

Riparian Habitat Mapping, Mitigation, and Monitoring Planning Project

FINAL

Field Survey Report and Vegetation Map



Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Executive Summary

Vegetation, as depicted in 2012 aerial imagery of the Restoration Area, was mapped as the first task of the Riparian Habitat Mapping, Monitoring, and Mitigation Planning Project (Project). This was done to document current riparian vegetation conditions and to begin to understand vegetation response to the Interim Flows, which began on October 1, 2009. The vegetation map was created using California Native Plant Society (CNPS) and California Department of Fish and Wildlife (DFW) mapping and field data collection protocols (e.g., DFG 2008 and CNPS/DFG 2011). The boundaries of vegetation types visible in 2012 aerial imagery were delineated in a Geographic Information System (GIS) to produce a preliminary riparian vegetation map of the Restoration Area.

A three-week field assessment survey was conducted to assess the preliminary map boundaries and vegetation types, describe the primary vegetation types in the Restoration Area, and begin to assess the influence of Interim Flows on vegetation conditions. (Although the GIS delineation and field assessment work occurred in 2013, the resulting map captures conditions visible in 2012 aerial imagery and is therefore referred to as a 2012 map.) Field assessment points were pre-selected from the preliminary vegetation map using a stratified random sampling design: the five Restoration Area reaches were stratified into accessible and non-accessible areas based on areas where landowners granted access for the survey, and areas predicted to be inundated by a 2,000 cfs flow and those inundated by higher flows (between 2,000 cfs and 8,000 cfs). During the field assessment survey, 257 polygons were sampled. In addition, the vegetation type of approximately 400 surrounding polygons was noted while accessing assessment polygons.

Field assessment polygons and the final riparian vegetation map were classified to vegetation alliances and groups according to *A Manual of California Vegetation* (Sawyer et al. 2009). Nearly 24,000 acres were mapped over the Restoration Area, which comprise 17 different vegetation groups and over 30 more-detailed vegetation alliances. The area of mapped vegetation in each of the Restoration Area reaches varies greatly, from just over 800 acres in Reach 4A to over 6,300 acres in Reach 5, as a result of reach length and the amount of area inundated under the flow magnitudes used to define the extent of mapping for this effort. The largest extents of two ecologically important native riparian vegetation types, broadleaf forest and woodland and riparian evergreen and deciduous woodland, occur in both the upstream- and downstream-most reaches. This distribution appears, at least in part, to be a result of the numerous protected areas in Reach 1A that support native vegetation and the influence of the wide floodplain in Reach 5 with sites of suitable relative elevation and soil type to support native woody vegetation, as well as the habitat conservation and water management provided by the San Luis National Wildlife Refuge and several State Parks. The largest extents of several nonnative vegetation groups occur in the upper reaches of the Restoration Area, such as introduced riparian scrub and introduced woodland and forest, which indicates that there is an abundant source of seeds and vegetative propagules for nonnative invasive species that can spread into downstream reaches as Interim and Restoration Flows occur.

One of the original intents of the Project was to compare the extent of vegetation types in 2012 with that seen in the 2000 and 2009 maps, which both capture pre-Interim Flow or baseline conditions, as a means of better understanding the influence of Interim Flows on riparian

vegetation conditions (see Reclamation 2013a). During the development of the 2012 vegetation map, however, it was recognized that differences in mapping methods and accuracy among the three mapping efforts make direct comparisons among them an inappropriate basis upon which to characterize riparian vegetation change. Instead, direct observations of native riparian trees and shrubs that have recruited naturally as a result of Interim Flows and that were made during the field assessment survey were used to characterize the riparian vegetation that has established from SJRRP actions.

During the field assessment survey, naturally recruited Goodding's willow, narrowleaf willow, and Fremont cottonwood, as well as a few other native tree species, all between approximately 1–4 years old, were observed throughout the portions of the Restoration Area that were accessed. In nearly all cases, such recruitment occurred in and immediately adjacent to the river channel. The size of many of the recently recruited trees suggests that the higher and more continuous flow conditions in water year 2010 resulted in much of the natural recruitment that was observed, as does the fact that recruitment was observed throughout the accessible portions of the Restoration Area (Interim Flow releases were curtailed downstream of Mendota Dam after water year 2010). The amount of the Restoration Area that could be directly observed during the field assessment survey was constrained by private property access and the time available to conduct the survey. As a result, the recruitment directly observed during the field assessment survey undoubtedly underestimates the amount of riparian vegetation that has been created by the SJRRP to-date. Unfortunately, it appears that the same elevation and substrate conditions that support the natural recruitment of native trees and shrubs under Interim Flows also support a number of high-priority nonnative species, such as giant reed and red sesbania. Recruitment of these nonnative species in response to Interim Flows was frequently observed in the same areas as native species, indicating that such species will continue to influence the quality of riparian habitat in the Restoration Area and, as such, the treatment of these species will be an ongoing management concern of the SJRRP.

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List of Abbreviations and Acronyms

cfs	Cubic Feet per Second
Cal-IPC	California Invasive Plant Council
CNPS	California Native Plant Society
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
DFW	California Department of Fish and Wildlife (formerly California Department of Fish and Game)
DWR	California Department of Water Resources
FWA	Friant Water Authority
GIS	Geographic Information System
GPS	Global Positioning System
Implementing Agencies	Reclamation, USFWS, NMFS, DWR, and DFW
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council
ORV	Off-road Vehicle
PEIS/R	San Joaquin River Restoration Program Environmental Impact Statement/Report
Project	The Riparian Habitat Mapping, Mitigation, and Monitoring Planning Project
QA/QC	Quality Assessment/Quality Check
Reclamation	U. S. Department of the Interior, Bureau of Reclamation
Restoration Area	Riparian and wetland habitats along the 149-mile section of the San Joaquin River from Friant Dam to the confluence with the Merced River
RHMMP	Riparian Habitat Mitigation and Monitoring Plan
RHSNC	Riparian Habitat and Other Sensitive Natural Communities
Settlement	Stipulation of Settlement in Natural Resources Defense Council, et al. v. Kirk Rodgers, et al., United States District Court, Eastern District of California, No. CIV. S-88-1658-LKK/GGH
Settling Parties	NRDC, FWA, U.S. Departments of the Interior and Commerce
SJRRP	San Joaquin River Restoration Program

TIPAR	Technical Implementation and Planning Approach Report
USACE	U. S. Army Corps of Engineers
USFWS	U. S. Fish and Wildlife Service
WUS	Waters of the U. S.

Chapter 1. Introduction

1.1 Background

After more than 18 years of litigation known as Natural Resources Defense Council (NRDC), et al., v. Kirk Rodgers, et al., the NRDC, Friant Water Authority (FWA), and the U.S. Departments of the Interior and Commerce (Settling Parties) reached agreement on the terms and conditions of the San Joaquin River Settlement (Settlement), which was subsequently approved by the Court in 2006. The San Joaquin River Restoration Program (SJRRP) is a direct result of the Settlement. The SJRRP is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of the Merced River and to restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from Interim and Restoration Flows. The anticipated benefits and potential impacts associated with implementation of the SJRRP were analyzed in the *San Joaquin River Restoration Program Environmental Impact Statement/Report* (PEIS/R) (Reclamation and DWR 2012).

In order to implement the Settlement, a comprehensive strategy for the conservation of listed and sensitive species and habitats—termed the Conservation Strategy—was prepared in coordination with the SJRRP Implementing Agencies, which consist of the U.S. Department of Interior, Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (DFW), and California Department of Water Resources (DWR). The Conservation Strategy’s purpose is to serve as a tool built into the PEIS/R project description to minimize and avoid potential impacts to sensitive species and habitats. The Conservation Strategy includes avoidance, minimization, monitoring, and management measures that would result in a net benefit for native riparian and wetland habitats in the Restoration Area.

The Restoration Area is a 149-mile section of the San Joaquin River, from Friant Dam to the confluence with the Merced River, in Fresno and Madera counties. The SJRRP divides the Restoration Area into the following reaches, which are ordered from upstream to downstream and are depicted in Figure 1-1.

Reach 1A	23 miles from Friant Dam to Highway 99
Reach 1B	14 miles from Highway 99 to Gravelly Ford
Reach 2A	13 miles from Gravelly Ford to the Chowchilla Bypass
Reach 2B	12 miles from Chowchilla Bypass to Mendota Dam
Reach 3	22 miles from Mendota Dam to Sack Dam
Reach 4A	14 miles from Sack Dam to the Eastside Bypass
Reach 4B1	21 miles from Eastside Bypass to Mariposa Bypass
Reach 4B2	12 miles from Mariposa Bypass to the Bear Creek confluence
Reach 5	18 miles from Bear Creek confluence to the Merced River confluence



Figure 1-1. Location of and reaches in the SJRRP Restoration Area.

One of the specific Conservation Strategy measures related to Riparian Habitat and Other Sensitive Natural Communities (RHSNC), RHSNC-2(a), states that a “Riparian Habitat Mitigation and Monitoring Plan for the SJRRP will be developed and implemented in coordination with DFG¹. Credits for increased acreage or improved ecological function [of] riparian and wetland habitats resulting from the implementation of the SJRRP actions will be applied as compensatory mitigation before additional compensatory measures are required.”

The Riparian Habitat Mapping, Monitoring, and Mitigation Planning Project (Project) will implement Conservation Strategy RHSNC-2(a) for riparian habitat in the Restoration Area. The Project’s Technical Implementation and Planning Approach Report (TIPAR) described how the Project will implement the Conservation Strategy (Reclamation 2013a). The first task of the Project was to map current riparian vegetation types and conditions in the Restoration Area, and to then compare those conditions with a previous vegetation map of the area from 2000 (Moise and Hendrickson 2002). This Field Survey Report and Vegetation Map describes the methods and results of this first task.

While wetland vegetation types were mapped during this Project, wetland boundaries were not delineated and the fulfillment of Conservation Strategy measure RHSNC-2(a) for wetland habitat and compensation of impacts to wetlands will be addressed separately as a part of Conservation Strategy measure Waters of the U.S. (WUS)-1 and WUS-2 in coordination with the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 as well as with the Central Valley Regional Water Quality Control Board (CVRWQCB) under Section 401 of the CWA.

1.2 Field Survey Objectives and Report Organization

Vegetation, as depicted in 2012 aerial imagery of the Restoration Area, was mapped in order to document current riparian vegetation conditions and to begin to understand vegetation response to the Interim Flows, which began on October 1, 2009. The boundaries of vegetation types visible in 2012 aerial imagery were delineated in a Geographic Information System (GIS) to produce a preliminary riparian vegetation map of the Restoration Area. Field assessment surveys were conducted to assess the preliminary map boundaries and vegetation types, describe the primary vegetation types in the Restoration Area, and begin to assess the influence of Interim Flows on vegetation conditions. (Although the GIS delineation and field assessment work occurred in 2013, the resulting map captures conditions visible in 2012 aerial imagery and is therefore referred to as a 2012 map.) Lastly, the 2012 vegetation map was compared with baseline (i.e., pre-Interim Flow) vegetation maps of the Restoration Area from 2000 (Moise and Hendrickson 2002) and 2009 (GIC 2013) in GIS to attempt to understand the changes in riparian vegetation and conditions in the Restoration Area as a result of four years of Interim Flow water releases.

This Field Survey Report and Vegetation Map:

¹ Prior to January 1, 2013, DFW was known as the California Department of Fish and Game (DFG). This report uses the agency’s current name except when citing documents or resources published under the previous name.

- describes the development of the preliminary riparian vegetation map and selection of field assessment sites;
- summarizes the methods used during the field assessment and an initial field reconnaissance;
- describes how the field survey information was used to finalize the riparian vegetation map;
- provides a map of the assessment points visited in the field (in Figure 3-1);
- presents the 2012 riparian vegetation map and describes the mapped vegetation types; and
- provides a summary description of the changes in vegetation type acreages between the 2000, 2009, and 2012 vegetation maps.

Chapter 1 of this Field Survey Report and Vegetation Map provides Project background information and summarizes the objectives of the field surveys and report. Chapter 2 describes the field and analytical methods used to develop the riparian vegetation map. Chapter 3 presents the results of the field surveys and the final riparian vegetation map, describes the mapped riparian vegetation types, and provides a comparison of vegetation conditions between 2000, 2009, and 2012.

Chapter 2. Methods

2.1 Approach and Objectives

The vegetation map of the Restoration Area (i.e., all of the SJRRP reaches, but none of the bypass reaches) was created using California Native Plant Society (CNPS) and DFW mapping and field data collection protocols (e.g., DFG 2008 and CNPS/DFG 2011). Specifically, a pre-existing vegetation map of the Restoration Area and interpretation of 2012 aerial photography were used to create a preliminary vegetation map and identify field assessment locations; and field data were collected to describe vegetation conditions, assign observed vegetation to vegetation types, and finalize the vegetation map. The objective of the mapping was to document current riparian vegetation conditions and vegetation response to the Interim Flows, which began on October 1, 2009. The objectives of using CNPS and DFW protocols were to produce a vegetation map that incorporates current vegetation classification standards and that can be integrated with and compared to other vegetation maps in the State.

2.2 Existing Information Sources

The following information sources were used to create the vegetation map and calculate the change in riparian habitat.

- CNPS (California Native Plant Society)/DFG (California Department of Fish and Game). 2011. Protocol for Combined Vegetation Rapid Assessment and Releve Sampling Field Form. CNPS, Sacramento, California. <http://www.cnps.org/cnps/vegetation/pdf/protocol-combined.pdf>
- DFG (California Department of Fish and Game). 2008. Legislative Analyst's Office Supplemental Report of the 2007 Budget Act: FY 2007-08, Item 3600-001-0001 Department of Fish and Game. Vegetation Mapping Standard for the State of California.
- GIC (Geographical Information Center, California State University Chico). 2013. Central Valley Riparian Mapping Project. Prepared for the California Department of Water Resources, Central Valley Flood Protection Program, Sacramento, California.
- Meidinger, D. V. 2003. Protocol for accuracy assessment of ecosystem maps. Technical Report 011. B.C. Ministry of Forestry, Victoria, British Columbia.
- Moise, G. W. and B. Hendrickson. 2002. Riparian Vegetation of the San Joaquin River. Technical Information Record SJD-02-1. California Department of Water Resources, San Joaquin District, Environmental Services Section, Fresno, California.
- NAIP (National Agricultural Imagery Program). 2012. Aerial photography imagery clipped to the Restoration Area vicinity.
- Reclamation. 2009. San Joaquin River flood inundation data.
- Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A manual of California vegetation. Second edition. California Native Plant Society Press, Sacramento, California.

2.3 Reconnaissance

A reconnaissance of the Restoration Area was conducted in May 2013 by two plant ecologists. The primary goals of the visit were to correlate vegetation types observed on the ground with vegetation features visible in aerial photographs, to better understand the relationship between vegetation type and environmental conditions in the Restoration Area, determine areas that may require special attention due to the presence of unique vegetation types or environmental conditions, and to test and refine the field data collection methods.

Prior to the reconnaissance, the required equipment was gathered (e.g., a laser rangefinder, compass, high resolution Global Positioning System (GPS) handheld unit, binoculars, and camera), the 2000 vegetation map of the Restoration Area (Moise and Hendrickson 2002) was printed and uploaded to the GPS unit, and a draft data form based on the CNPS/DFG (2011) vegetation rapid assessment protocol was prepared.

