Lower Cosumnes River Watershed Assessment

December 2006

Photos by The Nature Conservancy and Robertson-Bryan, Inc.,

Lower Cosumnes River Watershed Assessment

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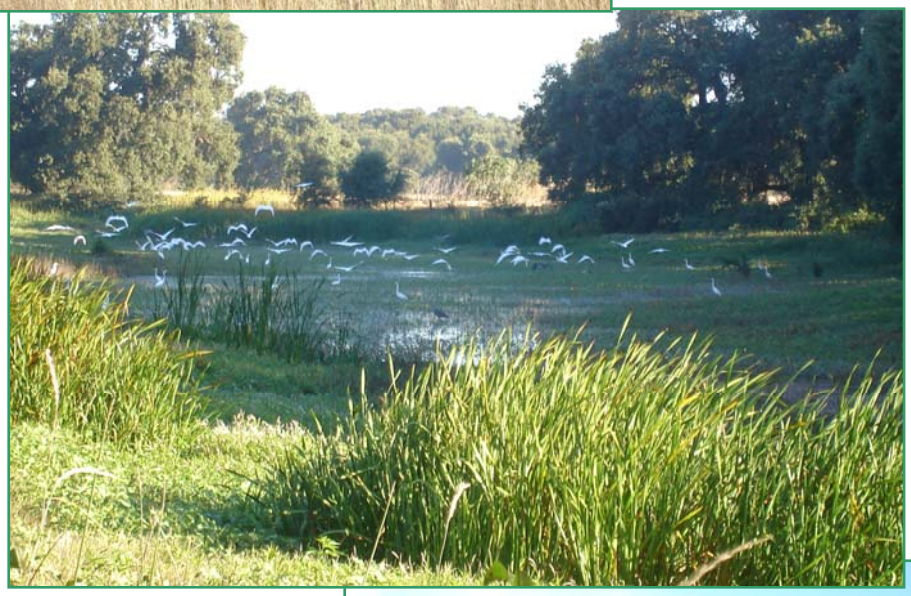
Table of Contents

List of Tables

List of Figures

List of Appendices



1 Introduction

The Lower Cosumnes River Watershed Assessment has been prepared to support the Cosumnes River Preserve Management Plan, which is being developed by the Cosumnes River Preserve. This assessment characterizes the physical processes, land uses, habitats, and wildlife in the Cosumnes River watershed. Specific emphasis is given to the lowest portion of the watershed, which includes the Cosumnes River Preserve—the largest land manager in the lower Cosumnes River watershed. The Cosumnes River Preserve is a cooperative partnership of the following entities:

- The Nature Conservancy
- Ducks Unlimited
- Sacramento County Department of Parks and Recreation
- California Department of Fish and Game
- California Department of Water Resources
- State Lands Commission
- Bureau of Land Management

The Cosumnes River Preserve and its Partners are dedicated to:

- Safeguarding and restoring the finest remaining example of a California valley oak riparian (streamside) ecosystem and its surrounding habitats.
- Restoring and creating freshwater wetlands to increase the Pacific Flyway's populations of migratory waterfowl.
- Demonstrating the compatibility of human uses—particularly agriculture, recreation, and education—with the natural environment.

1.1 Purpose and Intended Use of the Document

In 2006, the Preserve and its Partners embarked on a process to develop a comprehensive Management Plan that would guide future management activities. This watershed assessment has been prepared to support that process by compiling information on the various resources that could affect or would be affected by this management plan.

This document provides a baseline characterization of the current physical, biological, and cultural resources associated with the Cosumnes River. More specifically, the Lower Cosumnes River Watershed Assessment provides: (1) a summary of key documents, data sources, and

experts consulted, regarding the resources of the Cosumnes River; and (2) a summary of the current and historical state of these systems:

- to further our understanding of floodplain functions in the lower Cosumnes River watershed,
- to guide the development of management strategies for the Preserve and its important physical and biological resources, and
- to form the basis for evaluating potential management actions against documented current conditions.

1.2 DOCUMENT ORGANIZATION

The following sections summarize many technical and scientific documents, as well as numerous local, state, and federal databases.

Section 2 provides an overview of the geographic boundaries of the entire watershed, including a more detailed description of the Cosumnes River Preserve management area.

Section 3 provides a general characterization of the hydrology, floodplain topography and geomorphology, and water resources of the lower Cosumnes River watershed.

Section 4 provides a more focused characterization of the lower watershed and of the Preserve management area. This characterization includes a description of local land uses; biological resources, including vegetation, wildlife, and aquatic resources; cultural resources; and an overview of key restoration projects and research studies.

2 Geographic Scope

The following sections provide an overview of the geography of the Cosumnes River watershed. This overview is provided at two levels—a watershed level that provides a general description of the entire watershed, and a more specific overview of the Cosumnes River Preserve management area in the lower reach of the watershed.

2.1 General Watershed Characteristics

The Cosumnes River watershed covers approximately 940 square miles (approximately 600,000 acres), from its headwaters in the Sierra Nevada to its confluence with the Mokelumne River in the Sacramento-San Joaquin Delta (Figure 2-1). Elevations in the watershed range from a peak of 7,500 feet to slightly below mean sea level (msl) in the Delta. The watershed boundaries abut the American River watershed to the north and east, the Mokelumne watershed to the south, and the Delta to the west (Figure 2-1). The watershed includes portions of El Dorado, Amador, and Sacramento counties.

The Cosumnes River is notable because it is the only major Sierra Nevada stream system without a major dam on its mainstem or major tributaries. Thus, it retains a relatively natural flow regime of high flows in winter and very low flows in summer (Mount et al. 2001). Sly Park Reservoir is the only major impoundment in the upper watershed, but it does not have an appreciable effect on flows. This reservoir is located on Camp Creek, a tributary of the North Fork Cosumnes River. It has a storage capacity of 41,000 acre-feet (ac-ft) and supplies water northward to the El Dorado Irrigation District in the American River basin.

The Cosumnes watershed crosses the Sierra Nevada and Central Valley physiographic provinces (Figure 2-2). The upper watershed is in the Sierra Nevada province, while the lower watershed is in the Central Valley province. Moyle et al. (2003) described several distinct segments of the watershed, based on geologic, hydrologic, and land use/land cover characteristics, as follows.

The upper watershed is in the Sierra Nevada province, which includes steep-gradient, bedrock-controlled perennial streams that start in montane meadows (Segments V-VIII, Figure 2-2). Above Highway 49 the Cosumnes River is divided into three tributaries—the North, Middle, and South Forks. The upper watershed supports approximately 172,000 acres of conifer forest (29% of the total watershed) (JSA 2003). Ponderosa pine forest is the dominant vegetation community, with some red fir montane forest in the uppermost region near the headwaters (ESA 1991). The Sierra Nevada today is a mixture of private and public lands, mainly El Dorado National Forest, as well as some Bureau of Land Management holdings.

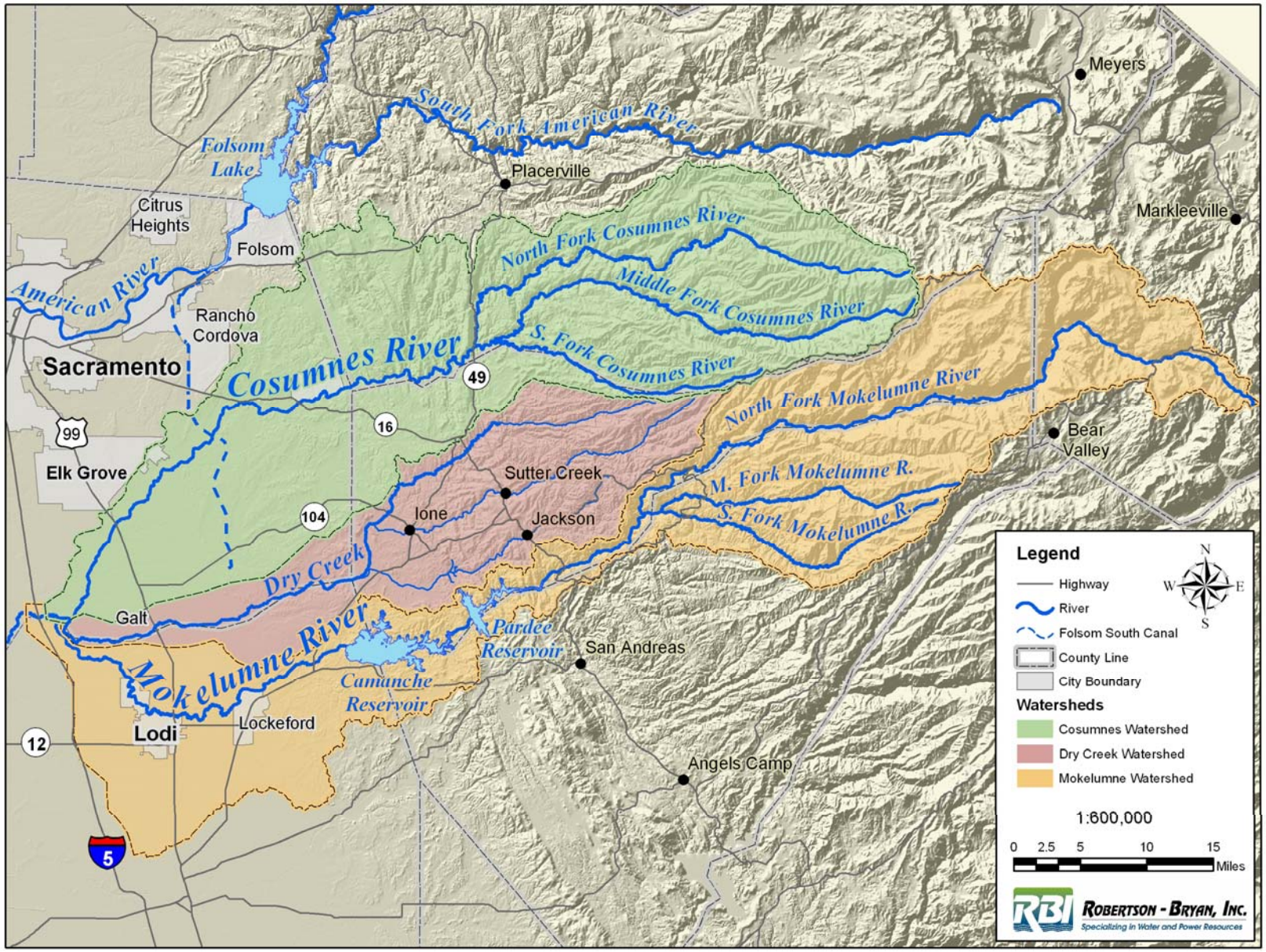
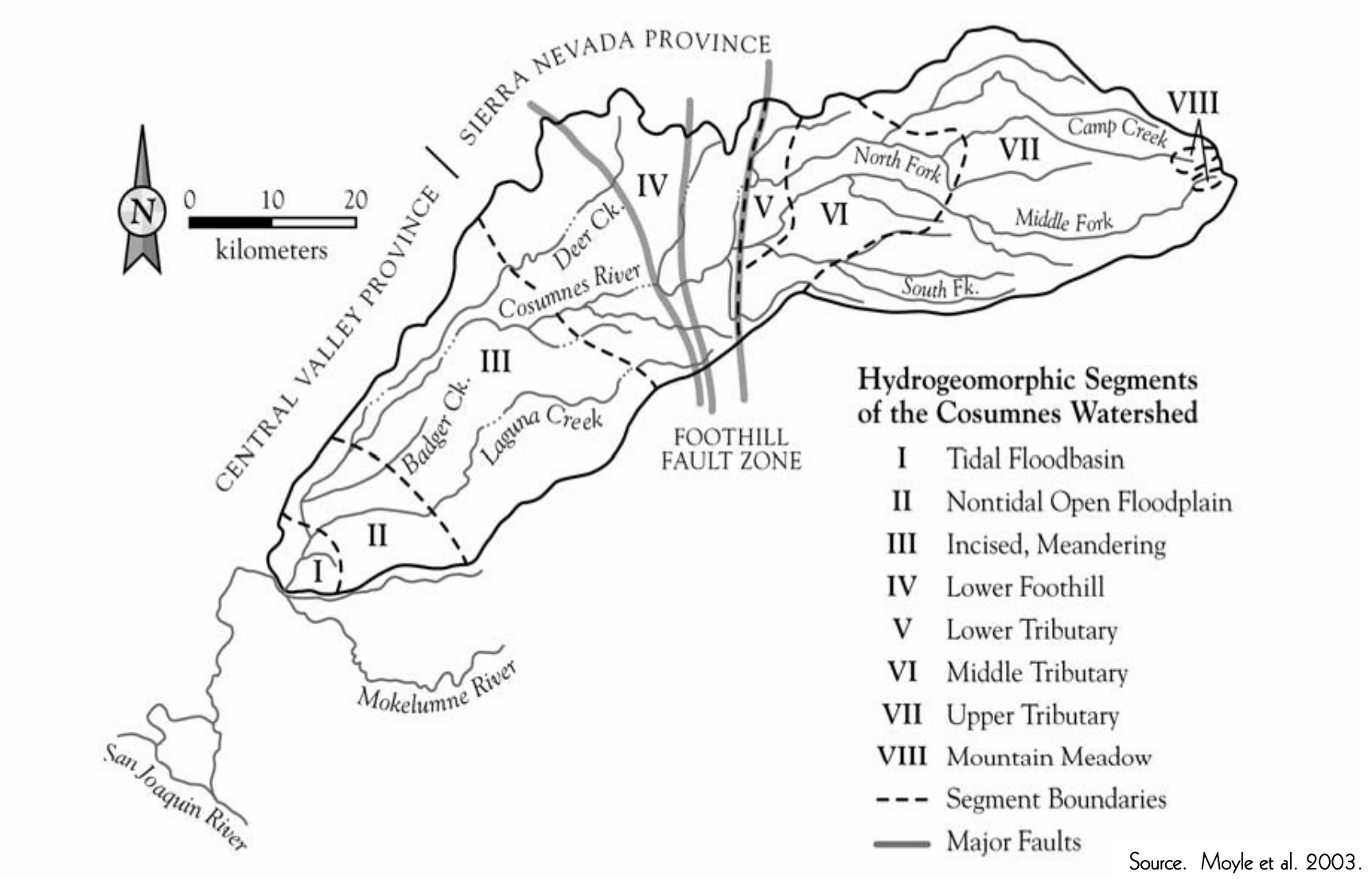


Figure 2-1. Cosumnes River, Dry Creek, and Mokelumne River watersheds.



Source. Moyle et al. 2003.

Figure 2-2. Cosumnes River watershed showing the major geologic regions, fault zones, and stream raches.

The uppermost watershed has been extensively logged and crossed by roads. Significant land use/land cover change is taking place in the lower reaches of these tributaries (Segments V-VI, Figure 2-2), principally associated with vineyards, grazing, and urbanization (Moyle et al. 2003).

The three forks of the Cosumnes converge near Highway 49 to form the mainstem Cosumnes River (Segment IV). Flows in the foothill mainstem reach are perennial, but typically low by late summer. Portions of this reach were heavily altered by hydraulic mining during the late 1800s and by gold dredging of stream placers in the 1900s. Latrobe Falls, the largest cascade in the entire watershed and the uppermost limit for migrating salmon, is close to the downstream boundary of the upper watershed. The middle portion of the watershed supports approximately 120,000 acres of oak woodlands and chaparral, which make up approximately 20% of the watershed. This area is largely privately owned. Land use today is dominated by grazing, with minor urbanization. The middle and upper watershed supports roughly 7,000 acres of vineyards, including the Shenandoah Valley region.

The lower watershed is in the Central Valley province, which contains the low-gradient, alluvial sections of river that are linked to broad floodplains that make up much of the valley floor (Moyle et al. 2003). Land use in the lower watershed includes over 50,000 acres (8%) of cropland and nearly 16,000 acres (2%) of orchards and vineyards (JSA 2003). The river segment from Highway 16 down to Highway 99 is an incised meandering channel (Segment III, Figure 2-2) that is lined with agricultural levees and limited riparian vegetation. Historically, the floodplain was dominated by riparian forest, grassland, and oak savannah. Today, almost all the adjacent floodplain is used for vineyards and irrigated row crops, with scattered single-family homes.

