which occurs at even relatively low tree cover, 8-10%), shrub vegetation types where vireos place most of their nests (shrub willows and mulefat) are not accounted for at all. Therefore, use of the NVCS protocol to map vireo habitat would be problematic since areas with high densities of shrub or tree willows (outstanding vireo nesting habitat) may be missed entirely.

To meet the objective of mapping potential LBVI nesting habitat, a more vireo-centric mapping classification was developed for the VireoVegMap protocol (Table 1). Stand classification criteria for VireoVegMap used straight dominance as the primary criteria for delineation of map units. For example, in a co-dominant stand of *Salix laevigata* and *Populus fremontii*, if the *Salix* had greater cover than the *Populus*, then the stand was classified as Tree Willow. If the *Populus* had greater cover than *Salix* then the stand was classified as *Populus*. In a co-dominant stand of *Salix laevigata* and *Platanus racemosa*, if the *Salix* had greater cover than the *Platanus,* then the stand was classified as Tree Willow. If the *Platanus* had greater cover than *Salix* the stand was classified as *Platanus racemosa*. This approach allowed for better accounting of vegetation polygons that included significant nesting habitat resources for vireos.

In secondary attributes for each polygon of a NVCS/VegCAMP vegetation database, tree cover is attributed separately for conifers, hardwoods, and all trees, not by tree species. Similarly, NVCS shrub cover estimates do not distinguish among shrub species. In this project, we created two different secondary attributes for each polygon: one that estimated the percentage of tree willow nesting habitat for each polygon and one that estimated the percentage of shrub willow/mulefat nesting habitat. Cumulatively, these mapping protocol elements ensured that polygons dominated by tree willow were mapped as such and that all polygons, regardless of their dominant map unit, included information about tree and shrub willow/mulefat components (e.g., vireo nesting habitat) when they were present. These changes make the VireoVegMap protocol far more sensitive to documenting potential vireo habitat than the NVCS. Figures 2 and 3 illustrate differences in vegetation mapping outcomes using the NVCS and this project's vireo-centric habitat classification.

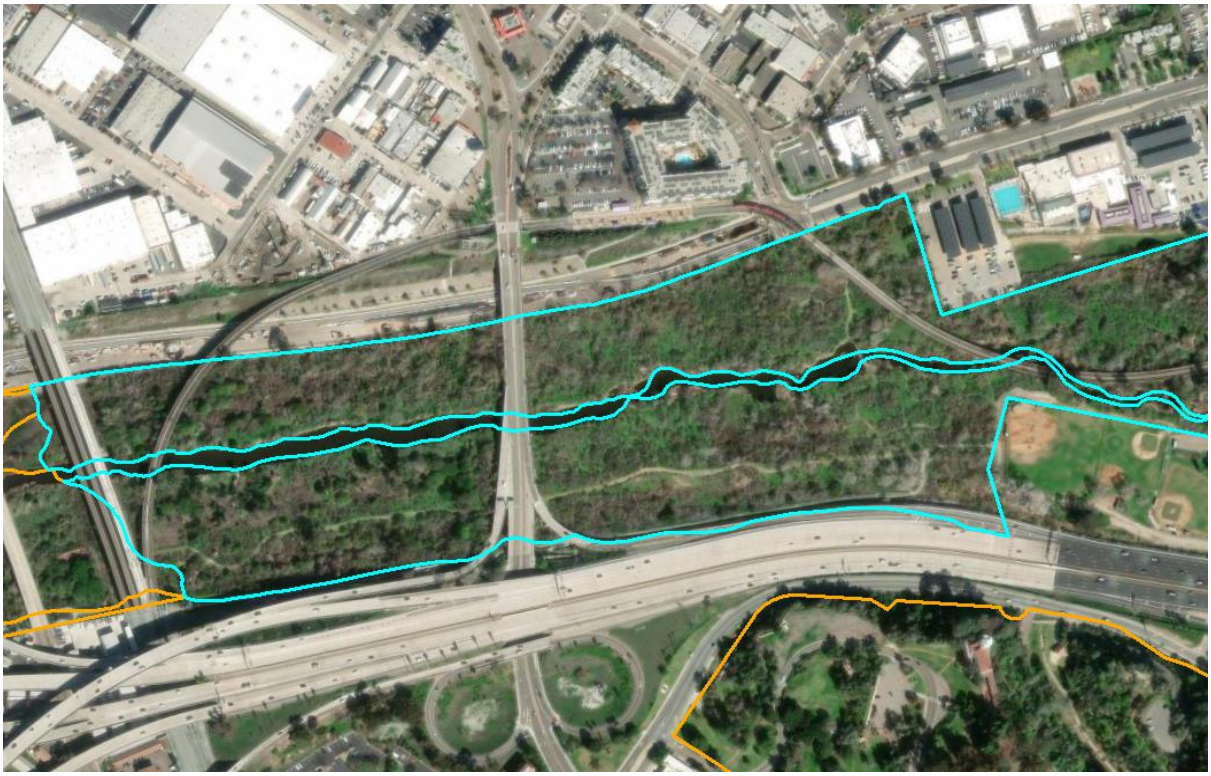

Figure 2: NVCS *Populus fremontii* Alliance (blue) mapped in San Diego County vegetation database.

Figure 3. Vireo-centric Tree Willow map class in current project vegetation database (Red hatched pattern).

2.5 Data Dictionary of VireoVegMap Attributes

The vireo-centric classification for this project includes eight attributes that were assigned to each unique vegetation polygon. These attributes include the primary map attribute of Map Unit (e.g., dominant vegetation type); five secondary attributes for percent tree willow, percent shrub willows/mulefat, percent *Arundo donax*, percent *Tamarix* spp., percent Dieback/Stress; HUC8 subbasin name; and Acres. Each of these attributes can be used to form lines between polygons during polygon delineation except for Acres. In other words, a change in values for ANY of these attributes would result in the closing of a given polygon and the creation of a new polygon. Using this approach, each polygon is defined by its exact combination of attributes, which are designed to characterize important aspects of vegetation conditions as they relate to vireo habitat. For example, Arundo is an exotic plant that decreases vireo nesting habitat quality. Polygons with favorable dominant species (e.g., tree willows) that have high values for the secondary attribute of Arundo, may represent areas of ongoing habitat degradation where Arundo management may significantly improve habitat quality. Map units may be primary LBVI nesting habitat (where most nests may be placed), secondary nesting habitat (which may form part of nesting territories but may not be heavily used for nest placement), or vegetation types that are not LBVI habitat. Map units for some dominant tree species (e.g., *Populus* or *Platanus*) may be favorable for vireo nesting when secondary attributes of tree or shrub willow are present and unfavorable for vireo nesting when they are absent.

Please note that 3 of our HUC8 modules (Santa Clara, Ventura, and Santa Ynez) were mapped first, in a pilot phase. During this phase polygons were attributed to the “low” percent cover category if they had >1% cover (e.g., even a trace amount of a vegetation for a secondary attribute would be recorded) and <15% cover. After reviewing pilot mapping data, we decided to change the lower bound for “low” cover to 5% and polygons with 1-4% cover of the secondary attribute were mapped with the code 0. In other words, for each of the other 25 HUC8 subbasins, the low cover category ranged from 5-15%. This is true for all attributes where percent cover was assigned to polygons. For this reason, polygons in pilot areas with very small amounts of a vegetation type associated with a secondary attribute (e.g., shrub willow, Arundo, etc.) were more likely to be given a percent cover code of 1 than 0 compared to polygons for all other, non-pilot, HUC8 mapping areas. Additionally, during the pilot phase, *Sambucus* and *Tamarix* shrubs were included in percent cover estimates as components of primary nesting shrub cover (with shrub willows and mulefat). In all other areas, they were treated as secondary mapping units and only shrub willows and mulefat were primary shrub nesting habitat. This may have resulted in higher values for the percent shrub nesting habitat attribute (called percent shrub willow/mulefat in the final map classification) for the 3 HUC8s mapped during the pilot phase.

The VireoVegMap classification scheme in Table 1 provides summary information about each of the categorical map units and each secondary attribute. For more detailed descriptions of common vegetation species mixes within each map unit, see Appendix

C. The VireoVegMap classification scheme was developed by CSDV and AIS, with input from vegetation ecologist Todd Keeler-Wolf, formerly of the California Department of Fish and Wildlife's VegCAMP program, to provide the most efficient mapping and coding parameters suitable for subsequent map production and use. Each of the main mapping units was given a "common name" vegetation type to complement categories based on scientific names and simplify map legends.

Table 1. The VireoVegMap Classification Table. This table provides a data dictionary for the 8 attributes associated with each polygon. Primary nesting habitat map units are highly suitable for vireo nesting, including shrub species that vireos use to place their nests as well as foraging habitat. Secondary nesting habitat map units may be used for vireo nesting if shrub willow species or mulefat are present in the stand (see % shrub willow/mulefat attribute). Otherwise, these map units may be present in vireo territories when they are near primary nesting habitat stands, in which case, they provide foraging habitat. Please note that each map unit has a numeric map unit code, a map unit name, and a shorter "vegetation name." Database field names are shown in brackets.

Map Unit Code [MapCode_1], Map Unit Name [Map Unit_1], and Vegetation Name [VegName][1]

PRIMARY NESTING HABITAT MAP UNITS
- TREE MAPPING UNITS
  - 111 = Tree Willow MU = "Tree Willow"
- SHRUB MAPPING UNITS
  - 121 = Riparian Shrub MU = "Shrub Willow/Mulefat"

SECONDARY NESTING HABITAT MAP UNITS
- TREE MAPPING UNITS
  - 211 = *Alnus* spp. – *Acer* spp. MU = "Alder"
  - 212 = *Platanus racemosa* MU = "Sycamore"
  - 213 = *Populus* spp. MU = "Cottonwood"
  - 214 = Riparian *Quercus* spp. MU = "Riparian Oak"
  - 215 = Riparian *Eucalyptus* spp., and other Exotics MU = "Exotic Trees"
  - 216 = *Prosopis* spp. MU = "Riparian Mesquite"
  - 217 = *Chilopsis linearis* MU = "Desert Willow"
- SHRUB MAPPING UNITS
  - 221 = *Rosa californica* – *Toxicodendron diversilobum* – *Vitis* spp. MU = "Rose/Grape/Poison Oak"
  - 222 = Riparian Alluvial Scrub MU = "Alluvial Scrub"
  - 223 = *Sambucus nigra* MU = "Elderberry"
  - 224 = Riparian *Tamarix* spp. MU = "Riparian Tamarisk"
  - 225 = *Pluchea sericea* MU = "Arrowweed"

[1] Map Unit Codes and Map Unit Names were used during map production. Vegetation Names were assigned after mapping for communication of results. Each map unit has a value for all 3 attributes (e.g., all polygons with the Map Unit Code "214" have the Map Unit Name "Riparian Quercus spp. MU" and the Vegetation Name "Oak".

TRANSITIONAL MAPPING UNITS

310 = Reservoir Delta MU ‘ “Reservoir Delta”
320 = Post-Disturbance Undifferentiated MU = “Unknown Disturbance”
321 = Post-Fire Disturbance Riparian MU = “Post-fire Disturbance”
322 = Post-Insect Disturbance Riparian MU = “Post-insect Disturbance”
323 = Post-*Arundo donax* Removal MU = “Post-Arundo Removal”
324 = *Arundo donax* Standing Dead MU = “Standing Dead Arundo”

EXOTIC GRASS MAPPING UNITS

410 = *Arundo donax* MU = “Arundo”

MISCELLANEOUS MAPPING UNITS (only used for map production, not in database)

777 = Not Assessed/Outside Focused Mapping Area MU = “Not Assessed”
999 = Not Suitable Habitat MU = “Water or Sand in Focused Mapping Area”[2]

SECONDARY ATTRIBUTES: Secondary attributes assigned to each mapped polygon. Please refer to Appendix A for the California Native Plant Society (CNPS) percent cover charts, which were used as a guide for determining percent cover for vegetation attributes of interest within each stand. Note: For pilot mapping areas on the Santa Clara, Santa Ynez, and Ventura Rivers, the “low” cover value of 1 was assigned to polygons with 1-15% cover. For all other HUC8 subbasins, the “low” cover value of 1 indicates 5-15% cover. Database field names during map production are underlined, common names for fields and data values (used for communication of results) are in “quotations” and final database short field names are [bracketed].

Percent Primary Habitat Trees = “Tree Willow Cover” = [pTrWillow]
This attribute represents the total % cover of tree willow species in mapped stands.

0 = “None/Trace” or “0-5%”
1 = “Low” or “5-15%”
2 = “Medium: or “15-40%”
3 = “High” or “>40%”
9 = “Not Assessed”

Percent Shrub Nesting Habitat = "Shrub Willow/Mulefat Cover” = [pShWillowM]
This attribute represents the combined total absolute cover of all shrub willow species and mulefat. In closed canopy stands of trees where understory shrubs cannot be seen, this attribute may be assigned code 9 (Not Assessed).

0 = “None/Trace” or “0-5%”
1 = “Low” or “5-15%”
2 = “Medium: or “15-40%”

[2] Polygons were assigned the Map Unit Codes “777” and “999” during map production (see Figure 4). However, these two map units are not included in the VireoVegMap2020 feature class in the final project geodatabase. In the final project geodatabase, all polygons with the “999” Map Code, which have the “Not Suitable Habitat MU” Map Unit Name, indicating bare sand, water, or upland vegetation were included in the Focused Mapping Area polygon feature class. All polygons with the “777” Map Code, which have the “Not Assessed/Outside Focused Mapping Area MU” Map Unit Name, were deleted.

3 = “High” or “>40%”
9 = “Not Assessed”

Percent *Arundo donax* = “Arundo Cover” = [pArundo]
A representation of the total absolute cover of *Arundo donax* in the mapped stand.
0 = “None/Trace” or “0-5%”
1 = “Low” or “5-15%”
2 = “Medium: or “15-40%”
3 = “High” or “>40%”
9 = “Not Assessed”

Percent *Tamarix* spp. = “Tamarisk Cover” = [pTamarisk]
A representation of the total absolute cover of riparian *Tamarix spp.* in the stand.
0 = “None/Trace” or “0-5%”
1 = “Low” or “5-15%”
2 = “Medium: or “15-40%”
3 = “High” or “>40%”
9 = “Not Assessed”

Percent Dieback (trees and shrubs) = “Dieback Index” = [pDieback]
A general indication of relative vigor/health of trees and shrubs as represented by the absolute percent cover standing dead and dieback of live trees and shrubs.
0 = “None” “0%”
1 = “Low” or “1-5%”
2 = “Medium: or “5-15%”
3 = “High” or “>15%”
9 = “Not Assessed”

Acres [Acres]
Calculated Acreage for each delineated polygon. Note: ESRI’s default “Shape_Area” field is the polygon’s area in square meters.

HUC8 Name [HUC8Name]
Text field with the HUC8 name, i.e., Aliso/San Onofre, Calleguas, Central Coastal, etc.

2.6 Minimum Mapping Unit (MMU)

The MMU polygon size for mapping of vegetation types (map units) was 1 acre, except for *Arundo donax*, which was mapped in stands as small as a half-acre (.5) MMU. If stands between 0.9 and 1 acres stood out on the imagery, then they may have been mapped. Similarly, for *Arundo donax*, stands between .4 and .5 acres may be mapped.

In addition to the MMU, the minimum mapping width of a map unit is typically half the width of the MMU square (1 acre or .5 acre). However, a map unit may be mapped down to one-quarter of the width where willow or mulefat components of the stand were >15% cover, continuous, and fluctuating around the minimum width.

2.7 Photointerpretation and Polygon Delineation

Photointerpretation is the process of identifying map units based on their photo signature. All land cover features have a photo signature. These signatures are defined by the color, texture, tone, size, and pattern exhibited on the aerial imagery. By observing the context and extent of the photo signatures associated with specific land cover types, the photo interpreter can identify and delineate the boundaries between plant communities as map units. It should be noted that vegetation stature, as well as the scale and resolution of the aerial imagery, determine the visibility of individual plants and the degree to which they can be photo interpreted. Trees and shrubs are usually visible as individuals on high-resolution digital imagery. However, grasses (other than bunch grass clumps) are rarely seen as individual plants.

Environmental factors, such as elevation, slope, and aspect, also play an important part in the photointerpretation decision-making process. Knowledge of these factors, and how plant communities respond to them, guides a photo interpreter in choosing among vegetation types with similar photo signatures. Beyond this, such knowledge enables vegetation mappers to create biogeographical models of expected vegetation communities where the vegetation types are indistinct on the imagery. This ecological approach produces a more accurate product than would be created by relying solely on extracting spectral information from the imagery, which is subject to variations in clarity and ground conditions.

Ancillary data sources and field reconnaissance data are typically used to complement and assist the mapper in their photointerpretation and attribute code assignment process. For example, classification plot point data contains the location of the plot as well as data related to species composition, abiotic and ecological information, and site history, such as fire information. Note that this project did not include field reconnaissance data collection. However, AIS has completed such work across the full range of vegetation types considered here for several mapping projects within the study area, has access to previously collected point plot data, and is familiar with all the potential plant communities that could be encountered.

2.8 Map Production

Just as the use of mental models by experienced photo interpreters contributes to the production of a high-quality vegetation map, the use of established mapping procedures allows for a map to be produced in a highly efficient manner. For example, the study area was divided into production modules that corresponded to the HUC8 watersheds. This expedited project workflow by enabling several staff members to work on the overall mapping effort simultaneously. Figure 4 illustrates the decision rules that photo interpreters used to assign attributes to polygons.

Each vegetation mapper brought one of the HUC8 modules into his or her ArcMap session. Using an on-screen heads-up digitizing method, the photo interpreters had at their disposal a suite of standard and custom ArcMap tools to facilitate the creation and

attribute assignment of polygons. The photo interpreters generally viewed imagery at scales ranging from below 1:1000 to 1:3000. They used variations in signature to draft boundaries separating areas of different vegetation types and/or distinct categories of the percentage of secondary attributes (tree and/or shrub willow cover, presence of Arundo or diebacks) in each area. To assist in boundary placement and coding decisions, photo interpreters also referenced supplemental imagery, Google Earth and Bing street view images, and other data, such as elevation contours and fire history. These sources were displayed in the ArcMap sessions as needed.

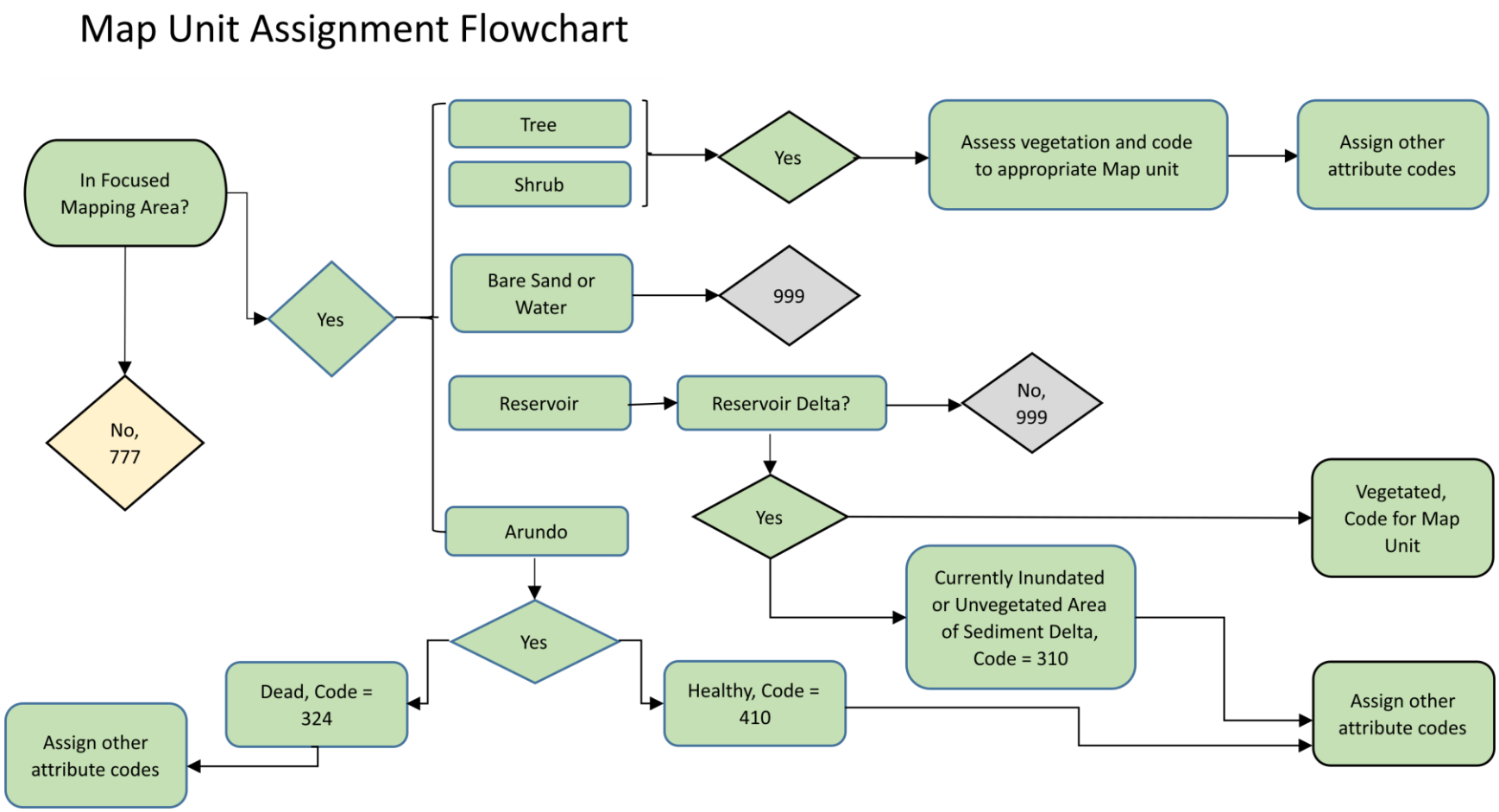

Figure 4. Decision tree for delineating polygons from aerial imagery using the VireoVegMap protocol. Code 777 is any area that was not assessed (e.g., it was outside the Focused Mapping Area). Code 999 is any area that was inside the Focal Mapping Area but not suitable for vireos in 2020 imagery (e.g., bare sand or water).

Values of all secondary attributes were averaged across delineated stands. However, stands of the same map unit that contained discrete regions with different percent cover codes for percent tree willow or percent shrub willow/mulefat, or any other secondary attribute, were subdivided and captured as separate polygons.

Photo interpreters assigned each polygon the appropriate attribute code string: Map Unit, percent tree willow, percent shrub willow/mulefat, percent *Arundo donax*, percent *Tamarix* spp., and percent Dieback. For example, the string 121 13 000 would define a primary shrub willow/mulefat nesting habitat (code 121) with a low cover of tree willow (code 1= 5-15%), a high cover of shrub willow/mulefat (code 3 = >40%) and with no Arundo, no Tamarisk, and no vegetation dieback (the final codes 000). A custom coding menu enabled values to be assigned efficiently, minimizing the possibilities for entry errors. The codes themselves were entered as numeric values, which are easier to input and manipulate than alphanumeric codes or drop-down menus.

2.9 Quality Control (QC)

QC is an iterative process, with procedures implemented throughout the mapping effort and before final delivery of the data. QC measures improve the consistency and accuracy of the overall database. For the entire duration of the project, photo interpreters consulted with one another as each module was mapped. This sharing of perspectives and examples ensured consistency in the mapping decisions throughout the study area.

Completed modules were subjected to a series of automated checks. Any instances of invalid codes, uncoded polygons, adjacent polygons with the same code, or topology problems were flagged for correction by the photo interpreter. Another type of automated check verified that illogical combinations of codes were not used. Additionally, a manual visual quality control was conducted, with each photo interpreter reviewing his or her completed module for consistent application of codes and MMU considerations.

When a module was completed, a senior photo interpreter reviewed the data for quality of delineations, registration of linework to the base imagery, code accuracy, consistency of interpretations, adherence to the mapping criteria, and omissions in data capture. Automated final checks were again conducted for invalid codes, code attribute correlations, and topology to ensure the database was error free.

2.10 Accuracy Assessment (AA)

No formal AA protocol was conducted for this project. Confidence in the accuracy of the VireoVegMap geodatabase relies on AIS's broad experience in the production of high thematic-resolution vegetation maps throughout California, where similar map units have been subjected to ground-based accuracy assessment. Vegetation databases produced by AIS have consistently exceeded the VegCAMP 80% threshold for overall accuracy at the alliance level and were in many cases above 90% (Using fuzzy logic

method, Congalton and Green 2009, Gopal and Woodcock 1994, Hagen 2003). Examples of AIS vegetation databases that have gone through the AA process are: the Nature Reserve of Orange County (Aerial Information Systems, Inc., 2015, overall AA score of 87%), Camp Pendleton (AECOM, 2018, Lower Limit 90% Confidence Interval score 64.3%, Upper Limit Confidence Interval score 72.7%, overall AA score of 68.5%, all non-fuzzy logic method) and the Desert Renewable Energy Conservation Project (DRECP), where maps were produced in 2013 (Menke et al., 2013, and VegCAMP and AIS, 2013, AA score of 85% overall) and 2023 (Reyes et al., 2023, overall AA score of 93%). Each of these databases are within the VireoVegMap project area or close proximity and all were completed in the past 10 years by the same photo interpreters and project managers involved with VireoVegMap production. Each of these previous projects are NVCS compliant and use a more detailed classification than what was used for the LBVI habitat mapping project. Accuracy may even be higher for the 2020 VireoVegMap, given its more generalized classification system (e.g., NVCS requires stands of shrub willow and mulefat to be separated, where these two species, which often intermixed, are grouped into the Shrub Willow/Mulefat nesting habitat map unit of VireoVegMap).

3 Results

3.1 Availability of the Final VireoVegMap Geodatabase

The range-wide riparian vegetation map for Least Bell's Vireo is currently available for download as a map package at: VireoVegMapDownload**.** This is the preferred format for download for ESRI ArcGIS Pro users, since the map package includes custom symbology that have been designed to make the map readable while multiple attributes are displayed. Readers who would like to access the data as a file geodatabase should contact the corresponding author at caseylott@ymail.com. We do not recommend distributing this data set in shapefile format. Too much information is lost from attribute tables with this option. Once this report has been finalized and the data have been reviewed by California Department of Fish and Wildlife's VegCAMP program, the spatial data and report will be made available through California's Biogeographic Information and Observation System (BIOS) at **BIOS** as data set ds-3118.