During the reconnaissance, publically accessible areas throughout the Restoration Area, including all five reaches, were visited. At each location, the previously identified vegetation stand (mapped polygon) was located and the following information was recorded: (1) dominant canopy species (using binoculars if necessary), (2) GPS location, (3) distance, and (4) bearing to the dominant canopy species using a laser rangefinder and compass, respectively. The position and boundaries of the target vegetation stand were also hand-drawn on the field maps. In addition, the draft data forms were tested to determine the practicality of gathering the information (time, clarity, repeatability), and to assess how well these metrics reflect on-the-ground interpretations of vegetation quality. Finally, photographs were taken and general observations on field conditions and methods were recorded.

Field notations, data, and hand-drawn field maps from the reconnaissance were transcribed, organized, and incorporated into a GIS database so that the exact location and attributes associated with each field recorded vegetation type were included. In addition, the data form was finalized using the results of the reconnaissance testing (see Appendix A).

2.4 Preliminary Riparian Vegetation Map

To prepare the preliminary riparian vegetation map of the Restoration Area, NAIP (2012) imagery was reviewed and the Moise and Hendrickson (2002) vegetation polygons were refined and modified in GIS using heads-up digitizing techniques to more accurately reflect the conditions visible in the 2012 aerial imagery and a 0.5-acre minimum mapping unit. The cross-sectional extent of the preliminary riparian vegetation map was limited to the area predicted to be inundated under an 8,000 cubic feet per second (cfs) flow release from Friant Dam (Reclamation 2009 San Joaquin River flood inundation data) (which equates to the Moise and Hendrickson [2002] vegetation mapping extent in most cases), with a greater focus on vegetation polygons within the 2,000 cfs inundation area. In water year 2011 (October 1, 2010–September 30, 2011) Interim Flows peaked at approximately 7,000 cfs, while in water years 2010, 2012, and 2013, they peaked at approximately 1,000 to 1,800 cfs. Focusing on the 2,000 cfs inundation area therefore allowed analysis to be concentrated where the Interim Flows were expected to have the greatest effect.

Although *A Manual of California Vegetation* classification scheme (Sawyer et al. 2009) was used for the final riparian vegetation map, the classification system used by Moise and Hendrickson (2002) was retained in the preliminary riparian vegetation map, and a cross-walk between the two classification systems was prepared (see Section 2.6 below).

2.5 Field Assessment Survey

After completing the reconnaissance and preliminary vegetation map, a three-week field assessment survey was performed according to DFW protocols to improve the accuracy of the final vegetation map.

Assessment points were pre-selected from the preliminary vegetation map using a stratified random sampling design. The five Restoration Area reaches were stratified into accessible and non-accessible areas based on areas where landowners granted access for the survey, and areas predicted to be inundated by a 2,000 cfs flow and those inundated by higher flows (between 2,000 cfs and 8,000 cfs). Most of Reach 1A and Reach 5 were accessible, while relatively large portions of Reaches 1B through 4B were not accessible (see the gaps in the field assessment locations in Figure 3-1). Within accessible portions of the area inundated under 2,000 cfs, seven assessment points per major vegetation type were randomly selected in each reach. Within accessible portions of the area inundated between 2,000 cfs and 8,000 cfs, one assessment point per major vegetation type was randomly selected in each reach. Agricultural fields, urban areas, and open water areas were excluded from the random sampling process as these land use types are readily identifiable during aerial imagery interpretation and it was not considered necessary to verify them in the field. This process resulted in the selection of 780 vegetation polygons for the field assessment. Not all 780 polygons could be sampled during the field survey, but all selected polygons were retained to provide survey crews the flexibility to select alternate assessment points as needed based on field conditions.

Prior to the field assessment survey, field equipment was gathered (e.g., laser rangefinder, compass, GPS unit loaded with pre-selected assessment points, binoculars, tablet with roadmaps and accessible areas outlined, and GPS-enabled camera) and field base maps and data forms were prepared. The field assessment polygons were printed on field base maps with 2012 NAIP aerial imagery background to help guide field crews. Although field base maps showed preliminary vegetation polygon boundaries, they were not labeled with the preliminary vegetation type to preclude bias during the field assessment survey (Meidinger 2003, DFG 2008).

The field team consisted of two field scientists, one of which was an experienced plant ecologist. They used GPS units, field base maps, and a tablet with roadmaps to navigate to pre-selected assessment polygons, with the goal of sampling as many of the pre-selected assessment polygons as possible during the three-week survey. Where a selected assessment polygon was inaccessible (e.g., there was a physical barrier or it would take an inordinate amount of time to travel to the point) and could not be viewed with binoculars, the field team consulted the field base maps and chose a replacement polygon that appeared representative of the original assessment polygon. If an assessment polygon was considered to contain more than one vegetation type with a minimum size of 0.5 acre, the field crew divided the polygon as appropriate and collected data for the polygon that appeared to best represent the original assessment polygon.

A stand of vegetation most representative of the pre-selected assessment polygon was located and sampled using a stream-lined version of the CNPS and DFW rapid assessment protocol (see Appendix A). At each point, the dominant plant species by strata were recorded, along with the species age code and percent cover. Other information collected, as summarized in the data form provided in Appendix A, included: overall canopy cover and leaf phenology of each stratum; stand physical conditions (e.g., size, fluvial surface, microtopography, soil texture, and flood/fire evidence), human disturbance categories; the presence of seedlings and saplings suggestive of natural recruitment due to Interim Flows; and any unusual or invasive species not captured in the dominant plant species information. A GPS-tagged photograph was taken at each field assessment point to document site conditions, and *A Manual of California Vegetation* (Sawyer et al. 2009) was used to key out a field-based vegetation type (alliance or group) for the point. Finally, the boundary of the assessment polygon and surrounding polygons were revised on the field base maps to better represent the conditions on the 2012 aerial imagery and as observed in the field. The vegetation type of any observable surrounding polygons was determined using Sawyer et al. (2009) membership rules and recorded on the field base maps and/or data forms.

While accessing and surveying assessment polygons, the presence of any seedlings and saplings suggestive of natural recruitment due to Interim Flows (i.e., seedlings and saplings between approximately 1 and 4 years old) were recorded, whether within or outside of pre-selected assessment polygons. This information was collected to document which native and non-native woody species had recently recruited and established naturally in the Restoration Area, where such recruitment and establishment had occurred, and the potential role of Interim Flows in natural recruitment and establishment. At each recruitment occurrence, a GPS point and photograph were taken, and the species, associated vegetation polygon number, and estimated relative elevation were recorded in a separate Microsoft Excel file.

Back in the office, data forms were checked for completeness, entered into a Microsoft Access database, and a thorough quality assessment/quality control (QA/QC) was performed on the data prior to analysis. Ten percent of the data forms were randomly selected and compared line-by-line to the database entry. Any necessary corrections were made to the database and applied to all other data form entries as relevant (e.g., corrected species names and growth forms). Additional batches of 10% of the remaining data forms were randomly selected and compared until no errors were identified. Any vegetation polygon boundary revisions were scanned and saved as PDF files. Assessment locations were downloaded from the GPS units into a GIS database. Digital photographs were archived into folders labeled by date.

2.6 Vegetation Classification

Moise and Hendrickson (2002), and therefore the preliminary riparian vegetation map, used a vegetation classification system based on Holland (1986). For the San Joaquin River, this system included cottonwood riparian forest, herbaceous (=grassland), mixed riparian forest, willow riparian forest, riparian oak forest, riparian scrub, river wash, wetland, willow scrub, exotic tree, and *Arundo donax*. (The common name, form, family, and native status of the plant species referred to in this report and in the 2012 riparian vegetation map in Attachment A are provided in Appendix B.) Additionally, woody vegetation types were placed in one of six structural/size classes.

Since 2002, however, DFW and CNPS adopted *A Manual of California Vegetation* classification scheme (Sawyer et al. 2009) as the standard for vegetation mapping projects under their purview. As such, field assessment polygons and the final riparian vegetation map were classified to vegetation alliances and groups according to *A Manual of California Vegetation* (Sawyer et al. 2009). An additional goal of the vegetation mapping effort was to maximize consistency with a more recent vegetation map of California's Central Valley, including the Restoration Area, which captures conditions in 2009 aerial imagery and classifies vegetation based on Sawyer et al. (2009) vegetation alliances and groups (GIC 2013). Sawyer et al. (2009) levels of classification, and the rules used to classify vegetation types for the 2012 vegetation map are summarized in Table 2-1.

The Microsoft Access database was then updated with the final vegetation type of each assessment polygon. Vegetation group, alliance, and semi-natural stand names correspond to those in *A Manual of California Vegetation* (Sawyer et al. 2009) unless otherwise noted, but have been shortened for simplicity by removing geographic information. Vegetation types documented during the field assessment effort that did not equate with a Sawyer et al. (2009) vegetation type but that had consistently similar composition and were repeatedly observed were assigned a provisional alliance. To allow for the comparison between the 2000 and 2012 vegetation maps, a cross-walk between the Holland (1986) and Sawyer et al. (2009) vegetation types relevant to the Restoration Area was created (Table 2-2).

Table 2-1.
Vegetation classification levels and decision rules.

CLASSIFICATION LEVEL	DEFINITION PER SAWYER ET AL. (2009)	DECISION RULE(S)
Group	The group level is based on a combination of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), with broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	The group level was the coarsest-scale classification level used. Vegetation was typed to the group level when the composition of vegetation did not clearly meet the membership rules described in Sawyer et al. (2009) for a single alliance. In these cases, vegetation was classified to the group level that best captured the dominant plant species present.
Alliance	The alliance level is based on diagnostic species, including some from the primary layer, which has moderately similar composition that reflects regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes. This level is based on native vegetation therefore the alliance description highlights ecology and management to maintain stands of native plants. Areas dominated by nonnative plants are not included in this level.	Vegetation was typed to the alliance level when the dominant and co-dominant species corresponded with alliance membership rules described in Sawyer et al. (2009).
Semi-Natural Stands	Areas dominated by nonnative plants are not classified within the alliance level but defined as "semi-natural stands" that can occur across myriad environments. These stands are typed separately to emphasize impacts to vegetation and habitat, and opportunities for restoration.	Vegetation was typed as semi-natural stands when a nonnative plant was a dominant or co-dominant species in an area. Because of the ecological and management implications of several high-priority nonnative species, the criteria for these species to be considered co-dominant was only 5–15% relative cover.
Provisional Alliances	Provisional alliances are described when sufficient data are available to propose the vegetation type, but there is not enough research and regional information to be confident about its status in California's vegetation.	Vegetation was typed as provisional alliances when species composition corresponded with the provisional alliance membership rules described in Sawyer et al. (2009), or similar plant species composition was repeatedly observed but was not described by Sawyer et al. (2009) (e.g., <i>Melilotus albus</i> Provisional Alliance, <i>Artemisia douglasiana</i> Provisional Alliance).
Association	The association level is the finest-scale vegetation classification level, and is based on diagnostic species, usually from multiple growth forms or layers, which have similar composition that reflects topo-edaphic climate, substrates, hydrology, and disturbance regimes.	For the 2012 riparian vegetation map, vegetation was not classified to the association level.

Table 2-2.
Cross-walk between Holland (1986) and Sawyer et al. (2009) vegetation types in the Restoration Area.

HOLLAND (1986) VEGETATION TYPES	SAWYER ET AL. (2009) VEGETATION TYPES	
	ALLIANCES/SEMI-NATURAL STANDS	GROUP
Alkali sink	<i>Frankenia salina</i>	Salt basin and high marsh
	<i>Distichlis spicata</i>	Tidal salt and brackish meadow
Arundo donax	<i>Arundo donax</i>	Introduced riparian scrub
Cottonwood riparian and Cottonwood riparian, low density	<i>Populus fremontii</i>	Riparian evergreen and deciduous woodland
Elderberry savanna	<i>Sambucus nigra</i>	Riparian/wash scrub
Exotic tree	<i>Eucalyptus</i> (spp.)	Introduced woodland and forest ²
	<i>Juglans hindsii</i> hybrids	
	Ornamental trees	
	<i>Sesbania punicea</i> ¹	Introduced riparian scrub
	<i>Tamarix</i> spp.	
Herbaceous	<i>Artemisia douglasiana</i> ¹	Annual forb/grass vegetation
	<i>Conium maculatum-Foeniculum vulgare</i> ³	Naturalized annual and perennial grassland
	<i>Leymus triticoides</i>	Marsh/seep
	<i>Lepidium latifolium</i>	Naturalized riparian and wetland
	<i>Persicaria lapathifolia-Xanthium strumarium</i>	
Mixed riparian and Mixed riparian, low-density	<i>Platanus racemosa</i>	Riparian evergreen and deciduous woodland
	<i>Alnus rhombifolia</i>	Riparian deciduous forest
	<i>Fraxinus latifolia</i>	
Riparian oak	<i>Quercus lobata</i>	Broadleaf forest and woodland
Riparian scrub	<i>Lupinus albifrons</i>	Seral scrub
	<i>Rubus armeniacus</i>	Naturalized nonnative deciduous scrub
	<i>Rubus</i> (<i>parviflorus</i> , <i>spectabilis</i> , <i>ursinus</i>)	Deciduous scrub
	<i>Acer negundo</i>	Riparian evergreen and deciduous woodland
	<i>Rosa californica</i>	Riparian/wash scrub
Wetland/marsh	<i>Melilotus albus</i> ¹	Freshwater emergent marsh
	<i>Schoenoplectus</i> (<i>acutus</i> , <i>californicus</i>)	
	<i>Typha</i> (<i>angustifolia</i> , <i>domingensis</i> , <i>latifolia</i>)	
Willow riparian and Willow riparian, low-density	<i>Salix gooddingii</i>	Riparian evergreen and deciduous woodland
	<i>Salix laevigata</i>	
Willow scrub and Willow scrub, low-density	<i>Baccharis salicifolia</i>	Riparian/wash scrub
	<i>Cephalanthus occidentalis</i>	
	<i>Salix exigua</i>	
	<i>Salix lasiolepis</i>	
Not defined	<i>Ludwigia</i> (<i>hexapetala</i> , <i>peplodes</i>)	Floating aquatic vegetation ^{1,2}
	Temperate freshwater floating mat	

¹ These are provisional alliances that are not described by Sawyer et al. (2009) but had consistently similar composition and were observed frequently enough to be considered unique types.

² This is technically a macrogroup, not group, in Sawyer et al. (2009).

³ This alliance is referred to in this report and the 2012 vegetation map as *Conium maculatum* Semi-natural Stands, as *Foeniculum vulgare* was not observed during the 2013 field assessment survey.

2.7 Final Riparian Vegetation Map

Subsequent to the field assessment survey, DWR produced an updated vegetation map of California's Central Valley, including the Restoration Area (GIC 2013). This map captures conditions based on 2009 aerial imagery and classifies vegetation based on Sawyer et al. (2009) vegetation alliances and groups. The 2009 map uses a 1-acre minimum mapping unit and, as a result of improved aerial imagery and mapping techniques since 2002, provides a much more accurate depiction of vegetation polygon boundaries than the 2000 vegetation map. Due to its very broad range, however, the 2009 vegetation map did not include the same intensity of field-based assessment and verification as did the current mapping effort, and was based upon 2009 aerial imagery, before the Interim Flows had been in effect.

The Moise and Hendrickson (2002)-based attributes in the preliminary vegetation map were replaced with those of the DWR 2009 (GIC 2013) map, and the 2009 vegetation polygons and types were overlain with the 2012 aerial imagery. The boundaries of the 2009 polygons were then revised based on the field assessment effort and to more accurately reflect conditions in the 2012 aerial imagery. The final vegetation types of the assessment polygons and surrounding polygons were applied to the final map.