The river channel below Highway 99 is less incised (PWA 1997). Discontinuous low-levees and riparian forests flank the channel. Flow in the nontidal, open floodplain reach of the Cosumnes decreases rapidly during the summer, typically becoming discontinuous by late August due to lowered groundwater conditions (Mount et al. 2001).

The tidal flood basin segment (Segment I, Figure 2-2) includes the portion of the Cosumnes from the confluence with the Mokelumne River, upstream to the limits of tidal influence (Twin Cities Road bridge). Historically, the river here consisted of multiple, shifting channels in a broad floodplain, which supported a mosaic of aquatic and terrestrial habitats, including riparian forest, seasonal and perennial wetlands, permanent sloughs, and seasonal floodplain lakes. Today, much of the tidally influenced floodplain is farm fields protected by low levees that do not prevent seasonal flooding. The Cosumnes River Preserve, located in the lowest reach of the watershed, has remnant valley oak riparian woodlands and is an important wintering area for waterfowl.

In addition to the mainstem Cosumnes River, several tributaries drain into the lower watershed—Deer Creek, Badger Creek, and Laguna Creek (Figure 2-2). Of these tributaries, Deer Creek is the largest and drains an area of low foothills approximately 9 miles northeast of Highway 16. Historically, Deer Creek and the Cosumnes River were part of the same connected floodplain downstream of Dillard Road, but are now separated by a system of levees.

Dry Creek, another major tributary to the Cosumnes River, drains about 348 square miles of the Sierra Nevada and Central Valley provinces between the Cosumnes and Mokelumne watershed (Figure 2-1). The upper Dry Creek watershed has a peak elevation of approximately 3,300 feet msl in an area characterized by relatively steep slopes. Dry Creek historically connected to the Mokelumne River, but was routed through Grizzly Slough to the Cosumnes River before 1910, when levees along the lower Cosumnes and Mokelumne rivers were constructed to convert sloughs and wetlands to arable land (PWA 2004). The watershed spans several elevational vegetation zones, from coniferous forests in the upper elevations, to valley oak riparian bottomlands in the lower portion.

2.2 Cosumnes River Preserve Management Area

The Nature Conservancy (TNC) and its partners—Ducks Unlimited, Sacramento County Department of Parks and Recreation, California Department of Fish and Game, Department of Water Resources, Bureau of Land Management, and the State Lands Commission established the Cosumnes River Preserve in 1987. By 1998 the Preserve included some 13,000 acres. Today, lands protected by these different organizations total approximately 45,600 acres.

A variety of habitats, including riparian forest, oak woodlands, valley grasslands, seasonal and perennial wetlands, tidal wetlands and agricultural lands, are found in the Preserve. The Preserve provides public access to the river and the surrounding riparian areas and opportunities to hike designated trails, kayak through sloughs, and observe wildlife that inhabit one of the last remaining tracts of bottomland riparian forest in the Central Valley.

3 Watershed Characterization

3.1 Hydrology

Federal, state, and local agencies have prepared numerous hydrologic and hydraulic studies on the Cosumnes River and the North Delta. Initial surveys of these watersheds date back to the 1860s and streamflow, stage, and climate data have been recorded since the early 1900s. Agencies conducting regional hydrologic and hydraulic studies include the U.S. Army Corps of Engineers (USACE), the U.S. Geological Survey (USGS), Omochumne-Hartnell Water District (OHWD), the California Department of Water Resources (DWR), TNC, and other local agencies. Relevant hydrologic and hydraulic studies that have been completed to date are listed in Appendix A, Cosumnes-Mokelumne Rivers Floodplain Reports and Studies.

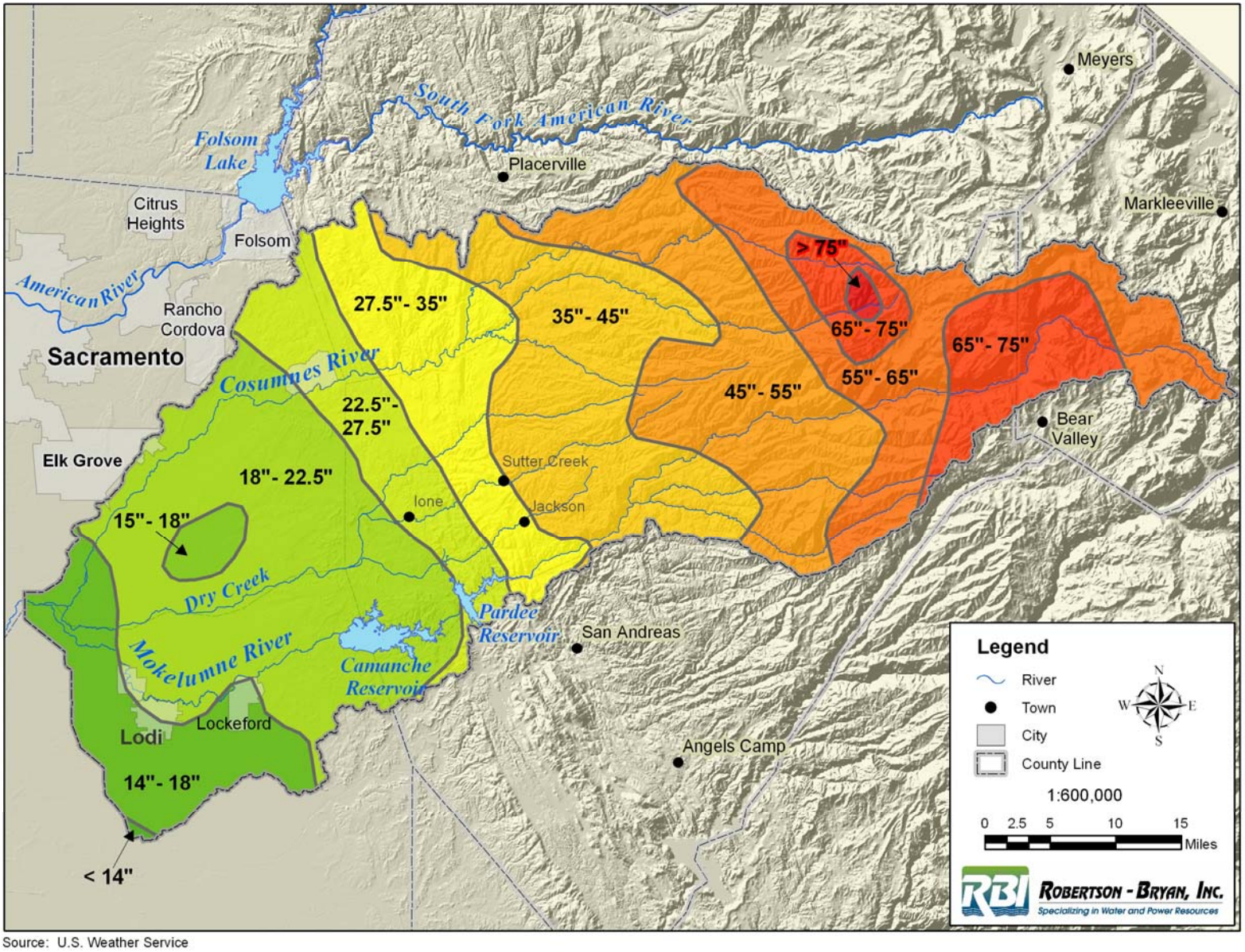
Past studies of the Cosumnes River watershed focused on the physical, biologic, and aquatic characteristics of the watersheds. Physical studies include assessments of the hydrologic, hydraulic, and geomorphic processes observed in the watershed with the purpose of developing a better understanding of these physical processes. A summary description of these processes in the study area, based on the results of studies cited in Appendix A, is presented in the following sections.

3.1.1 Precipitation

Winter storms account for about 80% of the annual precipitation in the Cosumnes River watershed. The mean annual precipitation ranges from about 22 inches at the foothill line (approximately 500 feet msl) to 60 inches in the upper portion of the watershed. Mean annual precipitation over the watershed is shown in Figure 3-1.

Figure 3-2 shows the typical monthly precipitation pattern for the valley floor region (Lodi, elevation 40 feet msl), the foothill region (Camp Pardee near Pardee Reservoir, elevation 658 feet msl, and Sly Park Reservoir, elevation 3,350 feet msl) over the Cosumnes and Mokelumne River watersheds.

USACE reports, and other studies suggest, that rain-on-snow events, rather than just snow melt, historically resulted in floods with the greatest peak runoff in the Cosumnes River watershed. However, the Cosumnes River watershed typically does not receive significant amounts of snowfall because of its low peak elevation and, therefore, most floods are caused by intense rainfall events (Sacramento County Water Agency 2005).



Source: U.S. Weather Service

Figure 3-1. Mean annual precipitation for the Cosumnes and Mokelumne river watersheds.

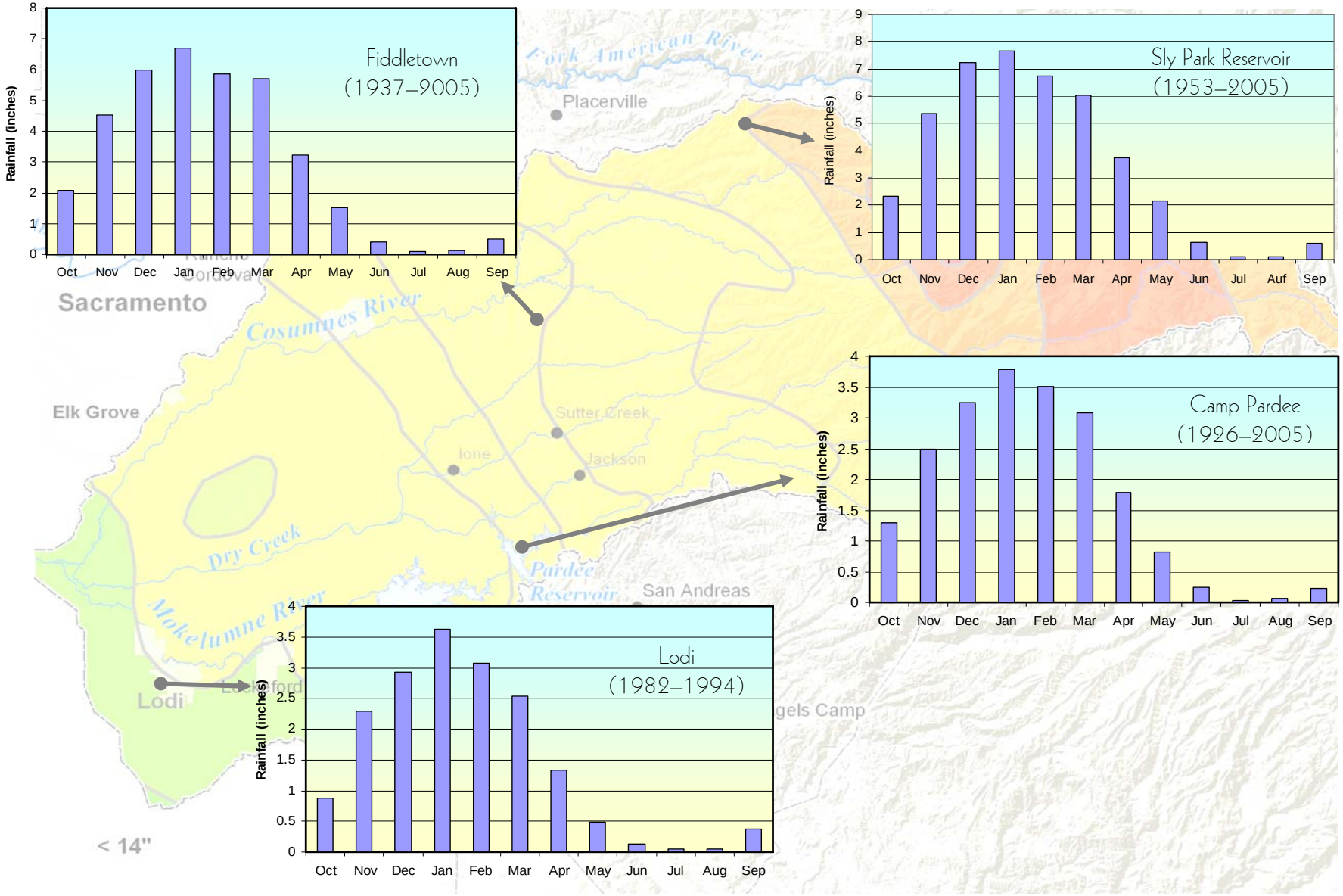


Figure 3-2. Typical average monthly precipitation at various locations in the Cosumnes and Mokelumne watersheds.

3.1.2 Historical Flow Patterns

Cosumnes River flows are primarily the result of winter storms, with limited seasonal snow melt. Only about 16% of the watershed lies above the typical snow-level elevation of 5,000 feet. Consequently, only a small portion of the upper reaches of the watershed receive significant snowfall, and the flow regime of the river is influenced primarily by rainfall.

Historically, below Highway 16 (river mile [RM] 33), the Cosumnes was hydraulically connected to the regional groundwater aquifer, making this segment of the river a "gaining river." The lack of precipitation during the summer reduced flows in the valley segment to near zero. However, the input of groundwater to the river channel historically kept the channel and associated wetland areas wet throughout the summer for the entire length of the river. Over the past 60 years, groundwater pumping has reduced groundwater levels in the valley segment, leading to a decline of groundwater input to the river and eventually making the river a "losing river." The groundwater table underlying the Cosumnes has fallen as much as 60 feet in some areas and has become disconnected from the river channel in this valley segment. Mount et al. (2001) estimated that the seepage loss from the Cosumnes River on the valley floor is on the order of 1–2 cubic feet per second (cfs) per river mile

Declining groundwater levels have caused the Cosumnes River to become completely dewatered from Highway 16 downstream to the tidally influenced reach of the river, below Twin Cities Road, during the summer and fall in all but the wettest years. A comparison of historical data from the USGS gauges at Michigan Bar (RM 36) and McConnell (RM 11) from 1941 to 1982 suggest that flow volumes in the valley segment of the Cosumnes have steadily decreased, despite no appreciable change in precipitation. Mount et al. (2001) showed that the number of days per year with average daily flows below 10 cfs at McConnell (downstream) has increased more than at Michigan Bar (upstream) from 1941 to 1982, indicating that flows losses between these two gauges has increased. Mount linked these losses to declining groundwater levels, which decreased and ultimately eliminated baseflow contribution from the regional groundwater aquifer to the Cosumnes River channel.

The historical average daily flow of the Cosumnes River at Michigan Bar is shown in Figure 3-3 for water years 1960–2004. The Michigan Bar gauge is located at river mile 33, where the river transitions from a bedrock-confined channel of the foothills to a broader channel on the low gradient alluvial floodplain. The average monthly flow pattern of the Cosumnes River is shown in Figure 3-4 and Table 3-1 provides the average monthly flow by water year type for the 1960–2004 period of record. The information presented in these figures and table shows that flows in August through October are typically below 30 cfs. When flows fall below 30 cfs at Michigan Bar, the Cosumnes River is generally dry below Highway 16 because of groundwater seepage and evaporation.