3.2 Acreage Summary by Map Unit for each HUC8 Subbasin

Figure 5 summarizes acreage by map unit type for each of the 28 HUC8 subbasins included in VireoVegMap, providing an overview of the distribution of potential vireo nesting habitat across the species entire geographic range in Southern and Central California. For narrative descriptions and photographic examples of all map units and common combinations of dominant vegetation and secondary attributes (e.g., Shrub Willow/Mulefat with medium Arundo cover) see Appendix C. More detailed analysis of the ecological and management-related factors that control the distribution of the vegetation types described herein will be provided in Lott et al. (in preparation).

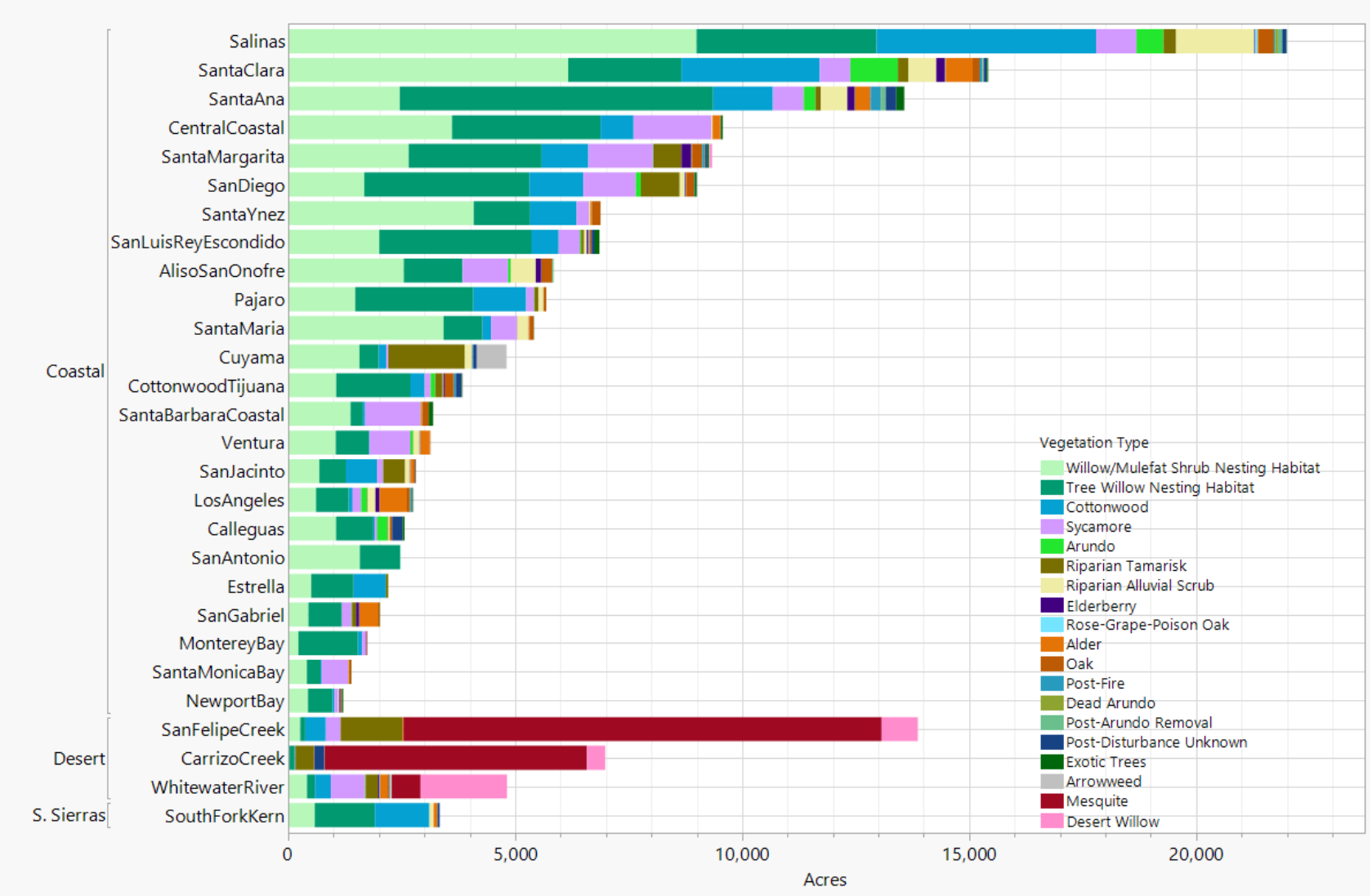

Figure 5. Acreage summary by map unit type for each of the 28 HUC8 subbasins covered by VireoVegMap. Sorted first by region, then by total acreage.

3.3 Acreage Summaries for All 2-way Combinations of Primary Map Units and Secondary Map Attributes

Figures 6-10 summarize acreage by all combinations of vegetation map units and secondary attributes. These illustrate which stand types are most common across the vireo's range. Figure 6 shows that most shrub willow/mulefat stands have either no tree willows or low cover of tree willows (5-15%). This indicates that in 2020, few shrub willow/mulefat stands were likely to become tree willow stands soon due to succession. Similarly, most tree willow stands had medium (15-40%) or high (>40%) tree willow cover, indicating established, mature willow stands with strong groundwater connections. Figure 6 also shows that most of the acreage in common tree-dominated stands that are not willow (e.g., Cottonwood and Sycamore) had low densities of tree willow (0-5% or <5-15% tree willow cover). Collectively, this information illustrates that most stands of the 3 most dominant tree types on coastal streams (Willow, Cottonwood, and Sycamore) are unlikely to transition to dominance by other tree species soon.

Figure 7 illustrates patterns of shrub willow/mulefat cover across map units. Note that many acres of tree-dominated map units had dense canopies where shrub willow/mulefat cover could not even be assessed (a shrub willow/mulefat attribute value of 9, which means "tree canopy too dense to assess understory conditions"). This is a further indication of older stands that are well established. Figure 7 also shows that relatively few acres in Cottonwood and Sycamore stands have medium (15-40%) or high (>40%) percent cover of shrub willow/mulefat in the understory (which would make them important components of vireo territories due to the presence of common shrubs for nest placement). In comparison, most acres of Cottonwood or Sycamore-dominated stands have either zero/trace (0-5%) or low (5-15%) cover of shrub willow/mulefat. On linear stream reaches where these stands are mixed with tree willow or shrub willow/mulefat-dominated stands, they may provide valuable foraging habitat. On stream reaches where these stands are the only type available, vireo nesting density may be lower due to the absence of preferred nesting shrubs.

Figure 8 shows patterns of Arundo cover across dominant map units. One of the most striking results here is that most Arundo patches have high densities of Arundo cover (>40%). This reflects the tendency for Arundo stands to become monocultures as rhizome masses grow together. Willows, which have similar groundwater requirements to Arundo, compete poorly with Arundo in these stands. Figure 8 also shows that mostly Tree Willow, Shrub Willow/Mulefat, and Cottonwood stands have secondary components of Arundo (e.g., percent Arundo cover >15%). Most other map unit types occur in drier areas where Arundo does not perform as well. These results indicate the direct threat that Arundo presents to vireo populations via habitat loss and degradation of primary nesting habitat stand types (Tree Willow and Shrub Willow/Mulefat).

Figure 9 shows patterns of Tamarisk cover by map unit. The strongest result here is that Tamarisk is usually a minor component of other dominant stand types (e.g., most acres have either zero/trace (0-5%) or low (5-15%) Tamarisk cover. Lacking a time series of

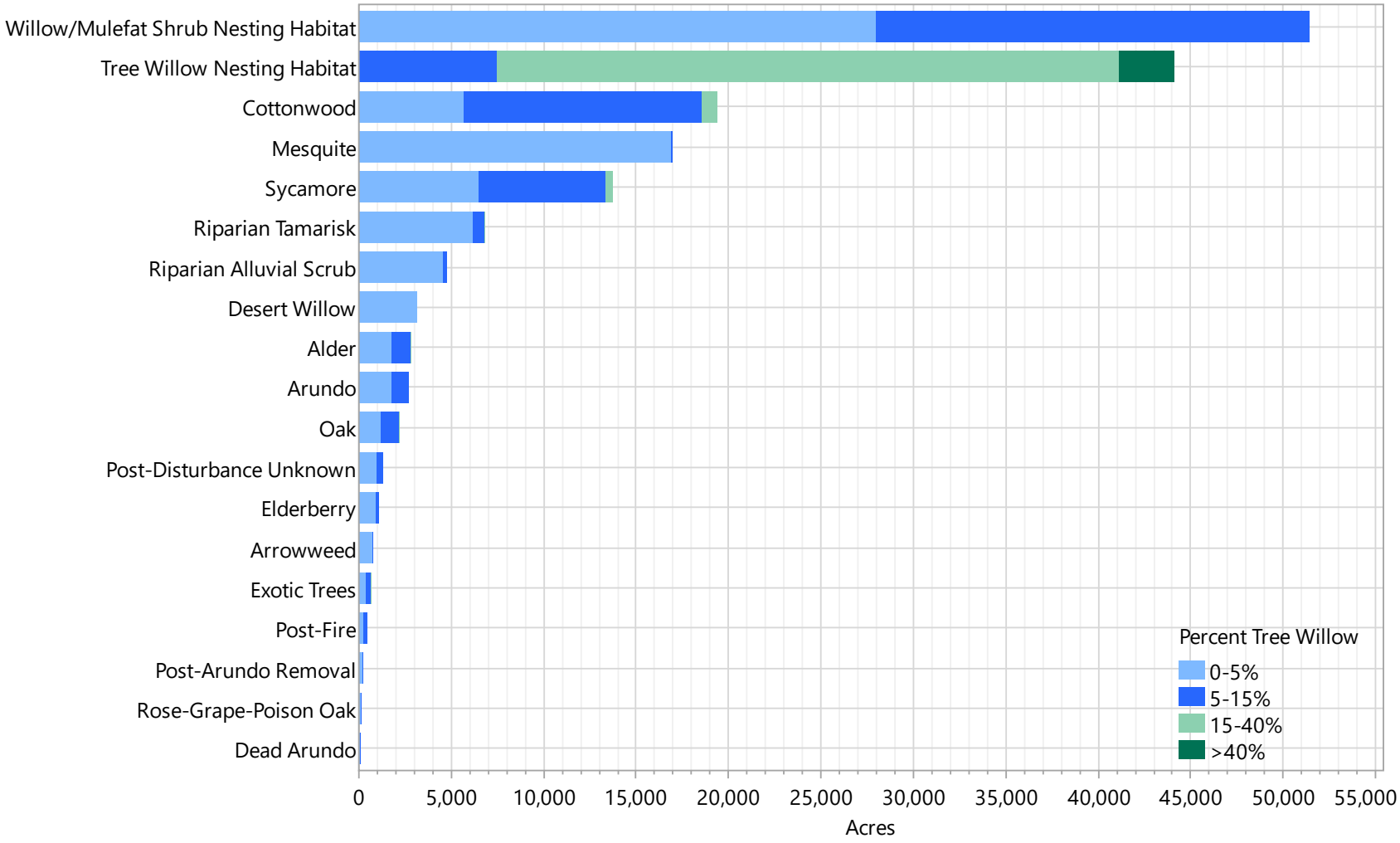

Figure 6. Percent Tree Willow attribute values by dominant map unit (summarized across the whole mapping extent).

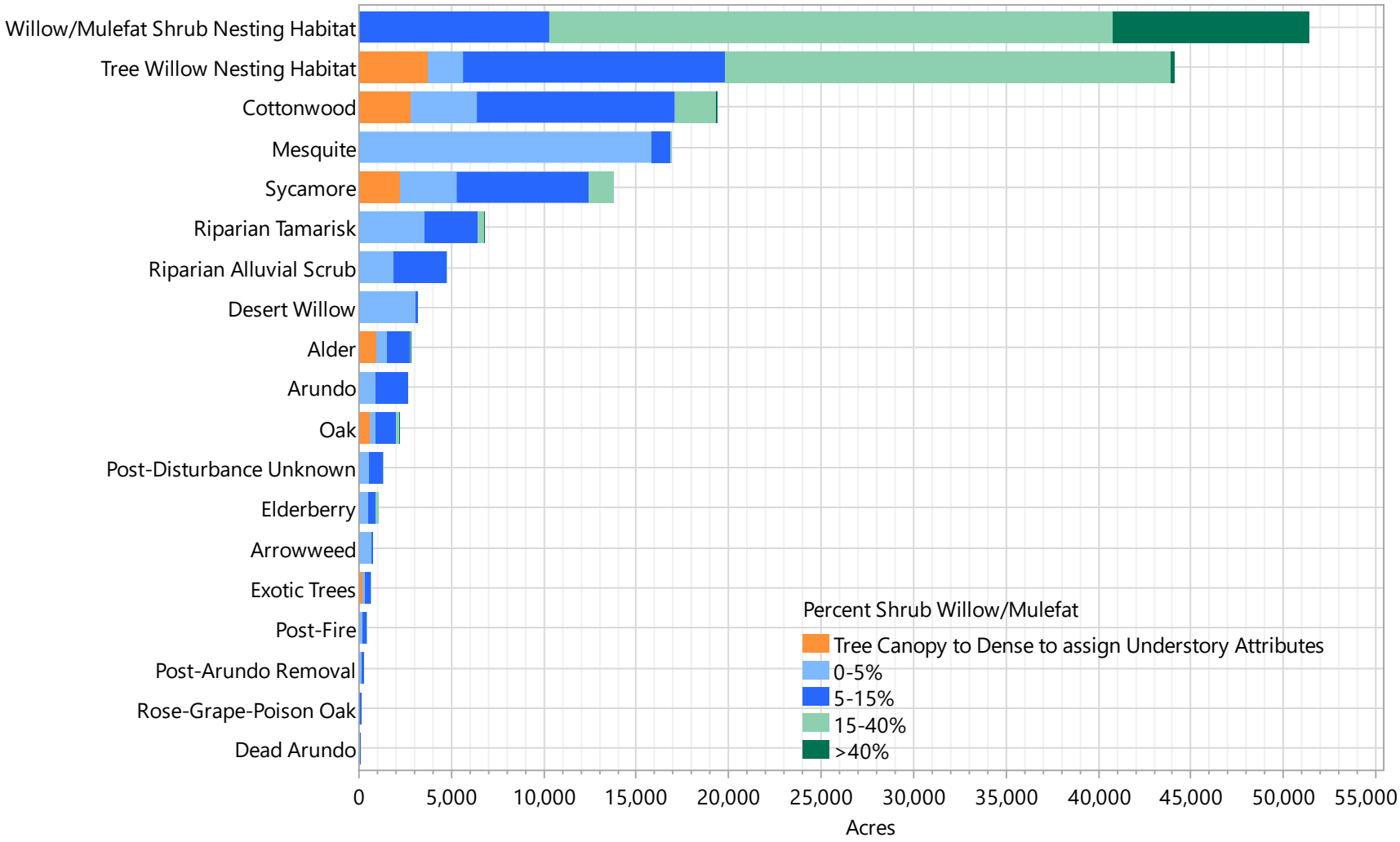

Figure 7. Percent Shrub Willow/Mulefat attribute values by dominant map unit (summarized across the whole mapping extent).

vegetation maps that follow this protocol, it is difficult to know if this result means that Tamarisk is a minor threat to vireo habitat loss (if it has been not overtaken other map unit types over a long period of time) or if Tamarisk is an emerging threat to vireo habitat that may still be manageable (since Tamarisk cover is mostly low, perhaps it can be kept that way). Additional research on competition between willow and tamarisk across a range of ecological settings on California rivers would be useful. So would targeted research on vireo breeding populations in areas where Tamarisk is present, since it is still uncertain whether Tamarisk is unlikely to provide Least Bell's Vireo nesting habitat or to provides low-quality nesting habitat (a common hypothesis) or if Tamarisk may provide adequate or high-quality LBVI nesting habitat, as it does for Arizona Bell's Vireo on the Colorado River. Figure 9 also shows that most of the acres that are currently dominated by Tamarisk have medium (15-40%) to high (>40%) Tamarisk cover. Many of these acres are on a large section of the Cuyama River (a dry, inland stream) where a long, linear section of the river is dominated by Tamarisk. In other parts of the Vireo's range, Tamarisk-dominated stands are far less common.

Figure 10 shows patterns of tree and shrub dieback by map unit. Note in the map legend for this figure that dieback cover categories are different from percent cover categories for all other secondary attributes (e.g., low is 1-5%, medium is 5-15%, and high is >15%). The 2020 VireoVegMap reflects severe drought conditions that prevailed at that time. Low groundwater levels in some parts of the vireo's range resulted in medium (5-15%) to high (>15% dieback), primarily in willow-dominated stands and in some cottonwood stands. However, even during the advance stages of this severe drought in 2020, most vegetation patches had zero or low (1-5%) cover of tree/shrub dieback.

3.4 Additional Summaries of VireoVegMap 2020 in Ecological Context

While this document provides high-level summaries of vegetation acreages for the project area, the 2020 VireoVegMap will be analyzed in greater detail in Lott et al. (in preparation), which will review the ecological factors that affect the range-wide distribution of Least Bell's Vireo nesting habitat. Lott et al. (in prep.) will provide additional summaries of riparian vegetation acreages and characteristics for a number of different spatial scales and ecological frameworks relevant to vireo recovery (e.g., by Level 1 River Networks, California Groundwater Basins, or Management Entities) and for more narrowly defined spatial units (e.g., individual streams and their in-stream reaches).These summaries will be based on the 2020 VireoVegMap for the currently occupied portion of the vireo's range in Southern California and areas of the Central California Coast where range expansion seems likely. For additional context, Lott et al. (in prep.) will summarize the distribution and characteristics of riparian vegetation across the Central Valley, another region formerly occupied by LBVI, which, due to high costs, was not included in the VireoVegMap effort. Central Valley summaries will be based on a compilation of prior vegetation maps produced using VegCAMP protocols with imagery dates that range from 2012 to 2016.

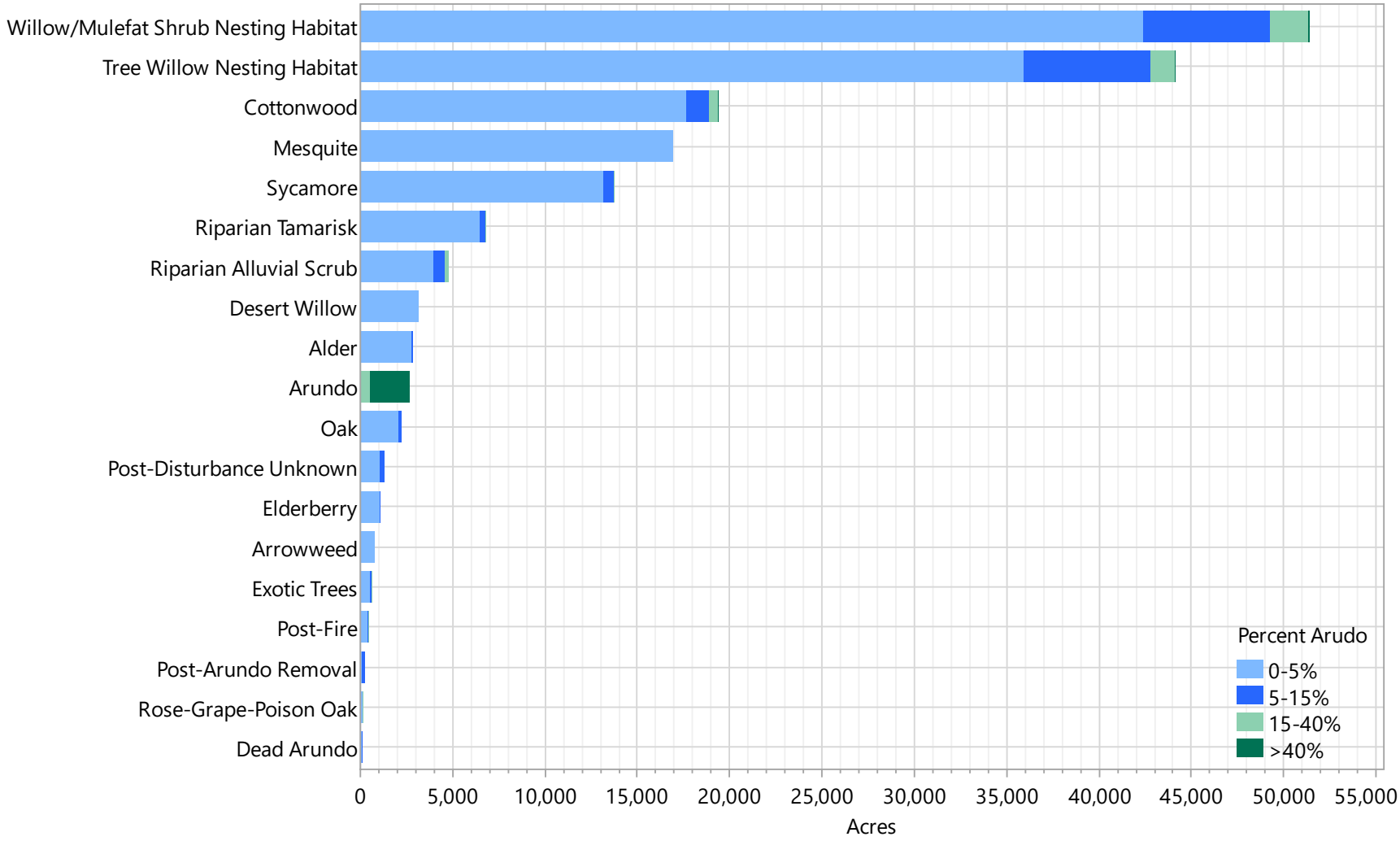

Figure 8. Percent Arundo attribute values by dominant map unit (summarized across the whole mapping extent).

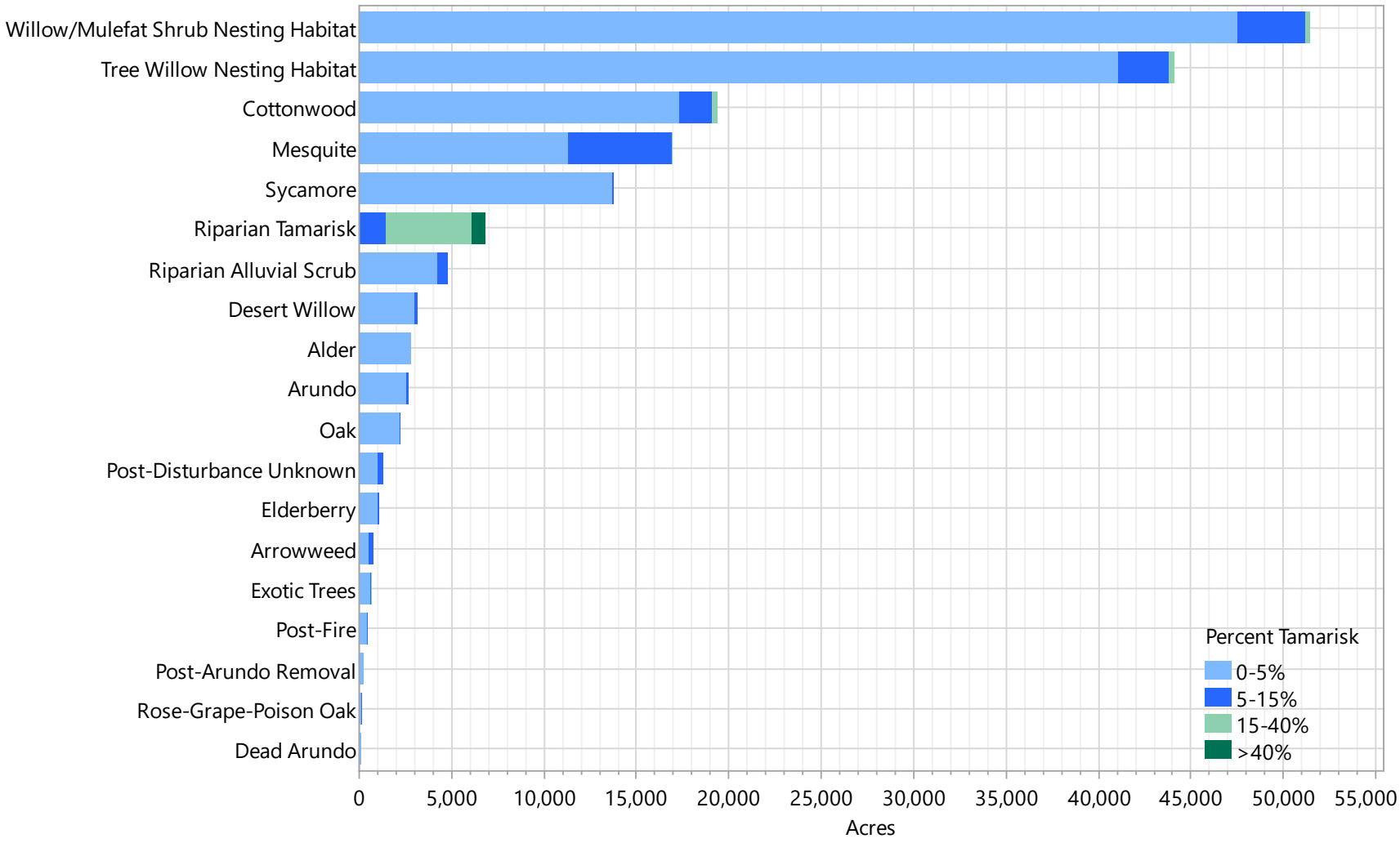

Figure 9. Percent Tamarisk attribute values by dominant map unit (summarized across the whole mapping extent).