Traditionally, the accuracy of preliminary vegetation maps is assessed according to the degree of match between the preliminary map polygon labels and the results of an accuracy assessment survey for that polygon. For this effort, however, pre-existing vegetation maps based on 2000 and 2009 aerial imagery were used as the preliminary vegetation map, and the objective of the mapping was to document change in the areas of the river most influenced by Interim Flows. Thus differences in mapped versus field-observed vegetation types reflected both inaccuracies in the original mapping efforts and on-the-ground changes in vegetation as a result of the Interim Flows. Therefore, it was unrealistic to expect the pre-existing maps to achieve high accuracy (80% is the accuracy required by DFW [Meidinger 2003, DFG 2008]) when compared to field assessment points taken in 2013. However, the degree of match between the field assessment points and the 2000 and 2009 vegetation types was still assessed to help further elucidate the change in vegetation composition and distribution between these years. Field assessment locations were intersected with both the 2000 and 2009 map polygon data (Moise and Hendrickson 2002 and GIC 2013, respectively) and the vegetation type assigned to each assessment polygon was compared with 2000 and 2009 vegetation type for that polygon (the vegetation type cross-walk in Table 2-1 was used to compare the assessment polygons with the 2000 vegetation types). The degree of match or mismatch between the assessment polygon and the 2000 and 2009 vegetation types was scored using Woodcock and Gopal (2000) 'fuzzy logic' values:

- Absolutely right: When the field assessment alliance matched the 2000 and/or 2009 vegetation type for that polygon, the polygon was given a score of 5.
- Good answer: When the field assessment alliance did not match the 2000 and/or 2009 vegetation type, but the group did, the polygon was given a score of 4.
- Reasonable or acceptable answer: When the field assessment alliance and group did not match the 2000 and/or 2009 vegetation type but had similar species composition, structure, and habitat value the polygon was given a score of 3.

- Understandable but wrong: When the field assessment alliance and group did not match the 2000 and/or 2009 vegetation type, did not have similar species composition, but did have similar structure such that the vegetation types could be readily confused during aerial photo interpretation, the polygon was given a score of 2. This included nonnative species that could be easily confused with native species, such as *Sesbania punicea* and *Salix exigua*.
- Absolutely wrong: When the field assessment alliance and group had no similarity at all to the 2000 and/or 2009 vegetation type, the polygon was given a score of 1.

The percent match between the field assessment polygons and the 2000 and 2009 vegetation maps was calculated based on the number of polygons with scores of 3 or higher (Woodcock and Gopal 2000).

The Moise and Hendrickson (2002) and GIC (2013) vegetation maps were compared with the final 2012 riparian vegetation map in GIS and using the vegetation type cross-walk in Table 2-2, to compare the extent and distribution of vegetation types in 2000, 2009, and 2012.

Chapter 3. Results

3.1 Field Assessment

During the field assessment survey, 257 polygons were sampled (see Figure 3-1) out of the 780 polygons that were selected. In addition, the vegetation type of approximately 400 surrounding polygons was noted while accessing assessment polygons. While relatively large portions of Reaches 1B through 4B were not accessible, previous vegetation maps (Moise and Hendrickson 2002, GIC 2013) and field observations suggest that the sampled polygons in those reaches are representative of overall vegetation conditions. All plant species observed during the field assessment survey are listed in Appendix B.

As discussed previously, the degree of match between the 2013 field assessment points and the 2000 and 2009 vegetation types reflects both the accuracy of these maps in relation to the current vegetation and the change in vegetation composition and distribution that has occurred since the maps were made. It is not possible to separate these two sources of mis-match between field observations and mapped vegetation types; and because of this combined effect, the match between the maps and field assessment points is expected to be lower than in cases where vegetation maps are drafted and then field checked quickly thereafter. This was borne out during the match analysis: only 59% of the field assessment polygons matched the 2000 vegetation type² for the same location. Field assessment polygons located in areas mapped as open water in 2000 had the most mismatches, and field assessment polygons located in areas mapped as cottonwood and willow vegetation types in 2000 had the most matches. This is expected given that 12 years passed between the 2000 map and field assessment survey, which included approximately four years of Interim Flow releases and notable improvements in photo interpretation and vegetation mapping tools and accuracy. Approximately 65% of the field assessment polygons matched the 2009 vegetation type³ for the same location. Field assessment polygons classified as *Arundo donax*, *Sesbania punicea*, and various wetland vegetation types were those least likely to match the 2009 vegetation type. This is likely a result of the emphasis made during the 2013 field assessment survey to identify and accurately map these vegetation types since they are either high-priority nonnative species or one of the vegetation types most subject to change as a result of Interim Flows. In addition, *Sesbania punicea* is very hard to distinguish from *Salix exigua* in aerial imagery interpretation and is not an alliance defined by Sawyer et al. (2009). As a result, the 2009 vegetation map underestimates the extent of *Sesbania punicea*; when field assessment polygons of this alliance were excluded from this comparison, the percentage of field assessment polygons matching the 2009 vegetation map increased to approximately 70%. Field assessment polygons mapped as *Salix gooddingii*, *S. exigua*, *Quercus lobata*, and *Populus fremontii* were those most likely to match the 2009 vegetation type. It should be noted that, because of the changes in map quality, varying levels of field assessment, and the influence of Interim Flows between years, the percent match between field assessment polygons and 2000 and/or 2009 vegetation types (59% and 70%, respectively) is not a reflection

² The original 2000 vegetation map of the Restoration Area (Moise and Hendrickson 2002) does not have a reported accuracy.

³ The accuracy of DWR's 2009 vegetation map of the Central Valley was 87% (GIC 2013).

of the accuracy of the 2012 vegetation map, which likely captures current conditions in much more than 70% of the Restoration Area.

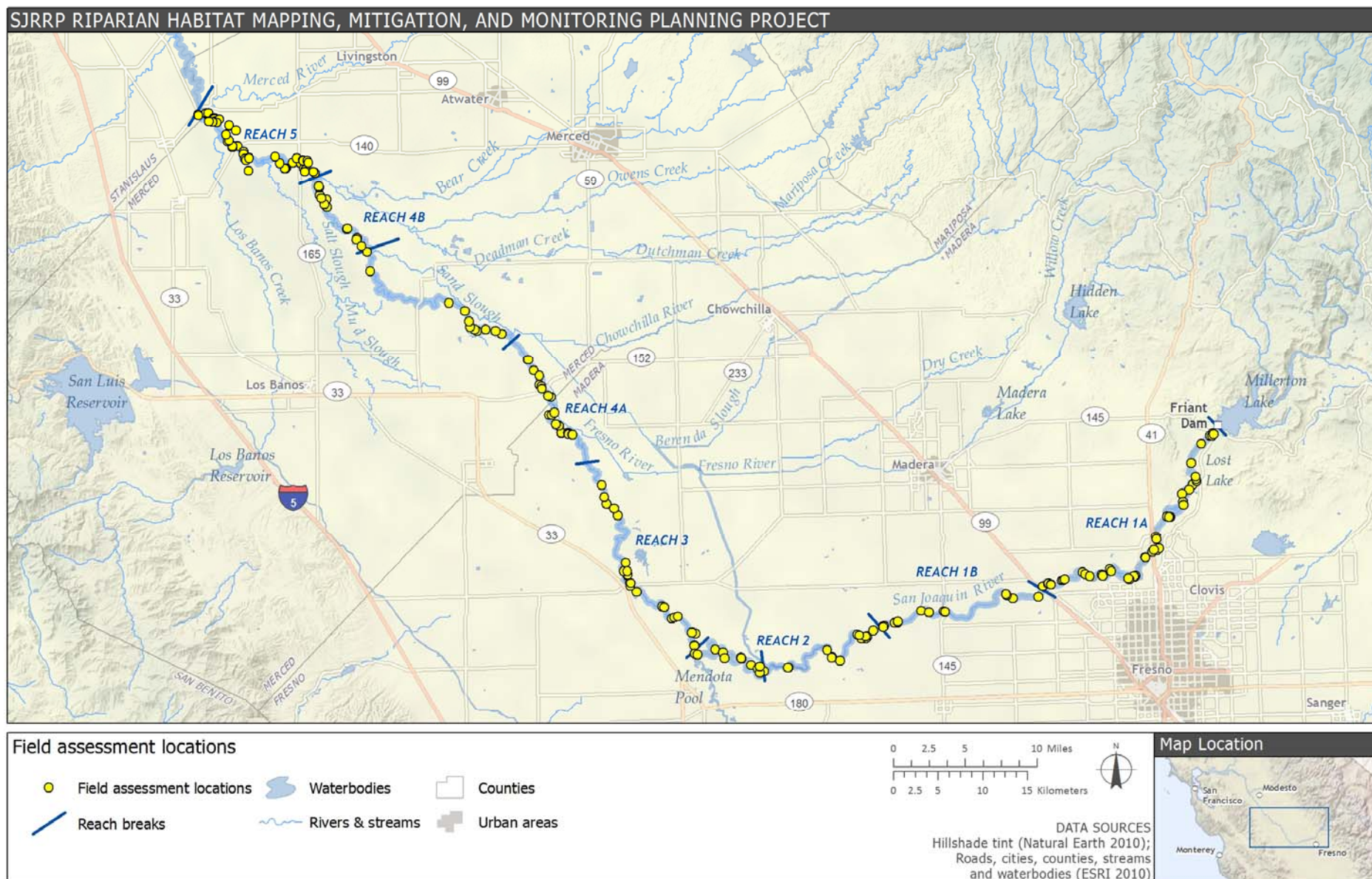


Figure 3-1. Field assessment locations.

3.2 Final Riparian Vegetation Map

The 2012 riparian vegetation map is provided in Attachment A. Table 3-1 lists all of the vegetation groups (Sawyer et al. 2009) and included alliances and semi-natural stands in the final map and their corresponding acreages. Table 3-2 summarizes the acreages of vegetation groups by reach. The common name, form, family, and native status of the plant species referred to in this report are provided in Appendix B.

Table 3-1.
Acres of vegetation groups and alliances in the Restoration Area in 2012.

VEGETATION GROUP	ACRES
Included alliances and semi-natural stands	
Agriculture	5,827
Annual forb/grass vegetation	93
Mugwort (<i>Artemisia douglasiana</i>) ¹	63
Annual forb/grass vegetation (not mapped to alliance level)	30
Bare gravel and sand	620
Broadleaf forest and woodland	325
Valley oak (<i>Quercus lobata</i>)	325
Deciduous scrub	1
California blackberry (<i>Rubus ursinus</i>)	1
Disturbed	499
Floating aquatic vegetation ²	76
Floating aquatic vegetation (not mapped to alliance level)	2
Floating primrose (<i>Ludwigia (hexapetala, peploides)</i>)	23
Temperate freshwater floating mat	51
Freshwater emergent marsh	311
Freshwater emergent marsh (not mapped to alliance level)	114
Sweetclover (<i>Melilotus albus</i>) ¹	13
Bulrush (<i>Schoenoplectus (acutus, californicus)</i>)	138
Cattail (<i>Typha (angustifolia, domingensis, latifolia)</i>)	46
Introduced riparian scrub	79
Giant reed (<i>Arundo donax</i>)	28
Red sesbania (<i>Sesbania punicea</i>) ¹	51
Introduced woodland and forest	111
Gum trees (<i>Eucalyptus (globulus, camaldulensis)</i>)	84
Northern California walnut (<i>Juglans hindsii</i>) hybrids	2
Ornamental trees	25
Marsh/seep	90
Marsh/seep (not mapped to alliance level)	73
Creeping wild rye (<i>Leymus triticoides</i>)	17

VEGETATION GROUP	ACRES
Included alliances and semi-natural stands	
Naturalized annual and perennial grassland	6,043
Poison hemlock (<i>Conium maculatum</i>)	154
Naturalized annual and perennial grassland (not mapped to alliance level)	5,889
Naturalized nonnative deciduous scrub	28
Himalayan blackberry (<i>Rubus armeniacus</i>)	28
Naturalized riparian and wetland	912
Perennial pepperweed (<i>Lepidium latifolium</i>)	71
Naturalized riparian and wetland (not mapped to alliance level)	838
Knotweed-common cocklebur (<i>Persicaria lapathifolia</i> - <i>Xanthium strumarium</i>)	3
Riparian deciduous forest	31
White alder (<i>Alnus rhombifolia</i>)	22
Oregon ash (<i>Fraxinus latifolia</i>)	9
Riparian evergreen and deciduous woodland	2,750
Box elder (<i>Acer negundo</i>)	5
California sycamore (<i>Platanus racemosa</i>)	48
Fremont cottonwood (<i>Populus fremontii</i>)	526
Riparian evergreen and deciduous woodland (not mapped to alliance level)	75
Goodding's willow (<i>Salix gooddingii</i>)	2,094
Red willow (<i>Salix laevigata</i>)	2
Riparian/wash scrub	933
Mulefat (<i>Baccharis salicifolia</i>)	6
Common buttonbush (<i>Cephalanthus occidentalis</i>)	1
Riparian/wash scrub (not mapped to alliance level)	59
California wildrose (<i>Rosa californica</i>)	12
Narrowleaf willow (<i>Salix exigua</i>)	724
Arroyo willow (<i>Salix lasiolepis</i>)	20
Blue elderberry (<i>Sambucus nigra</i>)	111
Salt basin and high marsh	2,406
Seral scrub	98
Silver lupine (<i>Lupinus albus</i>)	98
Tidal salt and brackish meadow	223
Saltgrass (<i>Distichlis spicata</i>)	200
Tidal salt and brackish meadow (not mapped to alliance level)	23
Water	2,489
Total Vegetation Group Acres	23,945

¹ These are provisional groups/alliances that are not described in *A Manual of California Vegetation* (Sawyer et al. 2009) but had consistently similar composition and were observed frequently enough in the Restoration Area to be considered unique types.

² This is technically a macrogroup, not group, in *A Manual of California Vegetation* (Sawyer et al. 2009).

Table 3-2.
Vegetation types and acreages in the Restoration Area in 2012.

VEGETATION GROUP	ACRES IN REACHES									
	1A	1B	2A	2B	3	4A	4B1	4B2	5	TOTAL
Agriculture	80	283	62	1,462	1,417	124	2,268	0	131	5,827
Annual forb/grass vegetation	2	2	4	0	0	2	0	36	47	93
Bare gravel and sand	46	142	285	67	3	73	0	0	4	620
Broadleaf forest and woodland	251	6	2	4	1	0	2	6	53	325
Deciduous scrub	0	0	0	1	0	0	0	0	0	1
Disturbed	120	22	5	0	39	115	88	77	33	499
Floating aquatic vegetation	42	0	0	4	0	0	22	3	5	76
Freshwater emergent marsh	6	1	7	60	10	62	90	27	48	311
Introduced riparian scrub	15	33	30	0	1	0	0	0	0	79
Introduced woodland and forest	44	54	1	0	0	0	3	0	9	111
Marsh/seep	1	0	0	13	0	0	0	19	57	90
Naturalized annual and perennial grassland	1,318	387	699	209	651	199	166	564	1,850	6,043
Naturalized nonnative deciduous scrub	9	1	0	2	10	4	0	0	2	28
Naturalized riparian and wetland	29	0	7	43	19	9	142	181	482	912
Riparian deciduous forest	24	2	5	0	0	0	0	0	0	31
Riparian evergreen and deciduous woodland	390	355	38	132	372	86	184	333	860	2,750
Riparian/wash scrub	215	112	19	171	138	69	121	30	58	933
Salt basin and high marsh	0	0	0	3	0	0	68	151	2,184	2,406
Seral scrub	0	0	94	4	0	0	0	0	0	98
Tidal salt and brackish meadow	0	0	3	0	0	0	2	30	188	223
Water	894	205	198	247	321	63	98	107	356	2,489
Total	3,486	1,605	1,459	2,422	2,982	806	3,254	1,564	6,367	23,945

The area of mapped vegetation in each of the Restoration Area reaches varies greatly, from just over 800 acres in Reach 4A to over 6,300 acres in Reach 5, as a result of reach length and the amount of area inundated under the flow magnitudes used to define the extent of mapping for this effort.