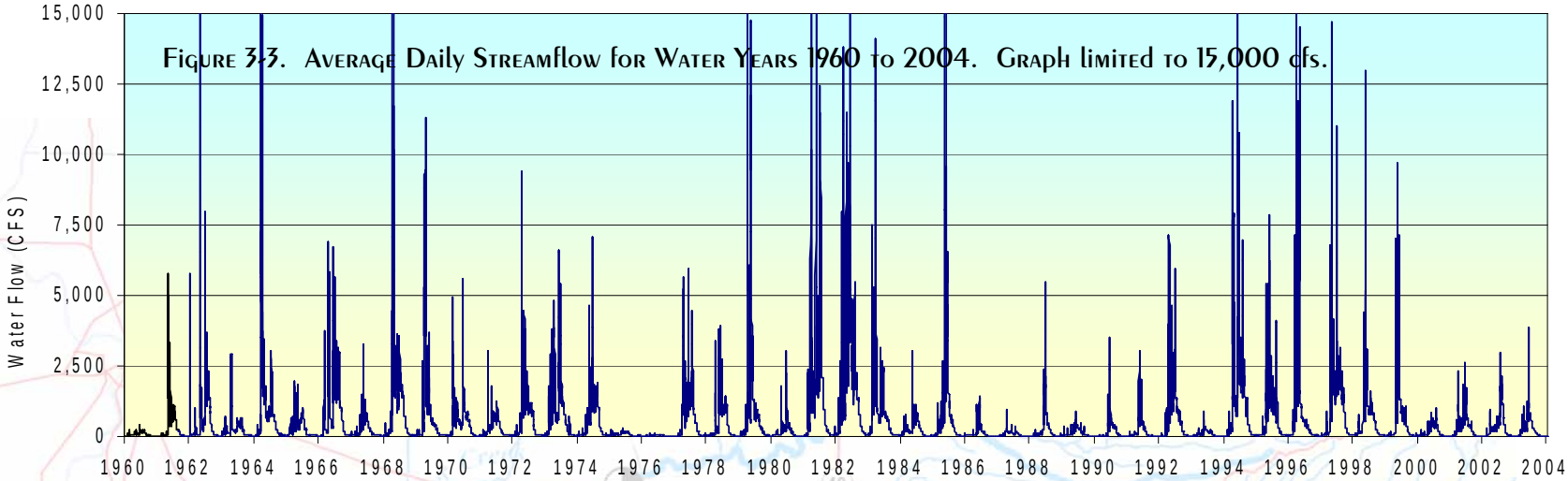


Figure 3-3. Average Daily Streamflow for Water Years 1960 to 2004. Graph limited to 15,000 cfs.

Cosumnes River
USGS Gauge at Michigan Bar

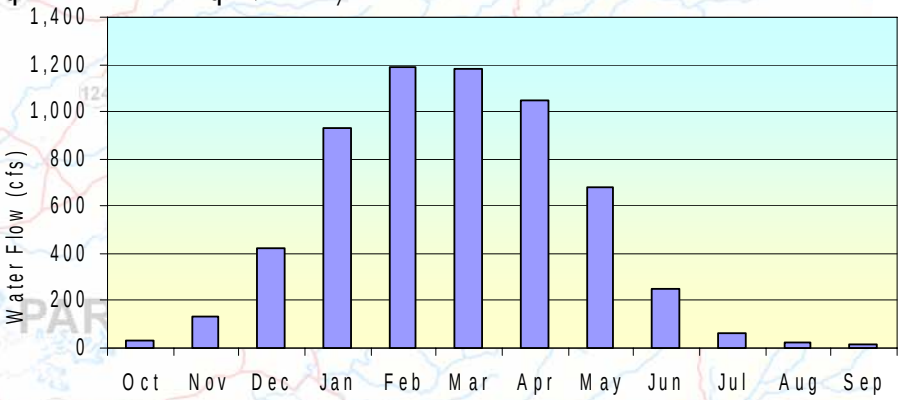


Figure 3-4. Average Monthly Streamflow for Water Years 1960 to 2004.

Table 3-1. Average Monthly Streamflow by Water Year Type for Water Years 1960 to 2004.

Water Year Type	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual Flow
	cubic feet per second												*acre-feet*
Period Average	31	137	425	931	1,188	1,182	1,047	683	250	60	20	15	357,082
Wet	43	193	819	1,916	1,935	1,902	1,597	1,101	435	113	38	27	606,221
Above Normal	29	245	410	1,103	1,489	1,463	1,105	753	257	57	19	15	414,960
Below Normal	26	94	309	419	1,025	815	1,048	586	199	45	17	10	273,638
Dry	23	74	140	219	536	703	617	371	106	21	7	7	168,859
Critical	22	34	74	121	222	350	288	194	80	13	3	2	84,146

3.1.3 Historical Peak flows and Floods

The USGS (1998) published flood recurrence intervals for the Cosumnes River based on more than 90 years of record from the Michigan Bar gauge (1907 to 1997). The USGS also extrapolated flood frequency data downstream to selected sites on the Cosumnes River. The data developed by the USGS is presented in Table 3-2, along with the peak flows for the January 2, 1997, the flood of record. The 1997 peak flow of 93,000 cfs has an estimated recurrence interval of 150 years.

flood recurrence interval

The average interval of time within which a flood of a given magnitude will be equaled or exceeded. For example, the chance that a flood with a 100-year recurrence interval will occur in any given year is 1 in 100 (a one percent probability or frequency).

During the period of record for the Michigan Bar gauge, 24 peak flow events of 22,500 cfs (5-year recurrence level) or greater have occurred. The dates and peak flows for these events are listed in Table 3-3. Of the peak flows recorded at Michigan Bar between 1907 and 1997, only two events were greater than a 50-year flow of 66,800 cfs—the 1907 flow of 71,000 cfs and the 1997 flow of 93,000 cfs, the latter which also exceeded the expected 100-year flow of 82,900 cfs. The peak flow of 1907 occurred before the Michigan Bar gauge was operational and was estimated from high-water marks. Seven years experienced peak flows greater than the expected 10-year flow (34,200 cfs) and below the 50-year flow, all occurring since 1955.

Table 3-2. Peak flows at selected recurrence intervals and locations on the Cosumnes River.

Cosumnes River location	Flow recurrence interval and annual exceedence probability (in parentheses) (cfs)					
	5-year (0.2)	10-year (0.1)	50-year (0.02)	100-year (0.01)	500-year (0.002)	Jan 2, 1997
Cosumnes River at Michigan Bar	22,500	34,200	66,800	82,900	125,000	93,000
Folsom South Canal	23,660	35,900	70,100	86,900	131,000	97,500
Wilton Road Bridge	24,400	37,000	72,200	89,500	134,800	100,000
Highway 99 at McConnel, including Deer Creek.	28,800	43,500	84,500	104,500	157,100	117,000

Major floods on the Cosumnes River and its major tributaries—Deer, Laguna, and Dry creeks—occurred as a result of intense precipitation events. Most of the damage that occurs from floods on the Cosumnes River results from levee failures, land erosion, and silt deposition, which causes damage to agriculture and roads. A few selected major flood events on the Cosumnes River are described below.

Table 3-3. Hourly peak flow events equal to or exceeding the 5-year recurrence interval (22,500 cfs).

Date	Peak flow (cfs)
March 19, 1907	71,000
January 13, 1909	28,400
January 31, 1911	28,400
February 21, 1917	22,900
February 6, 1925	23,800
March 25, 1928	22,900
March 31, 1940	26,200
January 27, 1942	24,500
March 10, 1943	22,900
November 18, 1950	27,600
December 23, 1955	42,000
April 3, 1958	29,300
February 1, 1963	39,400
December 23, 1964	37,500
January 21, 1969	22,500
January 13, 1980	34,200
February 16, 1982	37,000
March 13, 1983	26,100
February 17, 1986	45,100
March 11, 1995	24,400
January 2, 1997	93,000
February 3, 1998	29,700
December 31, 2005	35,100
April 4, 2006	32,600

November – December 1950 Storm

Several storms hit the Sierra Nevada between November 18 and December 10, 1950. The peak hourly flow of 27,600 cfs on the Cosumnes River caused levee breaks along the north bank in the Sloughhouse area. Approximately 17,600 acres of agricultural land were flooded along the Cosumnes River from Sloughhouse to its confluence with the Mokelumne River. An additional 3,900 acres were flooded along Dry Creek. The damage from this flood was estimated at $234,000, based on the dollar values at the time of the flood (USACE 1991).

There was a total of 43,600 acres inundated in the combined Cosumnes and Mokelumne floodplains, causing approximately $1.9 million in damages (based on dollar values at the time of the flood) to agricultural lands and equipment, pastures and livestock, and state and county roads and bridges (USACE 1991).

December 1955 Storm

The storm of December 1955 resulted in the second highest measured peak flow up to this time on the Cosumnes River—42,000 cfs. Deer and Dry creeks experienced peak flows of 13,000 cfs and 17,000 cfs, respectively. The flood caused 30 levee breaks along the Cosumnes River, flooding approximately 24,900 acres from Highway 16 to the confluence with the Mokelumne River (USACE 1991). Flooded lands were mostly cultivated and grazing lands. In addition to the agricultural damages, state and county roads and bridges were damaged. Approximately 5,200 acres were flooded along Dry Creek as a result of a peak flow of 17,000 cfs. Total damages along the Cosumnes River were estimated at $1.4 million, based on dollar values at the time of the flood.

A total of 57,600 acres were inundated in the combined Cosumnes and Mokelumne floodplains, causing approximately $2.8 million in damages (based on dollar values at the time of the flood)

to agricultural lands and equipment, pastures and livestock, and state and county roads and bridges (USACE 1991). No deaths were directly related to the flood.

February 1986 Storm

The storm of February 12–20, 1986, caused widespread flooding throughout northern California. The Cosumnes River experienced a peak flow of 45,100 cfs and a three-day volume of 198,000 ac-ft. Approximately 21,700 acres were inundated along the Cosumnes River, causing $1.6 million in damages, based on dollar values at the time of the flood. A peak flow of 30,300 cfs was recorded on Dry Creek, with a corresponding three-day volume of 98,000 ac-ft, both of which are the largest of the 51-year period of record for Dry Creek.

There was a total of 59,000 acres inundated in the combined Cosumnes and Mokelumne floodplains, causing an estimated $20 million dollars in damage, based on dollar values at the time of the flood (USACE 1991).

January 1997 Storm

Between December 26, 1996, and January 2, 1997, 19 inches of rain fell in Sacramento, and up to 30 inches fell in parts of the central Sierra Nevada. The storm resulted in the highest peak flow of record on the Cosumnes River—93,000 cfs—and caused 24 levee breaks along the river. Approximately 24,000 acres and 80 homes were inundated (Cosumnes River Task Force 2002). The Sacramento County Agricultural Commissioner estimated that financial losses to county agriculture reached $13 million.

3.2 FLOODPLAIN TOPOGRAPHY AND GEOMORPHOLOGY

The lower Cosumnes River floodplain (below Highway 16 at RM 32.7) occupies a broad alluvial fan formed from aggradation of detrital sediments transported west from the Sierra Nevada block. As the Sierran block was uplifted and tilted west, rivers draining the western Sierran slope cut deep canyons and deposited large quantities of sediment in the Great Central Valley. Over geologic time, this process formed a single extensive alluvial plain occupying all but

river mile [RM]

River mile numbers increase from downstream to upstream. Cosumnes River RM 0 is the confluence with the Mokelumne. Mokelumne River RM 0 is the confluence with the San Joaquin River.

the tidal portions of the California Trough (Piper et al. 1939) or what is now known as the Central Valley.

Although the Cosumnes River retains a largely unaltered hydrograph, the geomorphology of the river and floodplain has been considerably changed since the 1850s due to land use and flood management activities (rev. in Florsheim and Mount 2003). This system was historically an interconnected network of multiple river channels, with flows that regularly overtopped the banks. Since 1849, however, major anthropogenic disturbances have altered the river hydrogeomorphology and floodplain topography. Hydraulic mining and other erosive land uses resulted in excessive sedimentation that filled the stream channel. Levees constructed in the early 1900s confined flows, increased channel incision, and isolated the floodplain from its sediment source and channel network (PWA 1997). Since the 1920s, much of the floodplain has been cleared of riparian vegetation, levelled, and converted to agriculture.

The following description of floodplain topography and geomorphology is presented here by river section as delineated by major road crossings. Appendix B contains detailed topographic maps of the study area. The major road crossings of the lower Cosumnes River are:

- Highway 16 (RM 32.7)
- Dillard Road (RM 27.5)
- Wilton Road/Central California Traction Company railroad (RM 17.3)
- Highway 99 (RM 11.0)
- Twin Cities Road (RM 5.1)

3.2.1 Dillard Road to Wilton Road

The Cosumnes River and Deer Creek floodplains join immediately below Dillard Road (RM 27.5). Between Dillard Road and Wilton Road (RM 17.3) the floodplain width varies from 1 to 3 miles (Appendix B. Map 1). The headwaters of Deer Creek, a network of approximately six tributary streams, drain a low elevation foothill area approximately 9 miles northeast of Highway 16. In this segment, the Cosumnes River has five mostly unnamed tributaries entering from the east at RM 23.5, 22.3, 19.3, and 17.8. Several of these tributaries have small impoundments that store winter runoff for summer irrigation, livestock watering, and fire protection.

Historically, Deer Creek and the Cosumnes River were part of the same connected floodplain downstream of Dillard Road. Historical cross-section data show no topographic separation of these two watercourses in the floodplain (Constantine et al. 2004). The present day Cosumnes River, and to a lesser extent, Deer Creek, is separated from the floodplain by levees. During high flow events, the water level in the Cosumnes River channel can be over 10 feet higher than that of the floodplain.

Figure 3-5 shows a typical floodplain cross-section (looking downstream) between river miles 27.5 and 18. This figure shows the levees adjacent to the Cosumnes River are 15 feet above the floodplain. The right bank levee, which isolates the river from the floodplain along this entire segment, is up to 30 feet above the adjacent floodplain in some areas. The left bank levees are separate and much smaller, with heights of about 8–15 feet. Because Deer Creek has a much smaller drainage than the Cosumnes River, its levees are also smaller, and intermittent. Levees associated with Deer Creek, typically along its left bank, only reach heights of approximately 5 feet above the adjacent floodplain. Reclamation District 800 maintains the levees in this river segment from approximately RM 26 to RM 12.

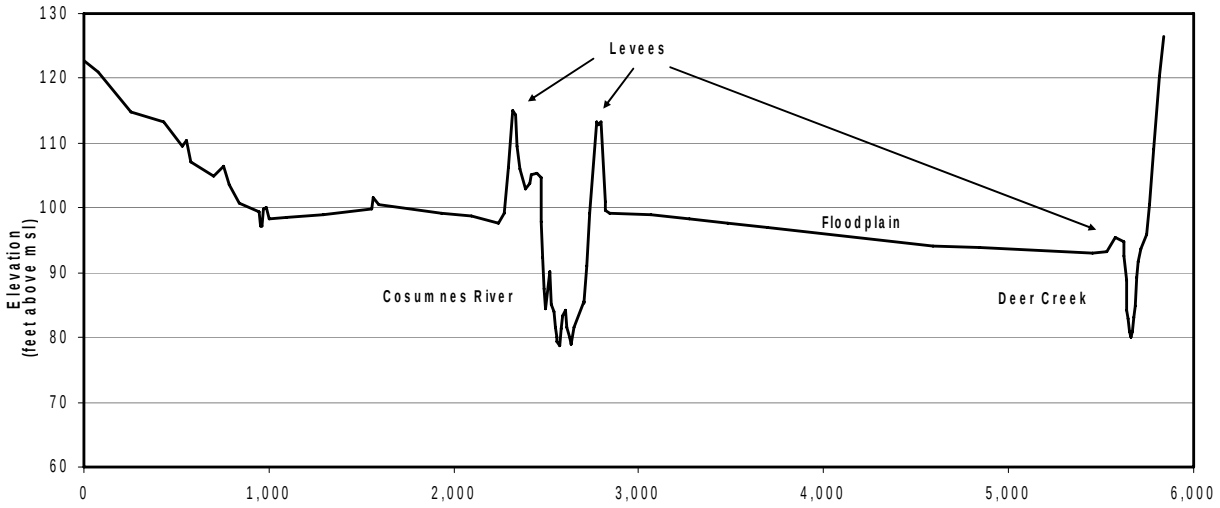


Figure 3-5. Profile of the Cosumnes River and Deer Creek floodplain at RM 25.4.

Flows confined by levees induce scour, causing this segment of the river to incise from 10–15 feet below the level of the floodplain. This incised river channel can convey high flows of 30,000 to 40,000 cfs, preventing floodplain inundation, except during extreme events (JSA 2003).

River bed substrate in this river segment alternates between alluvium—cobbles, gravel and sand—and duripan, an interglacial paleosoil typically well cemented and resistant to erosion. Incision changed the river morphology from an alluvial regime to a "rock-controlled" channel by exposing resistant duripan layers. This affects the erosion-depositional regime of the river by reducing transient sediment storage bedforms, such as riffles, the lack of which results in all suspended bed material being transported downstream. Recent studies suggest that the river is in the process of adjusting to incision through bank failure and channel widening (Constantine 2001).