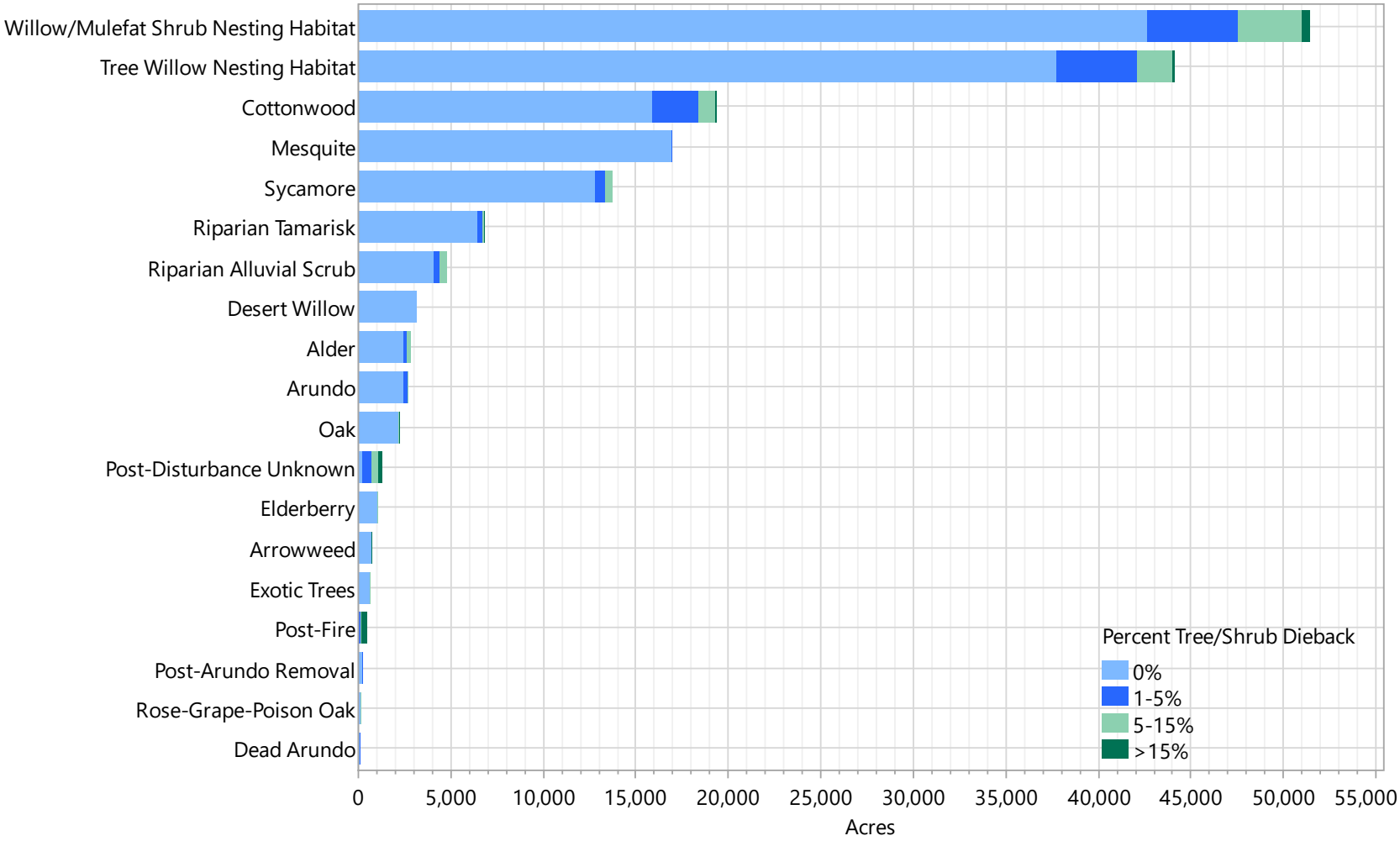

Figure 10. Percent Tree/Shrub Dieback attribute values by dominant map unit (summarized across the whole mapping extent).

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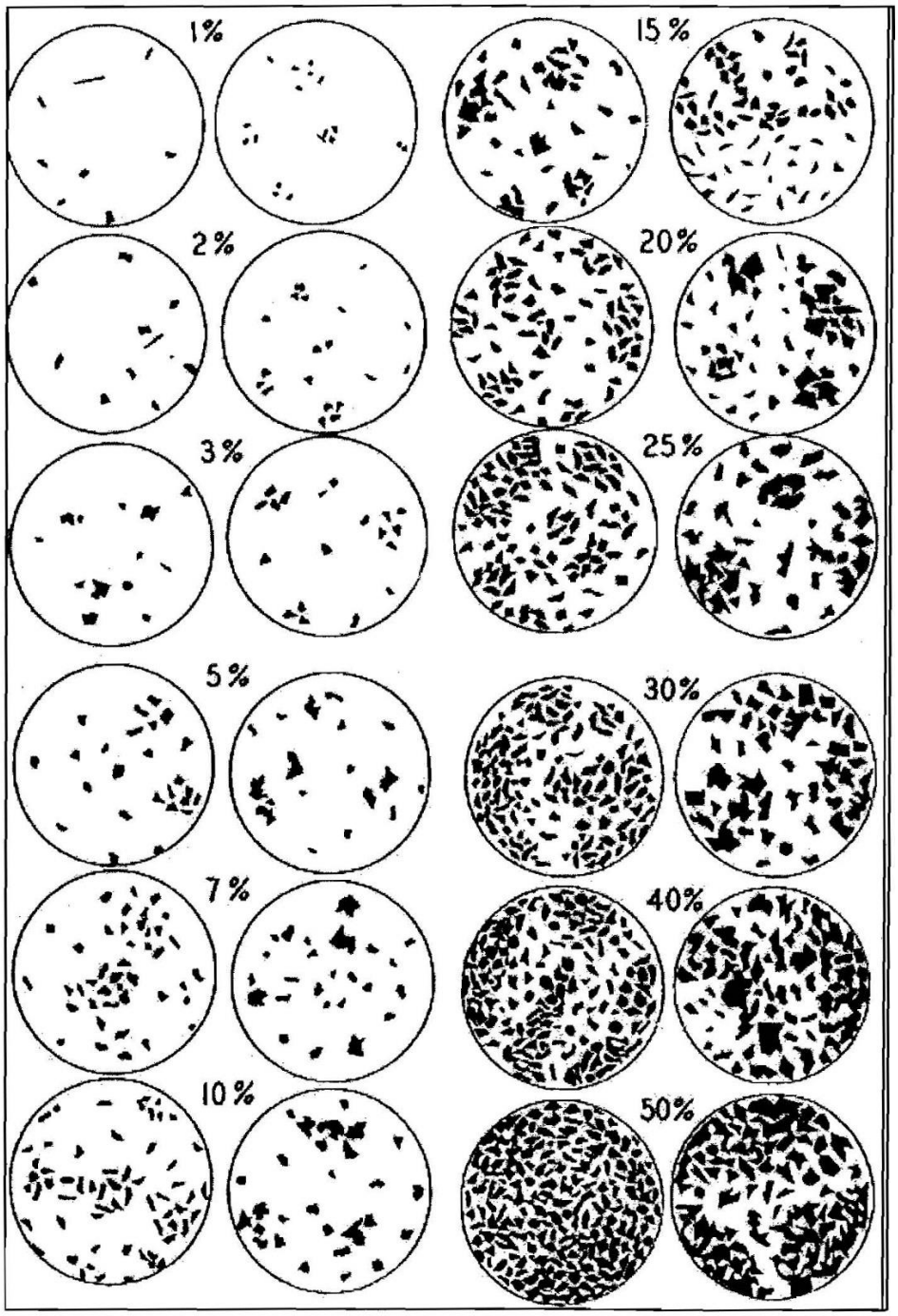
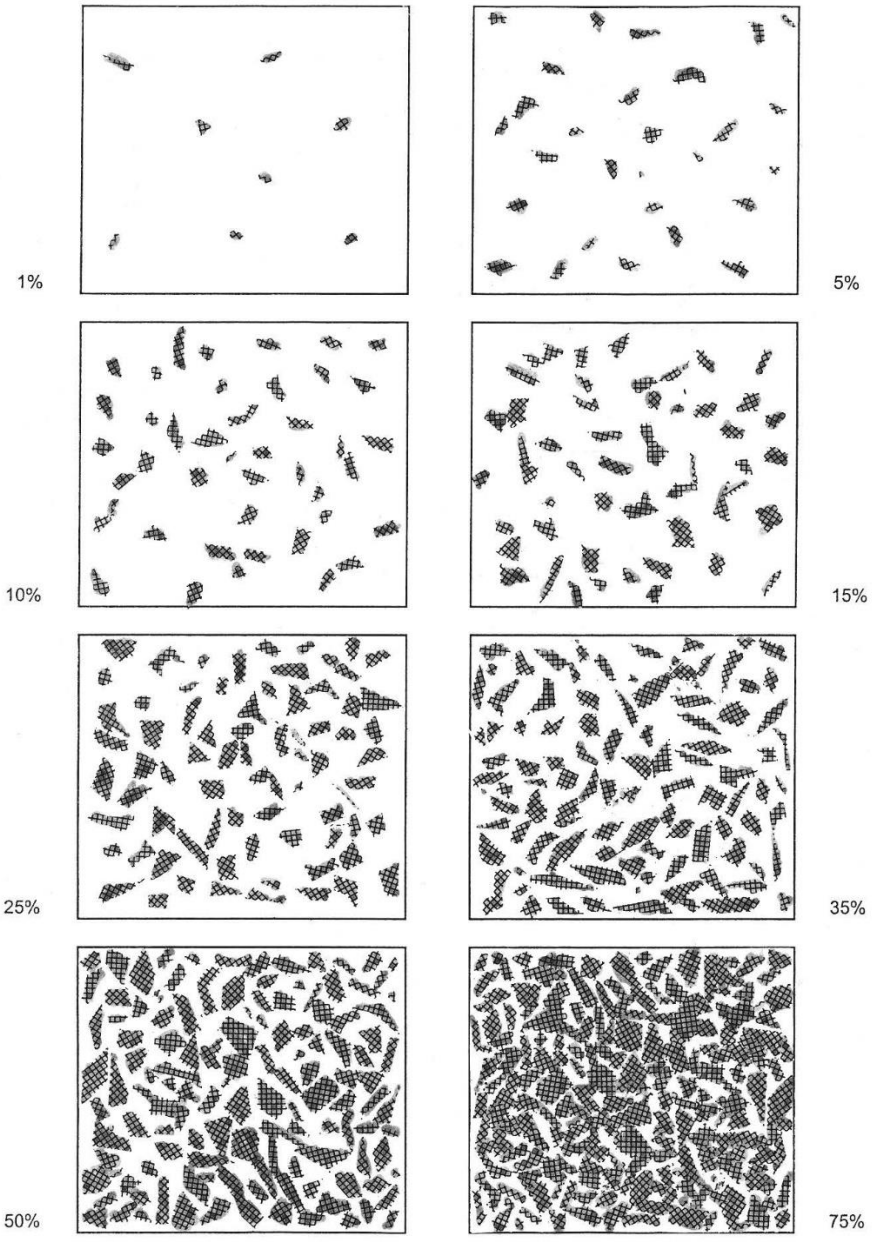
5.1 Appendix A: California Native Plant Society Percent Cover Graphs

These graphs were used as a reference for determining percent cover values for secondary attributes for vegetation patches viewed from above.



CNPS COVER DIAGRAMS



5.2 Appendix B: Methods for defining the Focused Mapping Area in Deserts

Because potential nesting habitat is limited on desert streams, the mapping criteria for desert HUC8s differed from that of the coastal HUC8s. There were very few StreamsToMap segments in desert areas, and therefore, the draft Focused Mapping Area within desert HUC8s was small. However, a considerable amount of desert area had been previously mapped by AIS for US Bureau of Land Management (BLM) and the California Energy Commission as part of the Desert Renewable Energy Conservation Plan (DRECP). The existing AIS DRECP vegetation data for desert HUC8s, showed primary and secondary types occurring outside the draft Focused Mapping Area based on the StreamsToMap layer. Therefore, we decided to add the entirety of the AIS-mapped DRECP study area falling within the project HUC8 watersheds to the Focused Mapping study area. Because of the inclusion of the AIS-Mapped DRECP areas three types of desert mapping procedures were applied:

- **Areas within the AIS-mapped DRECP study area:** The Focused Mapping Area was expanded to include the DRECP area. Primary and Secondary habitat types were extracted from the DRECP geodatabase and identified for further investigation. All extracted polygons were assessed against the 2020 base imagery. Polygons that were Primary habitat types were retained, coded, and updated for change since the original mapping. Secondary habitat type polygons were reviewed against the mapping criteria and were retained if they were proximate to the original StreamsToMap stream network or buffered Focused Mapping study area and adjusted as necessary to reflect any changes from the original mapping. All retained polygons were coded for all attributes. The remainder of the DRECP area within the HUC8 that was not included in the primary or retained secondary types was coded as Not Suitable Habitat (999).
- **Original Focused Mapping study area outside of the DRECP:** Using the base imagery and the other existing non-AIS mapped data sources all primary and secondary habitat types were mapped, regardless of percent tree willow or shrub willow/mulefat category within the original Focused Mapping study area, with the exception of the Riparian Alluvial Scrub MU, which needed to include a percent Tree Willow, percent Shrub Willow/Mulefat, or percent Tamarisk component with a cover value ≥2 (>≥15%) to map. Secondary Tree types followed the Coastal (Non-Desert) Methodology in the upper reaches of the watersheds. The remainder of the area within the Focused Mapping study area was coded as Not Suitable Habitat (999).
- **Outside the original Focused Mapping study area outside of the DRECP:** Other existing non-AIS mapped data sources and exploratory visualization of base imagery were used to assist in finding visually obvious large stands of potential habitat (including *Tamarix* spp. and Mesquite). These stands had to be

greater than 5 acres to be considered for mapping. These stands may have necessitated the creation of a new, isolated Focused Mapping Area or extension of the existing Focused Mapping Area. In addition to the 5-acre minimum, if a stand was classed as a dominant Secondary Desert Tree or Shrub type (including *Prosopis glandulosa* and *Chilopsis linearis*) and primary tree and/or shrub cover component did not exceed a trace amount (0-5%), then these stands were not captured.

All portions within the modified Focused Mapping study area extent were assessed for potential habitat. As in coastal areas, the extent of the Focused Mapping Area in headwater and tributary reaches were often extended upstream to included areas where the original buffer, based on the StreamsToMap dataset, may have fallen short of including potential nesting habitat. Where Primary Habitat species began to disappear at higher elevations within the Focused Mapping study area, the mapper only captured stands where vegetation polygons contained percent cover values of 1 (>5-15%), 2 (>15-40%), or 3 (>40%) of percent Tree Willow or percent Shrub Willow/Mulefat. The area past the last mapped category 1, 2, or 3 stand was then assessed upstream approximately 1 kilometer for potential habitat and the Focused Mapping Area was adjusted accordingly.

5.3 Appendix C: Description of Primary Map Units with Common Secondary Attribute Combinations

This appendix details mapping criteria and ecological characteristics for each of the map units (MU) in the VireoVegMap classification scheme (Table 1 in the body of this report). Each map unit (MU) description contains the following:

- A brief description of the value of the map unit as potential LBVI habitat.
- Description of plant species that may be present in typical patches. See Appendix D for a species list.
- Ecological contexts where this map unit may occur.
- Example signature(s) that indicate this map unit in high-resolution aerial photography.
- Ground-based photo(s) for a typical patch.

PRIMARY HABITAT MAP UNITS – The two primary nesting habitat map units (Tree Willow and Shrub Willow/Mulefat) are the vegetation types that are most favorable for LBVI nesting. Dominant vegetation in these stands are typically high-quality foraging habitat and preferred shrub species for nest placement are common.

General patterns of vegetation cover: Stands typically have an overstory tree cover greater than 8-10%, but tree cover may be less than 8% when overall vegetation cover is low (<20% total cover) and trees are evenly distributed in the stand. In desert settings, overstory cover may be as low as 5%.

Tree Willow MU (111) Common Name = Tree Willow

Coastal Streams: 5,564 polygons, 43,711 acres
Desert Streams: 105 polygons, 403 acres

Value of Map Unit as Least Bell's Vireo Habitat: The Tree Willow MU is the primary tree nesting habitat map unit of VireoVegMap. It is highly favorable for LBVI reproduction as it often contains both high-quality foraging resources and the specific shrub species that vireos prefer for nest placement.

Typical Plant Species: Overstory is dominated by tree willow species, which include *Salix gooddingii, Salix laevigata*, and/or *Salix lucida,* either alone or in combination with other tree species (*Populus* or *Platanus* are most common in streams that drain to the pacific coast, *Prosopis* and/or *Tamarix sp*. are more common in desert areas). Understory may include saplings or seedlings of these or other tree species, as well as any shrub species. Shrub *Salix sp*. or *Baccharis salicifolia*, which are often used for vireo nest placement, are common; as is the invasive exotic, *Arundo donax*. The Tree Willow MU was mapped extensively in coastal streams and occasionally in deserts. In

urban areas, this map unit may include common exotic plants such as *Eucalyptus*, Tree-of-Heaven (*Ailanthus altissima*), Palms, and Pampas grass (*Cortaderia*).

Ecological Contexts: Tree willows favor plenty of ground water or surface water, usually slow moving or still. Dense stands can be located near the mouth of creeks, active channels and floodplains in low-gradient deposition zones. Additional stands may occur in narrow canyons in higher-sloped or mountainous areas in the upper watershed. Large, productive stands typically occur on broad segments of the floodplain and are near or in the active channel. They also occur at stream confluences, reservoir margins (particularly on sediment deltas), and along broad curves in canyon bottoms. Tree Willow stands can also be found along lake or pond edges, and at seeps and springs. They are common in highly urbanized and agricultural areas where there is high water run-off or seepage into the adjacent floodplain or drainage. In slightly drier areas, or areas of slightly higher elevation relative to active river channels, they can mix with *Populus* and/or *Platanus*.

In desert settings, tree willow stands are uncommon in lower elevations, and limited to areas receiving a constant water supply, usually at or below springs, below confluences of perennial streams, and at perennial ponds and lakes. In higher elevations on desert-draining streams, tree willow stands may increase in frequency due to higher moisture regimes.

Photo Signatures and Examples: Multi-year Google Earth leaf-off imagery shows dark to medium gray signature with multiple branching in various directions. Shadows are prevalent indicating relative height above the ground and shorter shrubs. Multi-year Google Street View, where available, shows gray to dark trunks, a typical *Salix* branching structural pattern, and typical *Salix* narrow lance-shaped leaves, color, and pattern on the twigs and branches. At times signatures are difficult to differentiate between *Salix* and *Populus,* especially when mixing. In these situations, other ancillary datasets and imagery are used where available to help the mapper assign the MU code.

Tree-willow dominated stands are very common in our study area as both pure stands (all secondary attributes are 0%) and with varying combinations of secondary attributes. Figures C1-C18 show examples of different types of Tree Willow stands from aerial photographs and ground-based photography. Each example includes the number of stands and total acreage for both coast-draining streams and desert-draining streams. The summaries do not contain information for the single mapped HUC8 in the Sierras (South Fork of the Kern River), which will be reported in Lott et al. (in preparation).

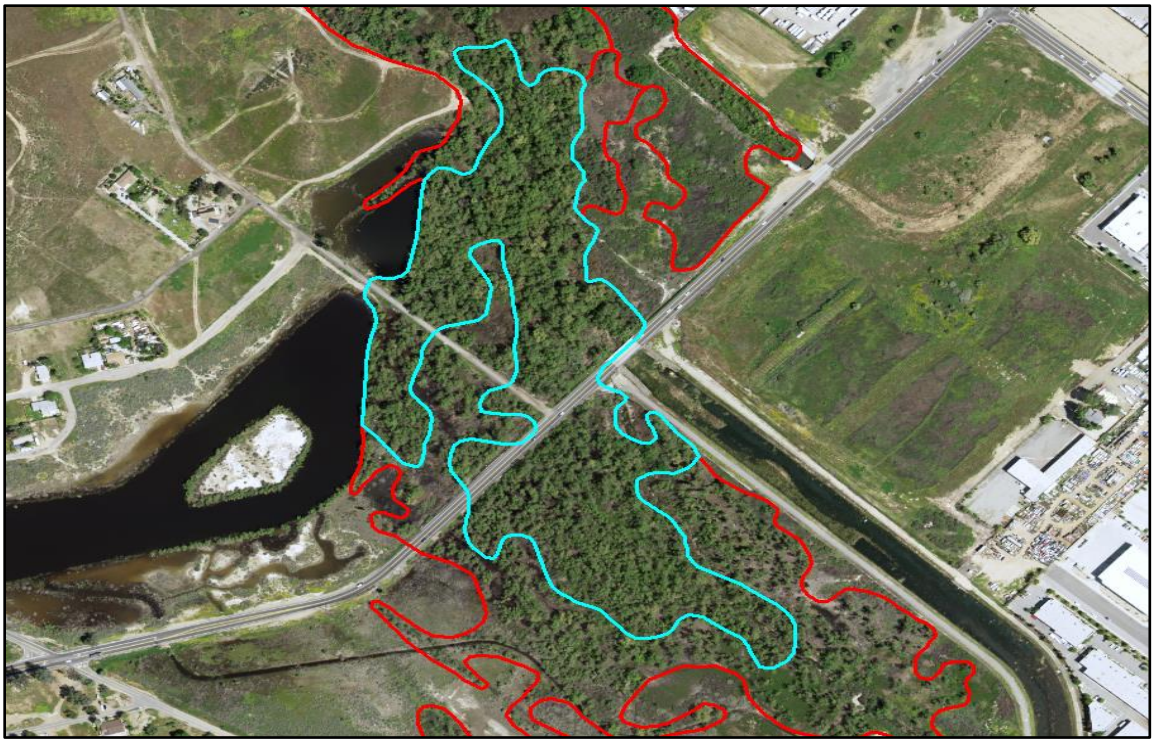


Figure C1. Tree Willow stand with high cover (>40%) of tree willow. This type of stand is very common on coastal streams (312 stands, 2,977 acres) and uncommon on desert streams (4 stands, 27 acres).

Figure C2. Tree Willow stand with high cover (>40%) of tree willow.

Figure C3. Tree Willow stand with medium cover (15-40%) of tree willow. This type of stand is very common on coastal streams (3,682 stands, 33,352 acres) and moderately common on desert streams (75 stands, 285 acres).

Figure C4. Tree Willow stand with medium cover (15-40%) of tree willow.

Figure C5. Tree Willow stand with low cover of tree willow (5-15%). This type of stand is very common on coastal streams (1,570 stands, 7,381 acres) and uncommon on desert streams (26 stands, 91 acres).

Figure C6. Tree Willow stand with low cover (5-15%) of tree willow (in winter with leaf-off conditions).

Figure C7. Tree willow stand that is mixed with *Populus* trees. This specific tree mixture would not be differentiated from other Tree Willow stand types in our classification since we did not collect a secondary attribute for *Populus* cover. An unknown fraction of our mapped Tree Willow stands may be mixed with *Populus*.

Figure C8. Tree willow stand that is mixed with *Populus* trees.

Figure C9. Tree Willow stand with low cover (5-15%) of willow shrub/mulefat. This type of stand is very common on coastal streams (2,363 stands, 14,030 acres) and uncommon on desert streams (45 stands, 151 acres).

Figure C10. Tree Willow stand with low cover (5-15%) of willow shrub/mulefat.

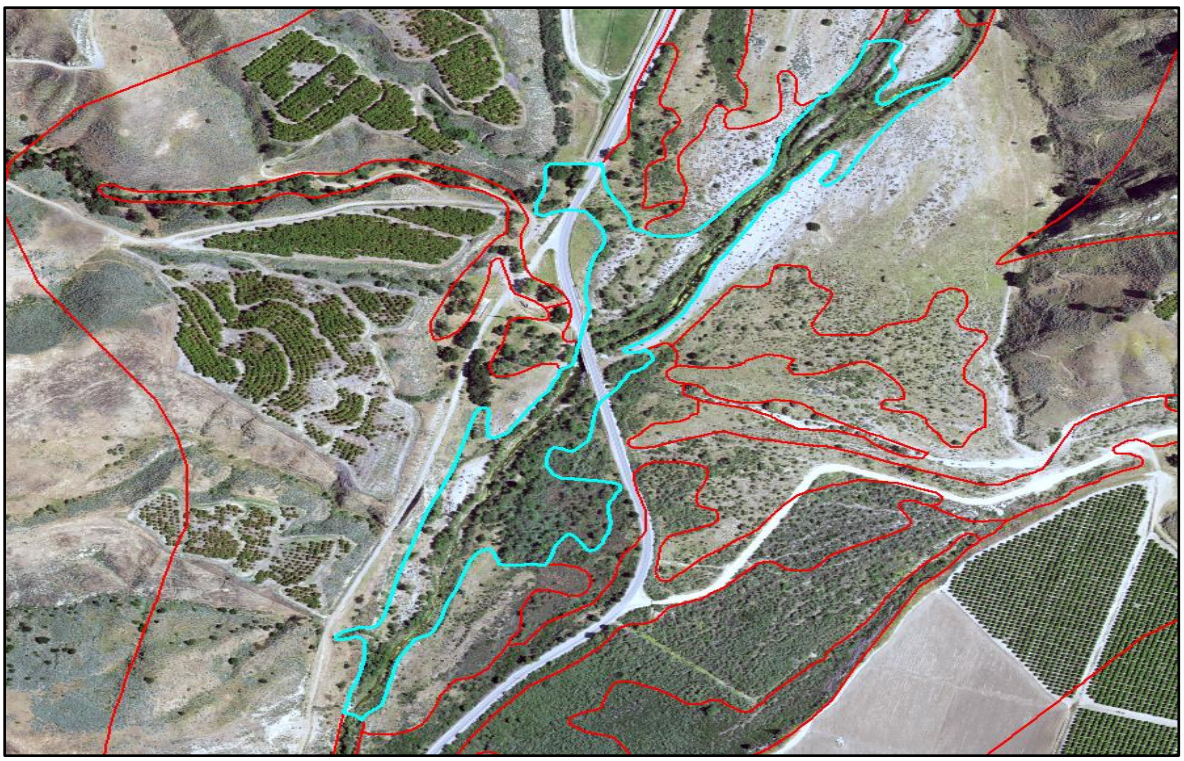


Figure C11. Tree Willow stand with medium cover (15-40%) of shrub willow/mulefat. This stand type is very common on coastal streams (2,326 stands, 23,974 acres) and uncommon on desert streams (23 stands, 136 acres).

Figure C12. Tree Willow stand with medium cover (15-40%) of shrub willow/mulefat.