The largest extents of two ecologically important native riparian vegetation types, broadleaf forest and woodland and riparian evergreen and deciduous woodland, occur in both the upstream- and downstream-most reaches. This distribution appears, at least in part, to be a result of the numerous protected areas in Reach 1A that support native vegetation and the influence of the wide floodplain in Reach 5 with sites of suitable relative elevation and soil type to support

native woody vegetation, as well as the habitat conservation and water management provided by the San Luis National Wildlife Refuge and several State Parks. These same land- and water-use conditions also contribute to the large extents of naturalized annual and perennial grassland in Reaches 1A and 5.

The largest extents of several nonnative vegetation groups occur in the upper reaches of the Restoration Area, such as introduced riparian scrub and introduced woodland and forest, which indicates that there is an abundant source of seeds and vegetative propagules for nonnative invasive species that can spread into downstream reaches as Interim and Restoration Flows occur.

A number of vegetation types increase notably in area in Reaches 4B1, 4B2, and 5, reflecting the much wider floodplain, the relatively greater seasonal availability of water, and the influence of sloughs and more saline and finer textured (clay, clay-loam) soils (Stillwater Sciences 2003). These include both of the saline-soil associated vegetation groups—salt basin and high marsh and tidal salt and brackish meadow—as well as annual forb/grass vegetation, marsh/seep, and naturalized riparian and wetland.

As might generally be expected, the larger reaches support a higher diversity of vegetation. Reach 2 has the greatest diversity of vegetation types and supports two groups that occur in no other reach: seral scrub and deciduous scrub (Table 3-2). Naturalized annual and perennial grassland is the predominant vegetation group in all reaches of the Restoration Area except for Reach 5, where it is surpassed by salt basin and high marsh vegetation (Table 3-2) (which is a common component of riparian and wetland areas along the floor of the Central Valley [DFW and GIC 2013, Buck-Diaz et al. 2012]). After naturalized annual and perennial grassland, riparian evergreen and deciduous woodland is next most prevalent vegetation group in all reaches. All of the Restoration Area reaches contain two or more nonnative vegetation groups (e.g., floating aquatic vegetation, introduced woodland and forest, naturalized nonnative deciduous scrub and introduced riparian scrub), although the highest acreages of nonnative vegetation occur in Reaches 1A–2. The vegetation groups and alliances listed in Tables 3-1 and 3-2 are described in the sections below.

3.3 Riparian Vegetation Types

The following sections describe the vegetation alliances and groups that are included in the 2012 riparian vegetation map (Attachment A), as documented during the field assessment survey. Vegetation group, alliance, and semi-natural stand names correspond to those in *A Manual of California Vegetation* (Sawyer et al. 2009) unless otherwise noted, but have been shortened for simplicity by removing geographic information. In addition to the vegetation types described below, the 2012 map includes the following vegetation types from the DWR 2009 (GIC 2013) map: California water temperate marsh/seep and *Leymus triticoides* alliance; temperate freshwater floating mat group and *Ludwigia (hexapetala, peploides)* semi-natural stands; naturalized riparian and wetland group and *Rubus armeniacus* semi-natural stands. These vegetation types were not documented or described during the field assessment survey, but are described by Sawyer et al. (2009). The common name, form, family, and native status of the plant species referred to in this report and in the 2012 riparian vegetation map in Attachment A are provided in Appendix B.

3.3.1. Agriculture

Areas mapped as agriculture include orchards and row crops. Lands used for livestock grazing are generally mapped as California naturalized annual and perennial grassland.

3.3.2. Annual forb/grass vegetation group

This group is referred to as California annual forb/grass vegetation in Sawyer et al. (2009). This group is a mixture of herbaceous annual forbs (e.g., *Anthriscus caucalis*, *Acmispon americanus* var. *americanus*), perennial herbs (e.g., *Datura wrightii*, *Artemisia douglasiana*) and naturalized annual and perennial grasses (e.g., *Bromus* spp., *Hordeum murinum*, *Cynodon dactylon*). Although areas mapped as annual forb/grass vegetation typically have a high percent cover of grasses, there are enough herbaceous forbs to distinguish them from the naturalized annual and perennial grassland group (see Section 3.3.9 below). Additionally, nonnative perennial *Hirschfeldia incana* and native *Rosa californica* can occur at low levels in this group. *Salix gooddingii* saplings can be present in this group where it occurs adjacent to the San Joaquin River channel. Mature tree and shrub canopy is non-existent to low in this group. Disturbances in this group include relatively low levels of off-road vehicle (ORV) activity, competition by exotics (e.g., *Lactuca serriola*), and road/trail construction. This group typically occurs in topographically flat areas on active or other floodplains. Annual forb/grass vegetation occurs in every reach, but the largest occurrences are in the lower reaches (Reaches 4A, 4B, and 5). This group was described in two field assessment polygons.

***Artemisia douglasiana* provisional alliance**

Artemisia douglasiana (mugwort) is a perennial herb in the Asteraceae family. *Artemisia douglasiana* is prevalent in the annual forb/grass vegetation group, but has very high relative percent cover (up to 85%) in some areas. Although this provisional alliance is not described by Sawyer et al. (2009), this pattern occurs repeatedly in the Restoration Area and warranted the creation of a provisional alliance. This provisional alliance is also used and described by GIC (2013) and Buck-Diaz et al. (2012) in their Central Valley vegetation maps.

The *Artemisia douglasiana* provisional alliance is defined by high relative cover of *A. douglasiana* along with annual and herbaceous forbs and naturalized annual and perennial grasses. These include *Hirschfeldia incana*, *Amsinckia* sp., *Grindelia camporum*, *Oenothera elata*, *Xanthium strumarium*, *Chenopodium murale*. Low cover of shrubs and trees can be present in this alliance. Disturbances in this provisional alliance include low to moderate levels of improper burning regime, grazing, and road/trail construction. *Populus fremontii* and *Salix gooddingii* saplings can be present along the river bank. This provisional alliance is typically located on floodplains estimated to have flooded in the last 2–4 years and on terraces estimated to have flooded more than 10 years ago. Fairly large areas (approximately 6 acres on average) of *Artemisia douglasiana* provisional alliance occur in Reaches 4B and 5, and smaller occurrences are in Reaches 1A and 1B. This provisional alliance is likely much more widely distributed in the Restoration Area, as indicated by the extent of the annual forb/grassland group, but it is difficult to identify this alliance by aerial photo interpretation alone. The *Artemisia douglasiana* provisional alliance was described in three field assessment polygons and documented in two adjacent polygons.

3.3.3. Bare gravel and sand

Areas mapped as bare gravel and sand include dry reaches of the San Joaquin River channel and adjacent sand and gravel deposits, as visible in the 2012 aerial imagery. Bare gravel and sand is mapped throughout the Restoration Area (Reaches 1A–4A, 5) except for Reach 4B. Bare gravel and sand was not mapped in Reach 4B likely due to the very narrow corridor and generally well vegetated conditions in that reach and routing of larger flood flows around this reach via the Eastside Bypass, which preclude the scour or deposition of large (i.e., greater than 0.5 acre) bare (unvegetated) patches of sediment.

3.3.4. Broadleaf forest and woodland

This group is referred to as California broadleaf forest and woodland in Sawyer et al. (2009). Vegetation types representative of this group in the Restoration Area included just one alliance, the *Quercus lobata* alliance, which was consistently mapped to the alliance level, and is described below.

***Quercus lobata* alliance**

Quercus lobata is a native deciduous tree in the Fagaceae family. This alliance is defined by a fairly dense, continuous tree canopy, with an intermittent shrub layer and a continuous herbaceous layer. Trees other than the *Quercus lobata* include *Salix gooddingii*, *Platanus racemosa*, *Fraxinus latifolia*, and *Populus fremontii*. Common shrubs include *Salix exigua*, *Cephalanthus occidentalis*, and *Rubus ursinus*. The herbaceous layer consists mainly of nonnative annual grasses and some forbs, *Artemisia douglasiana*, *Carduus pycnocephalus* ssp. *pycnocephalus*, and *Grindelia camporum*. Natural recruitment of *Salix gooddingii*, *Platanus racemosa*, and *S. laevigata* seedlings and saplings as a result of Interim Flows occurs in some areas of this alliance. Nonnative species in this vegetation type include: *Rubus armeniacus*, *Silybum marianum*, *Morus alba*, *Carduus pycnocephalus* ssp. *pycnocephalus*, and *Lepidium latifolium*. In addition to the nonnative species, other disturbances include grazing, recreational use/trails/compaction, road/trail construction, and development. This vegetation type is commonly found on active floodplains, isolated wetlands or oxbows, and floodplain terraces. The *Quercus lobata* alliance is the most common riparian woodland alliance in Reach 1A, and occurs along most of the reach. It also is widely distributed in the lower section of Reach 5, and occurs at much lower frequency in Reaches 1B–4B. The *Quercus lobata* alliance was described in ten field assessment polygons and documented in eight adjacent polygons.

3.3.5. Deciduous scrub group

This group is referred to as Vancouverian coastal deciduous scrub in Sawyer et al. (2009). Vegetation in the deciduous scrub group was consistently mapped to the *Rubus ursinus* alliance level, as described below.

***Rubus ursinus* alliance**

This alliance is referred to as the *Rubus* (*parviflorus*, *spectabilis*, *ursinus*) shrubland alliance in Sawyer et al. (2009). *Rubus ursinus* is a native shrub/vine in the Rosaceae family. This alliance is dominated by *Rubus ursinus* in the shrub layer. In these stands, the shrub canopy can grow up to 2 meters tall and is usually intermittent to continuous, while tree and herbaceous cover are sparse. This alliance is mapped in one location, a slightly upland area near Mendota Pool in Reach 2. The *Rubus ursinus* alliance was described in one field assessment polygon.

3.3.6. Disturbed

Areas mapped as disturbed include residential and commercial areas, buildings and work areas associated with farms, and ORV and other recreation areas, as visible in the 2012 aerial imagery. Disturbed areas occur throughout the Restoration Area, typically in more upland areas.

3.3.7. Freshwater emergent marsh group

This group is referred to as arid west freshwater emergent marsh in Sawyer et al. (2009). The freshwater emergent marsh group is typically densely vegetated with one or some combination of the following common species: *Typha latifolia*, *Schoenoplectus acutus* var. *occidentalis*, *Melilotus albus*, *Artemisia douglasiana*, *Acmispon americanus* var. *americanus*, *Cynodon dactylon*, *Erigeron canadensis*, *Grindelia camporum*, *Polypogon monspeliensis*, *Lotus bicolor*, and *Xanthium strumarium*. This group has very low to no shrub or mature tree cover, but the natural recruitment of *Salix gooddingii* and occasionally *Populus fremontii* ssp. *fremontii* and *Quercus lobata* seedlings and saplings has occurred as a result of Interim Flows in this vegetation type more than most others. Disturbances in this group include high to moderate levels of ORV activity, and low levels of competition from exotics and recreational trails/compaction. This group is found most often on flat or undulating active floodplains that have flooded within the last year, but also occurs in concave isolated wetlands and oxbows. This group is distributed throughout all reaches of the Restoration Area with a higher concentration and frequency in the lower reaches (Reaches 4A, 4B and 5). The freshwater emergent marsh group was described in seven field assessment polygons and documented in 18 adjacent polygons. In addition to the alliances described below, this group includes the *Typha* alliance mapped by GIC (2013).

***Melilotus albus* provisional alliance**

Melilotus albus is a nonnative annual herb in the Fabaceae family. This provisional alliance is not described by Sawyer et al. (2009), but occurs commonly in the freshwater emergent marsh vegetation group and warranted the creation of a provisional alliance for 2012 riparian vegetation map. This provisional alliance is defined by high cover of *Melilotus albus* (up to 90%) with the following common associated species: *Artemisia douglasiana*, *Acmispon americanus* var. *americanus*, *Cynodon dactylon*, *Polypogon monspeliensis*, and *Xanthium strumarium*. In the shrub layer, *Cephalanthus occidentalis* and *Nicotiana glauca* can occur at low levels, and *Salix gooddingii* may occur at low levels in the tree layer, mainly as saplings but occasionally as mature trees. Similar to the broader freshwater emergent marsh group, the natural recruitment of *Salix gooddingii* and occasionally *Populus fremontii* seedlings and saplings is common in this provisional alliance as a result of Interim Flows, and in some cases *Salix gooddingii* seedling and sapling cover is sufficient to map these areas as *Salix gooddingii* alliance (see Section 3.3.11 below). Disturbances include low to moderate levels of recreational use and competition by exotic species (most often *Arundo donax*). This provisional alliance is located in sandy substrates on undulating or convex active or other floodplains that have flooded within the last year. *Melilotus albus* provisional alliance is narrowly distributed in Reaches 4A and 5, typically adjacent to the San Joaquin River channel. This provisional alliance was described in five field assessment polygons and documented in two adjacent polygons.

***Schoenoplectus (acutus, californicus)* alliance**

Schoenoplectus acutus and *S. californicus* are relatively tall (3 m) native tules in the Cyperaceae family. This alliance combines the *Schoenoplectus acutus* alliance and the *Schoenoplectus*

californicus alliance described in Sawyer et al. (2009). Similar to DWR's Central Valley vegetation map (GIC 2013), these alliances were merged to describe areas that are dominated by one or a combination of these species. The herbaceous layer is continuous with dense stem cover and may include additional herbs or grasses, including *Mentha pulegium*, *Juncus* spp., *Xanthium strumarium*, *Typha latifolia*, and *Polypogon monspeliensis*. *Salix gooddingii* and *Cephalanthus occidentalis* can be present with low cover in the tree and shrub layer, respectively. In the relatively few areas where disturbance occurs, it has low levels of competition by exotic species. This combined alliance occurs in concave isolated wetlands and oxbows with clay soils. The *Schoenoplectus (acutus, californicus)* alliance is broadly distributed in Reach 4B, typically as narrow bands along the active channel, and less frequently in Reaches 2 and 3. This alliance was described in three field assessment polygons and documented in eight adjacent polygons.

3.3.8. Introduced woodland and forest group

This macrogroup is referred to as introduced North American Mediterranean woodland and forest in Sawyer et al. (2009). Vegetation types representative of the introduced woodland and forest group include *Eucalyptus (globulus, camaldulensis)* and *Juglans hindsii* hybrids semi-natural stands. In addition to these semi-natural stands, this group includes un-specified ornamental trees, including planted *Pinus ponderosa*, found typically in County parks or adjacent to residences and farms.

***Eucalyptus (globulus, camaldulensis)* semi-natural stands**

Eucalyptus spp. are nonnative trees in the Myrtaceae family that readily naturalize uplands and riparian corridors. The *Eucalyptus (globulus, camaldulensis)* semi-natural stand typically has very high cover of mature *E. globulus* trees (90–95%), with occasional sparse *Platanus racemosa*, *Fraxinus latifolia*, *Quercus lobata*, and *Populus fremontii* in the tree layer. The shrub layer is typically sparse, but the herbaceous layer has moderate to abundant cover, usually of nonnative annual grasses. Disturbances in this stand typically include low levels of recreational trails/compaction and competition from exotic species (e.g., *Arundo donax*, *Sesbania punicea*, and *Centaurea solstitialis*). This semi-natural stand is typically found on flat, retired floodplain terraces with loam soils and low flood frequency. *Eucalyptus (globulus, camaldulensis)* semi-natural stands are common in Reaches 1A and 1B, especially in managed areas (e.g., Scout Island, Island No. 1), and also occurs in Reaches 2, 4B, and 5. This semi-natural stand type was described in eight field assessment polygons and documented in 13 adjacent polygons.