The river slope between Dillard Road and Wilton Road is approximately 4.2 feet per mile (Appendix B, Map 1). Two seasonal diversion dams, at RM 23 and RM 24, control local channel elevation by creating deposition upstream of the structures (JSA 2003).

There are three river crossings in this section—Dillard Road (RM 27.5), Folsom South Canal (RM 22.9), and the Wilton Road-Central California Traction Company bridge complex (RM 17.4). The Dillard Road bridge crossing is perpendicular to the river channel with cylindrical piles supporting a concrete bridge deck that is above the 100-year flood level. The pilings and bridge abutments impede water flow and raise the upstream water surface elevation during normal seasonal events, causing the flows to slow and deposit sediment, as evidenced by the sand bar and vegetation immediately upstream of the bridge.

The Folsom South Canal is perpendicular to the floodplain, but does not obstruct flow in Cosumnes River or Deer Creek channels because the canal is piped beneath the channels by siphons. Between the Cosumnes River and Deer Creek, however, the canal is located on a raised levee that traverses the floodplain and diverts all floodplain flows to Deer Creek. Figure 3-6 shows a profile of the floodplain at RM 23.1 immediately upstream of the Folsom South Canal. Figure 3-7 provides an aerial view of the Cosumnes River floodplain for the same area shown in Figure 3-6. The aerial view shows the Cosumnes River and its right bank levee, the floodplain on the right, and the Folsom South Canal siphon crossing under the river.

The Wilton Road bridge impedes flow in the Cosumnes River channel by decreasing the channel width and reducing channel capacity. Because of the reduced capacity and the absence of levees on the right bank, high flows are allowed to flow from the river channel through a bypass channel toward Deer Creek. As high flows are redirected into the bypass channel, which was created by a sand and gravel mining operation and now known as the Wilton Bypass, sediment is deposited in the floodplain and in the main channel.

3.2.2 Wilton Road to Highway 99

The upland area adjacent to the floodplain is 7 to 15 feet above the floodplain and is drained by two small tributaries on the east side at RM 17.0 and RM 15.0. Two tributaries on the west side of the floodplain drain into Deer Creek (Appendix B. Map 2) The floodplain and river channel along this segment of the river are similar to the Dillard Road to Wilton Road segment, although channel capacity is significantly reduced to 6,000 cfs downstream of Wilton Road (JSA 2003). Downstream of the Cosumnes River Overflow Channel (RM 13) the river is less confined and there are no levees along the left bank, which, when combined with reduced channel capacity, allows high flows to spread out and inundate the floodplain below the overflow channel. Two seasonal diversion dams, at RM 12.7 and 16.6, also affect the channel elevation, causing shallower stream slopes immediately upstream and slightly steeper slopes immediately downstream of the dams.

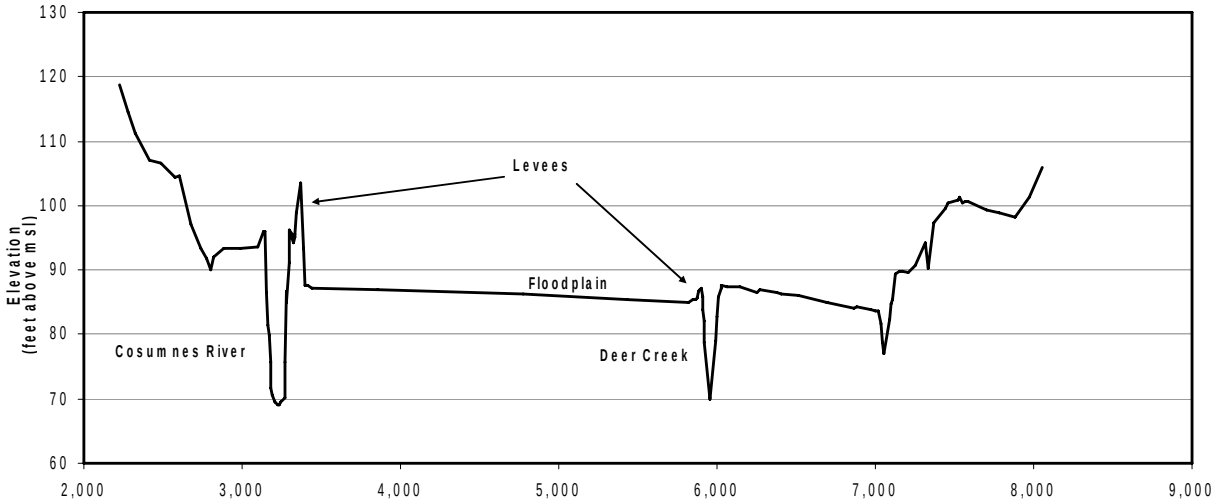


Figure 3-6. Profile of Cosumnes River and Deer Creek floodplain at RM 23, upstream of the Folsom South Canal.

Figure 3-7. Aerial view of the Cosumnes River, floodplain, and Folsom South Canal looking west.

The Cosumnes River Overflow channel (RM 13) allows overflow from the Cosumnes River to flow east and downstream toward Highway 99. Figure 3-8 shows the cross section of the incised river channel with no levee on the right bank of the Cosumnes River and a levee on the left bank of the Overflow Channel equal to the height of the floodplain. A third channel (middle channel) at RM 11.2, about 1.5 miles downstream of the Overflow Channel, allows additional flows to spread out to the east. Deer Creek enters the Cosumnes River directly across from the middle channel (Appendix B. Map 3 and 4). Figure 3-9 provides an aerial view of the Cosumnes River, Deer Creek, and middle channel.

From Highway 99 (RM 11) to the confluence, the Cosumnes has a large number of small drainages, canals, sloughs and seasonal lakes. The east side of the Cosumnes River has the most tributaries, including the Cosumnes River Overflow (RM 9.3), Badger Creek (RM 8.1), Laguna Creek (RM 4.7), Dead Man Gulch (RM 4.7), and two unnamed drainages at RM 9.5 and RM 4.0 (Appendix B. Map 3 and 4). From the south, Bear and Grizzly Slough merge and enter the Cosumnes River at RM 1.9 (Appendix B. Map 4). Historically, Grizzly Slough only drained a small area south of the Cosumnes floodplain, but Dry Creek was realigned in the early 1900s into Grizzly Slough, which now drains a much larger area encompassing the Dry Creek watershed. West of the river, several small unnamed channels drain agricultural areas of the floodplain into the Cosumnes at RMs 7.0, 5.1, 4.0, and 1.6. Willow Slough drains into the Cosumnes at RM 0.2 and Lost Slough drains into the Mokelumne River downstream of the confluence at Mokelumne RM 22.0.

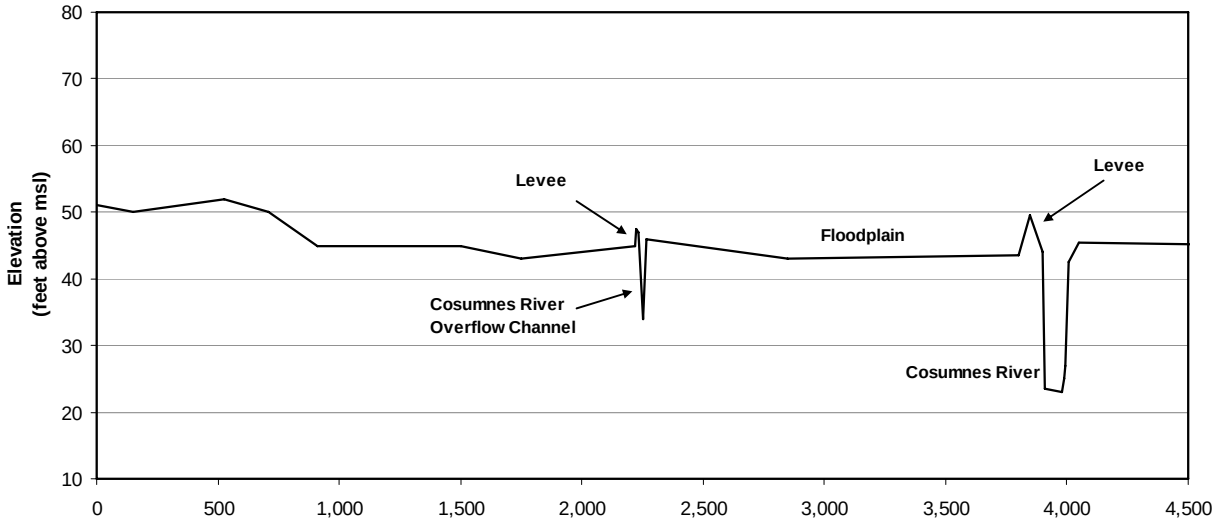


Figure 3-8. Profile of the Cosumnes River floodplain at RM 12, showing the Cosumnes River Overflow Channel.

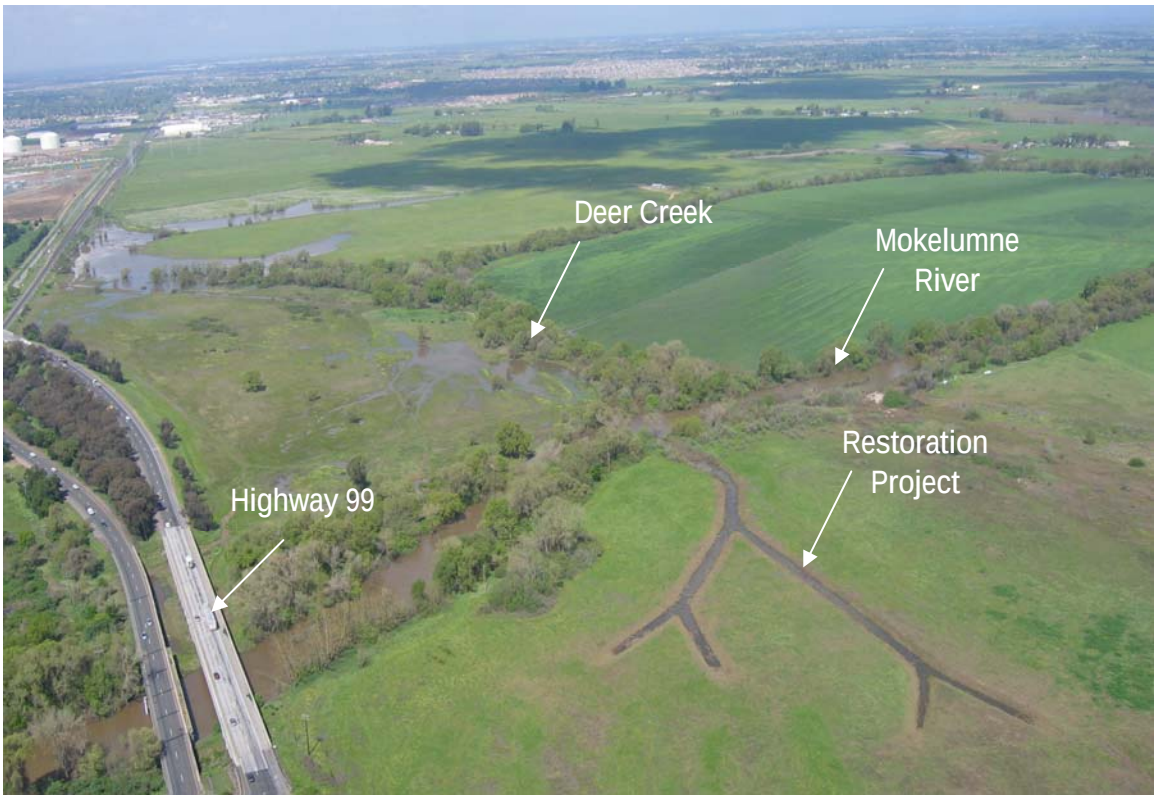


Figure 3-9. Cosumnes River looking north above Highway 99 showing the confluence with Deer Creek.

Abutments for the Highway 99 bridges (RM 11.0), the Southern Pacific Railroad bridge (RM 10.9) and the Twin Cities Road bridges (RM 5.1), which cross the floodplain, impede high flows. Downstream of the confluence of the Cosumnes, middle channel, and Cosumnes Overflow channels (near RM 9), moderate to high flows frequently inundate the floodplain because the river channel is less incised than the upstream reaches and some levees are set back several hundred feet from the channel. Figure 3-10 provides an aerial view of this segment of the Cosumnes River at an estimated flow of 10,000 cfs on March 25, 2005. As the photo shows, the Cosumnes River in this section does not have significant levees and at flows of this magnitude, extensive flooding occurred near Twin Cities Road. Relative to upstream reaches, channel capacity is reduced, varying from 300 to 1,500 cfs in this portion of the floodplain (JSA 2003).

Figure 3-11 shows levees on the right bank set back several hundred feet from the channel with the river confined on the left side of the floodplain by gradually sloping hills. Badger Creek is located in the left portion of the cross section. This cross section illustrates a geomorphically diverse floodplain with multiple flow channels. The complexity of the floodplain is also illustrated at Twin Cities Road (RM 5.1) where five bridges span multiple sloughs and channels (Appendix B. Map 4).

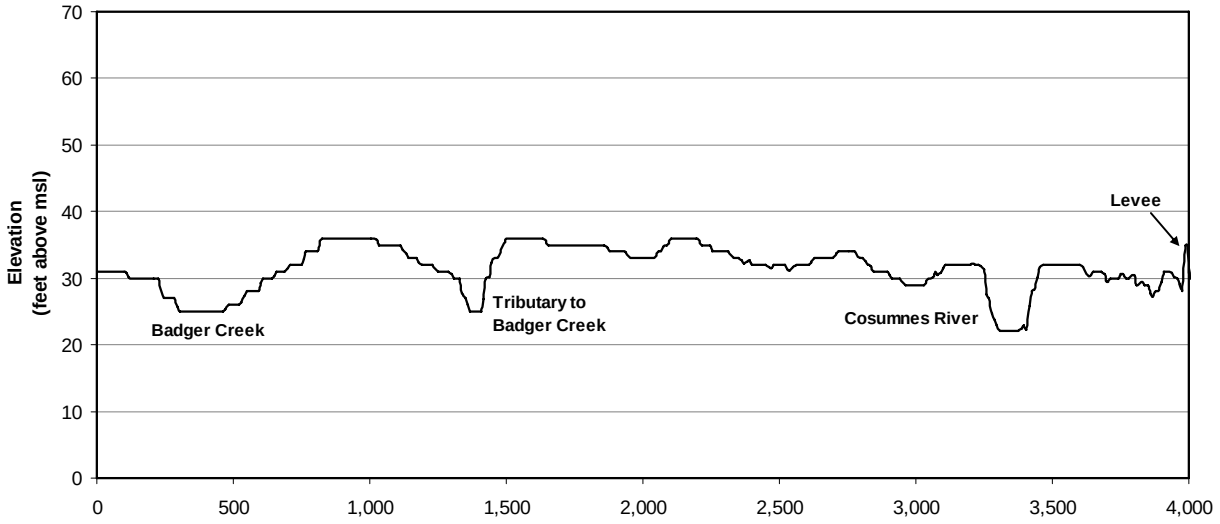


Figure 3-10. Cosumnes River at a flow of approximately 10,000 cfs on March 25, 2005.

Figure 3-11. Profile of the Cosumnes River floodplain at RM 8.1, including Badger Creek.

Upstream of Twin Cities Road, the river channel and bed material is composed of sand and gravel with frequent duripan outcrops (JSA 2003). Below Twin Cities Road, the channel becomes tidally influenced with low gradients where bed material is predominantly sand because the river flows can no longer transport coarse material.

Downstream of Twin Cities Road, intentional and accidental levee breaches in the Cosumnes River Preserve by TNC have caused the formation of sand splay complexes in the floodplain. TNC and UCD have conducted numerous studies in this section of the river, carrying out extensive geomorphic mapping that documents the processes and landforms associated with overbank flooding and levee removal and breeching. These studies indicate that erosion of bed sediment occurs in the main channel above levee breaches and deposition occurs in the channel downstream of a levee breach

3.3 WATER RESOURCES

Since the early 1900s surface water and groundwater resources in the watershed have been used for irrigation, drinking water, and power generation. The water resources of the Cosumnes provides water for individual irrigators in the agricultural areas in the valley floor segment of the river. While the Cosumnes provides domestic water supplies for foothill communities, such as Rancho Murieta in Sacramento County, river flow is sporadic and sediment loaded, which makes it an unreliable and costly water source.