Figure C13. Tree Willow stand with low cover (5-15%) of *Arundo donax.* This stand type is very common on coastal streams (539 stands, 6,873 acres) and absent on desert streams.

Figure C14. Border of a Tree Willow stand with low cover (5-15%) of *Arundo donax.*

Figure C15. Tree Willow stand with medium cover (15-40%) of *Arundo donax*. This stand type is moderately common on coastal streams (183 stands, 1,314 acres) and absent on desert streams.

Figure C16. Tree Willow with medium cover (15-40%) of *Arundo donax*.

Figure C17. Tree Willow stand with low cover (5-15%) of *Tamarix* spp shrub. This stand type is very common on coastal streams (374 stands, 2,734 acres) and uncommon on desert streams (10 stands, 28 acres).

Figure C18. Tree Willow with low cover (5-15%) of *Tamarix* spp. shrub.

Riparian Shrub MU (121) Common Name = Shrub Willow/Mulefat

Coastal Streams: 8,359 polygons, 50,704 acres
Desert Streams: 169 polygons, 703 acres

Value of Map Unit as Least Bell's Vireo Habitat: The Shrub Willow/Mulefat map unit is the primary shrub nesting habitat map unit of VireoVegMap. It is highly favorable for LBVI reproduction as it often contains both high quality foraging resources and the specific shrub species that vireos prefer for nest placement.

Typical Plant Species: The shrub overstory is dominated by shrub willow species, which may include *Salix exigua, Salix lasiolepis*, and shrub-statured *Salix gooddingii, Salix laevigata*, *and Salix lucida*. May include *Baccharis salicifolia* and/or *Baccharis sergiloides*, alone, or in combination with each other, as well as *Pluchea sericea*. Also, possibly present in the stand, but not included in dominance, are secondary shrub types *Sambucus nigra* and riparian *Tamarix* spp. Also possibly present, but not included in dominance, are saplings, seedlings, and shrub-statured secondary habitat trees, including *Platanus racemosa, Populus trichocarpa, Populus fremontii, Alnus* spp., and *Acer* spp. *Betula occidentalis* may be included in the Primary Shrub Habitat MU for desert HUCs. Riparian Shrub MU was mapped extensively in the Coastal Non-Desert region and occasionally mapped in the Desert region.

Ecological Contexts: Shrub Willow/Mulefat stands can occur on broad floodplains as well as the narrow mountain canyon bottoms. They can occur within or adjacent to the active channel, as well as on the adjacent floodplain terraces. They can also occur within or along abandoned stream course paths on the low terraces. Additionally, they can be found at the confluence of streams, at downstream and upstream side of dammed lakes, and along broad curves in canyon bottoms where water flow slows or pools. They can also be found along lake or pond edges, and at seeps and springs. They are also common in highly urbanized and agricultural areas where there is high water run-off or seepage into the adjacent floodplain or drainage. *Baccharis salicifolia* can occur as "runs" within and adjacent to the stream channel and scattered on adjacent terraces.

Shrub Willow/Mulefat will start to thin out on the terraces as they become more distant from the active channel. Alluvial scrub with coastal sage scrub species such as *Baccharis pilularis, Artemisia californica*, and *Eriogonum fasciculatum* may begin to mix and become dominant. Shrub Willow/Mulefat **c**an be an understory of open primary and secondary tree canopies, or shrub stands may alternate with tree stands. As the drainages become drier or narrower, Shrub Willow/Mulefat stands may gradually thin out or occur in short sparse runs, as moisture availability allows.

Photo Signatures and Examples: Multi-year Google Earth late fall to early spring imagery shows Shrub Willow/Mulefat stands as short, dark to medium gray signature all with leaves off. Shadows are less pronounced compared to trees. Multi-year Google Street View, where available, show shorter shrubs as compared to trees. The typical

Salix narrow lance-shaped leaves, color, and pattern on the twigs and branches are visible. Natural color imagery may show a brighter green signature compared with non-riparian shrubs, although *Baccharis salicifolia* may have a darker green color. On color infrared imagery it can appear as dark green. *B. salicifolia* individuals typically form wands coming out of the center of the plant and may be spaced apart or in clumps. *Salix lasiolepis* is much larger and can form rounded to amorphous individuals and clumps, more likely on edges or terraces of more active drainages, and within or along the drier active channels in the mountains. *Salix exigua* can appear bluish green on the natural color imagery, as well as pink on color infrared. One must be careful not to confuse it with *Arundo donax,* which can have a similar signature. It also tends to form dense thickets typically adjacent to the active channel. The Shrub Willow/Mulefat MU is difficult to discern in disturbed areas, especially in areas where *Baccharis pilularis* and coastal sage scrub may be present. In these situations, other ancillary datasets and imagery are used where available to help the mapper assign the MU code. In desert settings, Shrub Willow/Mulefat stands are uncommon in lower elevations, and limited to areas receiving a constant water supply, usually at or below springs, below confluences of perennial streams, and at perennial ponds and lakes. In higher elevations, Shrub Willow/Mulefat stands may increase in frequency due to higher moisture regimes. Figures C19-C32 provide example views from aerial photographs and ground-based photography.

Shrub Willow/Mulefat dominated stands are very common in our study area as both pure stands (all secondary attributes are 0%) and with varying combinations of secondary attributes. Figures C19-C32 show examples of different types of Shrub Willow/Mulefat stands from aerial photographs and ground-based photography. Each example includes the number of stands and total acreage for both coast-draining streams and desert-draining streams. The summaries do not contain information for the single mapped HUC8 in the Sierras (South Fork of the Kern River), which will be reported in Lott et al. (in preparation).

Figure C19. Strongly dominant Shrub Willow/Mulefat stand with high cover (>40%) of shrub willow/mulefat. This type of stand is very common on coastal streams (1,654 polygons, 10,507 acres) and uncommon on desert streams (26 polygons, 113 acres).

Figure C20. Strongly dominant Shrub Willow/Mulefat stand with high cover (>40%) of shrub willow/mulefat.

Figure C21. Shrub Willow/Mulefat stand with medium cover (15-40%) shrub willow/mulefat. This stand type is very common on coastal streams (4,861 stands and 30,010 acres) and moderately common on desert streams (108 polygons, 490 acres).

Figure C22. Shrub Willow/Mulefat stand with medium cover (15-40%) shrub willow/mulefat. This stand type is very common on coastal streams (4,861 stands and 30,010 acres) and moderately common on desert streams (108 polygons, 490 acres).

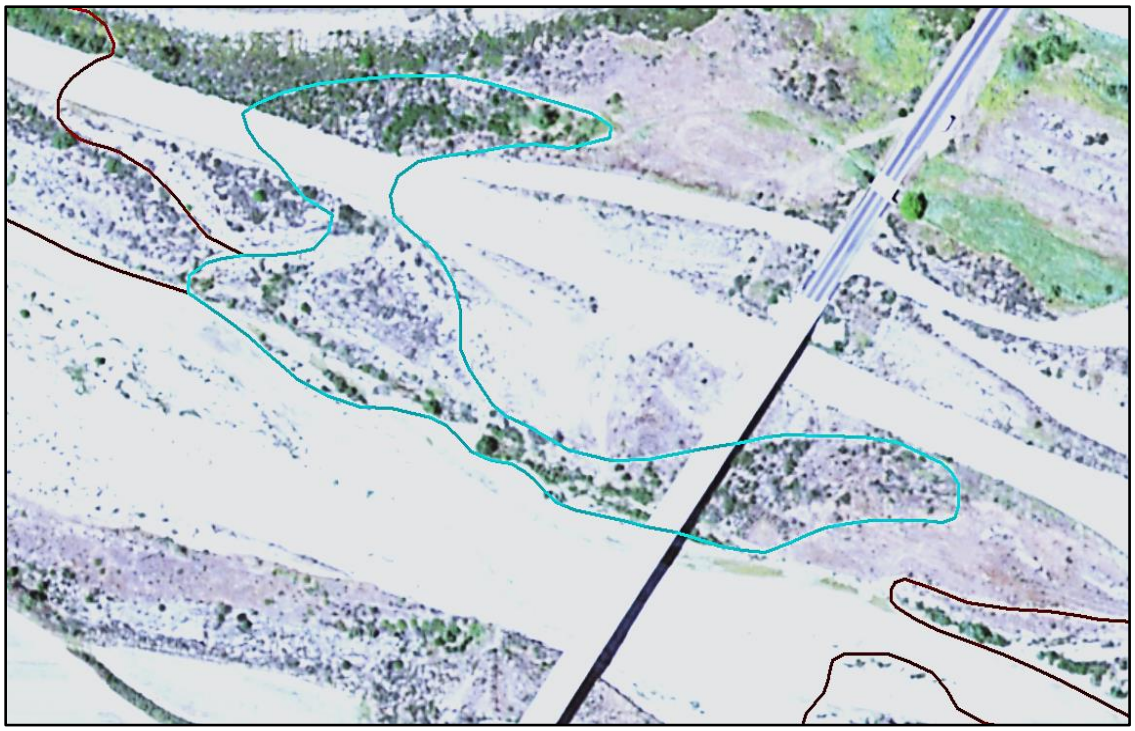


Figure C23. Shrub Willow/Mulefat stand with low cover (5-15%) shrub willow/mulefat. This type of stand is very common on coastal streams (1,844 polygons and 10,187 acres).

Figure C24. Shrub Willow/Mulefat stand with low cover (5-15%) shrub willow/mulefat.

Figure C25. Shrub Willow/Mulefat stand with low cover (5-15%) of tree willow. This type of stand is very common on coastal streams (3,013 polygons, 23,285 acres) and uncommon on desert streams (27 polygons and 161 acres).

Figure C26. Shrub Willow/Mulefat stand with low cover (5-15%) of tree willow.

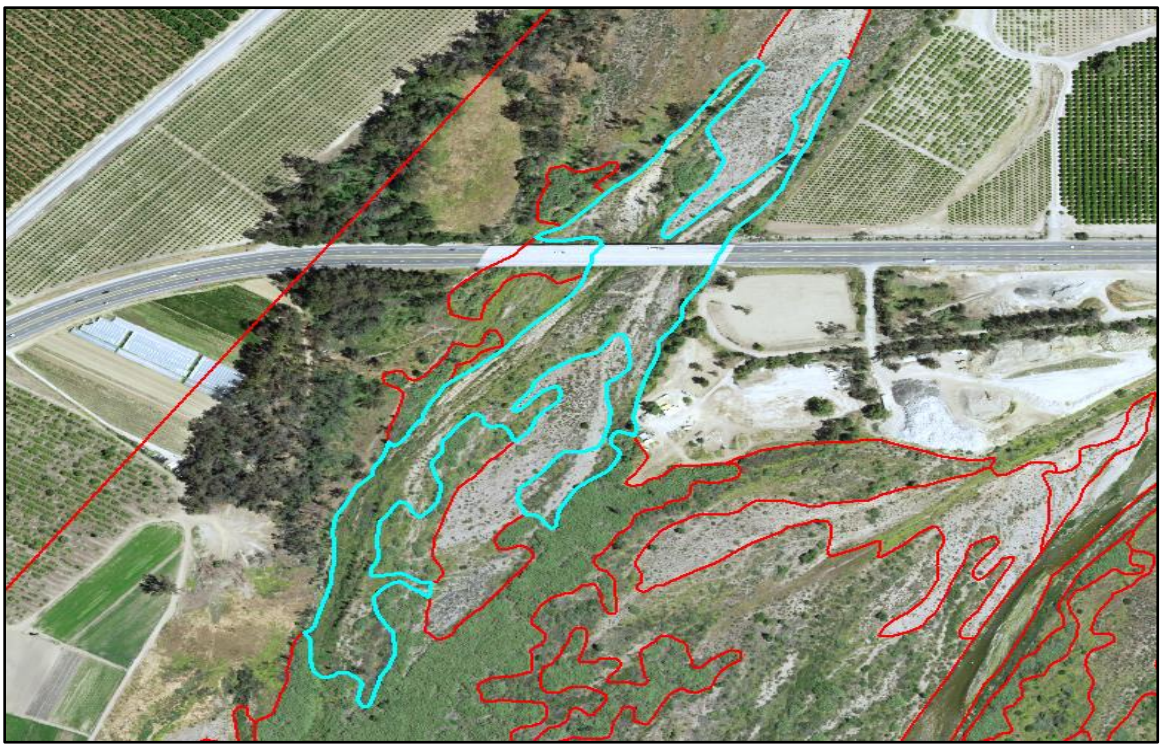


Figure C27. Shrub Willow/Mulefat with low cover (5-15%) of *Arundo donax*. This stand type is very common on coastal streams (849 polygons and 6,868 acres) and absent on desert streams.

Figure C28. Shrub Willow/Mulefat with low cover (5-15%) of *Arundo donax*.

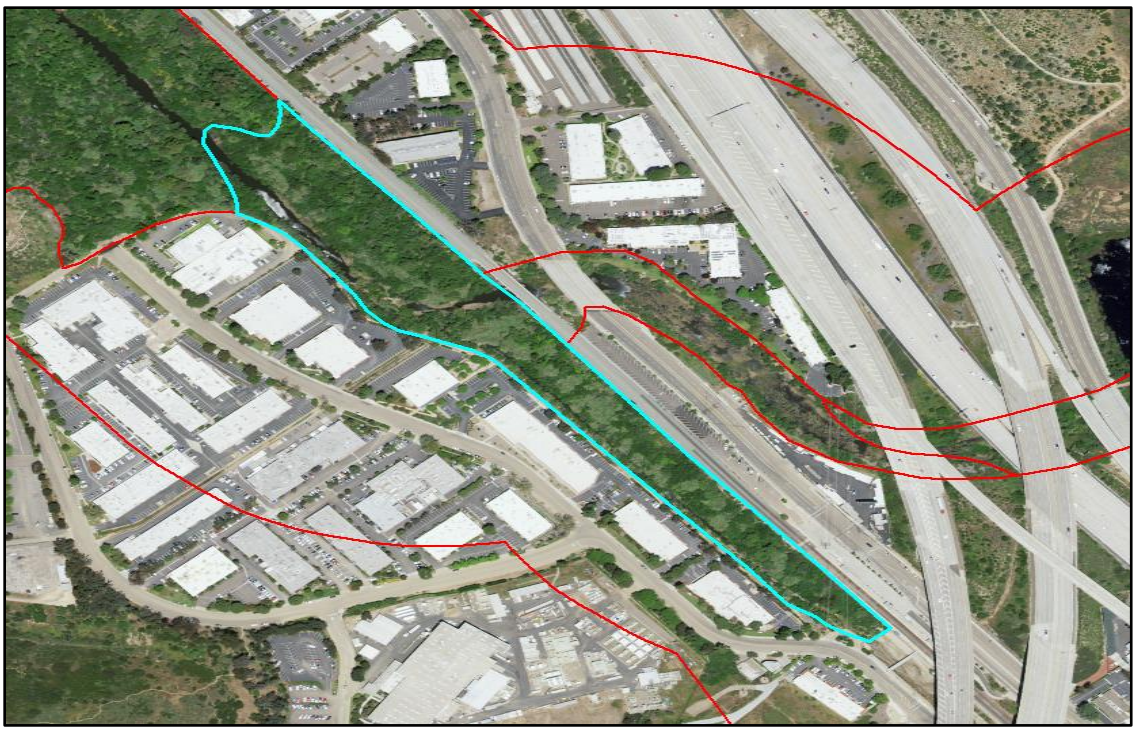


Figure C29. Shrub Willow/Mulefat stand with medium cover (15-40%) of *Arundo donax*. This stand type is moderately common on coastal streams (271 polygons and 2,075 acres) and absent on desert streams.

Figure C30. Shrub Willow/Mulefat stand with medium cover (15-40%) of *Arundo donax*.

Figure C31. Shrub Willow/Mulefat stand with low cover (5-15%) of Tamarisk. This stand type is very common on coastal streams (559 polygons and 3,609 acres) and uncommon on desert streams (6 polygons, 7 acres).

Figure C32. Shrub Willow/Mulefat stand with low cover (5-15%) of Tamarisk.

SECONDARY HABITAT MAP UNITS – Habitat may be favorable for LBVI nesting, especially when secondary components of tree willow and/or shrub willow/mulefat are present. Stands of many of these map units may be present within vireo territories, providing foraging habitat and cover, in areas where willow-dominated stands are present. However, in river reaches with little tree or shrub willow/mulefat, particularly long linear reaches where these stand types are strongly dominant to the exclusion of other types, vireo nesting may be rare.

General patterns of vegetation cover: Vegetation stands/types with an overstory of trees greater than 8-10% (Coastal Non-Desert), but occasionally may be less than 10% when overall vegetation cover is low (<20% total cover) and the trees are evenly distributed in the stand. In desert settings the overstory tree cover is approximately 5% or greater. Note that when the Focused Mapping study area went through highly urbanized areas common exotic species such as *Eucalyptus*, Tree-of-Heaven (*Ailanthus altissima*), *Arundo donax*, Palms, and Pampas grass (*Cortaderia*) may mix in varying amounts within riparian stands.

***Alnus* spp. – *Acer* spp. MU (211) Common Name = Alder**

Coastal Streams: 264 polygons, 2,636 acres
Desert Streams: 37 polygons, 182 acres

Value of Map Unit as Least Bell's Vireo Habitat: Alder-dominated stands are not highly favorable for LBVI nesting. In fact, these stands often map the upstream limit of LBVI nesting in headwater areas of stream networks where vireos may be common at lower altitudes.

Typical Plant Species: The tree overstory is dominated by *Alnus* spp. and/or *Acer* spp. alone or in combination with each other, including A*lnus rhombifolia, Alnus rubra, Acer macrophyllum,* and *Acer negundo.* Saplings or seedlings of these or other trees, as well as any shrub species may occur in the understory. Primary habitat tree species in any combination must not dominate the overstory. *Platanus* can occur with *Alnus,* on the drier edges of the canyon floodplains. Many *Alnus* stands occur at the upper reaches of the watershed and tend to be very dense with closed canopies adjacent to or in the rocky drainage and are unlikely to have many willows or mulefat, if any. Given our mapping criteria for cessation of mapping in headwater areas, some *Alnus* stands may not be mapped depending on the amount of Primary Tree or Shrub component in the stand. *Alnus* spp. – *Acer* spp. MU was mapped extensively in the Coastal Non-Desert region and occasionally mapped in the Desert region, especially in the higher elevations where *Alnus* spp. dominated stands may increase in frequency due to higher moisture regimes.

Ecological Contexts: *Alnus* tends to occur in the mountain canyons along steep swift-moving perennial streams on rocky substrate. *Alnus* typically is characterized as a narrow dense linear path adjacent to both sides of a stream. They are usually prevalent

on long straightaway paths as opposed to curving stream configurations. *Acer* spp. are typically rare and below MMU size.

Photo Signatures and Examples: Natural color imagery shows dense narrow linear stands with individual conical crowns side by side. Leaf-off imagery will depict tall narrow trees with a light gray to white color of trunk and branches. *Alnus* may be confused with *Populus* which is also white on leaf-off imagery but has a more pronounced wider crown with multiple branching. In post-fire recovery situations, pre-fire Google Earth imagery is consulted, which can show mature *Alnus* stands. *Alnus* will regenerate rather quickly after a fire. Street Views with leaf-on and leaf-off conditions are also checked for *Alnus*, looking for the tall narrow trees with conical crown, lining a creek. The trunks are straight and vertical with a light gray to gray color. *Acer negundo* will appear on natural color imagery as a bright green rounded crown tree, as a component of riparian stands. On Street View one can see the three to five pinnate and serrated bright green leaves unique to this tree as compared with other riparian trees.

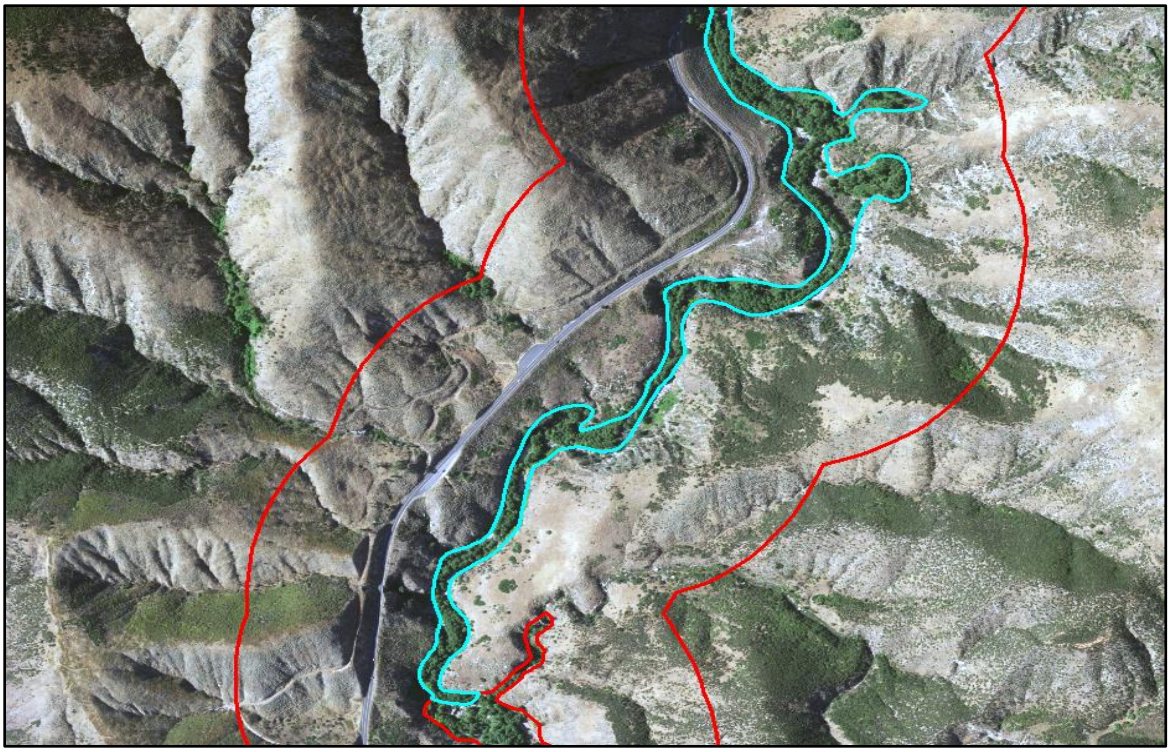


Figure C33. Example of a dense stand of an *Alnus* spp. map unit. This stand type is moderately common on coastal streams (264 polygons and 2,636 acres) and uncommon on desert streams (37 stands, 182 acres).

Figure C34. Example of a dense stand of an *Alnus* spp. map unit.

***Platanus racemosa* MU (212) Common Name = Sycamore**

Coastal Streams: 2,085 polygons, 12,672 acres
Desert Streams: 158 polygons, 1,083 acres

Value of Map Unit as Least Bell's Vireo Habitat: *Platanus* stands may be used for nesting by LBVI if tree or shrub willow/mulefat components are present. This stand type may be present in vireo territories in areas where tree willow or shrub willow/mulefat stands are present nearby, where it mostly provides foraging habitat.

Typical Plant Species: The tree overstory is dominated by *Platanus racemosa.* Saplings or seedlings of this or other trees, as well as any shrub species may occur in the understory. Primary habitat tree species in any combination must not dominate the overstory. It can occur in mixed stands with *Salix* and/or *Populus and* can be common with *Quercus agrifolia* in the mid to higher elevations of watersheds*. Platanus racemosa* MU was mapped extensively in the Coastal Non-Desert region and occasionally mapped in the Desert region.

Ecological Contexts: *Platanus* favors drier sites, and is common on wide floodplains, typically on terraces. In mountain canyons it can occur on intermittent stream beds as well as on terraces. It tends not to occur on the larger, wide river floodplains. It can also occur on narrow short and steep coastal drainages. Open stands of *Platanus* occurring on the driest terraces at the disturbed edges of the riparian zone, typically having an understory of upland grasses, coastal sage scrub (Coastal HUC8s), or seral shrubs, may not be mapped, as they are unlikely to have many shrub willows, mulefat, or tree willows, if any.

Photo Signatures and Examples: On natural color imagery *Platanus* has a wide crown with some coarse texture as compared to *Salix* and tends to be spaced apart with some clumping. On leaf-off imagery there tends to be a brown haze on the ground indicating leaf litter. The branches are white to light gray and tend to spread in a wide crooked way. In late fall imagery when leaves are still on the trees, the leaves may be rust to brown in color. On Street View the trees are generally upright to spreading, at times with some main branching from lower on the trunk. The trunks tend to be smooth and white with dark markings. The leaves are large and palmate, with three points. In the fall, leaves are rust to brown. Figures C35-C40 provide example views from aerial photographs and ground-based photography

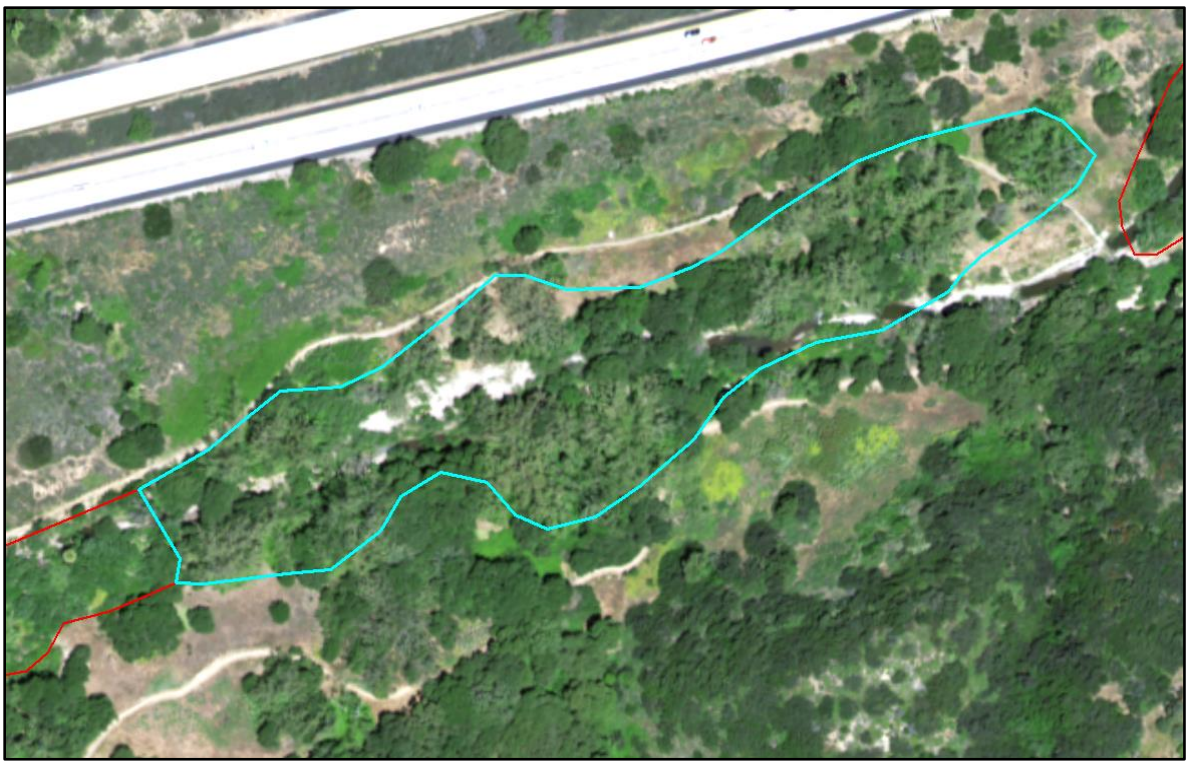


Figure C35. Example of a dominant stand of a *Platanus racemosa* map unit. This stand type is very common on coastal streams (2,085 polygons and 12,672 acres) and moderately common on desert streams (158 polygons, 1,083 acres).