***Juglans hindsii* hybrids semi-natural stands**

Juglans hindsii is a native or naturalized tree in the Juglandaceae family. *Juglans hindsii* trees in the Sacramento-San Joaquin Delta and San Joaquin River are considered naturalized occurrences; as such this vegetation type is best classified as *Juglans hindsii* hybrids semi-natural woodland stands in Sawyer et al. (2009). This semi-natural stand has a mostly continuous mixed tree layer with high cover of *Juglans hindsii*; and moderate to low cover of *Ficus carica*, *Quercus lobata*, *Pinus* sp., and/or *Platanus racemosa*. The shrub layer is intermittent to open with occasional *Cephalanthus occidentalis* shrubs. In addition to disturbance by nonnatives such as *Ficus carica*, low levels of disturbance from recreational trails/compaction or non-ORV recreational use may occur. This semi-natural stand is typically located on convex floodplains. It is only mapped in Reach 1A, immediately adjacent to the San Joaquin River channel. It may be more widely distributed in the Restoration Area, however, as indicated by the extent of riparian evergreen and deciduous woodland group, but it is difficult to identify this alliance by aerial

photo interpretation alone. This semi-natural stand type was described in one field assessment polygon and documented in one adjacent polygon.

3.3.9. Naturalized annual and perennial grassland group

This group is referred to as Mediterranean California naturalized annual and perennial grassland in Sawyer et al. (2009). Naturalized annual and perennial grassland is widespread throughout the field assessment. This group consists mainly of annual grasses such as *Bromus hordeaceus*, *B. diandrus*, *B. tectorum*, *B. madritensis*, *Cynosurus echinatus*, and *Hordeum murinum*, as well as a few perennial grasses such as *Cynodon dactylon*, *Festuca myuros*, and *Alopecurus pratensis*. Herbaceous species are typically present at low to moderate percent covers, including *Artemisia douglasiana*, *Grindelia camporum*, *Hirschfeldia incana*, *Anthriscus caucalis*, *Conium maculatum*, *Amsinckia* sp., and *Erodium* sp. *Lupinus albifrons* shrubs and *Salix gooddingii* and *Populus fremontii* trees can be present at low and scattered levels. This group is subject to a number of disturbances, including low to moderate levels of competition by other nonnative species, such as *Silybum maritimum*, *Lepidium latifolium*, *Sesbania punicea*, *Arundo donax*, *Lactuca serriola*, and *Conium maculatum*, and periodic fire, low to high levels of grazing, vandalism/dumping/litter, road/trail construction, recreation trails/compaction, and both ORV and non-ORV recreational use. This group is typically located on flat or undulating terraces and other floodplains. Naturalized annual and perennial grassland is distributed extensively through all the Restoration Area reaches (Reaches 1A–5) and is commonly mapped in wide bands in the more upland areas. This group was described in 26 field assessment polygons and documented in 87 adjacent polygons.

***Conium maculatum* semi-natural stands**

This alliance is referred to as *Conium maculatum*-*Foeniculum vulgare* semi-natural stands in Sawyer et al. (2009). *Conium maculatum* is a nonnative annual herb in the Apiaceae family (so is *Foeniculum vulgare*, although this species was not observed at field assessment points). *Conium maculatum* is a co-dominant or associated species in a number of vegetation types in the Restoration Area, such as naturalized annual and perennial grasslands and as a typical understory species in the *Salix gooddingii* alliance. In these semi-natural stands, *Conium maculatum* is the dominant species, typically with very high percent cover (e.g., 75%), and there is no shrub or tree cover. Other herbs in these stands include *Datura wrightii*, *Carex* sp., *Artemisia douglasiana*, *Verbascum* sp., and *Elymus triticoides*. The main disturbance in these stands is competition by exotic species, since there is typically very high cover of nonnative *Conium maculatum*. This stand type is typically found on flat terraces estimated to have flooded more than ten years ago. It occurs in Reaches 4A and 4B, with most of the mapped locations in the southern portion of the San Luis National Wildlife Refuge. *Conium maculatum* semi-natural stands were described in one field assessment polygon and documented in one adjacent polygon.

3.3.10. Naturalized riparian and wetland group

This group is referred to as naturalized warm-temperate riparian and wetland in Sawyer et al. (2009). Alliances from this group observed in the Restoration Area are described below.

***Lepidium latifolium* semi-natural stands**

Lepidium latifolium is a nonnative annual herb in the Brassicaceae family and is high priority for treatment and removal in the Restoration Area. Although Sawyer et al. (2009) define this semi-natural stand as having an absolute percent cover of *Lepidium latifolium* of greater than 30% in

the herbaceous layer, this semi-natural stand was designated in the riparian vegetation map where *Lepidium latifolium* comprised 15% or more cover in order to emphasize this species' distribution in the Restoration Area (see Table 2-1). In this semi-natural stand, herbaceous cover is typically dense (90–100%) and relatively tall (>12 inches), with a variety of annual and perennial herbaceous species, including *Bromus* spp., *Cynodon dactylon*, *Melilotus albus*, *Polypogon monspeliensis*, *Grindelia camporum*, and *Artemisia douglasiana*. Shrubs are generally lacking, and tree cover (almost exclusively *Salix gooddingii*) ranges widely from sparse to abundant. Some *Lepidium latifolium* semi-natural stands would be mapped as *Salix gooddingii* alliance, which requires only 10% or more cover of *Salix gooddingii*, were it not for the relatively low threshold for *Lepidium latifolium* percent cover used for this map to highlight occurrences of high-priority nonnative plants. This semi-natural stand commonly supports *Salix gooddingii* and *Populus fremontii* seedling recruitment. Disturbances include competition from exotics (*Lepidium latifolium*), and occasional grazing and recreational use (i.e., trails, compaction). These stands are generally on flat retired floodplain terraces, with loamy soils. This semi-natural stand is broadly distributed throughout Reach 5, often adjacent to the San Joaquin River channel. One additional occurrence is in the lower portion of Reach 2. This semi-natural stand type was described in 11 field assessment polygons.

***Persicaria lapathifolia*-*Xanthium strumarium* provisional alliance**

Xanthium strumarium is a native annual herb in the Asteraceae family typically found in disturbed places (*Persicaria lapathifolia* was not observed at field assessment points). This alliance is dominated by *Xanthium strumarium* with *Cuscuta* sp., *Eleocharis* sp., and low cover of other annual and perennial herbaceous species as associated species. The tree layer, when present, is typically a sparse cover (<10%) of *Salix gooddingii* trees and saplings. The shrub layer is lacking, but the herbaceous layer is abundant. Species found in this alliance are generally native, with the exception of nonnative *Mentha pulegium*. Recruitment of *Salix gooddingii* seedlings and saplings as a result of Interim Flows frequently occurs in this alliance. Disturbances in this alliance include competition from exotics (*Arundo donax*) and recreational trails/compaction. This alliance occurs on flat, active floodplains with sandy soils that have recently been inundated and occurs in two locations along Reaches 2 and 5. It was described in one field assessment polygon.

3.3.11. Riparian evergreen and deciduous woodland group

This group is referred to as southwestern North American riparian evergreen and deciduous woodland in Sawyer et al. (2009) and includes seven key alliances representative of native Central Valley riparian forests (described below). Riparian evergreen and deciduous woodland primarily consists of mature trees with intermittent to continuous cover and a fairly open understory. The tree canopy is mixed with *Populus fremontii* ssp. *fremontii*, *Quercus lobata*, *Salix gooddingii*, *Platanus racemosa*, *Fraxinus latifolia*, and *Alnus rhombifolia* as co-dominant species, and occasionally low cover of *Eucalyptus*. *Cephalanthus occidentalis*, *Rubus armeniacus*, *Salix exigua*, and *Cercis occidentalis* may have low to moderate cover in the shrub layer. The herbaceous layer is comprised of various nonnative annual grasses, as well as *Artemisia douglasiana*, *Urtica dioica* and *Juncus* spp. The natural recruitment of *Salix gooddingii*, *Populus fremontii*, and *Salix exigua* saplings occurs in some areas of this alliance. Nonnative shrubs and herbs, such as *Sesbania punicea*, *Rubus armeniacus*, and *Arundo donax*, may also occur in these areas. Low to moderate intensity disturbances in this vegetation type include various recreational uses, vandalism/dumping/litter, competition by exotics, and, in one

case, off-channel ponds and wetlands. This vegetation type is located primarily on flat or undulating terraces or other floodplains, and occasionally on convex low-flow streambanks and active floodplains. This group is widespread throughout all reaches of the Restoration Area, and was described in nine field assessment polygons and documented in 34 adjacent polygons.

***Acer negundo* alliance**

Acer negundo is a native deciduous tree in the Sapindaceae family. This alliance has high tree cover consisting of *Acer negundo*, *Fraxinus latifolia*, and *Juglans* sp., with an intermittent shrub layer of *Salix exigua*, *Cephalanthus occidentalis*, and *Sambucus nigra* ssp. *caerulea*. Herbaceous cover is typically low. Nonnative invasive *Arundo donax* may be present with relatively low cover. Additional disturbances in this alliance are primarily from adjacent agricultural operations. This vegetation type occurs on convex low-flow streambanks. The alliance is only located in Reach 5. It may be more widely distributed in the Restoration Area, as indicated by the extent of riparian evergreen and deciduous woodland group, but it is difficult to identify this alliance by aerial photo interpretation alone. *Acer negundo* alliance was described in one field assessment polygon and documented in one adjacent polygon.

***Platanus racemosa* alliance**

Platanus racemosa is a native deciduous tree in the Platanaceae family. This alliance has continuous tree cover with a sparse shrub and herbaceous understory. In addition to *Platanus racemosa*, typical trees include *Fraxinus latifolia* and *Salix gooddingii*. Low cover of *Cephalanthus occidentalis* and *Sambucus nigra* spp. *caerulea* can occur in the shrub layer and nonnative annual grasses are well distributed in the herbaceous layer. Disturbances in this alliance can include bank erosion and rip-rap. This alliance occurs on convex low-flow streambanks that have been recently flooded. It is widely distributed in Reaches 1A and 1B, typically in narrow bands along the San Joaquin River channel, and also occurs in Reach 2. *Platanus racemosa* alliance was described in two field assessment polygons and documented in four adjacent polygons.

***Populus fremontii* alliance**

Populus fremontii is a native deciduous tree in the Salicaceae family. This alliance has high cover of *Populus fremontii* and other trees, such as *Salix gooddingii*, *Fraxinus latifolia*, *Quercus lobata*, and *Platanus racemosa*, and a fairly open shrub layer of *Rubus armeniacus*, *R. ursinus*, *Rosa californica*, *Salix exigua*, and *S. laevigata*. The herbaceous layer is comprised of nonnative annual grasses with some nonnative forbs, such as *Hirschfeldia incana*, *Epilobium* sp. and *Cynodon dactylon*. Natural recruitment of *Salix gooddingii* seedlings and saplings as a result of Interim Flows occurs in some areas of this alliance. Other nonnative species that may occur in this alliance include *Eucalyptus* sp., *Sesbania punicea*, and *Conium maculatum*. Moderate levels of disturbance from recreational trails/compaction, non-ORV recreational use, as well as low levels of competition from exotics may occur in this alliance. This vegetation type typically occurs on active and other floodplains that flood every 1–10 years. This alliance is widely distributed throughout all the Restoration Area reaches (1A–5) and is commonly adjacent to the San Joaquin River channel. *Populus fremontii* alliance was described in nine field assessment polygons and documented in 18 adjacent polygons.

***Salix gooddingii* alliance**

Salix gooddingii is a native deciduous tree in the Salicaceae family. This alliance generally has very high (85–100%) vegetative cover composed of intermittent to continuous *Salix gooddingii* tree canopy cover, a low amount of shrub cover, and intermittent cover in the herbaceous layer. Other tree species contributing to the canopy cover include *Fraxinus latifolia*, *Populus fremontii*, and *Quercus lobata*. The most common shrubs are *Cephalanthus occidentalis*, *Salix exigua*, *Rosa californica*, and *Sambucus nigra* ssp. *caerulea*. The herbaceous layer is primarily nonnative annual grasses, *Artemisia douglasiana*, *Hirschfeldia incana*, *Conium maculatum*, and *Melilotus albus*. This alliance is dominated by mature trees, but natural recruitment of native tree seedlings and saplings (most frequently *Salix gooddingii*, occasionally *Populus fremontii* and *Fraxinus latifolia*) commonly occurs. Nonnative grasses and forbs are common, but higher-priority nonnative species (e.g., *Arundo donax*, *Lepidium latifolium*, *Sesbania punicea*) are uncommon and only with relatively low cover. Other common disturbances include recreational use/trails, improper burning regimes, and occasionally grazing and ORV disturbances. *Salix gooddingii* alliance is most frequently found on active or other floodplains that have recently flooded, but also on floodplain terraces, streambanks, outer banks, and oxbows. There is more *Salix gooddingii* alliance mapped in the Restoration Area than any other tree-dominated alliance. In particular, it is widely distributed along the San Joaquin River channel in Reaches 1B and 3–5. This alliance was described in 60 field assessment polygons and documented in 74 adjacent polygons.

***Salix laevigata* alliance**

Salix laevigata is a native deciduous tree in the Salicaceae family. This alliance has high vegetative cover, dominated by mature *Salix laevigata* trees, with *Salix gooddingii* co-dominant and sparse *Populus fremontii* trees. The shrub layer is intermittent and generally composed of *Rosa californica* and *Rubus ursinus*. The herbaceous layer is sparse, primarily containing *Polygonum* sp. Disturbances include agriculture, road/trail construction, recreational use, recreational trails/compaction, and competition from exotics (e.g., *Tamarix* sp.). This alliance occurs on active floodplains that have been flooded within the last year. The distribution of this alliance is limited to a few areas in Reaches 2 and 3. It may be more widely distributed in the Restoration Area, however, as indicated by the extent of riparian evergreen and deciduous woodland group, but it is difficult to distinguish this alliance by aerial photo interpretation alone. *Salix laevigata* alliance was described in one field assessment polygon and documented in one adjacent polygon.

3.3.12. Riparian deciduous forest group

This group is referred to as Vancouverian riparian deciduous forest in Sawyer et al. (2009). Vegetation types in the riparian deciduous forest group were consistently mapped to the alliance/semi-natural stand level, as described below.

***Alnus rhombifolia* alliance**

Alnus rhombifolia is a native tree in the Betulaceae family. Tree cover in this alliance is mature and continuous (90–95% cover), primarily of *Alnus rhombifolia* with scattered *Fraxinus latifolia* and *Quercus lobata*. Species in the intermittent shrub layer may include *Salix exigua*, *Cephalanthus occidentalis*, and/or *Rubus armeniacus*. The herbaceous layer is generally sparse cover of *Artemisia douglasiana* and/or *Urtica dioica*. Disturbances in this alliance are typically roads/trail construction and recreation trails/compaction. High-priority nonnative species are

typically absent, but nonnative *Mentha pulegium*, *Rubus armeniacus*, and annual grasses may occur. This alliance is located on active floodplains (with annual flooding) with loamy soils. The *Alnus rhombifolia* alliance occurs only in Reach 1A, generally immediately adjacent to the San Joaquin River channel. It was described in four field assessment polygons.