SURFACE WATER RIGHT

A surface water right is a legal right or contract entitlement to water which is not guaranteed in all hydrologic year types. The State Water Resources Control Board (SWRCB) has established and maintains a system of water rights in California to best develop, conserve, and utilize in the public interest the water resources of the state while protecting vested rights, water quality, and the environment. A database containing water rights applications and license records is maintained by the SWRCB and can be found at www.waterrights.ca.gov.

Groundwater is used extensively for irrigation and domestic uses, which began in the early 1900s. Domestic groundwater use increased substantially over the past 20 years as Sacramento County experienced increases in suburban development into areas that have been traditional agricultural land. Increased groundwater pumping resulted in substantial declines in the water table in many areas of the lower Cosumnes watershed.

Overlapping the study area are a number of public districts and agencies with some jurisdiction over water resources. Only those with a direct connection to the Cosumnes river floodplain are discussed in the following section. Figure 3-12 illustrates the numerous districts and agencies in the study area.

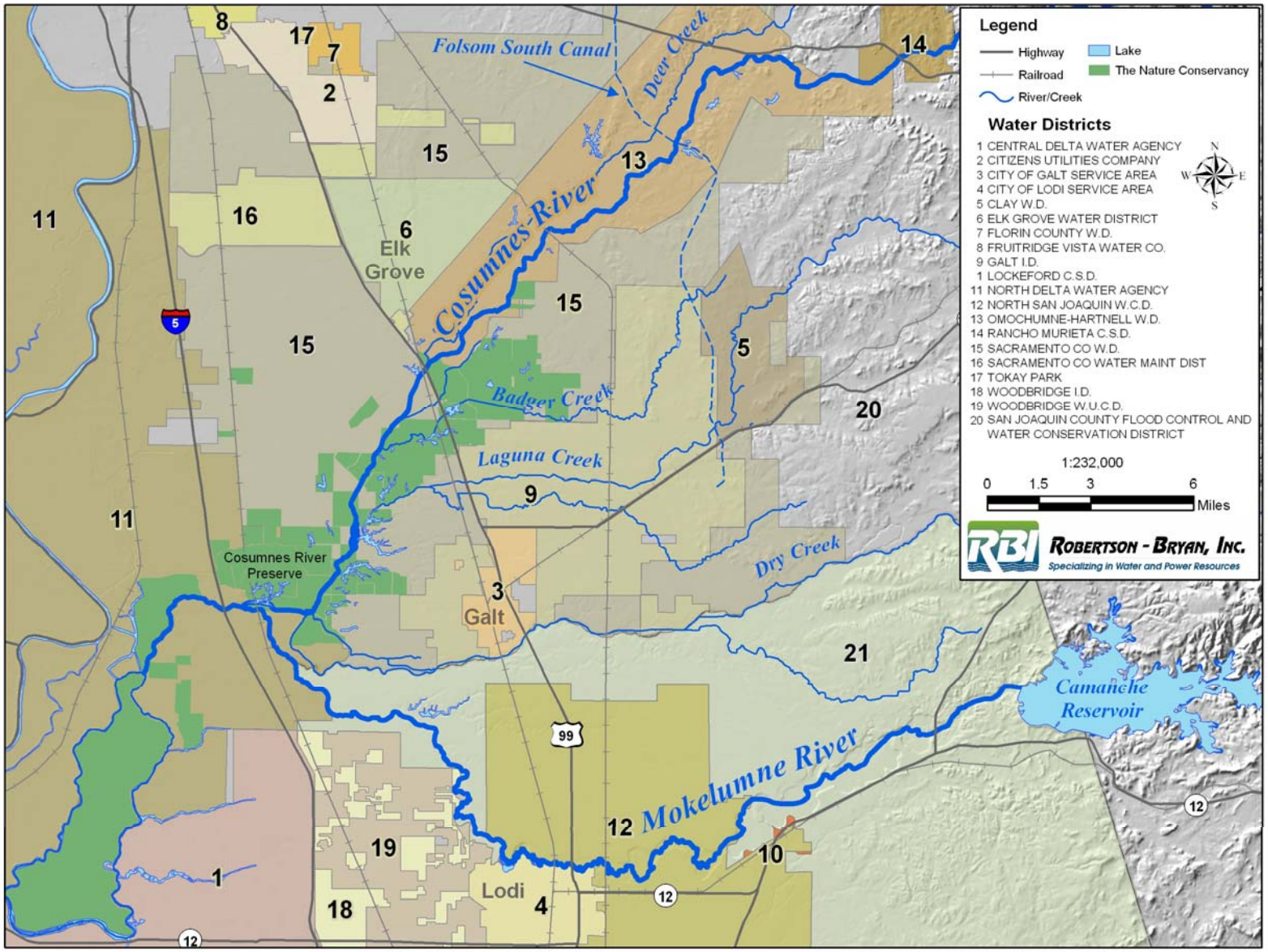


Figure 3-12. Water Districts in the study area.

The following section, Surface Water Resources, describes surface water resources, water supply infrastructure, groundwater resources, flood protection structures, and water quality in the study area. Information from a variety of sources was reviewed and incorporated into this section, with much of the information provided by recently completed groundwater management plans and water supply master plans prepared for Sacramento County.

3.3.1 Surface Water Resources

SWRCB records show there are approximately 133 active water rights applicants and licenses, representing an annual entitlement of up to 5,700 ac-ft in the lower Cosumnes River watershed. The principal uses for these rights is stock watering, irrigation, domestic use, fish and wildlife protection and enhancement, fire protection, and recreation. In addition to these private water rights, RMCSD holds multiple surface water rights on the Cosumnes River.

3.3.1.1 **Omochumne-Hartnell Water District**

Omochumne-Hartnell Water District (OHWD) boundaries extend north and south of the Cosumnes River. The district does not hold any surface water rights, but in the past has purchased surplus water from the USBR for use by irrigators adjacent to the Cosumnes River. Water purchased from the USBR was either delivered through the Folsom South Canal from Folsom Reservoir or from Sly Park Reservoir on Sly Park Creek, tributary to North Fork Cosumnes River. OHWD infrastructure is limited to four seasonal flashboard dams on the Cosumnes that historically facilitated diversions to riparian users. Currently, OHWD operates these dams under low flow conditions (< 25 cfs) in the summer to increase the wetted perimeter of the river channel and increase groundwater recharge. In recent years, riparian diverters significantly reduced their use of riparian water because of unreliable flows and because of increased use of drip irrigation, which requires sediment-free water, in vineyards and orchards—the dominant crops in the Cosumnes River-Deer Creek floodplain.

Water rights in the study area are almost exclusively riparian rights. These riparian entitlements are dependent on the variable seasonal flow of the Cosumnes River. As explained in previous sections, flows in the Cosumnes River cease during the summer to early fall months, corresponding to irrigation season for agriculture along the river. Under these conditions, the reported annual entitlement for riparian users within OHWD of 5,700 ac-ft is not typically fully utilized. A more accurate estimate is about 500 to 3,250 ac-ft per year by riparian users on the lower Cosumnes River (Sacramento County Water Agency 2005).

3.3.1.2 **Rancho Murieta Community Services District**

RMCSD has an annual entitlement of up to 4,500 ac-ft for municipal, agricultural, recreational, industrial, environmental, and stock-watering usage. RMCSD's water rights stipulate that diversions can occur only between November 1 and May 31 when flows exceed 76 cfs as

measured at the Michigan Bar gauge. Diversions by Rancho Murieta have steadily increased since 1989, corresponding with increased development in the Rancho Murieta community. Rancho Murieta diverted a total of 2,061 ac-ft in 2003.

RMCSD diverts Cosumnes River flows at Granlee's Dam (RM 34), where water is pumped into Lake Chesbro, Lake Calero, and Lake Clementia, which have a combined total storage capacity of 4,400 ac-ft.

RMCSD provides domestic supplies through a surface water treatment plant located at Lake Clementia, which has a total production capacity of 3.5 million gallons per day. The district regulates the treated supply with two water storage tanks with a total storage capacity of 4.2 million gallons.

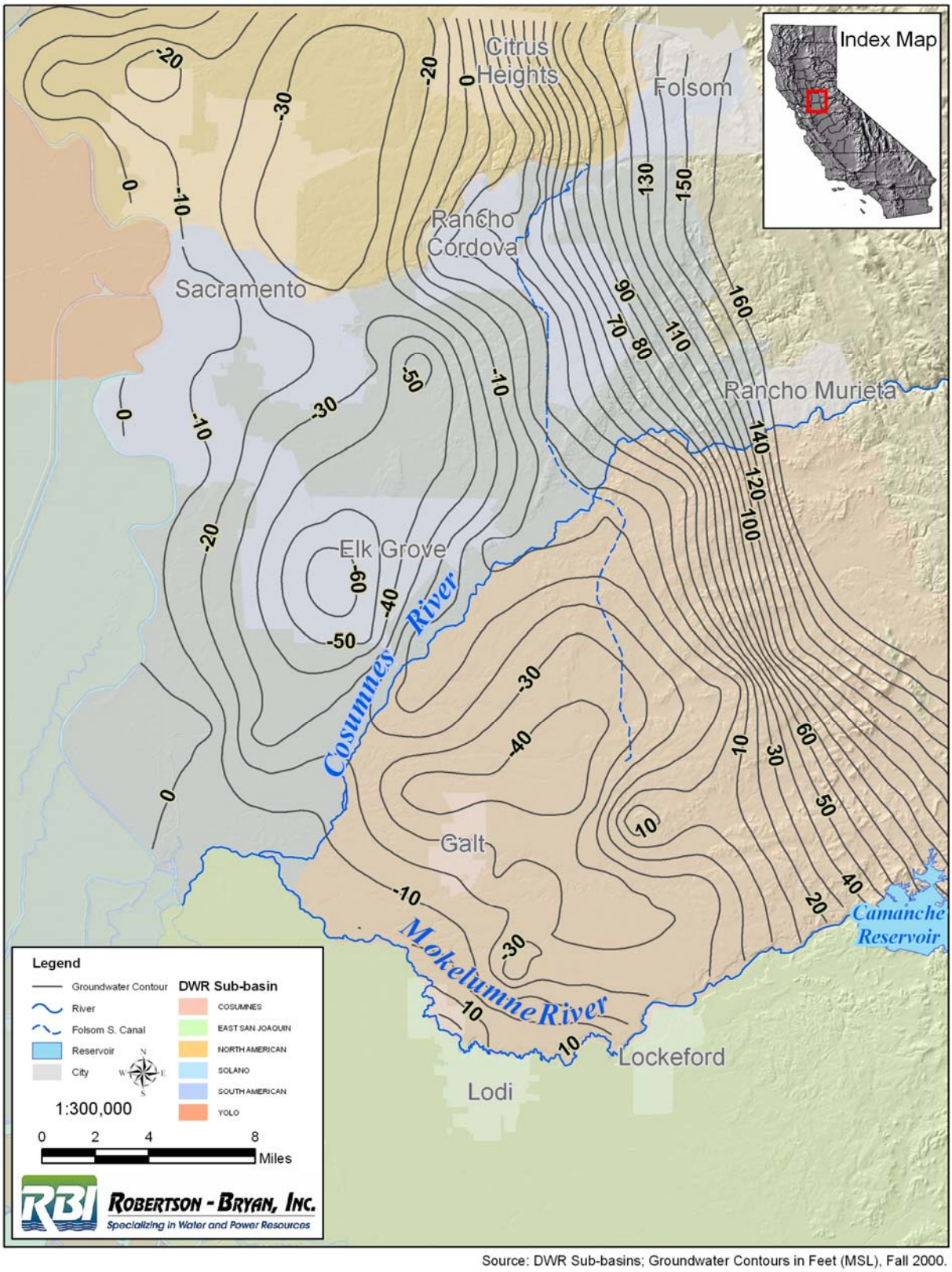
3.3.2 Groundwater Resources

DWR's Bulletin 118: California's Groundwater (DWR 2003) includes a description of all the major groundwater basins in California, including the Sacramento and San Joaquin basins. Recently, Sacramento County Water Agency, San Joaquin County Flood Control and Water Conservation District, and UCD completed additional studies (Mount et al. 2001).

The study area is located in the Sacramento and San Joaquin Valley groundwater basins of the Central Valley. In the larger Sacramento Groundwater Basin, the study area is further divided into smaller groundwater subbasins between the American River and the Mokelumne River. These subbasins include the South American Sub Basin (DWR Basin Number 5-21.65) and the Cosumnes Sub Basin (DWR Basin Number 5-22.16).

Water-bearing units in the study area include both recent alluvial deposits located in active stream channels and floodplains, as well as consolidated rocks of the Laguna, Victor, and Mehrten Formations . In these basins, groundwater is typically found in distinct shallow and deep aquifer zones. In general, the shallow aquifer extends 200–300 feet below ground surface with good water quality, except for the detection of arsenic in a few locations. The shallow aquifer is separated from the deep aquifer by a discontinuous clay layer that acts as a semi-confining layer for the deep aquifer. The deep aquifer has an average thickness of 1,600 feet, but typically produces water with higher TDS, iron, and manganese (City of Lodi 2004). Historically, the study area relied on groundwater from both the shallow and deep aquifers for agricultural, industrial, and residential water supplies.

Measured groundwater levels in the basin have shown a regional decrease in groundwater elevations characterized by areas of depressed groundwater elevations, termed "cones of depression," as shown in Figure 3-13. The cones of depression have formed north an south of the Cosumnes River, with groundwater levels as low as 80 feet below msl.



Source: DWR Sub-basins; Groundwater Contours in Feet (MSL), Fall 2000.

Figure 3-13. Groundwater contour map of the IRMP study area.

UC Davis researchers assessed groundwater and surface water interactions along the lower Cosumnes River (Mount et al. 2001). A nework of 33 existing irrigation and domestic wells was monitored between April 2000 and October 2001. The groundwater depression caused a hydraulic disconnect with the river channel (up to 55 below the river channel near Wilton Road). This makes the Cosumnes River a losing stream between Highway 16 and Twin Cities Road. Surface water-groundwater interaction simulations indicate that the average loss from seepage and evapotranspiration in the summer and early fall is about 1-2 cfs per river mile. This assessment established that the declining fall flows in the lower Cosumnes River are due in part to the loss of groundwater contribution to base flow.

Groundwater studies completed as part of the Zone 40 Water Supply Master Plan (WSMP) include an assessment of the central portion of Sacramento County, which includes portions of Elk Grove and Rancho Cordova and the 1993 Sacramento County General Plan Urban Policy Area (Sacramento County Water Agency 2005). The foundation for the WSMP is the Water Forum Agreement, including agreed-upon long-term average groundwater yields for each of the three sub-areas of the groundwater basin in Sacramento County. These limits include annual groundwater extractions of 131,000 ac-ft for the North Area sub-basin, 273,000 ac-ft for the Central Area sub-basin, and 115,000 ac-ft for the Galt Basin area. Figure 3-14 shows the delineation of these subbasins as defined by the Water Forum Agreement. At the prescribed average annual extraction rate of 273,000 ac-ft for the Central Area, groundwater modeling completed by the county predicted groundwater elevations at the Elk Grove cone of depression would stabilize at approximately 50 feet below existing levels. This would not, however, reconnect surface water with groundwater.

3.3.3 Flood Protection Facilities

On the Cosumnes River, which has no significant reservoir capacity, flood protection is limited to a system of levees built by landowners. Reclamation District 800 maintains the levees in a portion of the Cosumnes River. The result of this limited level of flood protection is frequent and sometimes devastating floods along the lower Cosumnes River. Appendix C provides maps of the levee system in the Cosumnes River watershed.