Figure C36. *Platanus racemosa* trees.

Figure C37. *Platanus racemosa* map unit with low cover (5-15%) of willow/mulefat shrubs in the understory. This stand type is very common on coastal streams (1,082 polygons and 6,795 acres) and moderately common on desert streams (56 polygons, 254 acres).

Figure C38. *Platanus racemosa* with low cover (5-15%) willow/mulefat shrubs.

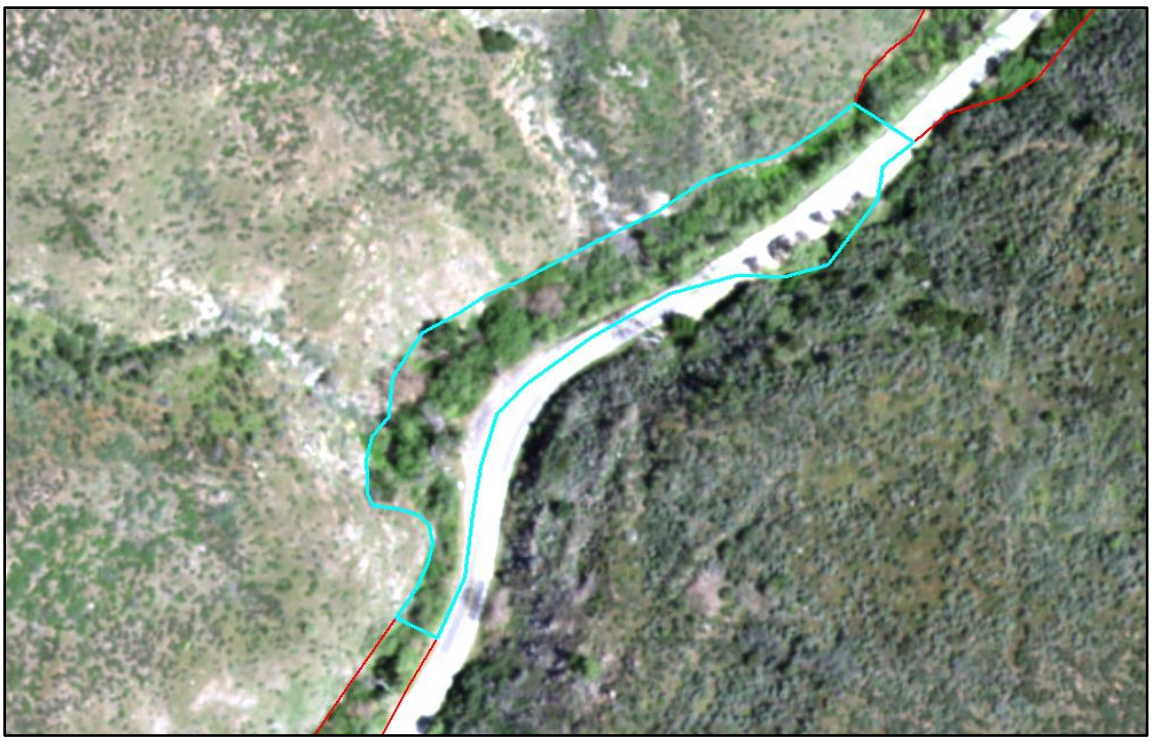


Figure C39. *Platanus racemosa* stand with low cover (5-15%) of tree willow. This stand type is very common on coastal streams (865 polygons, 6,453 acres) and moderately common on desert streams (49 polygons, 450 acres).

Figure C40. *Platanus racemosa* with low cover (5-15%) of tree willows.

Populus spp. MU (213) Common Name = Cottonwood

Coastal Streams: 2,634 polygons, 18,565 acres
Desert Streams: 145 polygons, 814 acres

Value of Map Unit as Least Bell's Vireo Habitat: *Populus* stands may be used for nesting by LBVI if tree or shrub willow/mulefat components are present. This stand type is common in areas where tree willow or shrub willow/mulefat stands are present nearby. Therefore, it is a common component of LBVI nesting territories, where it is mostly used for foraging.

Typical Plant Species The tree overstory is dominated by *Populus* spp., including *Populus fremontii* and *Populus trichocarpa.* Saplings or seedlings of these or other trees, as well as any shrub species may occur in the understory. *Populus* spp. MU was mapped extensively in the Coastal Non-Desert region and occasionally in the Desert.

Ecological Contexts: *Populus*, like Tree Willow, favors ample surface and ground water, especially on broad rivers and stream floodplains. It tends to occur along perennial streams and their adjacent terraces and diminishes on drier sites. Stands can vary in tree cover from very dense to open or sparse. *Populus* will give way to *Platanus* as sites become drier, but the two will mix on smaller streams, depending on water availability. *Populus* and *Salix* will mix in stands or alternate as dominant stands. Some mid to higher elevation stands will mix with both *Salix* and *Platanus*. Additionally, they can be found at the confluence of streams, along lake or pond edges, and at seeps and springs. They are also common in highly urbanized and agricultural areas where there is high water run-off or seepage into the adjacent floodplain or drainage. Open stands of *Populus* occurring on the driest terraces at the disturbed edges of the riparian zone, typically having an understory of upland grasses, coastal sage scrub (Coastal HUC8s), or seral shrubs, may not be mapped, as they are unlikely to have shrub willow/mulefat or tree willows.

Photo Signatures and Examples: On natural color imagery *Populus* has a wide crown with some coarse texture as compared to *Salix*. At times signatures are difficult to differentiate between *Salix* and *Populus,* especially when mixing. In these situations, other ancillary datasets and imagery were used where available to help the mapper assign the MU code. On any given imagery it can locally be either lighter or darker than the adjacent or nearby Tree Willow*.* Sometimes locally on late fall imagery *Populus* will appear yellow-green while the Tree Willow may be leaf-off. On leaf-off imagery *Populus* will appear as a very light gray to white signature of multi-branching crowns. Younger trees will also appear with a whitish color but with more straight trunks with limited branching. On Street View the trunks can be gray with vertical deep furrowing. The leaves will be of medium size and spade-shaped with a medium green color. Leaves are larger than *Salix*, but smaller than that of *Platanus*. On leaf-off views, the branches will be multi-stemmed and generally consistently upright and slightly spreading, with a distinct white color. In the fall, leaves will be bright yellow to yellow green compared to duller colors of Tree Willow and *Platanus*. Figures C41-C56 provide example views from aerial photographs and ground-based photography.

Figure C41. A dominant stand of the *Populus* spp. map unit. This stand type is very common on coastal streams (2,634 polygons, 18,565 acres) and moderately common on desert streams (145 polygons, 814 acres).

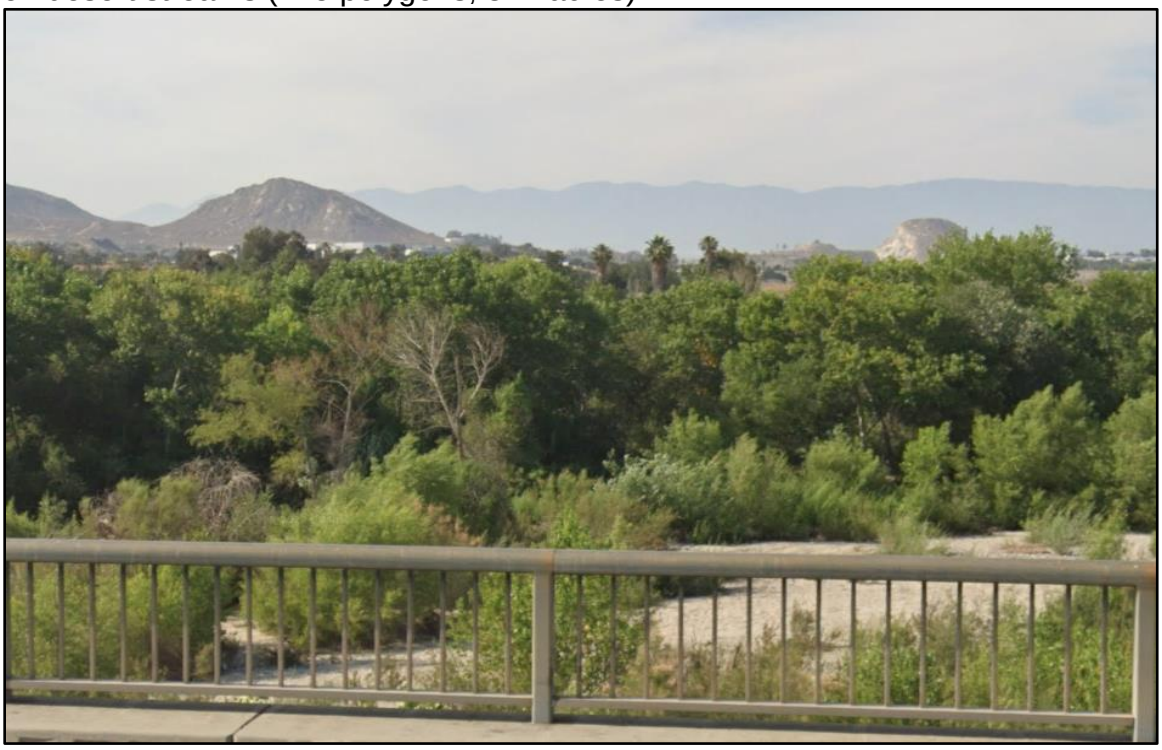


Figure C42. *Populus* trees.

Figure C43. *Populus* spp. stand with low cover (5-15%) of shrub willow/mulefat.

Figure C44. *Populus* spp. stand with low cover (5-15%) of shrub willow/mulefat in winter leaf-off conditions.

Figure C45. *Populus* spp. stand with medium cover (15-40%) of shrub willow/mulefat.

Figure C46. *Populus* spp. stand with medium cover (15-40%) of shrub willow/mulefat in winter with leaf-off conditions.

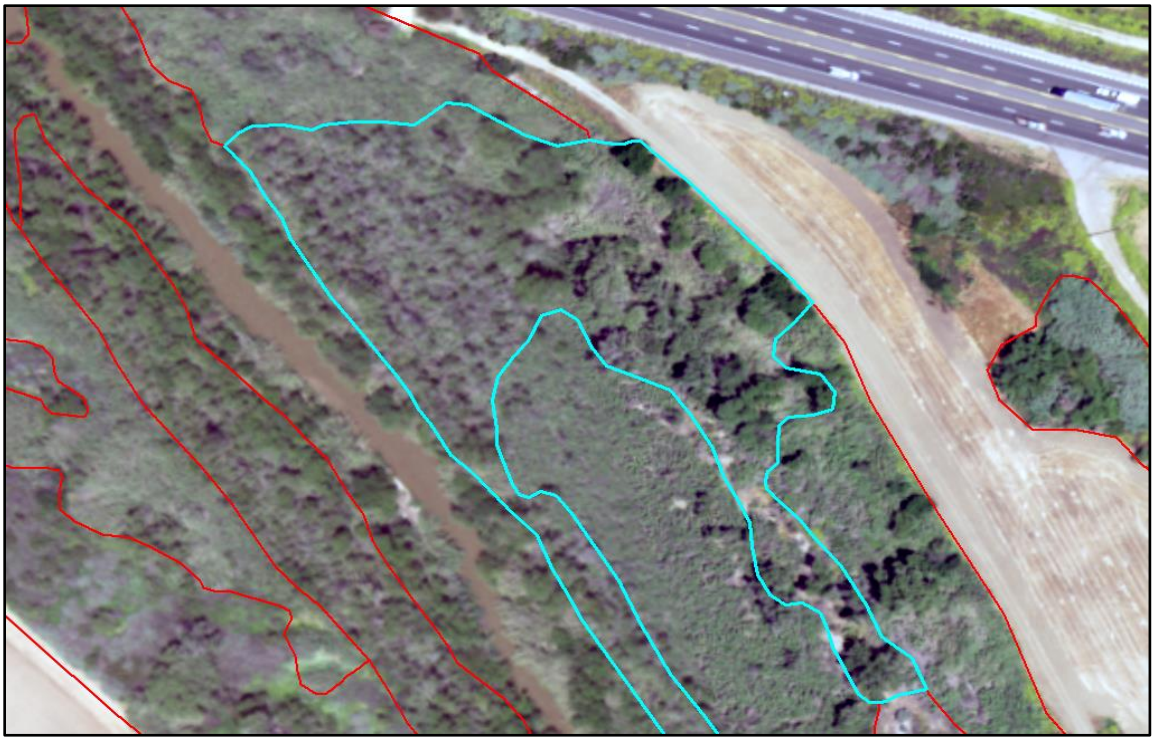


Figure C47. *Populus* spp. stand with low cover (5-15%) of tree willow. This stand type is very common on coastal rivers (1,582 polygons, 12,386 acres) and moderately common on desert streams (38 polygons, 450 acres).

Figure C48. *Populus* spp. map unit with low cover (5-15%) of tree willow. Note the yellow *Populus* and silver-gray *Salix* foliage.

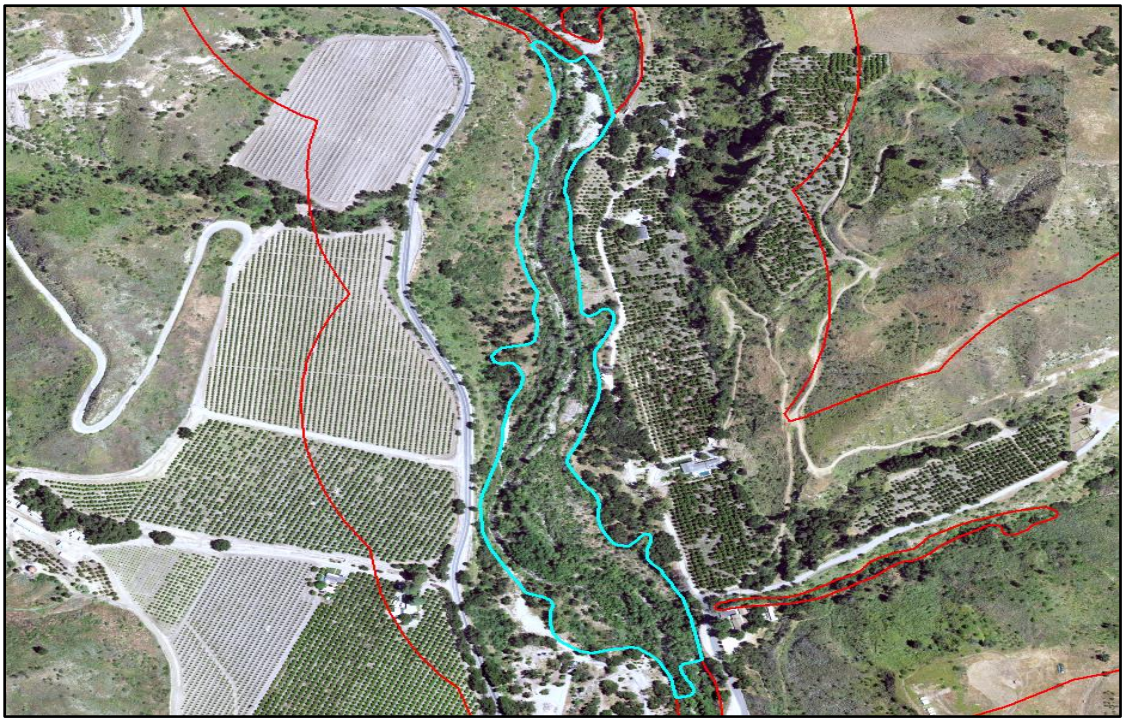


Figure C49. *Populus* spp. map unit with medium cover (15-40%) of tree willow. This stand type is moderately common on coastal streams (93 stands, 844 acres) and absent on desert streams.

Figure C50. *Populus* spp. with medium cover (15-40%) of tree willow. Note the larger greener leaves of *Populus* and the smaller lighter-colored leaves of *Salix*.

Figure C51. *Populus* spp. stand with low cover (5-15%) of *Arundo donax*. This stand type is moderately common on coastal streams (194 stands, 1,259 acres) and absent on desert streams.

Figure C52. *Populus* spp. stand with low cover (5-15%) of *Arundo donax*.

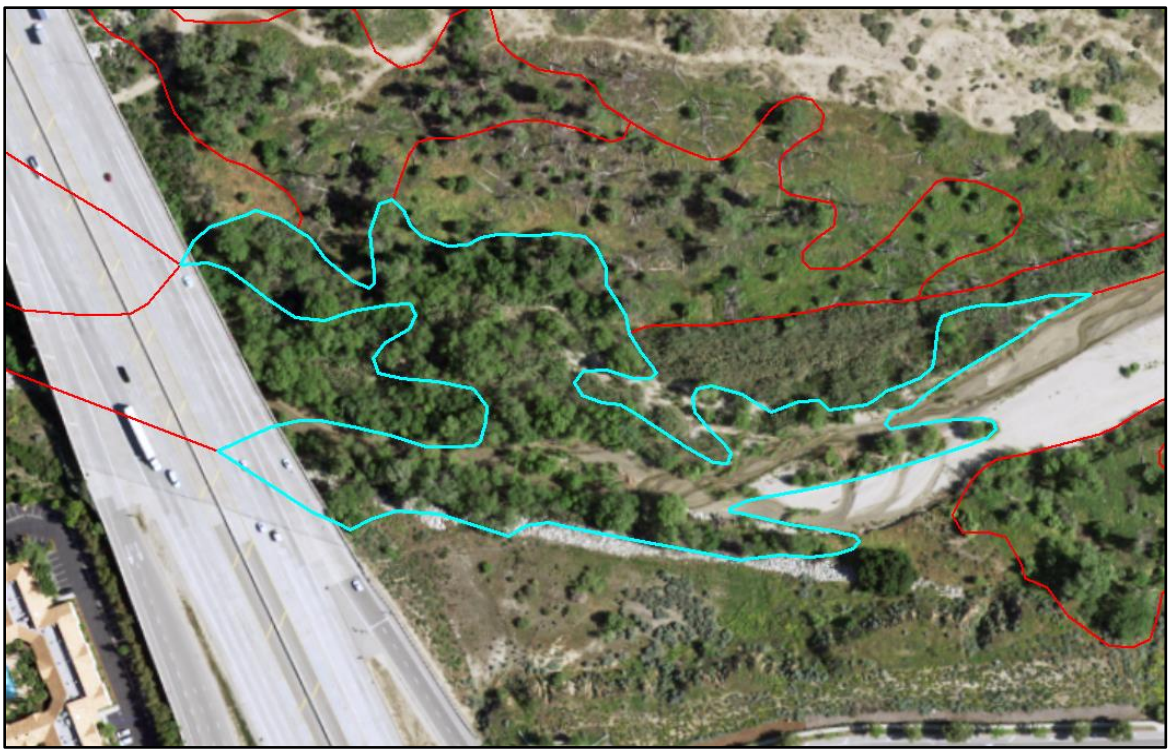


Figure C53. *Populus* spp. map unit with medium cover (15-40%) of *Arundo donax.* This stand type is uncommon on coastal streams (58 polygons, 481 acres) and absent on desert streams.

Figure C54. *Populus* spp. stand with medium cover (15-40%) of *Arundo donax.*

Figure C55. *Populus* spp. map unit with low cover (5-15%) of *Tamarix* spp. This stand type is moderately common on coastal streams (175 polygons, 1,746 acres) and uncommon on desert streams (8 stands, 56 acres).

Figure C56. *Populus* spp. map unit with low cover (5-15%) of *Tamarix* spp..

Riparian *Quercus* spp. MU (214) Common Name = Riparian Oak

Coastal Streams: 425 polygons, 2,156 acres
Desert Streams: 5 polygons, 46 acres.

Value of Map Unit as Least Bell's Vireo Habitat: Riparian Oak stands may be used for nesting by LBVI if tree or shrub willow/mulefat components are present. This stand type may be present in vireo territories in areas where tree willow or shrub willow/mulefat stands are present nearby, where it mostly provides foraging habitat.

Typical Plant Species: The tree overstory is dominated by tree *Quercus* spp. including *Quercus agrifolia, Quercus lobata,* and *Quercus wislizeni,* in a riparian setting. Saplings or seedlings of this or other trees, as well as any shrub species may occur in the understory. Any primary habitat tree species in any combination must not dominate the overstory. Note that upland occurrences of these oak species are considered Not Suitable Habitat (code 999). For the most part *Quercus* is not mapped on slopes outside of the riparian zone or along the driest margins of the riparian floodplain. In *Quercus* stands, if primary trees are visible on the imagery and/or occur with *Platanus*, then the stands are captured as the Riparian *Quercus* spp. MU. Where *Quercus* occur along the riparian corridor, if primary trees or shrubs can be pulled out leaving the oaks on the outside edges, the oak may not be mapped. Where primary trees and shrubs cannot be mapped separately from the oak, then the oaks are mapped with the primary species included. Oaks usually occur on the drier edge rather than within the wetter part of the drainage. Riparian *Quercus* spp. MU was mapped extensively in the Coastal Non-Desert region and rarely mapped in the Desert region.

Ecological Contexts: *Quercus agrifolia* mainly occurs at mid to upper elevations of the watersheds on intermittent drainages. Only *Quercus* in riparian settings, where riparian trees and/or shrubs are visible or likely present, are mapped.

Photo Signatures and Examples: *Quercus agrifolia* is an evergreen tree so has leaves on leaf-off imagery. On imagery it will be dark green in color, with a dense amorphous crown. Stands are typically dense to open. In closed canopy stands the understory will be obscured making the assessment of primary shrub difficult. *Platanus* can occur as a component of *Quercus agrifolia* stands. On Street View it will have a dense crown with small to medium dark green leaves.

Figure C57. Stand of the Riparian *Quercus* spp. map unit with tree willow, shrub willow/mulefat, *Platanus*, and *Arundo donax*. Riparian Oak stands are moderately common on coastal streams, often in headwater areas (425 stands and 2,156 acres) and uncommon on desert streams (5 stands and 46 acres).

Figure C58. Riparian *Quercus* spp. with tree willow, shrub willow/mulefat, *Platanus*, and *Arundo donax.*

Riparian *Eucalyptus* spp. and other Exotics MU (215) Common Name = Exotic Trees

Coastal Streams: 190 polygons, 644 acres
Desert Streams: 0 polygons

Value of Map Unit as Least Bell's Vireo Habitat: Exotic tree stands may be used, infrequently, for nesting by LBVI if tree or shrub willow/mulefat components are present in the understory. Otherwise, this map unit has little value for vireos.

Typical Plant Species: The tree overstory is dominated by *Eucalyptus* spp*., Ailanthus altissima* (Tree-of-heaven), *Schinus* spp., palms and/or other miscellaneous exotic trees in a riparian setting. Sapling or seedlings of these trees, as well as any shrub species may occur in the understory. Upland occurrences of these exotic species are considered Not Suitable Habitat (code 999). Where exotics occur along the riparian corridor, if primary trees or shrubs can be pulled out leaving the exotics on the outside edges, the exotics may not be mapped. Where primary trees and shrubs cannot be mapped separately from exotics, exotics are mapped with the primary species included as secondary attributes.

Ecological Contexts: Exotic species typically occur in proximity to urban or agricultural areas, especially if intensely developed. The most common exotic trees are *Eucalyptus* and palm trees. *Ailanthus altissima* and *Juglans hindsii* may also occur. These exotics are typically upland species but may be planted or naturalized into the riparian zone. Only those in the riparian zone, where riparian trees and/or shrubs are visible or likely to be found, are mapped.

Photo Signatures and Examples: *Eucalyptus* are typically the tallest trees in any context. The natural color imagery depicts these evergreen trees as a rusty to reddish brown color with an amorphous shape. They are in groups or as individuals. Street View shows *Eucalyptus* as very tall open crowned trees with drooping or cascading branches and branchlets, with long narrow leaves, generally dark green to brown in color. The bark is light to splotchy.

Ailanthus altissima stands can vary widely in height and are vigorously clonal. They are seen on imagery as dark green clusters of short to medium-sized trees with distinctive and irregularly shaped stand margins. Crowns appear consistent in height and slightly bumpy. Stands appear as coarsely textured uneven trees over tall or short shrubs or grass.

Juglans is a round crowned short tree occurring in open to dense stands. The crown can have finely textured edges, with a dark green to medium green color.

Palm trees are round individuals with a star-shaped pattern of the crown fronds emanating from the center. Palms are likewise in groups, swarms, or as individuals. Palms are tall single brown trunks with the spray of fronds at the top.

Figure C59. Example of a dominant stand of a Riparian Eucalyptus map unit with shrub willow/mulefat and *Tamarix spp*. Exotic tree stands are moderately common on coastal streams (190 stands and 644 acres) and absent on desert streams.

Figure C60. Example of a dominant stand of a Riparian Eucalyptus map unit with shrub willow/mulefat and *Tamarix spp*.