***Fraxinus latifolia* alliance**

Fraxinus latifolia is a native deciduous tree in the Oleaceae family. This alliance has a tree layer dominated by *Fraxinus latifolia*, with *Salix gooddingii* and scattered other riparian hardwood trees, and sparse to intermittent shrub and herb layers most commonly including *Salix exigua* and *Artemisia douglasiana*. Recreation trails and road/trail construction were the primary disturbances in this alliance. This alliance occurs on streambanks and floodplains that are flooded approximately annually and have sandy-loamy soils. The *Fraxinus latifolia* alliance has a narrow distribution in Reaches 1A–2. It was described in two field assessment polygons.

3.3.13. Riparian introduced scrub group

This group is referred to as southwestern North American introduced riparian scrub in Sawyer et al. (2009). Vegetation types in the riparian introduced scrub group were consistently mapped to the alliance/semi-natural stand level, and the two alliances within this group observed in the Restoration Area are described below.

***Arundo donax* semi-natural stands**

Arundo donax is a nonnative relative of bamboo in the Poaceae family that can be extremely invasive in riparian corridors. As a high-priority invasive weed, any stand that contained 15% or more *Arundo donax* cover was assigned to the *Arundo donax* semi-natural stand type. Approximately 40% of these stands are truly dominated by *Arundo donax* (e.g., with cover over 60%); the other stands would be mapped as *Salix gooddingii* alliance or other alliances in the riparian evergreen and deciduous woodland group were it not for the relatively low threshold for *Arundo donax* cover used for this map to highlight occurrences of high-priority nonnative plants (see Table 2-1). This alliance is typically intermittently to completely covered with mature shrubs, such as *Arundo donax*, *Salix exigua*, and *Cephalanthus occidentalis*, although some areas may have an intermittent canopy of mature *Salix gooddingii* trees, or occasionally *Fraxinus latifolia* and *Populus fremontii* trees. Herbaceous cover is generally intermittent: *Artemisia douglasiana* and nonnative annual grasses are the most common herbaceous species. Disturbances include competition from exotics (usually *Arundo donax* or *Sesbania punicea*) and recreation trails/compaction. These stands are typically located on floodplains that are flooded every 2–4 years; soils were usually loamy or sandy. *Arundo donax* semi-natural stands are primarily distributed in Reaches 1A–3, as fairly concentrated patches adjacent to the San Joaquin River channel, although *Arundo donax* the species occurs throughout the Restoration Area. The *Arundo donax* semi-natural stand type was described in 18 field assessment polygons and documented in five adjacent polygons.

***Sesbania punicea* provisional semi-natural stand**

Sesbania punicea is a nonnative shrub in the Fabaceae family that invades freshwater wetlands and channel banks, and is a high priority for treatment and removal in the Restoration Area. Although this provisional alliance is not described by Sawyer et al. (2009), this species is spreading in the Restoration Area and warranted the creation of a provisional alliance. Stands with greater than 15% *Sesbania punicea* cover were assigned the *Sesbania punicea* provisional

semi-natural stand type in order to emphasize this species' distribution in the Restoration Area. Without the relatively low cover threshold for *Sesbania punicea*, these stands would typically have been mapped as *Salix gooddingii* or *Salix exigua* alliances used for this map to highlight occurrences of high-priority nonnative plants (see Table 2-1). The tree layer typically has low to moderate cover of *Salix gooddingii*, *Platanus racemosa*, *Fraxinus latifolia*, and/or *Populus fremontii*. Shrub cover is generally moderate and typically comprised of *Salix exigua*, *Cephalanthus occidentalis*, and *Sesbania punicea*. Cover in the herb layer is typically *Artemisia douglasiana*, *Juncus* sp., and nonnative annual grasses and forbs. This provisional alliance frequently supports *Salix gooddingii* seedling natural recruitment. Disturbances in this alliance include competition from exotics (*Sesbania punicea* and *Arundo donax*), and recreational trails/compaction. These stands are typically in the active floodplain—flooding very frequently or annually—and exhibit sandy soils and a small amount of open water. *Sesbania punicea* provisional semi-natural stand type currently occurs only in Reaches 1A–2, typically adjacent to or on island bars and around old gravel mining pits in the San Joaquin River channel. The *Sesbania punicea* provisional semi-natural stand type was described in 15 field assessment polygons.

3.3.14. Riparian wash/scrub group

This group is referred to as southwestern North American riparian wash/scrub in Sawyer et al. (2009). This is a prevalent vegetation group in the Restoration Area and is usually comprised of a dense shrub layer, with a low to moderate tree canopy and a sparse to absent herbaceous layer. Shrubs include *Cephalanthus occidentalis*, *Salix exigua*, *Rosa californica*, *Rubus* spp., and *Sambucus nigra* spp. *caerulea*. Mature trees with low to moderate (generally <10%) cover include *Fraxinus latifolia*, *Salix gooddingii*, *Alnus rhombifolia*, *Quercus lobata*, *Platanus racemosa*, and *Salix laevigata*. Typically low cover of sapling and pole-aged trees occurs (i.e., *Fraxinus latifolia*, *Salix gooddingii*, and *Populus fremontii* ssp. *fremontii*). Common herbaceous species include *Anthriscus caucalis*, *Artemisia douglasiana*, and *Conium maculatum*. Nonnative *Ficus carica*, *Sesbania punicea*, and *Rubus armeniacus* may occur with very low cover. Disturbances in the group vary from competition from exotics to various recreational uses with low to moderate intensities. Evidence of fire may occur in this group. This group is commonly located on active floodplains and high-flow streambanks and is broadly distributed throughout all reaches of the Restoration Area. The riparian wash/scrub group was described in ten field assessment polygons and documented in 24 adjacent polygons. In addition to the alliances described below, this group includes the *Baccharis salicifolia* and *Salix lasiolepis* alliances mapped by GIC (2013).

***Cephalanthus occidentalis* alliance**

Cephalanthus occidentalis is a native deciduous shrub in the Rubiaceae family. This species is commonly along streambanks in the Restoration Area, but is not often a dominant species. This alliance is described by a high cover of *Cephalanthus occidentalis* in the shrub layer and low to absent tree canopy. The herbaceous layer is typically sparse and includes *Artemisia douglasiana* and various nonnative annual grasses. Nonnative *Sesbania punicea*, *Platanus hybrida*, and *Liquidambar* sp. may be present with low cover. Disturbances include competition by exotics and agriculture. This alliance is generally found on convex floodplains and low-flow streambanks. The *Cephalanthus occidentalis* alliance is only mapped in Reach 1A, but it is likely more widely distributed in the Restoration Area, as indicated by the extent of riparian wash/scrub group. This alliance was described in two field assessment polygons.

***Rosa californica* alliance**

Rosa californica is a native shrub in the Rosaceae family. This alliance has continuous, moderately dense shrub cover with sparse tree and herbaceous cover. The shrub layer consists of the dominant *Rosa californica* (up to 75% cover) along with *Salix exigua*, *Cephalanthus occidentalis*, and *Sambucus nigra* ssp. *caerulea*. Nonnative *Rubus armeniacus* can occur with moderate cover. When present, trees are typically *Salix gooddingii*. The herbaceous layer is a mixture of the native and nonnatives: *Artemisia douglasiana*, *Urtica dioica*, *Conium maculatum*, and *Hirschfeldia incana*. Evidence of fire in this alliance was observed. The primary disturbances are competition from the exotics (*Rubus armeniacus*, *Conium maculatum*, *Arundo donax*, *Nicotiana glauca*) and recreational uses, including ORV activity. This alliance is found in various locations; from convex high-flow streambanks to flat terraces estimated to have flooded 2–10 years ago. The *Rosa californica* alliance occurs in fairly narrow scattered area in Reaches 2, 4A, and 4B. It was described in five field assessment polygons and documented in three adjacent polygons.

***Salix exigua* alliance**

Salix exigua is a native, rhizomatous shrub in the Salicaceae family. This alliance has a continuous shrub layer with an intermittent tree canopy and fairly continuous herbaceous layer. Dominant shrubs of *Salix exigua* may be accompanied by *Cephalanthus occidentalis*, *Rosa californica*, *Baccharis salicifolia* ssp. *salicifolia*, and *Rubus ursinus*. Tree cover of *Salix gooddingii*, *Alnus rhombifolia*, *Fraxinus latifolia*, *Platanus racemosa*, and/or *Populus fremontii* is low to moderate. The herbaceous layer is a mixture of forbs (*Hirschfeldia incana*, *Acmispon americanus* var. *americanus*, *Artemisia douglasiana*, *Juncus* spp.) and nonnative annual grasses. Natural recruitment of *Salix gooddingii* saplings as a result of Interim Flows is prevalent in this alliance. Nonnative *Conium maculatum*, *Arundo donax*, *Rubus armeniacus*, *Sesbania punicea*, and/or *Nicotiana glauca* may be present. Additional low to moderate intensity disturbance in this alliance include recreational trails/compaction, road/trail construction, and vandalism/dumping/litter. This alliance occurs on flat to convex active and other floodplains, convex low-flow and high-flow streambanks, and flat or undulating terraces. It is the most frequently mapped riparian wash/scrub vegetation type in the Restoration Area; it is distributed in all five reaches, usually in bands adjacent to the San Joaquin River channel. The *Salix exigua* alliance was described in 30 field assessment polygons and documented in 47 adjacent polygons.

***Sambucus nigra* alliance**

Sambucus nigra subsp. *caerulea* (formerly *Sambucus mexicana*) is a native shrub or small tree in the Adoxaceae family, and is a common component of several alliances in the riparian evergreen and deciduous woodland and riparian wash/scrub groups. There are two distinct versions of the *Sambucus nigra* alliance in the Restoration Area: as a component of the riparian wash/scrub group typically along steep or the upper margins of streambanks; and as elderberry savannah on terraces and upper floodplains with very infrequent flooding and loamy soils. In both versions of the alliance *Sambucus nigra* subsp. *caerulea* is the dominant or co-dominant shrub species, typically with 15–40% cover. Along streambanks, co-occurring shrubs include *Salix exigua*, *Rosa californica*, and *Cephalanthus occidentalis*, *Salix gooddingii* and *Fraxinus latifolia* can occur at low (<25%) cover in the tree layer, and *Conium maculatum*, *Urtica dioica*, and *Artemisia douglasiana* are common in the herbaceous layer. As elderberry savanna, *Sambucus nigra* subsp. *caerulea* is typically the only shrub species present, with individual or groups of a few shrubs sparsely scattered across nonnative annual grassland. There is no tree canopy. In both versions of

Sambucus nigra alliance, nonnative *Nicotiana glauca* may be present with low cover. Disturbances in this alliance can include low to moderate competition by exotics and adjacent agriculture. The streambank version of *Sambucus nigra* alliance is mapped in Reaches 1A–2B and was described in three field assessment polygons; the savannah version occurs only at the Reach 2A/2B boundary and was described in two field assessment polygons.

3.3.15. Salt and brackish meadow group

This group is referred to as temperate Pacific tidal salt and brackish meadow in Sawyer et al. (2009). Alliances from this group observed in the Restoration Area are described below.

***Distichlis spicata* alliance**

Distichlis spicata is a native perennial grass in the Poaceae family. This alliance is dominated by *Distichlis spicata* in the herb layer, with no tree or shrub cover. Other species in the herb layer may include nonnative annual grasses and forbs, *Artemisia douglasiana*, *Amsinckia* sp., *Centromadia pungens*, and *Rumex crispus*. *Grindelia camporum* may occur at relatively low to moderate cover in the shrub layer. *Lactuca serriola* and *Lepidium latifolium* may occur at low cover. In addition to competition from exotics, grazing disturbance may occur. This alliance is typically found on undulating terraces but also on flat floodplains with variable flood recurrence intervals. The *Distichlis spicata* alliance occurs in the lower section of Reach 4B and throughout Reach 5, with locations ranging from immediately adjacent to the San Joaquin River channel to more upland regions. This alliance was described in three field assessment polygons.

3.3.16. Salt basin and high marsh group

This group is referred to as southwestern North American salt basin and high marsh in Sawyer et al. (2009). This vegetation group contains a high percentage of salt-tolerant herbaceous plants, such as *Salicornia pacifica*, *Atriplex prostrata*, *Frankenia salina*, *Distichlis spicata*, *Polypogon monspeliensis*, *Allenrolfea occidentalis*, and *Spergularia* sp., although more typically freshwater marsh species, such as *Schoenoplectus acutus* may also occur. Moderate intensity of road/trail construction-related disturbance may occur. This vegetation group is typically located in concave ponded isolated wetlands or oxbows. Salt basin and high marsh group is only located in Reach 5, generally in more upland areas away from the active channel. It was described in two field assessment polygons and documented in one adjacent polygon.

3.3.17. Seral scrub group

This group is referred to as Central and south coastal California seral scrub in Sawyer et al. (2009). Vegetation types representative of the seral scrub group included just one alliance, *Lupinus albifrons* alliance, which was consistently mapped to the alliance level, and is described below.

***Lupinus albifrons* alliance**

Lupinus albifrons is a native shrub to subshrub in the Fabaceae family. The *Lupinus albifrons* alliance is defined by a shrub layer dominated by *Lupinus albifrons*, although *Salix exigua* and *Arundo donax* also frequently occur at low levels in the shrub layer. *Salix gooddingii* can occur intermittently in the tree layer, and the herbaceous layer is typically dominated by nonnative annual grasses and forbs. The primary disturbance in this alliance is low to moderate levels of competition by nonnatives, specifically *Arundo donax*. This alliance occurs in sandy soils that are intermittently flooded (i.e., every 2–4 years). *Salix gooddingii* and *Populus fremontii*

seedlings and saplings can occur at the lowest elevation areas in this alliance. This alliance occurs only in Reach 2 and is typically immediately adjacent to bare gravel and sand. The *Lupinus albifrons* alliance was described in two field assessment polygons and documented in seven adjacent polygons.

3.3.18. Water

Areas mapped as water include the inundated San Joaquin River channel, inundated gravel mining pits, and other inundated off-channel features, as visible in the 2012 aerial imagery.

3.4 Change Analysis and Conclusions

3.4.1 Comparison with 2000 and 2009 vegetation conditions

One of the original intents of this Project was to compare the extent of vegetation types in 2012 with that seen in the 2000 and 2009 maps, which both capture pre-Interim Flow or baseline conditions, as a means of better understanding the influence of Interim Flows on riparian vegetation conditions (see Reclamation 2013a). During the development of the 2012 vegetation map, however, it was recognized that differences in mapping methods and accuracy among the three mapping efforts make direct comparisons among them an inappropriate basis upon which to characterize riparian vegetation change. Table 3-3 lists the vegetation types/groups and their acreages in the Restoration Area in 2000, 2009, and 2012 (all three maps were clipped to the same extent in GIS to facilitate comparison), and illustrates several of the constraints to comparing vegetation between years.

As Table 3-3 illustrates, the 2000 vegetation map used a different naming/classification convention for vegetation types than the 2009 and 2012 maps. As a result, different vegetation types must be grouped to create the most analogous basis for comparison. In addition, and more significantly, there were also substantial improvements in the accuracy of mapping between 2000 and 2009/2012, due to improved mapping resources and tools and the use of smaller minimum mapping units.

For this analysis, the 2009 vegetation map provides a good representation of pre-Interim Flow conditions since the imagery upon which the map was based was taken just before the first Interim Flow releases. However this mapping effort incorporated far less field verification than the 2012 mapping effort. As a result, even though the 2009 and 2012 maps used similar imagery interpretation methods and tools, minimum mapping units, and classification systems, there are differences in how vegetation patterns were interpreted and classified that make a direct comparison between them an inappropriate basis for characterizing riparian vegetation establishment.