Private, non-engineered levees and berms, owned and maintained by private landowner associations and public districts, line the Cosumnes River and Dry Creek. Reclamation District 800 maintains most of the right-bank levees along the northwest side of the Cosumnes River upstream of Wilton Road to Sloughhouse. On Dry Creek discontinuous private levees and berms are located from below Highway 99 at the Franklin Road Pond, to approximately 10 miles upstream. The town of Thornton, part of New Hope Tract located east of Interstate 5, is surrounded by approximately 19 miles of levees.

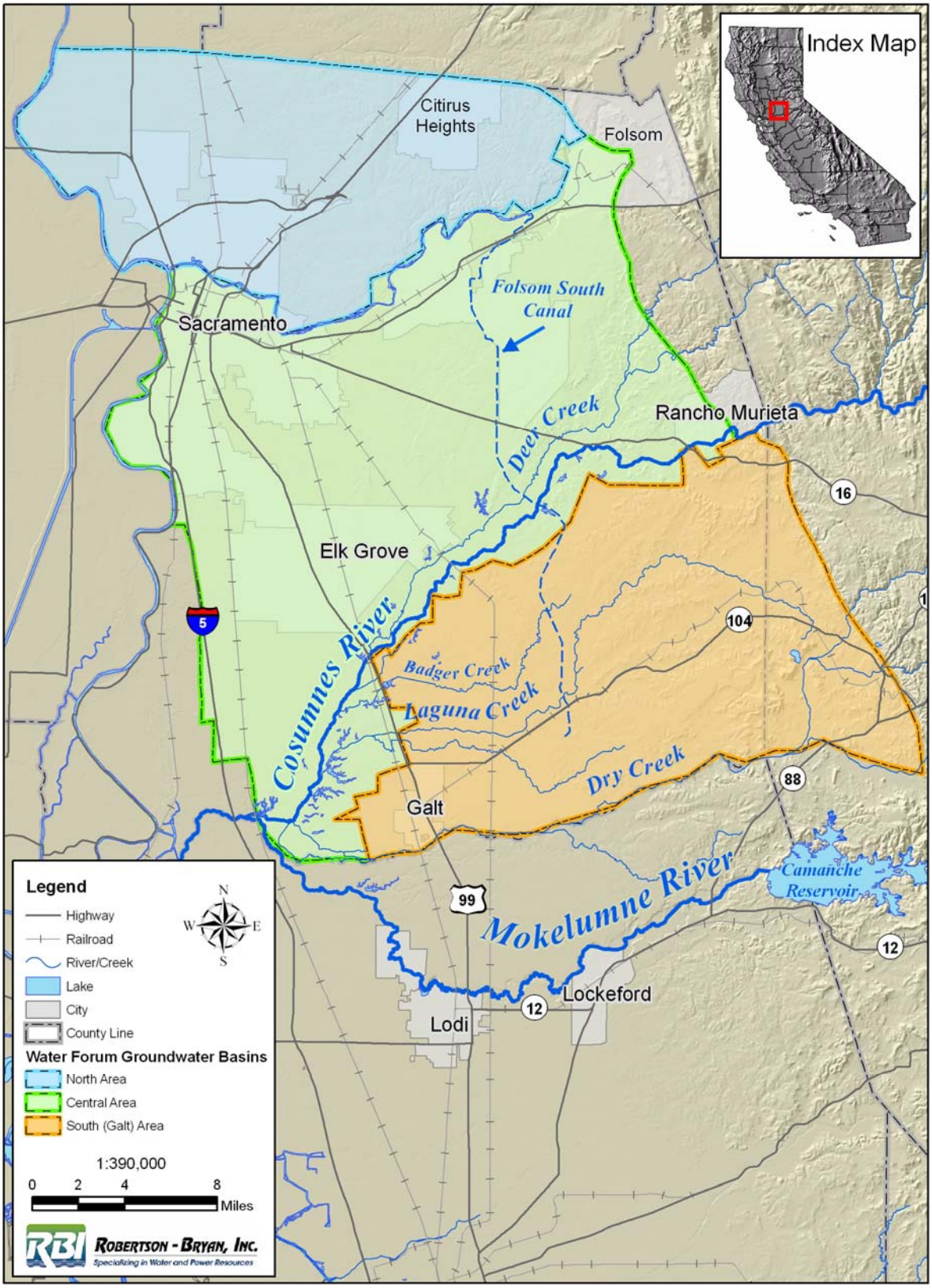


Figure 3-14. Groundwater subbasins delineated in the Water Forum Agreement.

3.3.4 Water Quality

Ahearn and Dahlgren (2005) examined the relationship of water quality in the upper and lower Cosumnes River watershed and concluded that the majority of the nutrients (i.e., nitrogen and phosphorus) and suspended sediments, originate in the lower watershed from both point (e.g., wastewater treatment facilities) and non-point (i.e., urban and agricultural runoff) sources. These investigators also reported that water temperature, conductivity, and pH levels generally increase downstream.

Other available water quality data are generally associated with specific research questions or hypotheses (e.g., Crain et al. 2004) and, therefore, cannot be reliably used to draw inferences for the larger river or its reaches. Several researchers (e.g., JSA 2003, Ahearn and Dahlgren 2005) have noted that the Cosumnes River carries a relatively high suspended sediment load, which likely has adverse impacts on anadromous salmonid eggs and fry.

Mercury has been well known as an environmental pollutant for several decades. Historically, Sierra Nevada miners used mercury to extract gold and discharged the waste into nearby water bodies where it accumulated in the sediment. Bacteria can convert elemental mercury into a more toxic form, methylmercury, which can bioaccumulate in aquatic life, especially predatory fish and fish-eating birds.

The Delta and the lower Cosumnes has been designated as an impaired waterway for mercury under EPA (303d). Recent studies by the State Water Resources Control Board, the CALFED Mercury Project, and UC Davis have indicated that some fish species in the lower Cosumnes and lower Mokelumne rivers contain elevated levels of mercury and could pose a health risk to people who eat them frequently. The Central Valley Regional Water Quality Control Board (CVRWQCB) is developing Total Maximum Daily Loads (TMDLs) for total mercury and methyl mercury and a Basin Plan Amendment for mercury in the Delta, expected in 2007 (California EPA 2005).

CVRWQCB's Resolution No. R5-2003-0105, *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands* (Waiver), requires agricultural coalition groups to develop and implement monitoring programs to assess the sources and impacts of waste in discharges from irrigated lands and, where necessary, to track progress in reducing the amount of waste discharged that affects the quality of the waters of the state and its beneficial uses.

The Sacramento Valley Water Quality Coalition, which represents alliances from 10 Central Valley "sub-watersheds," was formed to assist irrigators in complying with applicable water quality objectives and the regulations of the Waiver. The South Sacramento/Amador Water Quality Alliance, a voluntary program created by the Sacramento and Amador counties RCDs, represents the Cosumnes River sub-watershed. The Waiver requires the Alliance to monitor a subset of CTR/NTR constituents, including physical parameters (e.g., temperature, turbidity,

flow, pH), pathogens (i.e., *Escherichia coli*), pesticides, metals, and nutrients. A complete list of constituents to be monitored can be found in CVRWQCB 2003.

Sampling is required annually during two major storm events and monthly during the irrigation season. Six rounds of sampling have been conducted to date in the Cosumnes River at Twin Cities Road. Thus far, the results indicate that all constituents are below applicable criteria, with the exception of one *E. coli* sample collected in May 2005.

4 Cosumnes River Preserve Resource Characterization

The Cosumnes River Preserve was established in 1987 to protect valuable habitat in the lower reaches of the Cosumnes watershed. The long-term goal of the Preserve is to encompass large and naturally functioning examples of Central Valley and foothill ecosystems, including a full spectrum of the region's natural communities. Four natural communities occur in the Preserve: seasonal and permanent wetlands, riparian communities, valley oak savannas, and grassland-vernal pool mosaics. Portions of the Preserve remain in use as cropland and for grazing.

Seven partners own land that constitutes the Preserve—TNC, Ducks Unlimited, Sacramento County Department of Parks and Recreation, California Department of Fish and Game, Department of Water Resources, State Lands Commission, and the U.S. Bureau of Land Management. Table 4-1 provides a summary of the Preserve land holdings (both fee title ownership and conservation easements) and Figure 4-1 illustrates the locations of the Preserve Partner parcels.

Table 4-1. Summary of Cosumnes River Preserve Land Holdings.

Owner	Year Acquired	Acres	Parcels
The Nature Conservancy	1985	324.6	3
The Nature Conservancy	1987	451.3	1
The Nature Conservancy	1988	503.2	1
The Nature Conservancy	1992	73.5	1
The Nature Conservancy	1994	579.7	1
The Nature Conservancy	1996	2,529.4	4
The Nature Conservancy	1998	90.1	1
The Nature Conservancy	1999	10,744.9	2
The Nature Conservancy	2000	485.4	1
Total		15,782.1	15
Ducks Unlimited	1991	258.2	1
Total		258.2	1

Owner	Year Acquired	Acres	Parcels
Sacramento County Dept. of Parks & Recreation	1991	100.0	1
Sacramento County Dept. of Parks & Recreation	1993	527.5	1
Sacramento County Dept. of Parks & Recreation	1997	271.8	1
Total		899.3	3
California Department of Fish & Game	1991	1,060.4	2
California Department of Fish & Game	1994	210.2	1
California Department of Fish & Game	1996	219.6	1
California Department of Fish & Game	1997	1,046.5	1
California Department of Fish & Game	1998	2,036.6	3
Total		4,573.3	8
Department of Water Resources	1990	436.2	1
Total		436.2	1
State Lands Commission	1998	187.8	1
Total		187.8	1
Bureau of Land Management	1987	71.6	1
Bureau of Land Management	1990	128.4	1
Bureau of Land Management	1991	242.1	1
Bureau of Land Management	1992	981.8	1
Bureau of Land Management	2000	180.4	1
Bureau of Land Management	2003	139.9	1
Total		1,744.2	64
Conservation Easement	1984	64.5	1
Conservation Easement	1996	597.5	1
Conservation Easement	1998	198.2	1
Conservation Easement	1999	12,673.4	2
Conservation Easement	2000	2,611.8	6
Conservation Easement	2001	1,205.2	4
Conservation Easement	2002	332.8	1
Conservation Easement	2003	4,133.3	5
Total		21,816.7	21

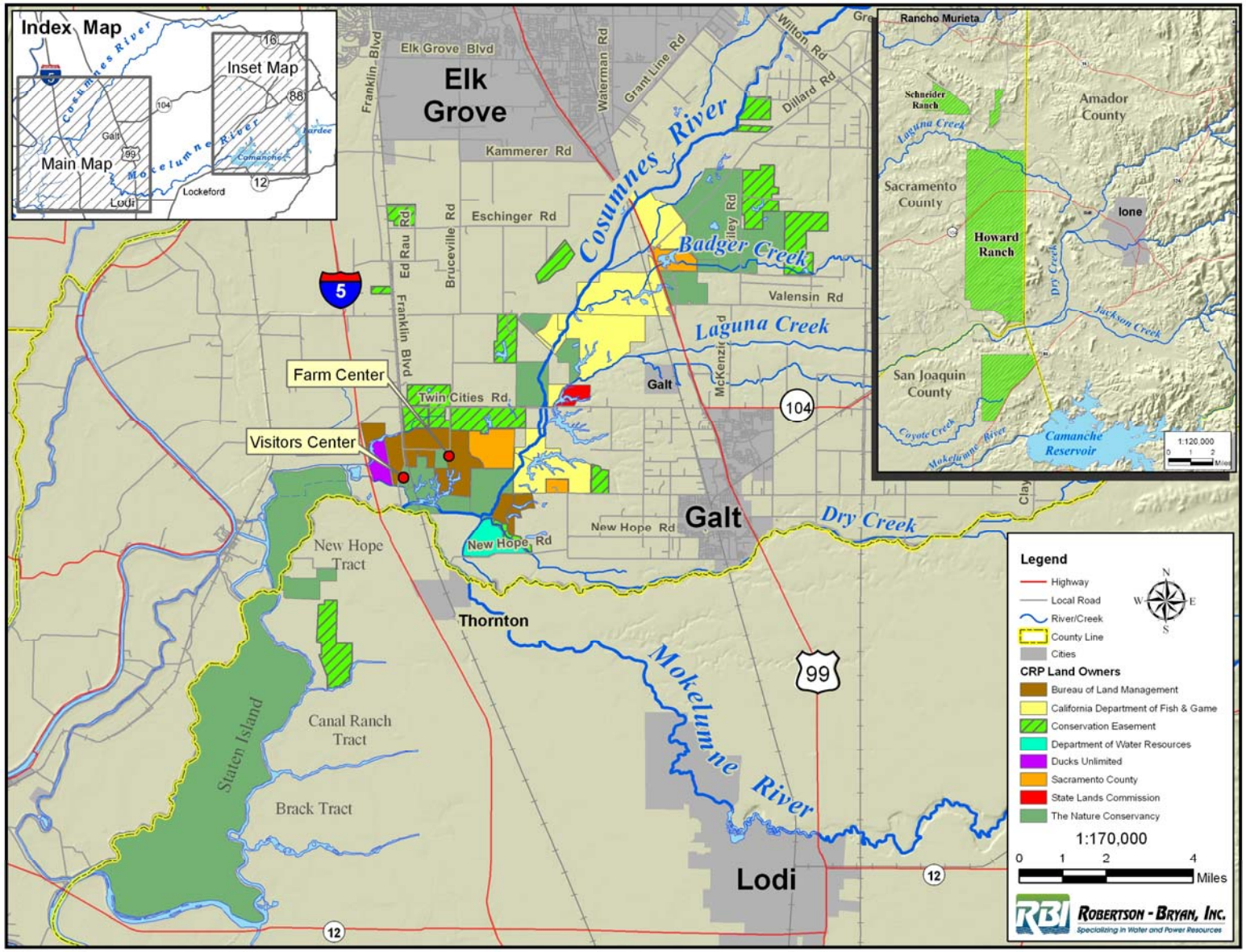


Figure 4-1. Cosumnes River Preserve Land Holdings

4.1 LAND USE

The current landscape of Central Valley, including the lower Cosumnes watershed, consists largely of agriculture, especially intensively managed irrigated crops (Figures 4.2 and 4.3). Agriculture in the southern Sacramento County includes croplands (43,430 acres, such as wheat, corn, alfalfa, and vegetables), vineyards (20,114 acres), irrigated pasture (16,087 acres), orchards (1,523 acres), and dryland pasture (Sacramento County Municipal Services Agency 2006). Trends projected for Sacramento County include continued residential development and concomitant losses of agricultural lands (anticipated 2% per year based on historic trends), and continued conversion of "lower" value cropland such as row and field crops to higher value perennial crops such as orchards and vineyards (Sacramento County MSA 2006).

The Central Valley is one of California's more rapidly growing regions. Between the years 1980 and 1995, the valley saw an increase of 1.8 million residents, a gain of almost 50% (Sokolow 2006). In the last several years the Sacramento region has experienced explosive growth, with urban expansion driving further south and east. Two new cities, Elk Grove and Rancho Cordova, appear poised to expand beyond the Urban Service Boundary established by in the Sacramento County General Plan (Sacramento County MSA 2006). The Sacramento Area Council of Governments (SACOG) has projected that the population of the Sacramento Region will increase by 1.7 million people in the next 45 years. This population increase has put pressure on the communities around the Preserve to expand their jurisdictional boundaries and incorporate open space and farmland into their sphere of influence.

There are three communities in close proximity to the Preserve—Elk Grove, Galt, and Thornton. Table 4-2 describes the different land use zones in these communities and Figure 4-2 illustrates how the area is divided into these zones. The following sections provide information on the land use and general plans of these communities.

Table 4-2. Land Use Zone Definitions

Land Use	Description
Agricultural	Intensive agriculture, extensive agriculture, general agriculture, grazing land
Industrial	Heavy industry and light industry
High density commercial	Downtown commercial, office commercial, highway commercial, civic centers, regional commercial, and other land use with the features of high density commercial
Low density commercial	Neighborhood commercial, general commercial, community commercial, schools, institutional, public/quasi-public facilities and the commercial land use that is not included in high density commercial
High density residential	Density is more than eight dwelling units per acre

Land Use	Description
Medium density residential	Density is equal to or less than eight dwelling units per acre and bigger than 0.5 dwelling units per acre
Low density residential	Lot size is more than two acres and less than or equal to twenty acres
Very low density residential	Lot size is bigger than twenty acres and smaller than 160 acres
Open space and public lands	
Water	

4.1.1 Sacramento County General Plan

The Sacramento County General Plan was last updated in 1994. The 1994 update was comprehensive and added policies for protection of natural resources that recognized the multiple values of the Cosumnes River corridor. County staff are currently working on a limited update of the general plan that will focus on urban development issues in the "urban policy boundary." This update is unlikely to have a direct effect on the Cosumnes River or watershed. The update is planned for completion and adoption in 2007.