***Prosopis* spp. MU (216) Common Name = Riparian Mesquite**

Coastal Streams: 0 polygons
Desert Streams:573 polygons, 16,934 acres

Value of Map Unit as Least Bell's Vireo Habitat: Riparian Mesquite is an important nesting habitat type in desert areas, particularly in stands on or adjacent to stream beds (less so in drier, more isolated stands). It is highly favorable for LBVI reproduction as it often contains both high quality foraging resources and the specific shrub species that vireos prefer for nest placement. Vireos will also place nests within mesquite shrubs.

Typical Plant Species: The overstory is dominated by Prosopis species, alone or in combination with each other, including *Prosopis glandulosa* and/or *Prosopis pubescens. Prosopis* spp. MU was mapped extensively in the Desert region and occasionally mapped in the Coastal Non-Desert region.

Ecological Contexts: *Prosopis* spp. occurs primarily in the desert or desert transition areas on the edge of the inland portions of the coastal region. They are associated with stabilized dunes, sand sheets adjacent to playas and basins, in canyons, washes, and near seeps or other water sources. For this project, only Prosopis stands in proximity to the active riparian zone or containing primary habitat or *Tamarix* spp. were mapped. All other stands of *Prosopis* spp. were mapped as Not Suitable Habitat (999).

Photo Signatures and Examples: Stands range in cover from sparse to extremely dense, with the low spreading trees appearing bluish gray to dark green in color. Some stands with heavy die-off can appear light gray to dark gray in color with very little green signature. The tree crown is rounded with a well-defined edge. These small trees typically occur on small sandy mounds, often giving them a hummocky appearance.

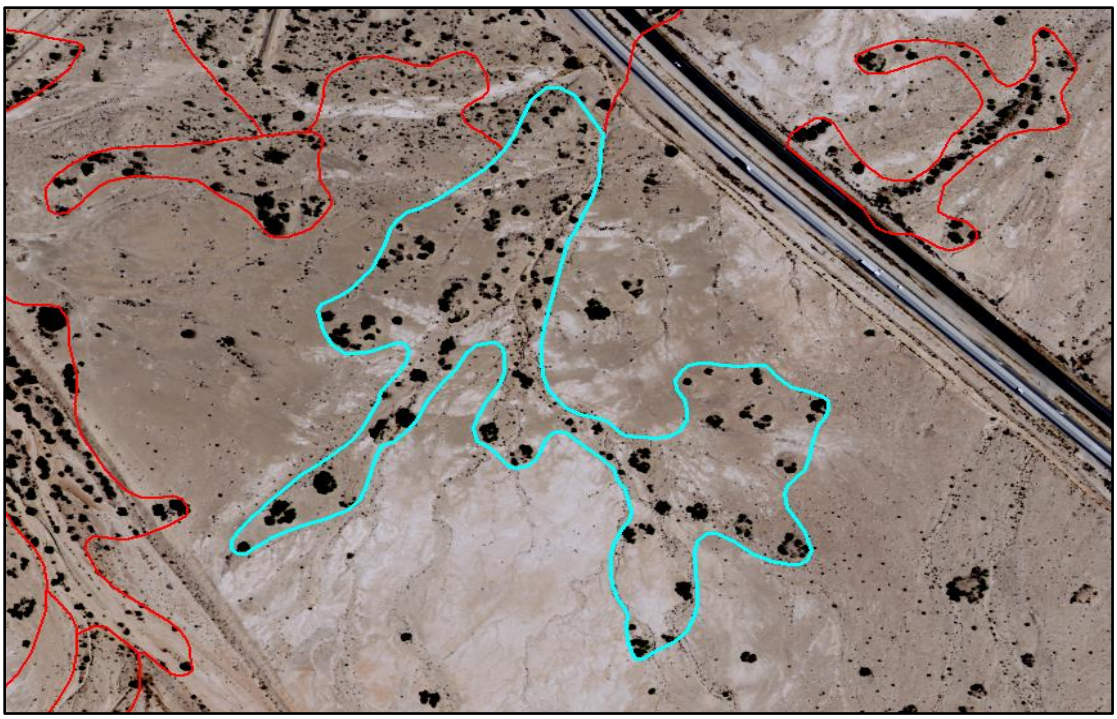


Figure C61. Example of a *Prosopis* spp. map unit in the San Felipe watershed of the Colorado Desert. Riparian mesquite stands are absent from coastal streams and very common on desert streams, which are mostly intermittent (573 stands and 16,934 acres).

Figure C62. Example of a *Prosopis* spp. map unit in the San Felipe watershed of the Colorado Desert.

***Chilopsis linearis* MU (217) Common Name = Desert Willow**

Coastal Streams: 4 polygons, 53 acres
Desert Streams: 245 polygons, 3,108 acres

Value of Map Unit as Least Bell's Vireo Habitat: Desert Willow stands may be used for nesting by LBVI if tree or shrub willow/mulefat components are present. This stand type may be present in vireo territories, particularly in areas near mesquite or willow stands, where it mostly provides foraging habitat.

Typical Plant Species: The overstory is dominated by *Chilopsis linearis. Chilopsis linearis* MU was mapped extensively in the Desert region and occasionally mapped in the Coastal Non-Desert region.

Ecological Contexts: *Chilopsis linearis* occurs in washes, intermittent channels, arroyos, or lower canyons that are intermittently flooded. Stands tend to occupy sandy or gravelly washes where wash energy is dissipated across a relatively wide flood path. *C. linearis* is also noted along washes where shallow bedrock or pediment forces underground water to flow up to or near the surface.

Photo Signatures and Examples: Stands of Chilopsis linearis may be sparse to moderately dense in cover with individuals exhibiting a gray to grayish green, diffuse, irregularly shaped crown with a coarse texture. Individual plants can be quite large, at times measuring over 5 meters across. Plants appear scattered apart and follow the edges of large high-energy washes, creating stands that are linear in shape with a white sandy substrate.

Figure C63. Example of a stand of a *Chilopsis linearis* map unit in the San Felipe watershed of the Colorado Desert. This stand type is uncommon on coastal streams (4 polygons and 53 acres) and very common on desert streams (245 polygons and 3,108 acres).

Figure C64. Example of a stand of a *Chilopsis linearis* map unit in the San Felipe watershed of the Colorado Desert.

***Rosa californica – Toxicodendron diversilobum – Vitis* spp. MU (221) Common Name: Rose/Grape/Poison Oak**

Coastal Streams: 60 polygons, 131 acres
Desert Streams:8 polygons, 14 acres

Value of Map Unit as Least Bell's Vireo Habitat: Rose/Grape/Poison Ivy stands are sometimes used for nesting by LBVI if tree or shrub willow/mulefat components are present, and even sometimes when they are not. This stand type may be present in vireo territories in areas where tree willow or shrub willow/mulefat stands are present nearby, where it provides foraging habitat.

Typical Plant Species: The shrub overstory is dominated by *Rosa californica, Toxicodendron diversilobum, Vitis californica,* and/or *Vitis girdiana,* above the MMU, alone or in combination with each other. Stands tend to be smaller in size and are often below MMU. These small stands are typically inclusions in other types and rarely large enough to map on their own, thus this type may be underrepresented. Any primary habitat species in any combination must not dominate the overstory. This MU may also include *Cornus sericea*, *Rosa woodsii, Rhus trilobata, Forestiera pubescens, Ribes quercetorum,* and *Ribes armeniacus*. Upland *Toxicodendron* is not mapped. *Rosa californica – Toxicodendron diversilobum – Vitis* spp. MU was rarely mapped in both the Coastal Non-Desert region and Desert region.

Ecological Contexts: In riparian settings this MU may occur on disturbed low terraces adjacent to the active channel, within floodplains of small perennial streams, or downstream of seeps and springs. It does not occur on drier sites

Photo Signatures and Examples:
These species usually occur as low dense mats or thickets. On the natural color imagery *Rosa* will appear as medium to bright green smooth rounded shapes with a finite edge and a low stature. It may occur as several patches in an area. *Toxicodendron*, on the other hand, may appear as spreading very low stature stands over larger areas, with a medium to bright green color. It may have minimal or flat texture as compared to shrub willow/mulefat types.

Figure C65. Example of a dense stand of strongly dominant *Toxicodendron diversilobum.* The ground view below shows the T*oxicodendron* stand in the middle foreground. This stand type is uncommon on coastal streams (60 polygons and 131 acres) and even less common on desert streams (8 stands and 14 acres).

Figure C66. Dense stand of strongly dominant *Toxicodendron diversilobum.* T*oxicodendron* in the middle foreground.

Riparian Alluvial Scrub MU (222) Common Name = Alluvial Scrub

Coastal Streams: 779 polygons, 4,775 acres
Desert Streams: 0 polygons

Value of Map Unit as Least Bell's Vireo Habitat: This map unit is present in many areas that may include LBVI nesting territories but is not highly favorable for LBVI nest placement unless shrub willows or mulefat are present. When it is adjacent to stands with tree willow or shrub willow/mulefat components, it mostly provides foraging habitat.

Typical Plant Species: Alluvial scrub species may include *Eriogonum fasciculatum, Artemisia californica, Baccharis pilularis,* and/or *Lepidospartum squamatum.* Any primary habitat species in any combination must not dominate the overstory. The shrub layer is dominated by one or a combination of alluvial scrub species. Alluvial Scrub MUs occurring adjacent or near areas of dominant primary tree and/or shrub species are assumed to contain at least a category 1 in the percent tree willow and/or shrub willow/mulefat attribute field and are typically captured. Note that in the Coastal Non-Desert regions occurrences of these alluvial species and/or stands in areas where the primary habitat species are waning must have at least 15% absolute cover of primary habitat species or *Arundo donax* to be considered for mapping. In Desert settings, the amount of primary habitat species was lowered to >trace (5%) amounts to be considered for mapping in the Focused Mapping study area.

Ecological Contexts: Riparian Alluvial Scrub occurs primarily on higher drier terraces and disturbed areas within the river or stream floodplain. They are also found within the active channel and on adjacent terraces in the drier intermittent and ephemeral stream floodplains. It may be difficult to discern alluvial scrub dominance vs. riparian scrub dominance, especially in disturbed areas. *Baccharis pilularis* does not occur in the active channel or on moister terraces edging the channel. *Eriogonum* and *Artemisia* occur mainly on the drier higher terraces*. Lepidospartum* can occur within the channel on cobbly substrate or on the adjacent low to high terraces.

Photo Signatures and Examples: *Baccharis pilularis* is an evergreen shrub and appears on the natural color imagery as a short medium to dark green shrub with some slight texture. On color infrared imagery it can appear as a dark red to burgundy color, like *Baccharis salicifolia* which is deciduous. Non-deciduous *Eriogonum fasciculatum* is small, short, and round, and can appear as a tan to brown signature on the natural color imagery, with a sharp crown edge. *Artemisia californica*, also small, short, and rounded, and non-deciduous, is green to blue green to gray on the natural color imagery. *Lepidospartum squamatum* is green to dark green and is short and round on the imagery, with a sharp distinct crown edge, and is non-deciduous. Figures C67-C72 provide example views from aerial photographs and ground-based photography

Figure C67. Example of a dominant *Baccharis pilularis* stand as an Alluvial Scrub map unit on a floodplain terrace.

Figure C68. Example of dominant *Baccharis pilularis* stand as an Alluvial Scrub map unit on a floodplain terrace.

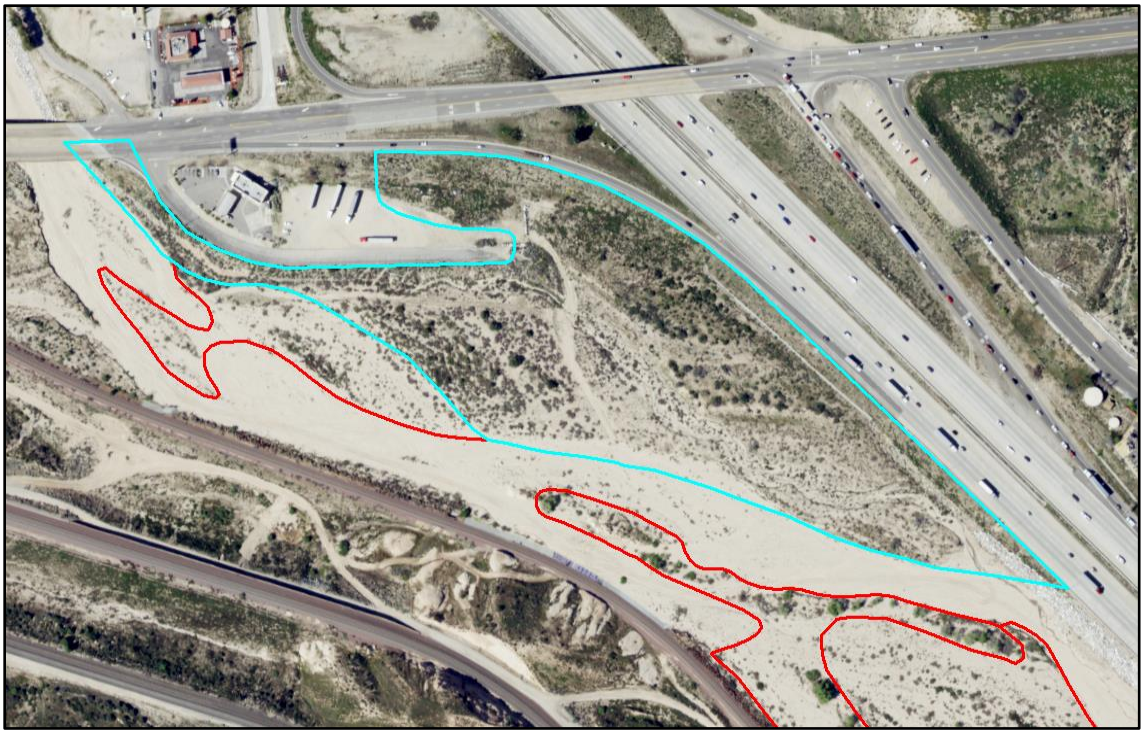


Figure C69. Example of a coastal sage scrub stand as an Alluvial Scrub map unit on floodplain terraces.

Figure C70. Example of a coastal sage scrub stand as an Alluvial Scrub map unit on floodplain terraces.

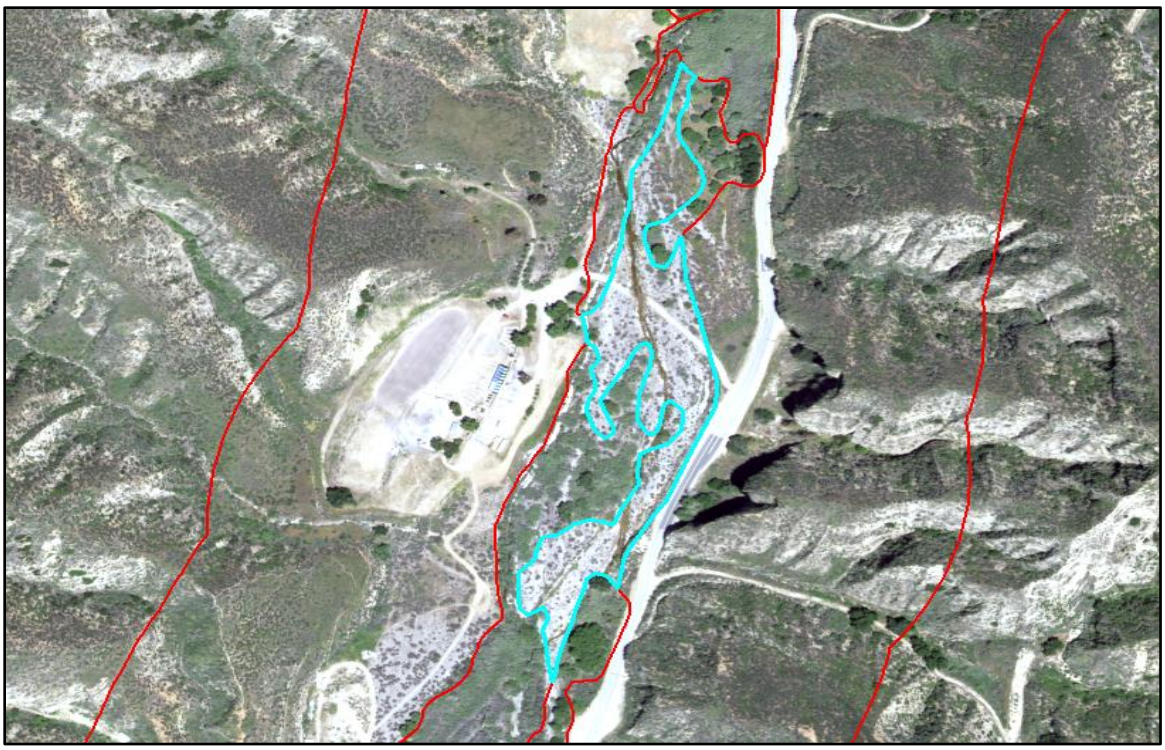


Figure C71. The Alluvial Scrub map unit with low cover (5-15%) of shrub willow/mulefat. This stand type is moderately common on coastal streams (444 polygons and 2,875 acres) and absent from desert streams.

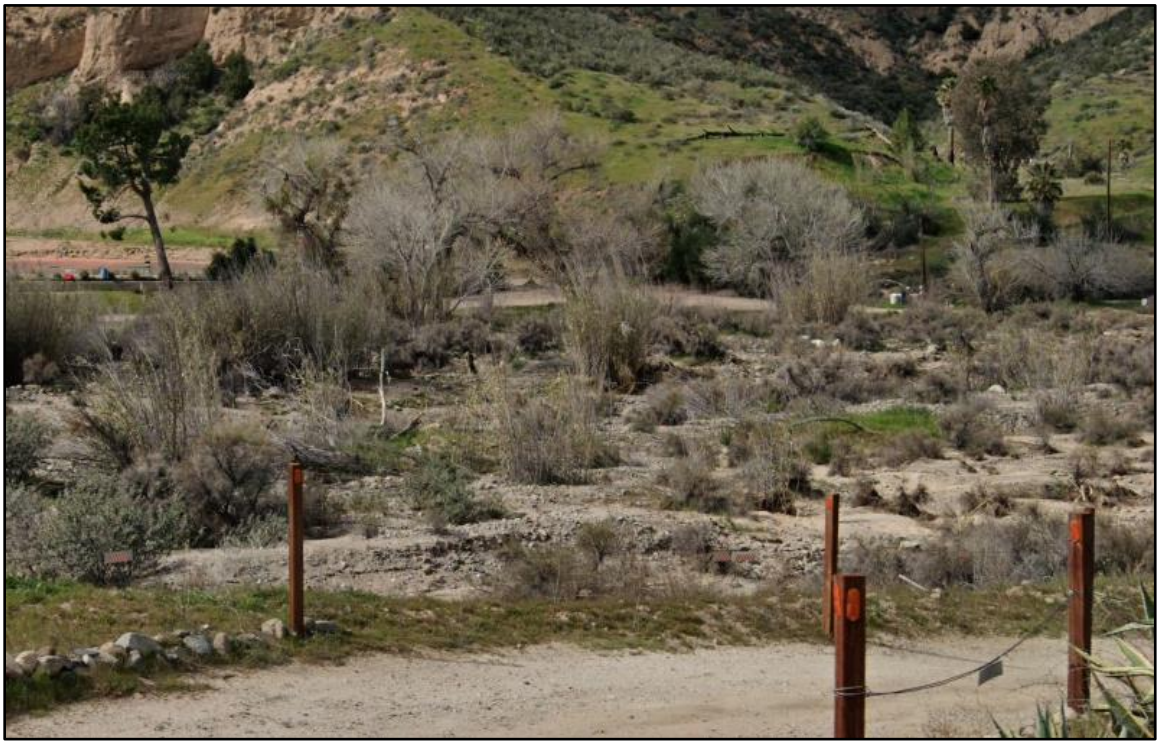


Figure C72. The Alluvial Scrub map unit with low cover (5-15%) of shrub willow/mulefat.

***Sambucus nigra* MU (223) Common Name = Elderberry**

Coastal Streams: 290 stands, 1,041 acres
Desert Streams: 6 stands, 31 acres

Value of Map Unit as Least Bell's Vireo Habitat: Elderberry stands are used for nesting by LBVI if tree or shrub willow/mulefat components are present, and even sometimes when they are not. This stand type may be present in vireo territories in areas where tree willow or shrub willow/mulefat stands are present nearby, where it also provides foraging habitat.

Typical Plant Species: The shrub overstory is dominated by *Sambucus nigra* above the MMU size. Stands below MMU are not mapped or are included in other types, where applicable. Note that *Sambucus* often is below MMU or is very sparse.

Ecological Contexts: *Sambucus* tends to occur at the margins of the riparian zone in disturbed terrace areas of mixed vegetation or with a grassy understory. They are typically unevenly well-spaced. Street View, albeit limited in availability and sometimes of poor quality, is used to verify occurrences of *Sambucus* where it is not as obvious on the imagery. In all, *Sambucus* may be under mapped.

Photo Signatures and Examples: Google Earth leaf-off shows dark gray to brown color of the medium tall shrub/arborescent tree. Its appearance as an open-cover tall shrub on disturbed grassy to mixed shrub dry terraces gives a strong indication of its presence. On Street View it appears as a tall densely crowned rounded shrub/arborescent tree with small compound-pinnate leaves, at times with an array of white inflorescences scattered on the crown.

Figure C73. Example of a stand of the *Sambucus nigra* map unit. Note the characteristic flowering shrub pattern of *Sambucus* in the ground view below. This stand type is moderately common on coastal streams (290 polygons, 1,041 acres) and uncommon on desert streams (6 polygons, 31 acres).

Figure C74. Example of a stand of the *Sambucus nigra* map unit. Note the characteristic flowering shrub pattern of *Sambucus*.

Riparian *Tamarix* spp. MU (224) Common Name = Riparian Tamarisk

Coastal Streams:719 stands, 4,764 acres
Desert Streams:173 stands, 2,048 acres

Value of Map Unit as Least Bell's Vireo Habitat: The value of riparian tamarisk stands to LBVI in unclear and should be resolved. On the Colorado River, LBVI build nests in tamarisk, and it is often a major component of territories. Away from the Colorado, in California, tamarisk use by LBVI has been sparsely documented and is sometimes viewed as an inferior nesting habitat type. Given this uncertainty, the effect of extensive tamarisk removal on vireo populations is difficult to predict.

Typical Plant Species: The shrub overstory is dominated by riparian *Tamarix* species. *Tamarix* species that are not mapped as the map unit are represented by the percent *Tamarix* spp. attribute where they occur above trace amounts (>5%). Note that stands of *Tamarix* spp. may not have been mapped if associated with homesteads or planted windrows unless they were near a major drainage. Within the Desert HUC8s, *Tamarix* spp. was treated like a primary nesting habitat species, and if a dominant secondary species had >5% component of *Tamarix* spp., the secondary type was mapped following the established criteria.

Ecological Contexts: In Non-Desert HUC8s *Tamarix* spp. can occur anywhere along a drainage from the coast to the mid to upper elevations but is most prevalent in the inland moderate elevation locations. It can occur in disturbed environments as well as invade less disturbed sites. It can occur in the active channel of dry intermittent to ephemeral streams, as well as on the moist to dry terraces of river and stream floodplains. It can also be found on intermittent to ephemeral basins and ponds. *Tamarix* spp. can tolerate salinity. In Desert settings, *Tamarix* spp. can occur in very open to very dense cover and are typically found along riparian washes and in disturbance areas, including man-made canals and ditches. Structural characteristics vary considerably, from stands containing sparse short shrubs along sandy river flats to dense tall thickets adjacent to the active channel.

Photo Signatures and Examples: *Tamarix* spp. has a variable signature. On natural color imagery it can appear round and dark green in some years, in others it will have a soft blue-green tone with sprays of branches flowing out from the center, with some texture. On some leaf-off imagery it can appear brown to dark brown, sometimes with a reddish cast. In some color infrared imagery, it can appear light pink, and sometimes as reddish burgundy in color. In many cases the color infrared imagery will have a mixture of dark and medium red colors with dark black interstices, giving a chaotic feel to the area. On Street View the flowing fine feathery branches of the short to tall shrub will come up and out wispily from the center. Colors vary from bright green to dull green to yellow, tan, brown, and rust. The white to yellowish inflorescences at the end of the pointed leafy branches can make *Tamarix* spp. stand out from the other shrubs and trees.

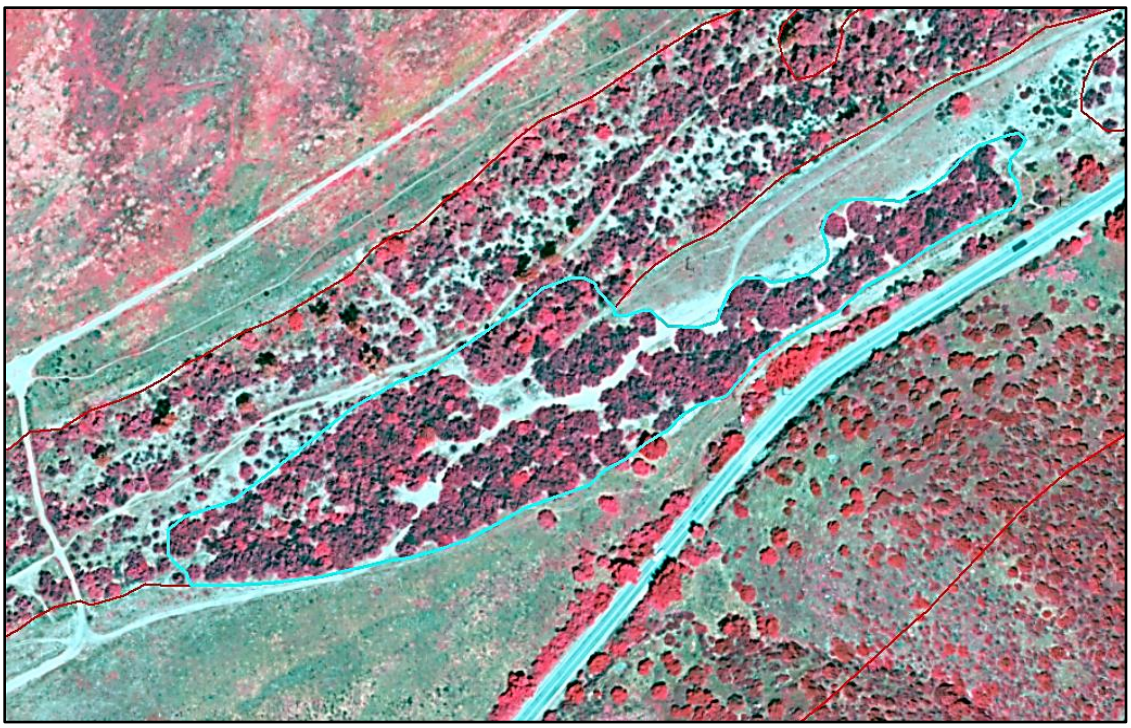


Figure C75. Example of a dominant stand of the *Tamarix* spp. map unit with a high cover (>40%) of *Tamarix spp.* Note the dark mottled signature on the color infrared image. This stand type is moderately common on coastal streams (87 polygons, 423 acres) and desert streams (25 polygons, 296 acres).