Table 3-3.
Vegetation types and acreages in the Restoration Area in 2000 and 2012.

2000		2009		2012	
VEGETATION TYPE ¹	AREA (AC)	VEGETATION TYPE ²	AREA (AC)	VEGETATION TYPE	AREA (AC)
Alkali sink	9	Salt basin and high marsh; Tidal salt and brackish meadow	3,511	Salt basin and high marsh; Tidal salt and brackish meadow	2,629
Ag field	5,171	Agriculture	5,640	Agriculture	5,827
Disturbed; Urban	1,561	Disturbed; Urban	44	Disturbed	499
Riverwash	351	Bare gravel and sand	730	Bare gravel and sand	620
Open water	2,927	Water	2,185	Water	2,489
Cottonwood riparian; Elderberry savannah; mixed riparian; riparian oak; riparian scrub; willow riparian; willow scrub	5,963	Broadleaf forest and woodland; Seral scrub; Naturalized non-native deciduous scrub; Riparian evergreen and deciduous woodland; Riparian/wash scrub; Riparian deciduous forest	4,458	Broadleaf forest and woodland; Seral scrub; Naturalized nonnative deciduous scrub; Riparian evergreen and deciduous woodland; Riparian/wash scrub; Deciduous scrub; Riparian deciduous forest	4,166
Arundo; exotic tree	80	Introduced riparian scrub; Introduced woodland and forest	61	Introduced riparian scrub; Introduced woodland and forest	190
Wetland/marsh	762	Freshwater emergent marsh	166	Freshwater emergent marsh	311
Herbaceous	6,708	Annual forb/grass vegetation; Marsh/seep; Naturalized annual and perennial grassland; Naturalized riparian and wetland	6,468	Annual forb/grass vegetation; Marsh/seep; Naturalized annual and perennial grassland; Naturalized riparian and wetland	7,138
Not defined ³	--	Temperate freshwater floating mat; Naturalized temperate Pacific freshwater vegetation	71	Floating aquatic vegetation	76
TOTAL⁴	23,532	TOTAL⁴	23,334	TOTAL⁴	23,945

¹ Source: Moise and Hendrickson (2002), which used Holland (1986)–based vegetation descriptions.

² Source: GIC (2013), which used *A Manual of California Vegetation* (Sawyer et al. 2009) classification system.

³ The 2000 vegetation map (Moise and Hendrickson 2002) does not include equivalent types for these 2009 (GIC 2013) and 2012 vegetation types.

⁴ Totals exclude unmapped areas and land use and vegetation types that do not have a group-level designation, which contributes to the different number of acres between the vegetation maps.

Several of the vegetation types in Table 3-3 are good examples of how differences in mapping tools, methods, and vegetation classification make direct comparisons of acreages by year problematic. The dramatic increase in alkali sink vegetation since 2000, for example, is primarily a result of the more detailed classification of herbaceous vegetation used in the 2009 and 2012

maps; in 2000, brackish meadow vegetation, which is extensive in Reach 5, was all mapped as herbaceous. The decrease in riparian forest and scrub types is primarily due to the difference in the minimum mapping unit used in 2000 and 2009/2012; areas mapped as riparian forest in 2000 frequently included large swaths of herbaceous vegetation that were separated out in the 2009 and 2012 maps. Similarly, the increase in bare gravel and sand and decrease in wetland/marsh vegetation types in 2009/2012 is a result of bare areas being distinguished from wetland/marsh areas as a result of the smaller minimum mapping unit. The notable increase in nonnative invasive vegetation between 2000/2009 and 2012 is likely due to the more extensive field assessment that occurred with the 2012 mapping; several nonnative invasive species in the Restoration Area are very difficult to distinguish from native species during aerial photography interpretation, but were distinguished during the field assessment that was used to inform the 2012 map.

Due to the inability to separate real vegetation change from the mapping and classification differences among years, it was determined that comparing vegetation map types and acreages to characterize riparian vegetation establishment under the SJRRP to date was not appropriate. Instead, direct observations of native riparian trees and shrubs that have recruited naturally as a result of Interim Flows were used to characterize the riparian vegetation that has established and is potentially available to compensate for impacts to riparian habitat resulting from SJRRP actions (see Section 3.4.2 below).

3.4.2 Recruitment in response to Interim Flows

During the field assessment survey, naturally recruited Goodding's willow (*Salix gooddingii*), narrowleaf willow (*S. exigua*), and Fremont cottonwood, as well as a few other native tree species, all between approximately 1–4 years old, were observed throughout the portions of the Restoration Area that were accessed. In nearly all cases, such recruitment has occurred in and immediately adjacent to the river channel. Recruitment was primarily observed in areas mapped as bare gravel and sand, freshwater emergent marsh, riparian woodland (which includes the *Salix gooddingii* and *Populus fremontii* alliances), and riparian/wash scrub (which includes the *Salix exigua* Alliance), and less frequently in broadleaf forest and woodland, naturalized annual and perennial grassland, naturalized riparian and wetland (which includes the *Lepidium latifolium* Semi-natural Stand), and introduced riparian scrub (which includes the *Sesbania punicea* Provisional Semi-natural Stands). These are vegetation types and areas that occur on low relative elevation surfaces (typically less than 1 m above the baseflow water surface elevation) and that, as a result of regular inundation, typically have seasonally available bare areas where seedlings can recruit and that are close enough to surface water and/or groundwater to promote maintenance of seedlings and subsequent establishment of saplings likely to survive to reproductive maturity. The availability of suitable elevation and bare mineral substrate areas, as expected, appears to have a strong bearing on where recruitment has occurred. This may explain why Reach 1A and 1B did not appear to have notably greater amounts of recent natural recruitment; while Interim Flows have been higher and more consistent in these reaches, they are also some of the narrowest and have the coarsest substrate, with relatively few broad unvegetated areas upon which cottonwoods and willows typically recruit. Furthermore, the lack of unvegetated areas in Reach 1A and 1B is likely related to the fact that these reaches have experienced more consistent flows since construction of Friant Dam, so riparian vegetation was already well established in the most suitable areas of these reaches before Interim Flows began, unlike the downstream reaches. The size of many of the recently recruited trees suggests that the

higher and more continuous flow conditions in water year 2010 resulted in much of the natural recruitment that was observed, as does the fact that recruitment was observed throughout the accessible portions of the Restoration Area (Interim Flow releases were curtailed downstream of Mendota Dam after water year 2010). Overall, recruitment appears to have occurred in relatively small patches. The photographs in Figure 3-2 are examples of the recruitment response to Interim Flows that was observed during the field assessment survey. Additional detail on recruitment response areas are provided in the Riparian Habitat Mitigation and Monitoring Plan (RH MMP) developed as a part of the Project (Reclamation 2014).

The amount of the Restoration Area that could be directly observed during the field assessment survey was constrained by private property access and the time available to conduct the survey (see Figure 3-1 for the location of all field assessment points). As a result, the recruitment directly observed during the field assessment survey undoubtedly underestimates the amount of riparian vegetation that has been created by the SJRRP to-date. That said, observed natural recruitment locations and species provide an important field verification that Interim Flows have already begun to establish additional riparian vegetation areas.

Unfortunately, it appears that the same elevation and substrate conditions that support the natural recruitment of *Salix gooddingii*, *S. exigua*, and *Populus fremontii* under Interim Flows also support a number of high-priority nonnative species, such as *Arundo donax* and *Sesbania punicea*. Recruitment of these nonnative species in response to Interim Flows was frequently observed in the same areas as native species, indicating that such species will continue to influence the quality of riparian habitat in the Restoration Area and, as such, the treatment of these species will be an ongoing management concern of the SJRRP. It was not clear from the observations in 2013 whether native species will be able to out-grow and eventually shade out the nonnative species, or whether the nonnative species will grow fast enough to out-compete the native species.

In a study that is separate from but related to the vegetation mapping, Reclamation (2013b) compared vegetation composition along 22 transects in the Restoration Area to estimate the effects of the Interim Flows between 2011 and 2012. The transect in Reach 2B was the only one to demonstrate a clear response to Interim Flows: numerous willow seedlings were documented in 2011, Interim Flows maintained these seedlings, and in 2012 overstory cover increased (Reclamation 2013b). (Other vegetation changes between 2011 and 2012, such as a decrease in native cover and increase in nonnative cover, were determined to be a result of dramatic differences in precipitation and instream flows between those years, rather than a specific response to the Interim Flows [Reclamation 2013b].) The limited response to Interim Flows documented by Reclamation (2013b) can likely be explained, at least in part, by the patchy distribution of natural recruitment that was observed during the field assessment survey (i.e., if a transect did not overlap with a recruitment “patch” then no recruitment would be detected) and limited number of transects. The transect results suggest that periodic remapping of suitable natural recruitment areas (i.e., those subject to regular inundation) using similar methods to those described in this Field Survey Report is likely to provide the most accurate overall estimate of riparian vegetation change in the Restoration Area as a result of Interim and eventually Restoration Flows. The detailed information on species composition from Reclamation’s (2013b) transects compliments the broader scale information from vegetation mapping.

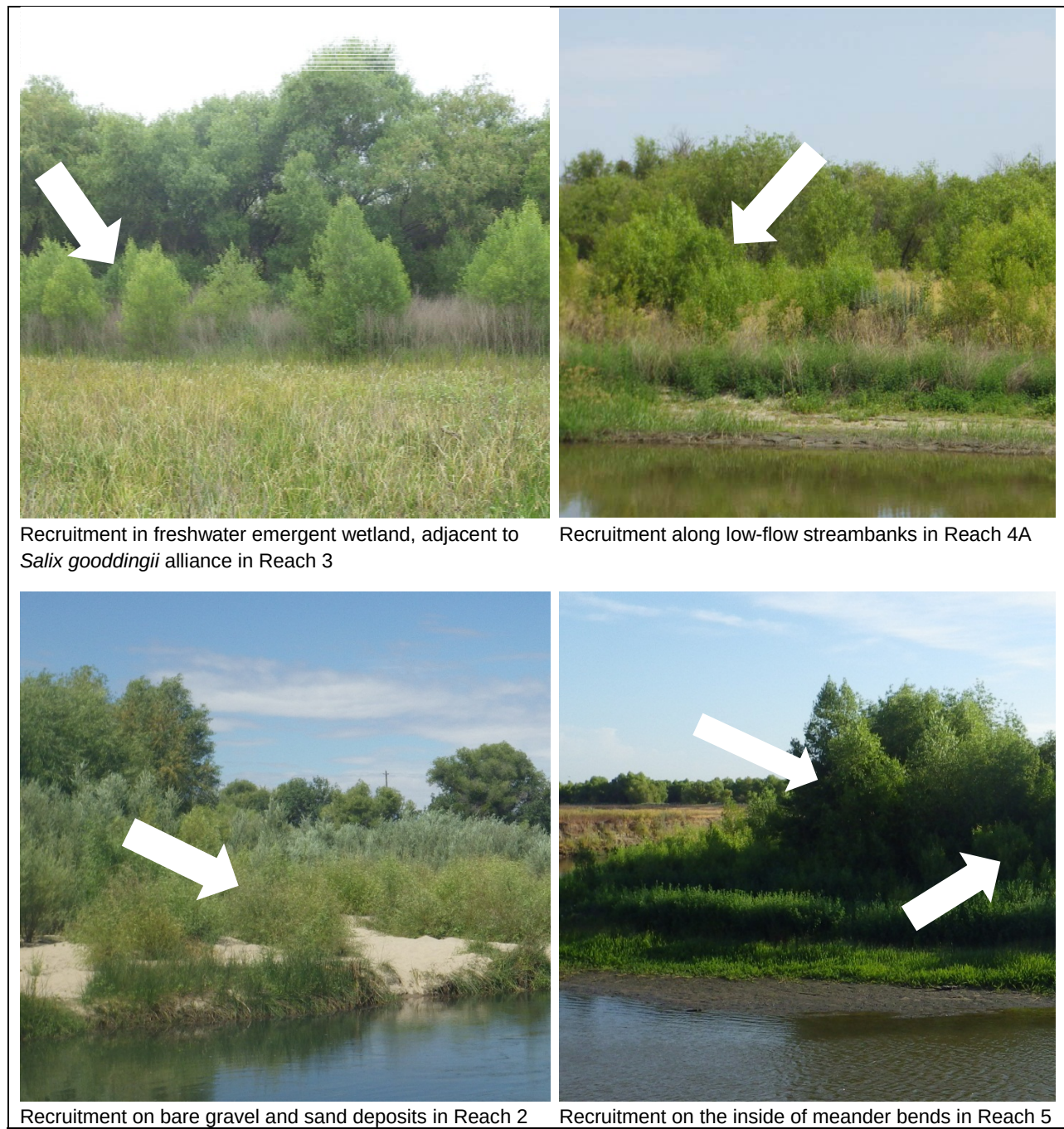


Figure 3-2. Examples of natural recruitment in response to Interim Flows.

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⁴ Additional literature and information sources used to inform the Project methods and discussions, but not directly cited in this Field Survey Report, are included in the Project's TIPAR (Reclamation 2013a) and RHMMMP (Reclamation 2014).

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Appendix A: Field Assessment Survey Data Form (revised from CNPS/DFG [2011])

CNPS and DFW Vegetation Rapid Assessment Form (revised by Stillwater Sciences)

QC (initials/date):

LOCATIONAL/ENVIRONMENTAL DESCRIPTION							
Polygon/Stand #:		Field Tile #:		Date:		Name(s) of Surveyors (circle recorder)	
GPS wypt #: ___ GPS name: ___ Datum: ___ or NAD83							
GPS within stand? Yes / No If No, cite from waypoint to stand, distance ___ (ft/m) & azimuth ___ (degrees)							
Relative Elevation: ft/m Camera Name/Photograph #'s:							
Stand Size (acres): <1, 1-5, >5 Plot Shape _____ x _____ ft/m or Circle Radius _____ ft/m							
Estimated last time surface flooded (circle years since present) <1, 1, 2-4, 5-10, >10							
Stand Fluvial Surface ¹ code: _____ Stand Microtopography: convex flat concave undulating							
Soil Texture ² code: _____							
% Surface Cover of Plot:							
H2O: ___ BA ³ : ___ Stems: ___ Litter: ___ Bedrock (Incl. outcrops): ___ Boulder(>25cm): ___ Cobble(6.4-25cm): ___							
Fines (<2 mm Incl. sand, mud): _____ = 100%							
Flood Evidence : Yes / No (circle one) If Yes, describe: _____							
Fire Evidence: Yes / No (circle one) If Yes, describe in Site History section, including date of fire, if known							
Adjacent Disturbances (within 100 m on same side of river) CODES: _____							
% of Polygon Boundary by Natural Lands (lands with native or non-native but non-invasive dominated species): _____ %							
Stand Age CODE ⁶ : Oldest plants: _____ Dominant plants: _____							
Disturbance Code ⁴ /Intensity (L,M,H): ___/___/___/___/___/___ "Other" _____/___							
II. HABITAT AND VEGETATION DESCRIPTION							
Unusual/Invasive species: _____							
Total % vegetation cover: _____ Stand is dominated by (circle one): herbs shrubs trees							
Age code ⁶	Species	% cover	C ⁵	Age code	Species	% cover	C
III. INTERPRETATION OF STAND							
Stand Health and Regeneration Assessment:							
Site History:							
Field-assessed vegetation alliance name: _____							
Field-assessed association name (optional): _____							
Adjacent alliances/direction: _____							
Confidence in alliance identification: L M H Explain:							
Leaf phenology (E,P,L): Herb Shrub Tree Other identification or mapping information:							
Is poly > 1 type: Yes / No If Yes, were other types sampled separately? Yes / No							
*DRAW A BOUNDARY AROUND STAND ON FIELD MAP AND LABEL STAND NUMBER. DONE? (Y / N)							
Final vegetation type name:				Alliance _____			
				Association			