4.1.2 Elk Grove General Plan

Following Elk Grove's incorporation as a City in 2000, it developed a new General Plan that was adopted in 2002. While the plan has a direct effect only on lands within the City's current boundary, the plan did identify a large area of land south of the City as a "future study area," with the understanding that the City would at some point consider this area for annexation and urbanization. This area is located between Highway 99 and Interstate 5 and is generally south of Elk Grove Boulevard. With the current downturn in the real estate market, Elk Grove has no short-term need to revisit its general plan or consider annexations southward.

Currently, the City's sphere of influence does not extend beyond the City's boundaries and there are no formal indications that the City plans to expand its boundaries. However, the pattern of land speculation by major homebuilders in the area shows signs of mounting pressure to extend the City's boundary south to Eschinger Road.

The City of Elk Grove and TNC have been working together on mitigation for the loss of Swainson's hawk habitat. The results have been impressive—over 1,500 acres of Swainson's hawk habitat protected over the last 3 years. It is possible that this collaboration will broaden to include active collaboration on the planning of a permanent edge between the City and the rich farmlands and habitat lands to the south of Elk Grove, approaching the Cosumnes River.

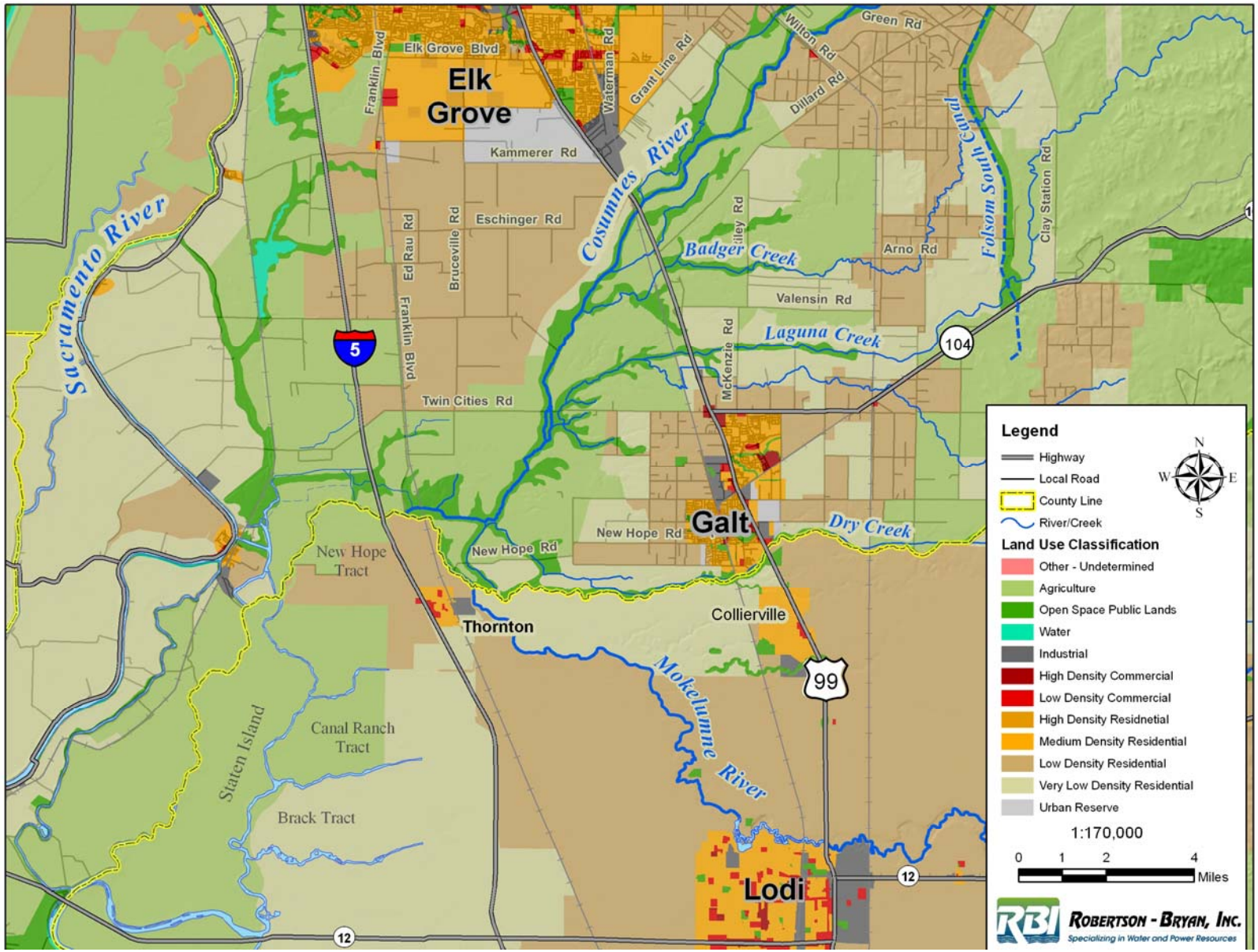


Figure 4-2. Land Use Zones Surrounding the Lower Cosumnes River Watershed.

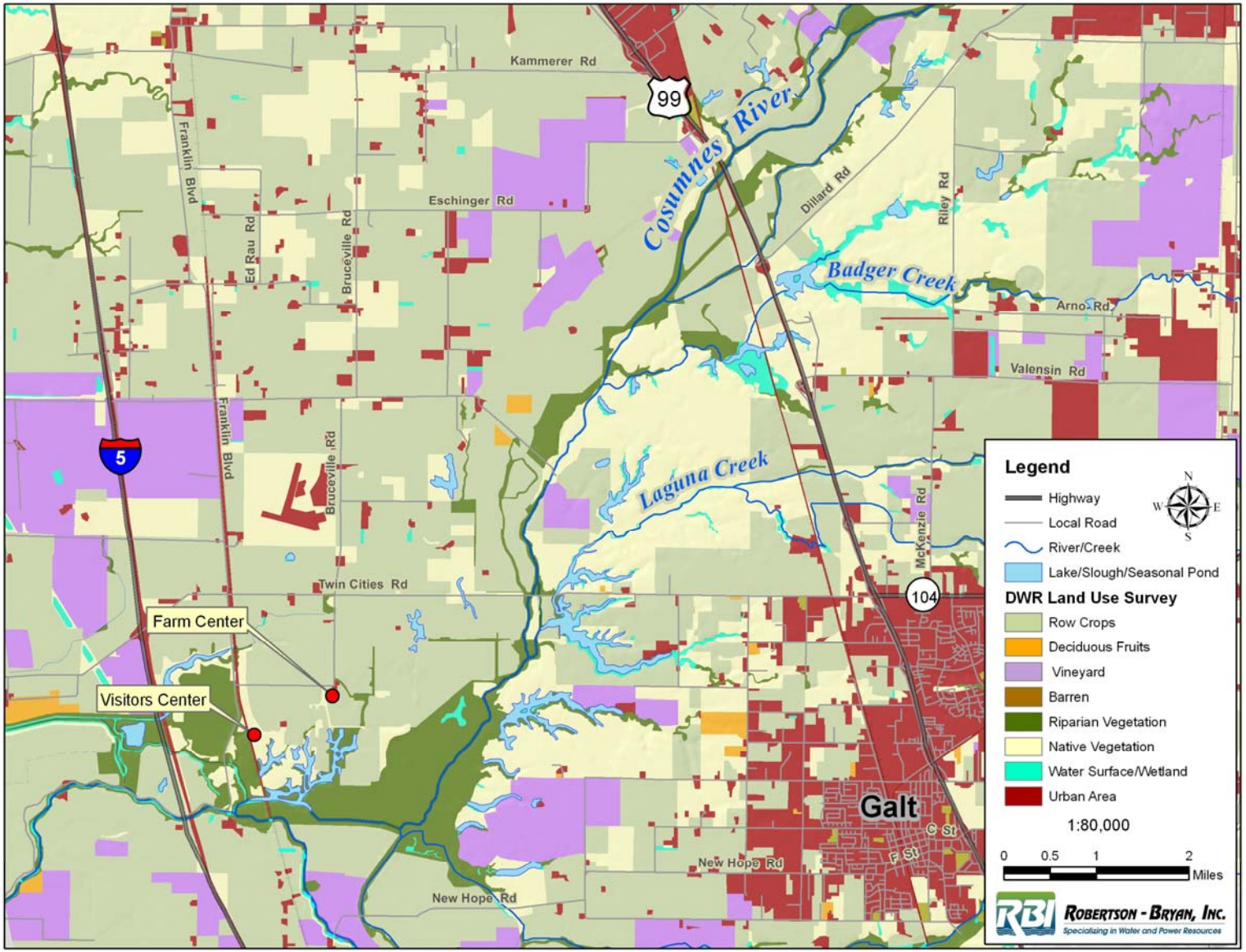


Figure 4-3. Vegetation Types in the Preserve.

4.1.3 Galt General Plan

Galt has been working on a General Plan update for more than 3 years, but has made little progress due largely to community opposition to growth northward. A new City Council majority (effective December 2006) will likely steer the general plan update in a more moderate and pragmatic direction, with plan adoption likely in late 2007 or early 2008. Given the orientation of the new Council, the plan will also likely be supportive of the resource values of the Cosumnes River watershed.

4.1.4 The Town of Thornton

Thornton is located south of the Preserve in San Joaquin County. Because it is not incorporated, it does not have its own general plan, but is governed by provisions of the San Joaquin County General Plan. Like other towns in the area, there is mounting pressure for new growth and development and land speculation in the area has increased. Rumors of a possible "new town" proposal were abundant in 2006, but the real estate downturn has likely ended that threat in the short term.

4.2 BIOLOGICAL RESOURCES

This section describes existing vegetation, wildlife and aquatic resources in the Cosumnes River Preserve. Information from a variety of sources was reviewed and include Cosumnes and Mokelumne Rivers Floodplain Integrated Resources Management Plan (RBI 2006), Terrestrial Natural Communities of California (Holland 1986), California Natural Diversity Database (CNDDB) (CDFG 2006), California Native Plant Society Inventory of Rare and Endangered Plants (CNPS 2006), and the U.S. Fish and Wildlife Service species list by quad (USFWS 2006). Relevant information from these documents is provided in the following sections.

4.2.1 Vegetation

The Preserve is located in the Great Central Valley floristic province of California (Hickman 1993). The study area bisects two floristic subregions—the Sacramento Valley to the north and the San Joaquin Valley to the south. Although these subregions are now dominated by agriculture, in the past they supported grassland, marshes, extensive riparian woodlands, and valley-oak savanna (Hickman 1993). Detailed vegetation mapping has not been conducted on the Preserve, but is a priority for the future.

The area's Mediterranean climate has cool, wet winters and hot, dry summers, which limits the growing season because the supply of water during winter and the need for water by plants during summer, are exactly out of phase (Major 1995). Vegetation is lush in the spring after winter rains and is usually desiccated by mid-summer, with the exception of riparian areas. Riparian areas with year-round water have high plant productivity and stand out in the dry

summer landscape as sinuous areas of lush, green vegetation. Irrigated agricultural lands achieve high plant productivity during the dry summer months, with water generally supplied from groundwater sources. For this reason, and because of fertile soil conditions of the valley, much of the Great Central Valley's native vegetation has been replaced by agriculture (Major 1995).

4.2.1.1 Plant Communities

The plant communities of the Cosumnes River Preserve and surrounding areas were mapped in 2000 by the Department of Water Resources (DWR) as part of their land use survey (Figure 4-3). DWR interpreted aerial photos (scale 1:24,000) and conducted extensive field surveys to ground-truth the data. The DWR survey emphasizes agricultural cover types and hence provides only coarse-scale information about natural communities in three classes: riparian vegetation, water surface, and native vegetation. These classes can be further subdivided using the Department of Fish and Game's Wildlife Habitat Relationship (CWHR) vegetation types. This scale of map, however, was not readily available for this assessment. A crosswalk of the classification systems and definitions of the CWHR communities is provided in Table 4-3.

In addition, the California Natural Diversity Database (CNDDB) identified three special-status plant communities in the study area: Great Valley Valley Oak Riparian Forest and Great Valley Mixed Riparian Forest (both found in the Foothill Riparian), and Northern Hardpan Vernal Pool (found amid Annual Grasslands). The major plant communities (CWHR) of the Cosumnes River Preserve and surrounding lower watershed are described below.

Table 4-3. Vegetation Crosswalk Table.

CWHR Class	DWR Class	Some NDDB Communities Found in these Habitats	Description (Mayer and Laudenslayer 1988)
Tree Dominated Habitats			
Valley Foothill Riparian	Riparian Vegetation	Great Valley Valley Oak Riparian Great Valley Mixed Riparian	Habitats seasonally flooded or saturated. Occurs in floodplains along streams and rivers. Dominated by Fremont cottonwood (*Populus fremontii*), white alder (*Alnus rhombifolia*), box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), and walnuts (*Juglans* sp.). Elderberry (*Sambucus mexicanus*), coyote brush (*Baccharis pilularis*), California rose (*Rosa californica*), poison oak (*Toxicodendron diversilobum*), wild grape (*Vitis californica*) or willows (*Salix* sp.) may be present. Trees < 30 m tall with continuous canopy cover, sparse shrubs and variable ground layer.
Valley Oak Woodland	–	–	Occurs in soils intermittently flooded or seasonally saturated. Valley oak (*Quercus lobata*) is the sole

CWHR Class	DWR Class	Some NDDB Communities Found in these Habitats	Description (Mayer and Laudenslayer 1988)
			or dominant tree in the canopy. Blue oak (*Quercus douglasii*), interior live oak (*Quercus wislizenii*), and/or Oregon ash (*Fraxinus latifolia*) may be present. Trees < 30 m tall with continuous, intermittent or open canopy. Shrubs and lianas common. Ground layer grassy.
Blue oak woodland	Native Vegetation	–	The canopy is dominated blue oak trees (16 to 50 ft tall), commonly forming open savanna-like stands on dry ridges and gentle slopes. Shrubs are often present but rarely extensive (e.g. California buckeye, manzanita spp., poison-oak). Typical understory is composed of an extension of Annual Grassland vegetation.
Herbaceous Dominated Habitats			
Perennial Grass	Native Vegetation	–	Habitat seasonally saturated with shallow water table and dominated by creeping ryegrass (*Leymus triticoides*) OR on non-saturated soils dominated by purple needlegrass (*Stipa pulchra*), foothill needlegrass (*Stipa lepida*) and/or nodding needlegrass (*Stipa cernua*). May include non-native annual species such as bromes (*Bromus* sp.), oats (*Avena* sp.) and fescue (*Festuca* sp.) and forbs. Grass < 1 m tall with open cover.
Annual Grass	Native Vegetation	Northern Hardpan Vernal Pool	Annual grasses and herbs dominate in the ground layer. Typical species include ripgut (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), foxtail chess (*Bromus madritensis*), filaree (*Erodium botyrs* and *E. cicutarium*), goldfields (*Lasthenia californica*), lupine (*Lupinus bicolor*), oats (*Avena barbata* and *A. fatua*), rye (*Lolium multiflorum*), and mustards (*Brassica* sp.). Grass < 1 m tall with continuous or open cover.
Fresh Emergent Wetland	Water Surface	–	Habitat seasonally flooded or saturated with fresh or saline water; dominated by spikerush (Eleocharis sp.), pickleweed (Salicornia sp.), sedges (Carex sp.), bulrush (Scirpus sp.) and/or cattail(Typha sp.).
Developed Habitats			
Cropland	Grain and Hay Crops, Field Crops	–	Grain and hay crops, pasture, row crops and idle lands.