Figure C76. Example of a dominant stand of the *Tamarix* spp. map unit with a high cover (>40%) of *Tamarix spp.*

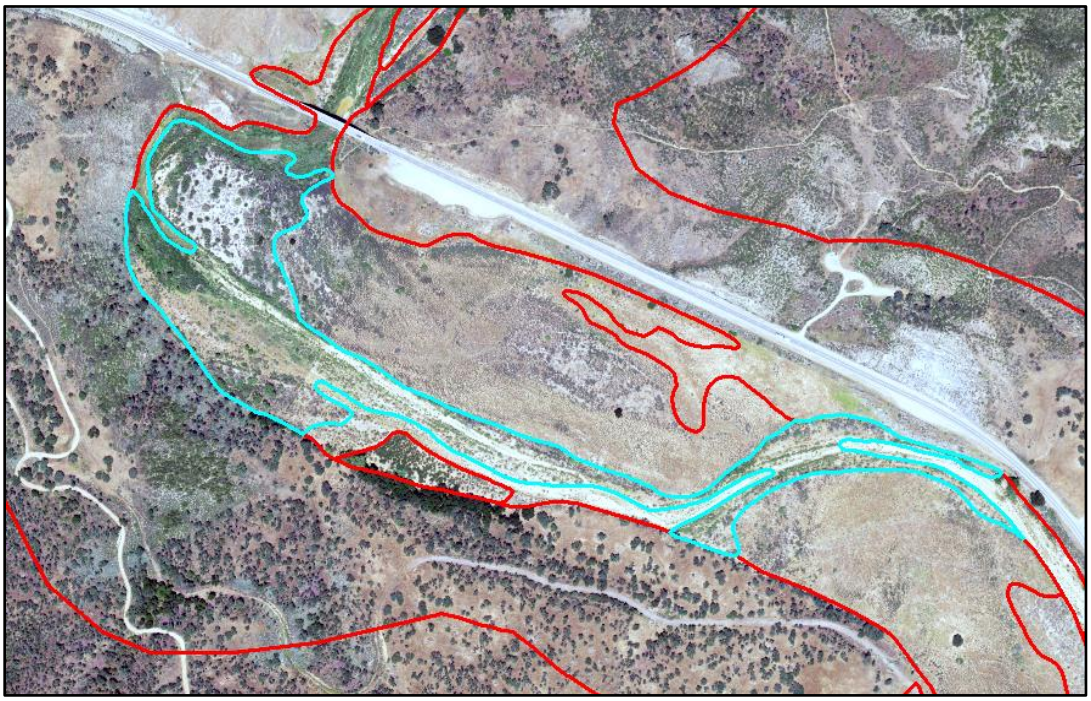


Figure C77. Example of a dominant stand of the *Tamarix* spp. map unit with a medium cover (15-40%) of *Tamarix* spp. This stand type is uncommon on most coastal streams, but common on the Cuyama River (489 polygons, 3,676 acres) and moderately common on desert streams (99 polygons, 964 acres).

Figure C78. Example of a dominant stand of the *Tamarix* spp. map unit with a medium cover (15-40%) of *Tamarix* spp.

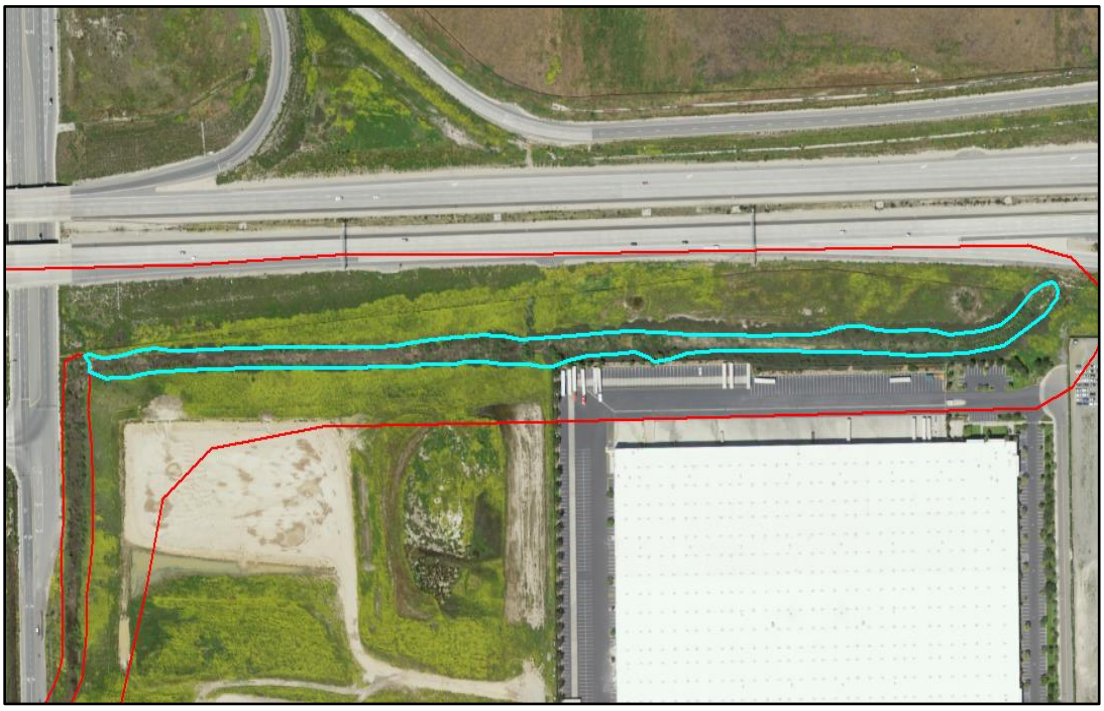


Figure C79. Example of stand of the *Tamarix* spp. map unit with a low cover (5-15%) of *Tamarix* spp. This stand type is moderately common on coastal streams (143 polygons, 643 acres) and desert streams (49 polygons, 787 acres).

Figure C80. Example of stand of the *Tamarix* spp. map unit with a low cover (5-15%) of *Tamarix* spp.

Figure C81. *Tamarix* spp. map unit with low cover (5-15%) of shrub willow/mulefat. This stand type is very common on coastal rivers (384 polygons, 2,610 acres) and uncommon on desert rivers (35 polygons, 100 acres).

Figure C82. *Tamarix* spp. map unit with low cover (5-15%) of shrub willow/mulefat.

***Pluchea sericea* MU (225) Common Name = Arrowweed**

Coastal Streams: 116 stands, 697 acres
Desert Streams:15 stands, 52 acres

Value of Map Unit as Least Bell's Vireo Habitat: Arrowweed stands are rarely used for nesting by LBVI. This stand type may be present in vireo territories in areas where tree willow or shrub willow/mulefat stands are present nearby, where it may provide foraging habitat.

Typical Plant Species: The shrub overstory is dominated by *Pluchea sericea* above the MMU size. Stands below MMU are not mapped or are included in other types, where applicable. *Pluchea sericea* MU occurring adjacent to or near areas of dominant primary tree and/or shrub species are assumed to contain category 1 in the percent tree willow and/or shrub willow/mulefat attribute field and are typically captured. Note that occurrences of these species and/or stands in areas where the primary habitat species are waning must have at least 15% absolute cover of primary habitat species or *Arundo donax* to be considered for mapping.

Ecological Contexts: *Pluchea* is rhizomatous and typically occurs in dense cohesive stands adjacent or near the active channel, although they may also occur in drier portions of the adjacent floodplain. They are mainly found in the low to moderate elevations of the watershed and are more prevalent in inland southern California. *Pluchea* tolerates salinity and alkalinity.

Photo Signatures and Examples: On the natural color imagery individuals may appear as gray to gray-green dots in close array or clumped with many other individuals into a cohesive consistent stand. They may appear like *Salix exigua* in color and proximity to the active channel, however *Pluchea* favors drier locations and is alkaline.

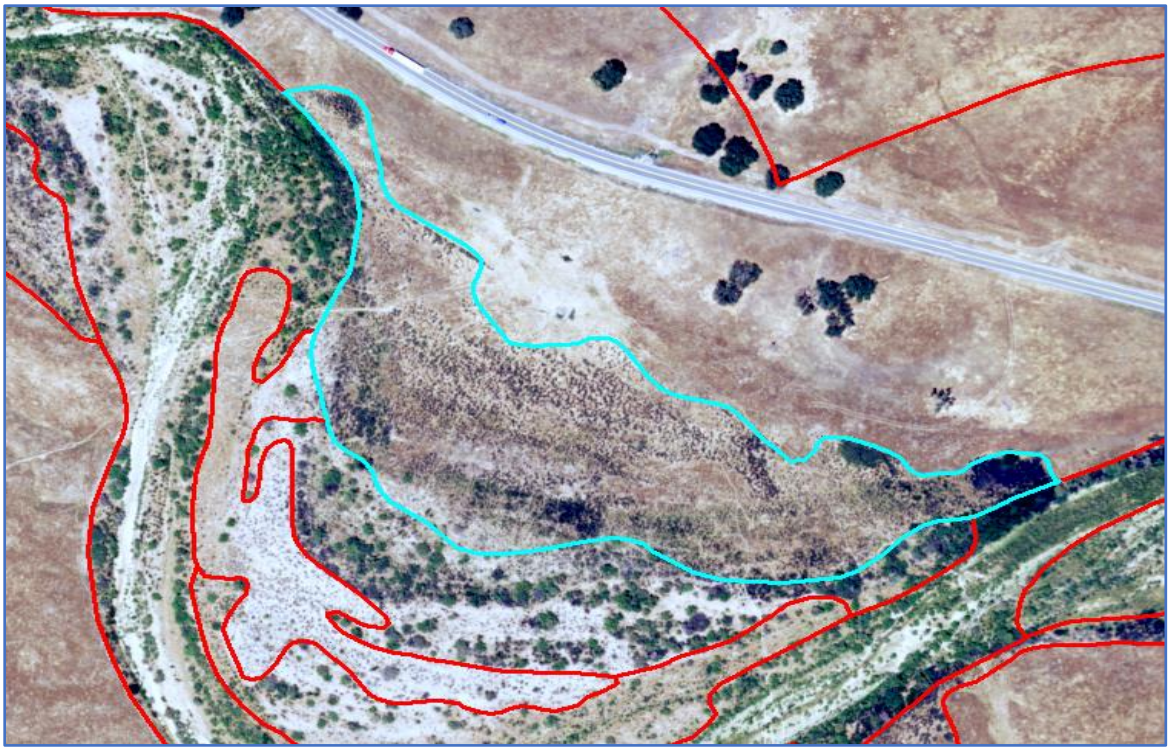


Figure C83. Example of a dominant stand of the *Pluchea sericea* map unit. This stand type is moderately common on coastal streams (116 polygons, 697 acres) and uncommon on desert streams (15 polygons, 52 acres).

Figure C84. Example of a dominant stand of the *Pluchea sericea* map unit.

TRANSITIONAL MAP UNITS

Stands in the riparian zone that have undergone disturbance and may have potential for LBVI nesting during succession. These are map units that often undergo rapid change.

Reservoir Delta MU (310) Common Name = Reservoir Delta

Coastal Streams: 72 polygons, 14,835 acres
Desert Streams: 0 stands

Value of Map Unit as Least Bell's Vireo Habitat: This map unit differs from other VireoVegMap units in that multiple years of aerial photography were used to find the maximum footprint of reservoir deltas *when reservoir levels were at their lowest*. In years with higher reservoir levels, many acres are covered by water. Fluctuating reservoir levels create conditions were recruitment of riparian vegetation may occur where rivers enter reservoirs and sediment is deposited as deltas. In periods with low lake levels, these areas can mature into suitable nesting habitat for LBVI (e.g., above Lake Cachuma on the Santa Ynez or above Lake Isabella on the South Fork of the Kern). When reservoir levels rise again, these areas are flooded, which may result in tree and shrub mortality (depending on flood duration). The presence, extent, and characteristics of vegetation patches on this map unit are highly variable over time.

Ecological Contexts: This mapping unit represents upper reaches of reservoirs where water levels fluctuate due to annual, seasonal, or intermittent changes in water input, due to drought, flood, or reservoir operations. This fluctuation may result in silting of the area, possibly providing an environment conducive to the development of potential LBVI nesting habitat when the silted area is exposed over an extended period. This type represents a transitional zone, which may contain variable stages of species succession. Historical imagery in conjunction with the 2020 base imagery is used to determine the extent of the Reservoir Delta. Mappers use the Potential Reservoir Delta geodatabase layer to identify areas where fluctuations in water levels may create potential habitat, especially where streams/rivers input into the reservoir along the margins. Any vegetation stands along this delta area that are above water in 2020 and can be confidently assigned to a Primary or Secondary MU type, are assigned as such accordingly. If an area is underwater as shown on the base 2020 NAIP imagery, but older imagery (of differing dates) displays lower reservoir levels, with riparian vegetation present or regenerating, then the portion underwater in 2020 is called Reservoir Delta MU. To classify an area as a Reservoir Delta, there must be significant riparian stands mapped upstream. If the Reservoir Delta area is above water on the 2020 base imagery it is usually an area of shallow deposition, herbaceous succession, and/or unidentifiable trees or shrubs disturbed by a flooding event. Reservoir Delta has an MMU of 5 acres.

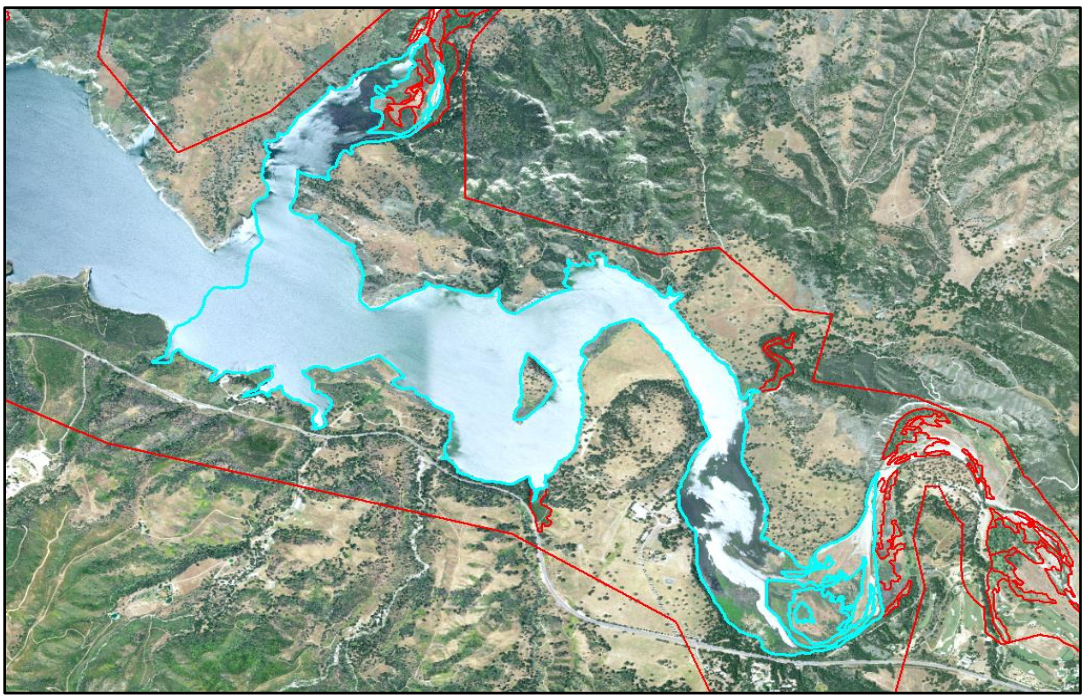


Figure C85. Example of the Reservoir Delta map unit showing the Santa Ynez River delta at Lake Cachuma at full inundation of the area on the 2020 base imagery. This map unit was moderately common (72 polygons, 14,835 acres) on coastal streams and absent from desert streams.

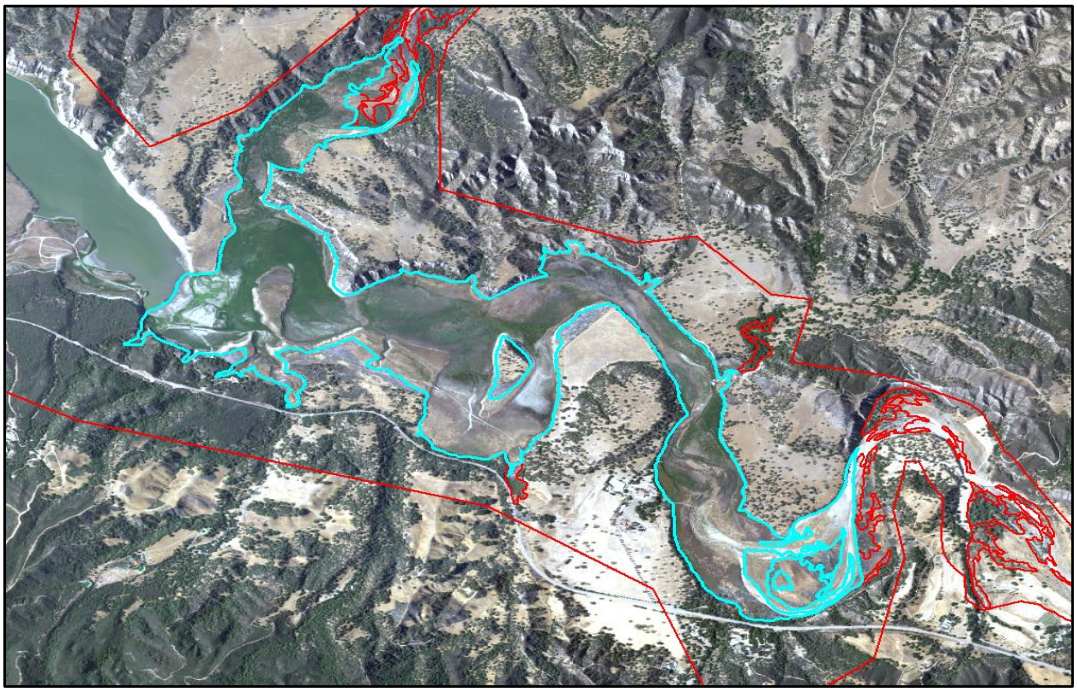


Figure C86. Example of the Reservoir Delta map unit showing the Santa Ynez River delta at Lake Cachuma (same area as Figure C85) at lower water where the delta is partially exposed on the 2016 NAIP imagery.

Post-Disturbance Riparian MU Undifferentiated (320) Common Name = Unknown Disturbance

Coastal Streams:74 polygons, 1,062 acres
Desert Streams: 6 polygons, 237 acres

Value of Map Unit as Least Bell's Vireo Habitat: The value of all areas where disturbance has set back succession depends entirely on what happens after the disturbance. If favorable habitat (e.g., willow riparian) returns to the site, disturbance can have a positive effect on vireo populations. If weeds, exotics, or unfavorable native vegetation types return to the site, disturbance can have negative effects on LBVI.

General Description and Ecological Contexts: Vegetation stands that have undergone a high level of disturbance in the recent past and are in a state of transition. This unknown disturbance class is used for vegetation stands where primary or secondary habitat species cannot be determined with confidence and the nature or cause of the disturbance cannot be determined. The stands may have a weedy/grassy/herbaceous signature and rapid regrowth may occur within 6 months after clearing. Possible reasons for disturbance include fire, pestilence, drought, prolonged inundation, vegetation removal or scraping, repeated clearing, and early stages of restoration.

Photo Signatures and Examples: Figures C87-90 illustrate a range of conditions that result in the classification of a polygon to Unknown Disturbance with example views from aerial photographs and ground-based photography

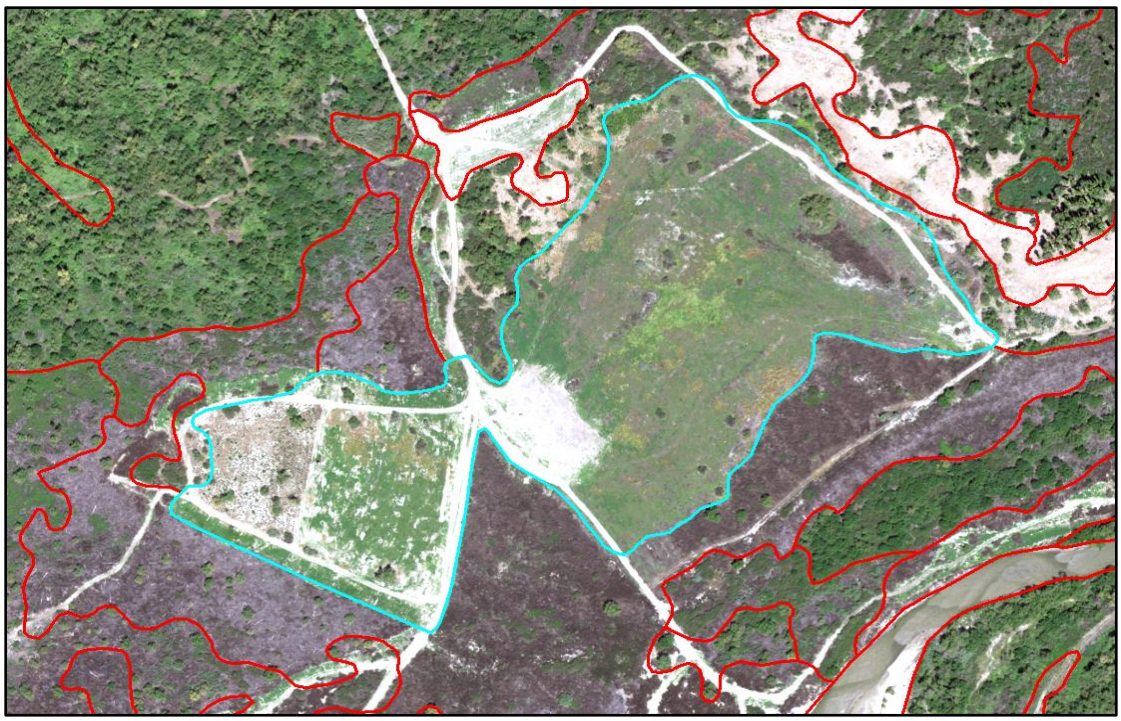


Figure C87. Example of the Post-Disturbance Riparian MU Undifferentiated. This map unit was moderately common on coastal streams (74 polygons, 1,062 acres) and uncommon on desert streams (6 stands, 237 acres).

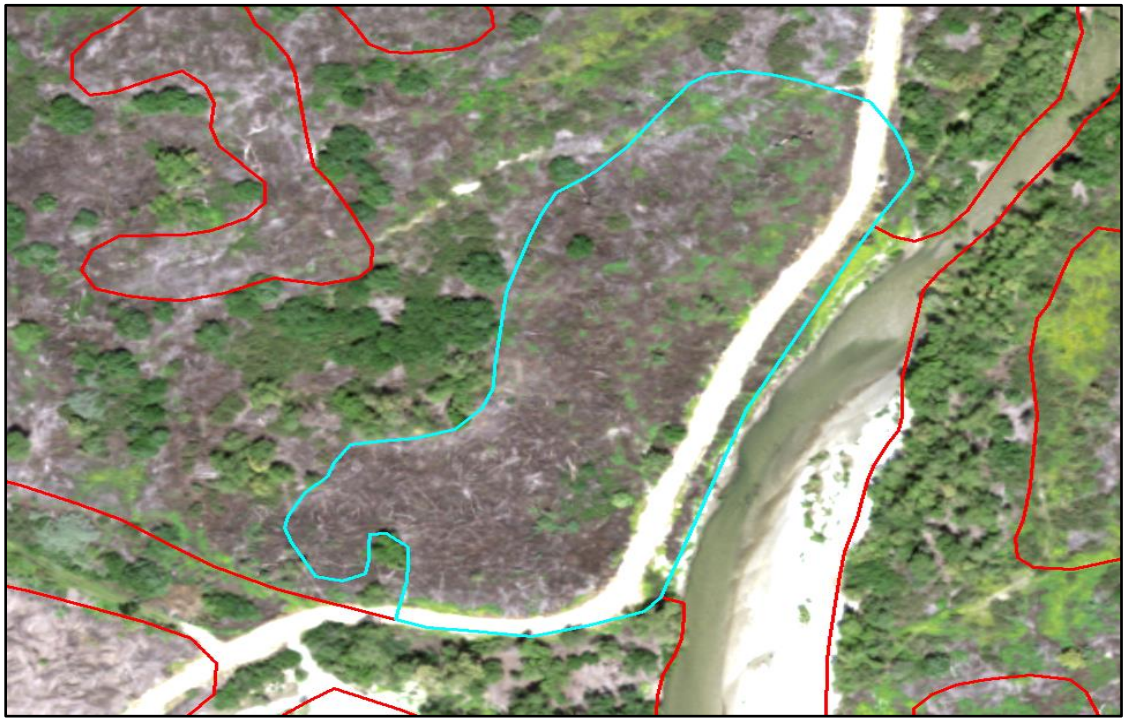


Figure C88. Example of the Post -Disturbance Riparian MU Undifferentiated, with post burn recovery from a 2015 fire.