¹ **Fluvial surface codes**

1. Active Floodplain
2. Other Floodplain
3. Channel Bank (Low Flow)
4. Outer Bank (High Flow)
5. Terrace (Retired FP)
6. Isolated Wetland or Oxbow

² **Soil texture codes**

1. Gravel (G)
2. Silt (Si)
3. Loam (L)
4. Clay (C)
5. Sand (S)

³ **BA** = Basal Area

⁵ **C** = Collected specimen for office ID

⁶ **Age Codes**

Tree Age Code

- T1= Seedling (0-1 yrs)
T2= Sapling (2-4 yrs)
T3= Pole (5-10 yrs)
T4= Mature (>10 yrs)
T5= Decadent (≥20% canopy dead)

Shrub Age Codes

- S1= Seedling (≤1 yr old)
S2= Mature (>1 yr old)
S3= Decadent (≥20% dead)

Herbaceous Age Codes

- H1 < 12" ht
H2 > 12" ht

⁴ **Disturbance codes:**

- 01 Development (buildings, pavement)
02 Landfill
03 ORV activity
04 Agriculture
05 Grazing
06 Competition from exotics
07 Logging
08 Wood cutting
09 Mining/Tailings
10 Road/trail construction/maintenance
11 Agricultural return flows (pipe)
12 Altered flow regime
13 Groundwater pumping
14 Surface water diversion
15 Dam/inundation
16 Off-channel ponds and wetlands
17 Improper burning regime
18 Erosion/runoff (record source)
19 Rip-rap, bank protection
 - Low 10-30% of banks
 - Medium 30-60 % of banks
 - High >60% of banks
20 Actively eroding banks
 - Low 10-30% of banks
 - Medium 30-60 % of banks
 - High >60% of banks
21 Channel incision
 - Low (0-2 feet)
 - Medium (2-4 feet)
 - High (> 4 feet)
22 Recreational trails/compaction and trampling
23 Recreational use (non ORV)
24 Vandalism/dumping/litter
25 Feral animals
25 Other (describe in Site History)

Appendix B: Plant Species Documented in the Restoration Area during the Field Assessment Survey

SPECIES	COMMON NAME	LIFEFORM	FAMILY	NATIVE (YES OR NO ¹)
<i>Acer negundo</i>	box elder	tree	Sapindaceae	y
<i>Acmispon americanus</i> var. <i>americanus</i>	American bird's-foot trefoil	annual herb	Fabaceae	y
<i>Ailanthus altissima</i>	tree of heaven	tree	Simaroubaceae	n (m)
<i>Allenrolfea occidentalis</i>	iodinebush	shrub	Chenopodiaceae	y
<i>Alnus rhombifolia</i>	white alder	tree	Betulaceae	y
<i>Alopecurus pratensis</i>	meadow foxtail	perennial herb	Poaceae	n (nl)
<i>Ambrosia acanthicarpa</i>	annual bur-sage	annual herb	Asteraceae	y
<i>Amsinckia</i> sp.	fiddleneck	herb	Boraginaceae	y
<i>Anaphalis margaritacea</i>	western pearly everlasting	perennial herb	Asteraceae	y
<i>Anthemis</i> sp.	chamomile	herb	Asteraceae	n (nl)
<i>Anthriscus caucalis</i>	bur-chervil	annual herb, vine	Apiaceae	n (nl)
<i>Aptenia cordifolia</i>	baby sun-rose	perennial herb	Aizoaceae	n (nl)
<i>Artemisia douglasiana</i>	mugwort	perennial herb	Asteraceae	y
<i>Arundo donax</i>	giant reed	perennial herb	Poaceae	n (h)
<i>Asclepias fascicularis</i>	narrow-leaf milkweed	perennial herb	Apocynaceae	y
<i>Atriplex prostrata</i>	fat-hen	annual herb	Chenopodiaceae	y
<i>Atriplex spinifera</i>	spiny saltbush	shrub	Chenopodiaceae	y
<i>Avena sativa</i>	cultivated oat	annual, perennial herb	Poaceae	n (m)
<i>Baccharis salicifolia</i> ssp. <i>salicifolia</i>	mulefat	shrub	Asteraceae	y
<i>Bidens</i> sp.	beggarticks	herb	Asteraceae	both
<i>Brassica nigra</i>	black mustard	annual herb	Brassicaceae	n (m)
<i>Bromus diandrus</i>	ripgut brome	annual herb	Poaceae	n (m)
<i>Bromus hordeaceus</i>	soft chess	annual herb	Poaceae	n (l)
<i>Bromus madritensis</i>	compact brome	annual herb	Poaceae	n (h)
<i>Bromus tectorum</i>	cheat grass	annual herb	Poaceae	n (h)
<i>Carduus pycnocephalus</i> ssp. <i>pycnocephalus</i>	Italian thistle	annual herb	Asteraceae	n (m)
<i>Carex</i> sp.	sedge	herb	Cyperaceae	both
<i>Catalpa bignonioides</i>	southern catalpa	tree	Bignoniaceae	n (nl)
<i>Centaurea solstitialis</i>	yellow star-thistle	annual herb	Asteraceae	n (h)
<i>Centromadia pungens</i>	common tarweed	annual herb	Asteraceae	y
<i>Cephalanthus occidentalis</i>	California button willow	shrub	Rubiaceae	y
<i>Cercis occidentalis</i>	Western redbud	tree, shrub	Fabaceae	y
<i>Chenopodium</i> sp.	goosefoot	herb	Chenopodiaceae	both
<i>Chenopodium murale</i>	nettleleaf goosefoot	annual herb	Chenopodiaceae	n (nl)
<i>Cirsium vulgare</i>	bull thistle	perennial herb	Asteraceae	n (m)
<i>Claytonia</i> sp.	springbeauty	herb	Montiaceae	n (nl)
<i>Conium maculatum</i>	poison hemlock	perennial herb	Apiaceae	n (m)
<i>Crypsis schoenoides</i>	swamp prickly grass	annual herb	Poaceae	n (nl)
<i>Cuscuta</i> sp.	dodder	annual herb, vine (parasitic)	Convolvulaceae	y
<i>Cynodon dactylon</i>	Bermuda grass	perennial herb	Poaceae	n (m)
<i>Cynosurus echinatus</i>	bristly dogtail grass	annual herb	Poaceae	n (m)
<i>Cyperus</i> sp.	flatsedge	herb	Cyperaceae	both
<i>Cyperus eragrostis</i>	tall flatsedge	perennial herb	Cyperaceae	y

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SPECIES	COMMON NAME	LIFEFORM	FAMILY	NATIVE (YES OR NO ¹)
<i>Datura wrightii</i>	sacred thorn-apple	perennial herb	Solanaceae	y
<i>Deschampsia</i> sp.	hairgrass	perennial herb	Poaceae	y
<i>Distichlis spicata</i>	salt grass		Poaceae	y
<i>Eleocharis</i> sp.	spikerush	herb	Cyperaceae	y
<i>Eleocharis macrostachya</i>	pale spikerush	perennial herb	Cyperaceae	y
<i>Elymus glaucus</i>	blue wild rye	perennial herb	Poaceae	y
<i>Elymus triticoides</i>	beardless wild rye	perennial herb	Poaceae	y
<i>Epilobium</i> sp.	willowherb	herb	Onagraceae	y
<i>Equisetum</i> sp.	horsetail	herb	Equisetaceae	y
<i>Erigeron canadensis</i>	horseweed	annual herb	Asteraceae	y
<i>Erodium</i> sp.	stork's bill	herb	Geraniaceae	both
<i>Eschscholzia californica</i>	California poppy	annual, perennial herb	Papaveraceae	y
<i>Eucalyptus</i> sp.	gum	tree	Myrtaceae	n
<i>Eucalyptus globulus</i>	blue gum	tree	Myrtaceae	n (m)
<i>Festuca myuros</i>	rattail sixweeks grass	perennial herb	Poaceae	n (nl)
<i>Festuca perennis</i>	rye grass	perennial herb	Poaceae	n (nl)
<i>Ficus carica</i>	edible fig	tree	Moraceae	n (m)
<i>Frankenia salina</i>	alkali heath	perennial herb	Frankeniaceae	y
<i>Fraxinus latifolia</i>	Oregon ash	tree	Oleaceae	y
<i>Grindelia camporum</i>	Great Valley gumweed	perennial herb	Asteraceae	y
<i>Helianthus annuus</i>	common sunflower	annual herb	Asteraceae	y
<i>Heliotropium curassavicum</i> var. <i>oculatum</i>	seaside heliotrope	perennial herb	Boraginaceae	y
<i>Hemizonia congesta</i>	hayfield tarweed	annual herb	Asteraceae	y
<i>Heterotheca grandiflora</i>	telegraph weed	annual, perennial herb	Asteraceae	y
<i>Hirschfeldia incana</i>	shortpod mustard	perennial herb	Brassicaceae	n (m)
<i>Hordeum murinum</i>	wall barley	annual herb	Poaceae	n (m)
<i>Juglans</i> sp.	walnut	tree	Juglandaceae	n
<i>Juglans hindsii</i> (hybrids)	Northern California black walnut hybrids	tree	Juglandaceae	n
<i>Juncus</i> sp.	rush	herb	Juncaceae	both
<i>Juncus effusus</i>	soft rush	perennial herb	Juncaceae	y
<i>Juniperus</i> sp.	juniper	shrub, tree	Cupressaceae	both
<i>Lactuca serriola</i>	prickly lettuce	annual herb	Asteraceae	n (nl)
<i>Lepidium latifolium</i>	broadleaved pepperweed	perennial herb	Brassicaceae	n (h)
<i>Liquidambar styraciflua</i>	sweetgum	tree	Hamamelidaceae	n (nl)
<i>Lotus</i> sp.	trefoil	herb	Fabaceae	both
<i>Lotus corniculatus</i>	bird's-foot trefoil	perennial herb	Fabaceae	n (nl)
<i>Ludwigia hexapetala</i>	six petal water primrose	perennial herb	Onagraceae	n (h)
<i>Ludwigia peploides</i>	floating primrose willow	perennial herb	Onagraceae	y
<i>Ludwigia</i> sp.	primrose-willow	herb	Onagraceae	both
<i>Lupinus</i> sp.	lupine	herb	Fabaceae	y
<i>Lupinus bicolor</i>	miniature lupine	annual, perennial herb	Fabaceae	y
<i>Malvella leprosa</i>	alkali-mallow	perennial herb	Malvaceae	y
<i>Melilotus albus</i>	white sweetclover	annual, biennial	Fabaceae	n (nl)

SPECIES	COMMON NAME	LIFEFORM	FAMILY	NATIVE (YES OR NO ¹)
		herb		
<i>Mentha pulegium</i>	pennyroyal	perennial herb	Lamiaceae	n (m)
<i>Mimulus</i> sp.	monkeyflower	herb	Phrymaceae	y
<i>Morus alba</i>	white mulberry	tree	Moraceae	n (nl)
<i>Nicotiana acuminata</i> var. <i>multiflora</i>	manyflower tobacco	annual herb	Solanaceae	n (nl)
<i>Nicotiana glauca</i>	tree tobacco	tree, shrub	Solanaceae	n (m)
<i>Oenothera elata</i>	Hooker's evening primrose	perennial herb	Onagraceae	y
<i>Oreostemma alpigenum</i> var. <i>andersonii</i>	tundra aster	perennial herb	Asteraceae	y
<i>Paspalum dilatatum</i>	dallis grass	perennial herb	Poaceae	n (nl)
<i>Phalaris arundinacea</i>	reed canary grass	perennial herb	Poaceae	y
<i>Phoradendron</i> sp.	mistletoe	shrub (parasitic)	Viscaceae	y
<i>Phyla nodiflora</i>	turkey tangle fogfruit	perennial herb	Verbenaceae	y
<i>Pinus</i> sp.	pine	tree	Pinaceae	both
<i>Pinus ponderosa</i>	ponderosa pine	tree	Pinaceae	y
<i>Platanus racemosa</i>	western sycamore	tree	Platanaceae	y
<i>Pluchea odorata</i> var. <i>odorata</i>	salt marsh fleabane	annual, perennial herb	Asteraceae	y
<i>Polygonum</i> sp.	knotweed	herb	Polygonaceae	both
<i>Polypogon monspeliensis</i>	annual beard grass	annual herb	Poaceae	n (l)
<i>Populus fremontii</i> ssp. <i>fremontii</i>	Fremont cottonwood	tree	Salicaceae	y
<i>Quercus agrifolia</i>	coast live oak	tree	Fagaceae	y
<i>Quercus lobata</i>	valley oak	tree	Fagaceae	y
<i>Robinia pseudoacacia</i>	black locust	tree	Fabaceae	y
<i>Rosa californica</i>	California rose	shrub	Rosaceae	y
<i>Rubus armeniacus</i>	Himalayan blackberry	vine, shrub	Rosaceae	n (h)
<i>Rubus ursinus</i>	California blackberry	vine, shrub	Rosaceae	y
<i>Rumex</i> sp.	dock	herb	Polygonaceae	both
<i>Rumex crispus</i>	curly dock	perennial herb	Polygonaceae	n (l)
<i>Salicornia pacifica</i>	Pacific swampfire	perennial herb	Chenopodiaceae	y
<i>Salix exigua</i>	narrowleaf willow	tree, shrub	Salicaceae	y
<i>Salix gooddingii</i>	Goodding's black willow	tree	Salicaceae	y
<i>Salix laevigata</i>	red willow	tree	Salicaceae	y
<i>Salix lasiolepis</i>	arroyo willow	tree, shrub	Salicaceae	y
<i>Salvia</i> sp.	sage	herb, shrub	Lamiaceae	both
<i>Sambucus nigra</i> ssp. <i>caerulea</i>	blue elderberry	shrub	Adoxaceae	y
<i>Schoenoplectus acutus</i> var. <i>occidentalis</i>	common tule	perennial herb	Cyperaceae	y
<i>Schoenoplectus californicus</i>	southern bulrush	perennial herb	Cyperaceae	y
<i>Sesbania punicea</i>	scarlet sesban	shrub	Fabaceae	n (h)
<i>Silybum marianum</i>	blessed milkthistle	annual, perennial herb	Asteraceae	n (l)
<i>Solidago</i> sp.	goldenrod	herb	Asteraceae	both
<i>Spergularia</i> sp.	sandspurry	herb	Caryophyllaceae	both
<i>Stachys</i> sp.	hedgenettle	herb	Lamiaceae	both

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SPECIES	COMMON NAME	LIFEFORM	FAMILY	NATIVE (YES OR NO ¹)
<i>Stachys albens</i>	whitestem hedgenettle	perennial herb	Lamiaceae	y
<i>Symphotrichum</i> sp.	aster	herb	Asteraceae	both
<i>Tamarix</i> sp.	tamarisk	tree, shrub	Tamaricaceae	n (h)
<i>Taraxia ovata</i>	goldeneggs	perennial herb	Onagraceae	y
<i>Typha latifolia</i>	broad-leaved cattail	perennial herb (aquatic)	Typhaceae	y
<i>Urtica dioica</i>	stinging nettle	perennial herb	Urticaceae	y
<i>Verbascum</i> sp.	mullein	herb	Scrophulariaceae	n
<i>Vicia</i> sp.	vetch	herb	Fabaceae	both
<i>Xanthium strumarium</i>	cocklebur	annual herb	Asteraceae	y