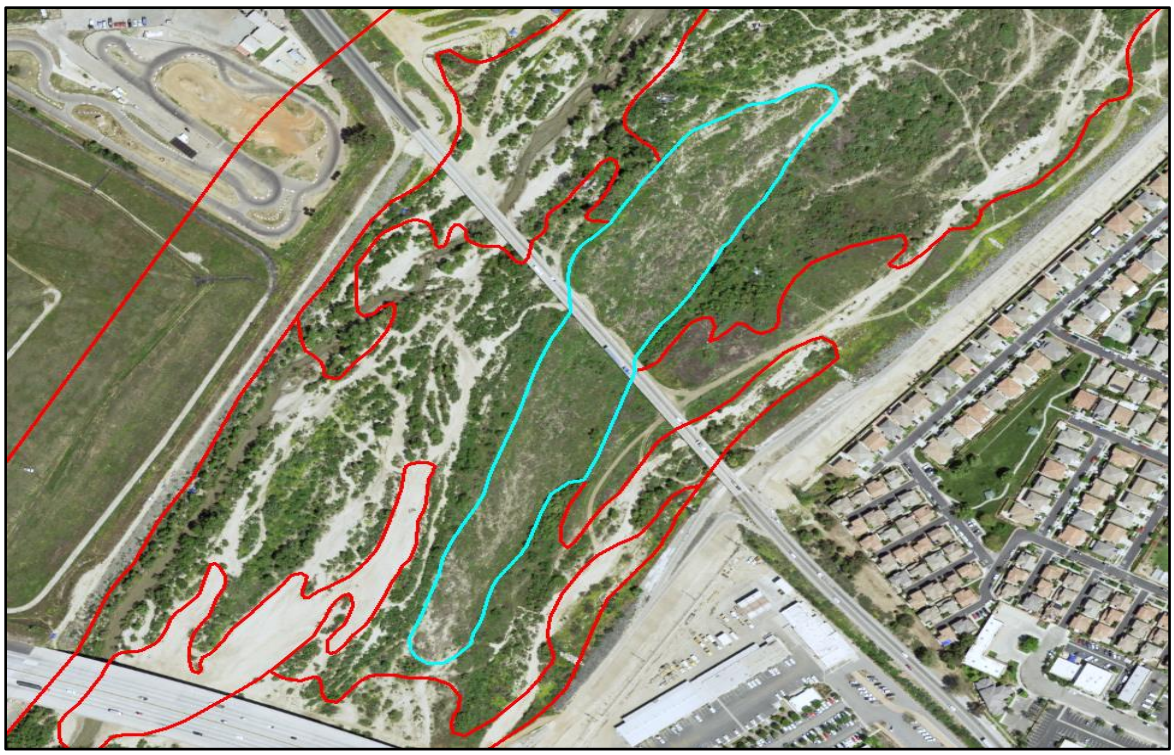


Figure C89. Example of the Post-Disturbance Riparian MU Undifferentiated, from native riparian removal in 2020.

Figure C90. Example of the Post-Disturbance Riparian MU Undifferentiated as a restoration area.

Post-Fire Disturbance Riparian MU (321) Common Name = Post-fire Riparian

Coastal Streams: 52 polygons, 457 acres
Desert Streams: 0 stands

General Description and Ecological Contexts: The vegetation type as primary or secondary habitat species cannot be determined with confidence. The vegetation stand is in a state of transition, and it has undergone a high level of disturbance in the recent past due to fire. Evidence of recent fires is apparent on the imagery sets. In addition, the ancillary fire geodatabase layer notes the timeframe and extent of the fire history. In older burns, mappers attempt to determine the dominant vegetation type. Older imagery is used to see what was previously there, with considerations for post-fire succession and intensity of burn.

Figure C91. Example of the Post-Fire Disturbance Riparian MU. This map unit was moderately common on coastal streams (52 polygons, 457 acres) and absent on desert streams.

Post-Insect Disturbance Riparian MU (322) = Common Name = Post insect Disturbance Riparian

Coastal Streams:0 stands
Desert Streams: 0 stands

General Description and Ecological Contexts: The vegetation stand is in a state of transition, and it has undergone a high level of disturbance in the recent past due to insect infestation. Vegetation type as primary or secondary habitat species cannot be determined with confidence. This class was not mapped due to lack of ancillary information needed to verify the cause of the disturbance as insect infestation.

This map unit was developed before mapping in the hopes that we could document insect disturbance from aerial photography, but no polygons were mapped. Most likely, insect effects are poorly accounted for on this map, contributing only, perhaps, to the dieback attribute and the classification of some unknown disturbance polygons.

Post-*Arundo donax* Removal MU (323) Common Name = Post-Arundo Removal

General Description and Ecological Contexts: An *Arundo donax* stand has undergone a high level of disturbance due to removal of *Arundo donax* in the recent past and is in a state of transition. Evidence of removal is indicated by bare ground and “scrape” markings, with little vegetation remaining. Past imagery may show presence of *Arundo donax* in the areas of removal. If there are “islands” of shrub willow/mulefat or other primary or secondary types within the removal area the mapper may be able to aggregate the patches into a mappable stand and code the unit accordingly. Past imagery will show *Arundo donax* as a distinct blue to blue-green signature on most natural color imagery. It is pink on most color infrared imagery. It forms highly dense amorphous stands and patches with some texture from the wands of reeds sticking up or laying sideways or falling over on each other. The current imagery will show the same area with bare ground as white to gray signature with very little or no remnant vegetation present.

Photo Signatures and Examples: Figures 92 and 93 illustrate photo signatures after Arundo removal.

Figure C92. Example of the Post-*Arundo donax* Removal MU. Above shows *Arundo donax* stand removed on 2020 base imagery. This map unit was moderately common on coastal streams (49 polygons, 244 acres) and absent from desert streams.

Figure C93 shows the same area as Figure 93, below Arundo removal, with *Arundo donax* present on 2016 NAIP imagery,

***Arundo donax* Standing Dead MU (324) Common Name = Standing Dead Arundo**

Coastal Streams:46 stands, 95 acres
Desert Streams:0 stands

General Description and Ecological Contexts: Stand of *Arundo donax* has undergone a high level of disturbance, mainly in the form of stress or dieback resulting in death of the *Arundo donax* as seen on the base imagery. Past imagery will show a healthy *Arundo donax* stand. *Arundo donax* stands that do not show extreme dieback are coded 910 (*Arundo donax* MU). Herbicide treatment may be the cause of death, but it is not definitive from photo interpretation alone without collateral sources. Past imagery will show *Arundo donax* as a distinct blue to blue-green signature on most natural color imagery. It is pink on most color infrared imagery. It forms highly dense amorphous stands and patches with some texture from the wands of reeds sticking up or laying sideways or falling over on each other. The current imagery will show tan to dark gray color of dead *Arundo donax* laying sideways in a chaotic disarray. Color infrared imagery will show no pink signature in the stand indicating the lack of life in the plant.

Photo Signatures and Examples: Figures C94 and C95 show a standing dead Arundo stand and what the stand looked like with live vegetation.

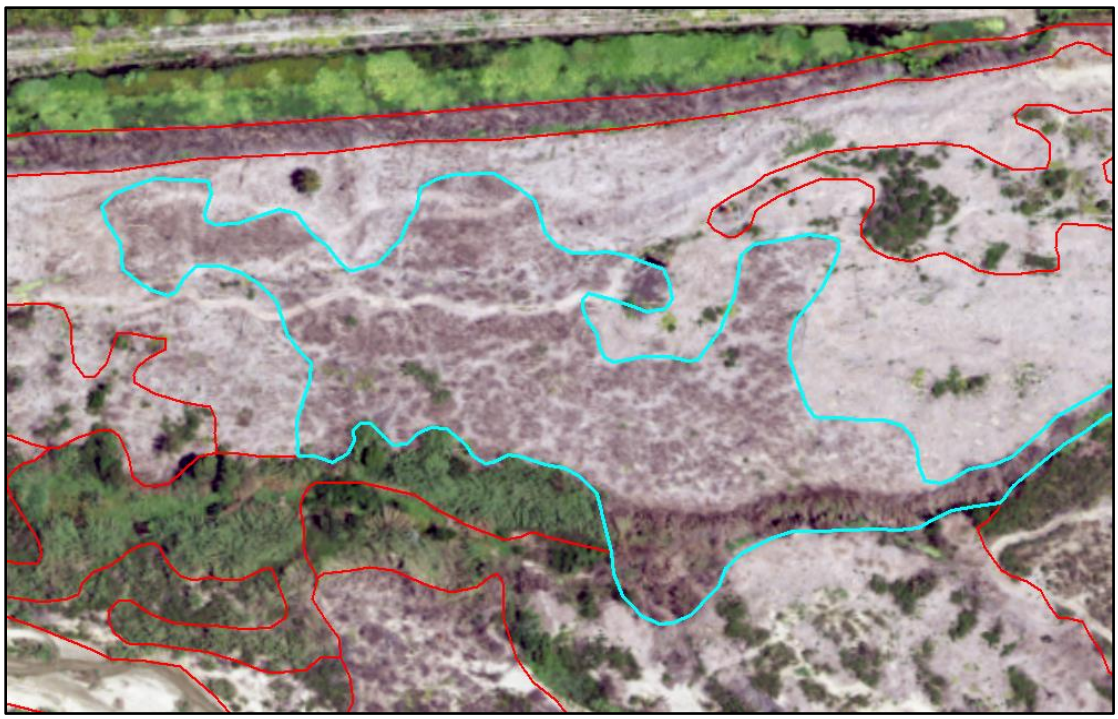


Figure C94. Example of the *Arundo donax* Standing Dead MU. 2020 base imagery shows the dead *Arundo donax*. below 2016 NAIP imagery shows the same area as a live *Arundo donax* stand. This map unit was uncommon on coastal streams (46 polygons, 95 acres) and absent on desert streams.

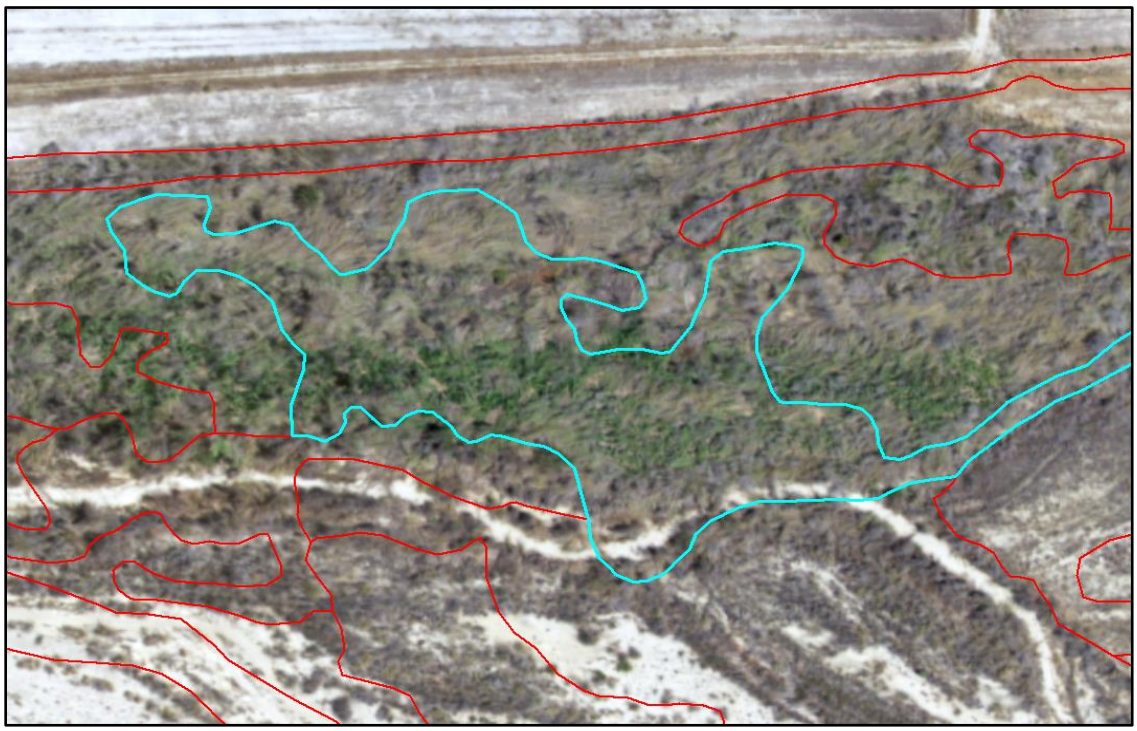


Figure C95. Example of the *Arundo donax* polygon that later became the standing dead Arundo unit in Figure C94 (2016 NAIP imagery).

EXOTIC GRASSES MAP UNIT

***Arundo donax* MU (410**) (>.5-acre MMU) Common Name = Arundo

Coastal Streams:1,040 stands, 2,662 acres
Desert Streams:7 stands, 12 acres

Value of Map Unit as Least Bell's Vireo Habitat: Arundo has next to no value for LBVI. It competes with, and sometimes replaces, willow riparian stands that are highly favorable for LBVI nesting. It is rarely used by LBVI for foraging. Frequent fires in riparian areas may result in conversion of willow riparian to dense Arundo stands over time. Arundo reduces habitat-based carrying capacity for LBVI and its removal is a top management priority.

General Patterns of Vegetation Cover: Stand characterized and dominated by the non-woody herbaceous invasive species *Arundo donax* in the canopy meeting at least 8-10% cover and evenly distributed in the stand. Shrubs, if present, usually comprise <10% of the vegetation. Emergent trees, if present, generally compose <5% cover. The trace cover of *Arundo donax* in a disturbed stand on the edge of the riparian zone, with only grass or non-riparian shrubs dominating, is not mapped, but included in the Not Suitable Habitat (999).

Context: *Arundo donax* can occur anywhere throughout the riparian zone of the watershed but is usually not found at the higher elevations. It is most prevalent in the main floodplain or adjacent to the active channel and on moist terraces but can be found on drier terraces and on minor streams and ditches.

Photo Signature: *Arundo donax* has a distinct blue to blue-green signature on most natural color imagery. It is pink on most color infrared imagery. It forms highly dense amorphous stands and patches with some texture from the wands of reeds sticking up or laying sideways or falling over on each other. Where there is one patch, there are usually more in the vicinity. The signature can be confused with *Salix exigua* which has a finer texture and is deciduous*. Arundo donax* is not deciduous*.* On Street View the *Arundo donax* appears as dense clumps with the blue green to tan wands sticking straight up then curving over, with large lanceolate leaves spaced along the branch. Tufts of gray to tan inflorescences may top each wand. Figures C96-C103 provide example views from aerial photographs and ground-based photography.

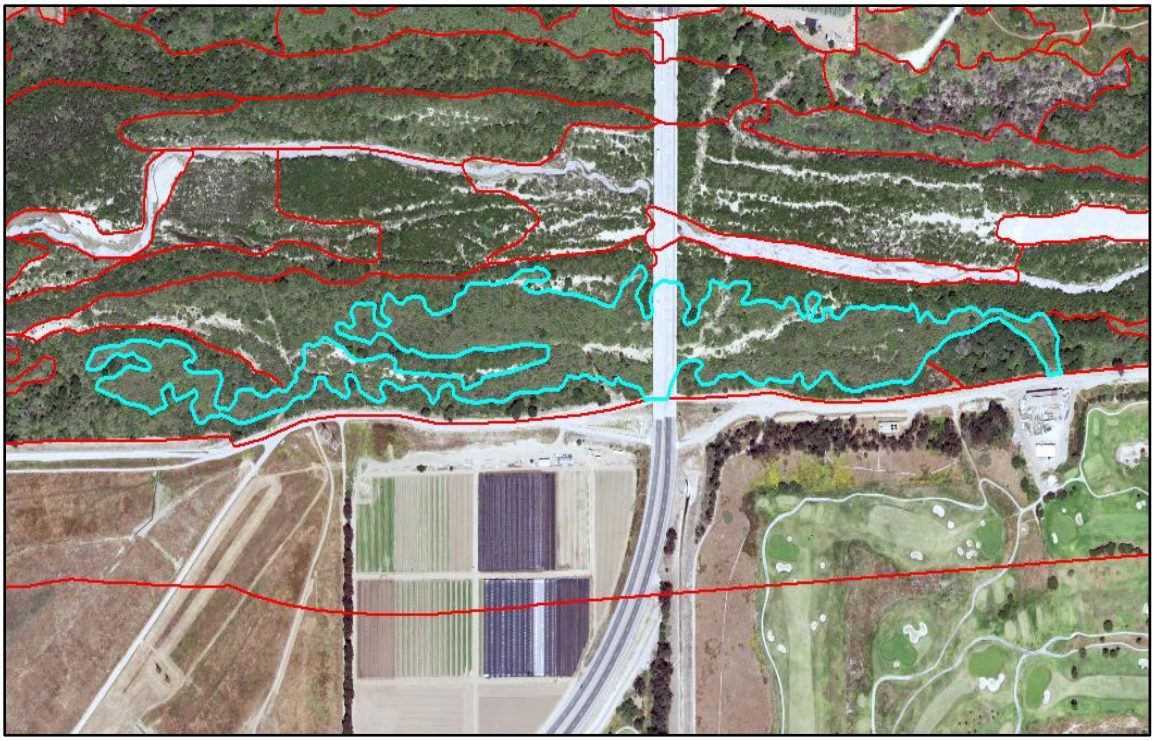


Figure C96. Example of a stand of the *Arundo donax* MU, with high cover (>40%) of *Arundo donax*. This stand type is very common on coastal streams (825 polygons, 2,121 acres) and absent on desert streams.

Figure C97. Example of a stand of the *Arundo donax* MU, with high cover (>40%) of *Arundo donax*.

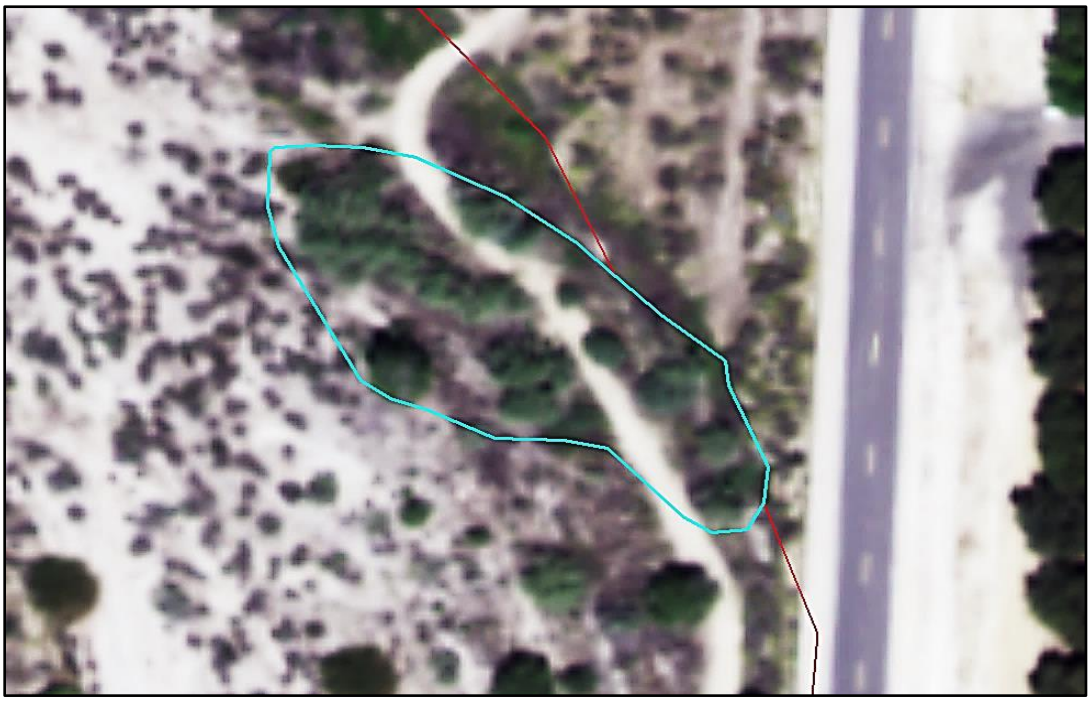


Figure C98. Example of a stand of the *Arundo donax* MU, with medium cover (15-40%) of *Arundo donax*. This stand type is moderately common on coastal streams (195 polygons, 490 acres) and absent on desert streams).

Figure C99. Example of a stand of the *Arundo donax* MU, with medium cover (15-40%) of *Arundo donax*.

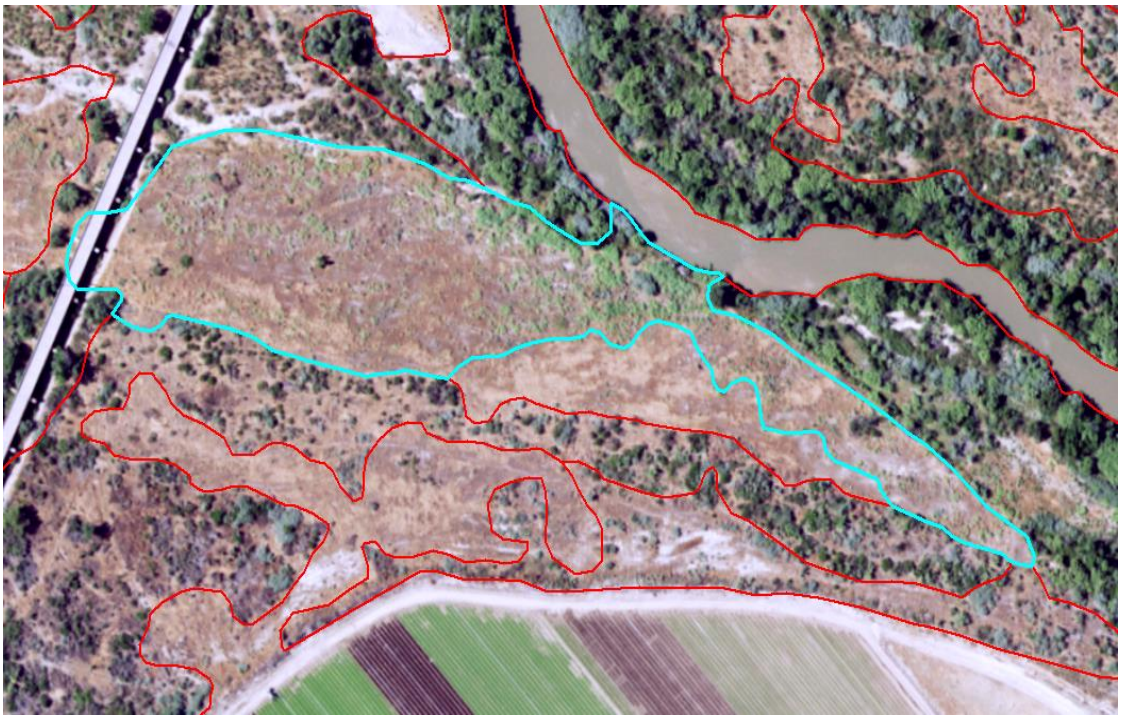


Figure C100. Example of a stand of the *Arundo donax* MU, with low cover (5-15%) of *Arundo donax*. This stand type was uncommon on coastal streams (20 polygons, 50 acres) and absent on desert streams.

Figure C101. Example of a stand of the *Arundo donax* MU, with low cover (5-15%) of *Arundo donax*.

Figure C102. *Arundo donax* map unit with low cover (5-15%) of shrub willow/mulefat. This stand type is moderately common on coastal streams (640 polygons, 1,757 acres) and absent on desert streams.

Figure C103. *Arundo donax* map unit with low cover (5-15%) of shrub willow/mulefat.

5.4 Appendix D: Common and Scientific Names of Riparian Plants within the Focused Mapping Area

Life Form	Scientific Name	Common Name
Herb	*Arundo donax*	Giant Reed
Herb	*Cortaderia spp.*	Pampas Grass
Shrub	*Artemisia californica*	California Sagebrush
Shrub	*Baccharis pilularis*	Coyote Brush
Shrub	*Betula occidentalis*	Water Birch
Shrub	*Eriogonum fasciculatum*	California Buckwheat
Shrub	*Forestiera pubescens*	Desert Olive
Shrub	*Lepidospartum squamatum*	Scale Broom
Shrub	*Pluchea sericea*	Arrow Weed
Shrub	*Rhus trilobata*	Basket Bush, Skunk Bush
Shrub	*Ribes armeniacus*	Himalayan Blackberry
Shrub	*Ribes quercetorum*	Oak Gooseberry
Shrub	*Rosa californica*	California Rose
Shrub	*Rosa woodsii*	Wood's Rose
Shrub	*Salix exigua*	Narrowleaf Willow, Sandbar Willow
Shrub	*Salix lasiolepis*	Arroyo Willow
Shrub	*Sambucus nigra*	Black Elderberry
Shrub	*Tamarix spp.*	Tamarisk
Shrub	*Toxicodendron diversilobum*	Poison Oak
Shrub	*Vitis californica*	California Wild Grape
Shrub	*Vitis girdiana*	Desert Wild Grape
Tree	*Acer macrophyllum*	Big Leaf Maple
Tree	*Acer negundo*	Box Elder
Tree	*Ailanthus altissima*	Tree-of-Heaven
Tree	*Alnus rhombifolia*	White Alder
Tree	*Alnus rubra*	Red Alder
Tree	*Chilopsis linearis*	Desert Willow
Tree	*Eucalyptus spp.*	Eucalyptus
Tree	*Juglans californica*	California Walnut
Tree	*Juglans hindsii*	Hind's Black Walnut
Tree	*Olneya tesota*	Desert Ironwood
Tree	*Phoenix dactylifera*	Date Palm
Tree	*Platanus racemosa*	California Sycamore
Tree	*Populus fremontii*	Fremont's Cottonwood
Tree	*Populus trichocarpa*	Black Cottonwood
Tree	*Prosopis glandulosa*	Honey Mesquite
Tree	*Prosopis pubescens*	Screwbean Mesquite

Tree	*Psorothamnus spinosus*	Smoke Tree
Tree	*Quercus agrifolia*	Coast Live Oak
Tree	*Quercus lobata*	Valley Oak
Tree	*Quercus wislizeni*	Interior Live Oak
Tree	*Salix gooddingii*	Black Willow
Tree	*Salix laevigata*	Red Willow
Tree	*Salix lucida*	Shining Willow, Yellow Willow
Tree	*Schinus spp.*	Pepper Tree
Tree	*Washingtonia filifera*	California Fan Palm
Tree	*Washingtonia robusta*	Mexican Fan Palm