CWHR Class	DWR Class	Some NDDB Communities Found in these Habitats	Description (Mayer and Laudenslayer 1988)
Orchard	Deciduous Fruits and Nuts, Citrus and Subtropical	–	Orchards in California are typically open single species tree dominated habitats. Depending on the tree type and pruning methods they are usually low, bushy trees with an open understory to facilitate harvest. Trees range in height at maturity for many species from 5 to 10 m (15 to 30 ft), but may be 3 m (10 ft) or less in some dwarf varieties, or 18 m (60 ft) or more in pecans and walnuts. Crowns usually touch, and are usually in a linear pattern. Spacing between trees is uniform depending on desired spread of mature trees.
Vineyard	Vineyard	–	Vineyards are composed of single species planted in rows, usually supported on wood and wire trellises. Vines are normally intertwined in the rows but open between rows. Rows under the vines are usually sprayed with herbicides to prevent growth of herbaceous plants. Between rows of vines, grasses and other herbaceous plants may be planted or allowed to grow as a cover crop to control erosion.
Barren	Barren and Wasteland	–	Barren habitat is defined by the absence of vegetation.
Urban	Urban, Urban Residential, Urban Commercial, Urban Industrial, Urban Landscape, Urban Vacant	–	Urban Areas are characterized by commercial, industrial and residential development with vegetation composed of trees, lawns, and shrubs. A distinguishing feature is the mixture of native and exotic species of vegetation.

Valley Foothill Riparian

Many of the areas bordering the river and sloughs on the Preserve are of this habitat type. Below Highway 16, nearly 3,000 acres of forest canopy (riparian forest and possibly some valley oak woodland) exists along the Cosumnes River (K. Petrik, Ducks Unlimited, unpubl. data). Most trees are winter deciduous with the dominant species consisting of valley oak and cottonwood. Subcanopy trees are Oregon ash, box elder, and white alder. Canopy height is nearly 100 feet in mature forest, such as the Tall Forest, and canopy cover can vary from 20% to 80%.

Lianas of California grape frequently festoon both trees and shrubs, and provide 30 to 50% of the ground cover. Typical understory shrub layer plants include wild grape, wild rose, California blackberry, blue elderberry, poison oak, button bush, and willows. Herbaceous vegetation constitutes about one percent of the cover, except in openings where tall forbs and shade-tolerant grasses occur. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce, Douglas sagewort, poison hemlock, and hoary nettle. Often the understory is impenetrable and includes fallen limbs and other debris.

CNDDB identified two special status plant communities along the Cosumnes River riparian zone. Great Valley Valley Oak Riparian Forest is found on low-gradient, depositional reaches of major streams. It is restricted to the highest parts of the flooplain, but still receives annual inputs of silty alluvium and subsurface irrigation. It is dominated by valley oak with an understory of Oregon ash. Great Valley Mixed Riparian Forest is also found within floodplains of low-gradient streams. The canopy is mostly closed and consists of box elder, Fremont cottonwood, black willow, red willow, and shining willow.

Valley Oak Woodland

The best representation of valley oak woodland on the Preserve is the 200-acre savannah south of the Farm Center. These woodland canopies are dominated almost exclusively by valley oaks. Tree associates include California sycamore and box elder. The shrub understory is often sparse and consists of such species as poison oak and California blackberry. Various sorts of brome, wild oats, barley, ryegrass, and needlegrass dominate the ground cover.

Blue Oak Woodland

The best examples of blue oak woodland at the Preserve are on the Howard Ranch. Generally, these woodlands have an overstory of scattered trees. The canopy is dominated by trees 15-50 feet tall, commonly forming open savanna-like stands on dry ridges and gentle slopes. Blue oaks may reach 82 feet in height. Shrubs are often present but rarely extensive, often occurring on rock outcrops. Typical understory is composed of an extension of Annual Grassland vegetation.

Blue oak is the dominant tree species, comprising 85-100% of the trees present. Common associates in the canopy are interior live oak and Valley oak. The ground cover is comprised mainly of annuals such as brome grass, wild oats, foxtail, needlegrass, filaree, fiddleneck, and others.

Perennial Grassland

Although perennial grasses such as creeping wildrye and meadow barley are commonly found in the understory of some valley oak woodland habitat on the preserve, no remnant perennial grassland habitat exists. The Preserve has undertaken some native grass restoration projects, including the conversion of a vineyard to perennial grass habitat on the Valley Oak property. Perennial grass species such as purple needlegrass, meadow barley and blue wild rye were planted on that property. Perennial grassland habitat may provide important upland nesting habitat for a variety of waterfowl species.

Annual Grassland

Vast annual grassland habitat on the Preserve is found on the Valensin and Howard Ranche properties. These habitats are open grasslands composed primarily of annual plant species. Many of these species also occur as understory plants in Valley Oak Woodlands. Annual plant seeds germinate with the first fall rains and grow slowly during the cool winter months, remaining low in stature until spring, when temperatures increase and stimulate more rapid growth. Introduced annual grasses generally dominate the cover in this habitat while native annual forbs contribute significantly to the species diversity. Common annual grasses include wild oats, soft chess, ripgut brome, wild barley, and annual ryegrass. Common forbs include filaree, turkey mullein, toad rush, tarweed and popcorn flower.

California poppy is also found in this habitat. Vernal pools, which support downingia, meadowfoam, and other native plant species, are found in small depressions within the annual grassland underlain by a hardpan or bedrock layer.

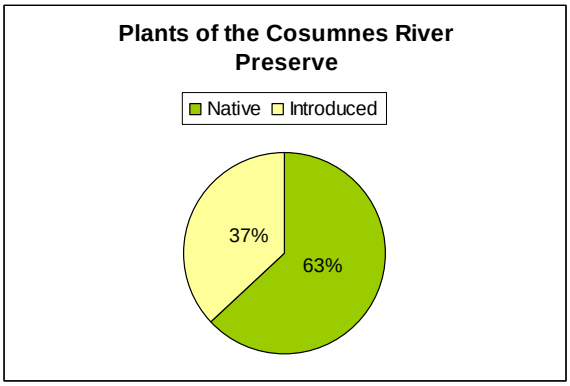
Many wildlife species use Annual Grasslands for foraging, but some require special habitat features such as cliffs, caves, ponds, or habitats with woody plants for breeding, resting, and escape cover. Characteristic reptiles include the western fence lizard, common garter snake, and gopher snake. Mammals typically found in this habitat include black-tailed jackrabbit, California ground squirrel, Botta's pocket gopher, western harvest mouse, California vole, and coyote. Common birds are horned lark, and western meadowlark. Grasslands are also important foraging habitat for turkey vulture, northern harrier, American kestrel, black-shouldered kite, burrowing owl and prairie falcon.

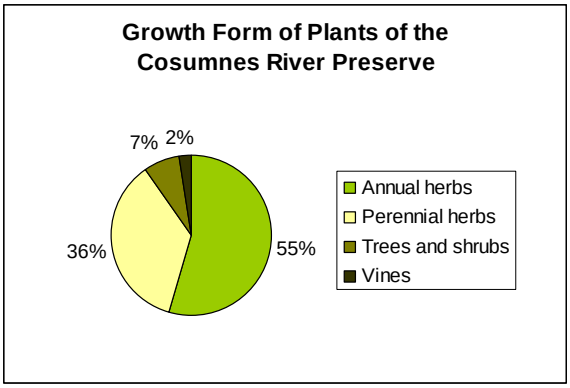
The Northern Hardpan Vernal Pool community is found amid the matrix of annual grassland, most notably on Valensin and Howard Ranches. These seasonal wetlands form in localized depressions in areas underlain by an impervious layer. Winter rainfall perches on very acidic, cemented, hardpan soils forming pools in the depressions. Water levels are reduced by evaporation in the spring, resulting in concentric bands of vegetation that encircle the drying pool. Vernal pools are dominated by annual herbs and grasses. In contrast to the surrounding grassland of non-native grasses, vernal pools are dominated by native species, including many rare and endemic plants species such as dwarf downingia and legenere.

Fresh Emergent Wetland

Fresh Emergent Wetlands on the Preserve are located immediately adjacent to the river and sloughs, primarily downstream of Twin Cities Road as well as on lower Badger Creek. These perennial wetlands depend on year-round water. Marshes are characterized by erect, rooted herbaceous hydrophytes, generally perennial monocots such as common cattail, tule bulrush, and arrowhead.Plant Species

The Cosumnes River Preserve protects a rich diversity of plant species—442 species are identified, 279 (63%) of these are native to California and 163 (37%) are introduced species. Of the 442 species, there are 241 annual herbs, 158 perennial herbs, 32 trees and shrubs, and 11 vines (Appendix D, Cosumnes River Plant List).





4.2.1.2 Management and Recovery of Special-Status Plant Species

There are four known and 10 potentially occurring special-status plant species in the Preserve that are associated with vernal pools, marshes, or slough habitats (Table 4-4). The four documented species include:

- **Dwarf dowingia** (*Downingia pusilla*)
- **Rose-mallow** (*Hibiscus lasiocarpus*)
- **Legenere** (*Legenere limosa*)
- **Sandford's arrowhead** (*Sagittaria sanfordii*)

Dwarf downingia (*Downingia pusilla*)
CNPS List 2.2

Dwarf downingia is an annual herb in the bellflower family (Campanulaceae). It grows 3 to 8 cm tall with small linear leaves and tiny, radially symmetric flowers that are less than 1 cm across. This species is different from other *Downingia* species, which have larger, showy, asymmetric flowers. The white or blue flowers are borne at the ends of branches and have two small yellow spots near the throat (Hickman 1993).

Dwarf downingia is found from Merced and Mariposa counties in the south, to Tehama County in the north; it also has a disjunct population in vernal pools of South America. Dwarf downingia grows in vernal pools, playa pools, and on the margins of vernal lakes. It is also found in mesic areas in valley and foothill grassland, both in alkaline (saline) and non-alkaline soils. It occurs with other rare and endemic wetland and vernal pool species such as legenere (*Legenere limosa*). It flowers in the spring months, March through May (Hickman 1993, CNDDB 2006, CNPS 2006). Overall, the habitat of dwarf downingia is threatened by development, agriculture, grazing, off-road vehicles, and industrial forestry (CNPS 2006).

Table 4-4. Special–Status Plant Species Known to Occur in the Study Area.

Scientific/Common Name	Status: CNPS State Federal	Blooming Period	Life Form and Habitat (CNPS type)	Cosumnes River	Potential for Occurrence in the Cosumnes River Preserve
Aster lentus Suisun Marsh aster	1B None SC	May–Nov	Perennial rhizomatous herb growing in marshes and swamps (MshSw) (brackish and freshwater). 0–3 meters.	Potential	Rare, known to occur in the Thornton USGS quad.
Castilleja campestris ssp. succulenta succulent owl's–clover	1B CE FT	Apr–May	Annual hemiparasitic herb growing in vernal pools (VnPls) (often acidic). 50–750 meters.	Potential	Rare, known to occur in the Lockeford USGS quad.
Downingia pusilla dwarf downingia	2 None None	Mar–May	Annual herb growing in valley and foothill grassland (VFGrs) (mesic), Vernal pools (VnPls). 1–445 meters.	Known	Known to occur within the Preserve
Gratiola heterosepala Boggs Lake hedge–hyssop	1B CE None	Apr–Aug	Annual herb growing in marshes and swamps (MshSw) (lake margins), and vernal pools (VnPls) / clay. 10–2,375 meters.	Potential	Rare, known to occur in the Elk Grove and Sloughhouse USGS quads.
Hibiscus lasiocarpus rose–mallow	2 None None	Jun–Sep	Perennial, emergent, rhizomatous herb growing in marshes and swamps (MshSw) (freshwater). 0–120 meters.	Potential	Rare in California, known to occur in the Preserve.
Juncus leiospermus var. ahartii Ahart's dwarf rush	1B None FSC	Mar–May	Annual herb growing in valley and foothill grassland (VFGrs) (mesic). 30–100 meters.	Potential	Rare, may occur in appropriate habitat.
Lathyrus jepsonii var. jepsonii Delta tule pea	1B None FSC	May–Sep	Perennial herb growing in marshes and swamps (MshSw) (freshwater and brackish). 0–4 meters.	Potential	Rare, known to occur in the Bruceville and Thornton USGS quads.
Legenere limosa legenere	1B None FSC	Apr–Jun	Annual herb growing in vernal pools (VnPls). 1–880 meters.	Known	Known to occur within the Preserve
Lilaeopsis masonii Mason's lilaeopsis	1B CR FSC	Apr–Nov	Perennial rhizomatous herb growing in marshes and swamps (MshSw) (brackish or freshwater), and Riparian scrub (RpScr). 0–10 meters.	Potential	Rare, known to occur in the Bruceville and Thornton USGS quads.

Scientific/Common Name	Status: CNPS State Federal	Blooming Period	Life Form and Habitat (CNPS type)	Cosumnes River	Potential for Occurrence in the Cosumnes River Preserve
Limosella subulata Delta mudwort	2 None None	May–Aug	Perennial stoloniferous herb growing in marshes and swamps (MshSw). 0–3 meters.	Potential	Rare in California, known to occur in the Bruceville and Thornton USGS quads.
Orcuttia tenuis slender Orcutt grass	1B CE FT	May–Oct	Annual herb growing in vernal pools (VnPls). 35–1,760 meters.	Potential	Rare, known to occur in the Elk Grove USGS quad.
Orcuttia viscida Sacramento Orcutt grass	1B CE FE	Apr–Jul	Annual herb growing in vernal pools (VnPls). 30–100 meters.	Potential	Rare, may occur in appropriate habitat.
Sagittaria sanfordii Sanford's arrowhead	1B None FSC	May–Oct	Perennial, emergent, rhizomatous herb growing in marshes and swamps (MshSw) (assorted shallow freshwater). 0–610 meters.	Known	Known to occur within the Preserve.
Scutellaria lateriflora Blue skullcap	1B None None	Jul–Sep	Perennial rhizomatous herb growing in marshes and wet meadows. < 500 meters.	Potential	Rare, may occur in appropriate habitat.

STATE STATUS

CR = California Rare

CT = California Threatened

CE = California Endangered

CNPS = CALIFORNIA NATIVE PLANT SOCIETY

1B = rare, threatened or endangered in California and elsewhere

2 = rare in California but more common elsewhere

3 = need more information

4 = plants of limited distribution; a watch list

_.1 = Seriously endangered in California (over 80% of occurrences threatened / high degree and immediacy of threat)

_.2 = Fairly endangered in California (20-80% occurrences threatened)

_.3 = Not very endangered in California (<20% of occurrences threatened or no current threats known)

FEDERAL STATUS

FC = Candidate Species

FE = Federal Endangered

FPE = Federally proposed for listing as endangered

FT = Federal Threatened

FSS = Forest Service Sensitive

SNF MIS = Sierra National Forest Management Indicator Species

Twelve populations of dwarf downingia are documented on the Cosumnes River Preserve—four occurring on the Valensin Ranch (near Highway 99) and eight on the Howard Ranch. TNC is not actively restoring habitat for this species; however, research is underway to look at the effects of grazing and burning on the vegetation of vernal pools, with a long-term goal of developing best management guidelines to maintain diversity in vernal pool grasslands.

Rose-mallow (*Hibiscus lasiocarpus*)
CNPS List 2.2

Rose-mallow is a rhizomatous, emergent, perennial herb in the mallow family (Malvaceae). It has hairy stems and reaches 1 to 2 m tall, growing prostrate or erect. The heart-shaped leaves are 6 to 10 cm long with toothed margins, and the large, showy flowers (petals 6 to 10 cm) are white or rose, with a red base (Hickman 1993).

Rose-mallow occurs in the Sacramento Valley and the northern part of the San Joaquin Valley (San Joaquin and Contra Costa counties). It is also widespread in the central and southeastern United States. Rose-mallow grows on the margins of freshwater marshes, wet riverbanks, and on low, peat islands in sloughs. It blooms from June through September (Hickman 1993, CNPS 2006). Rose-mallow is threatened by riverbank alteration, channelization, recreation (including boating that creates wakes that erode the shoreline), agricultural conversion, and development (Hickman 1993, CNPS 2006).

Two occurrences were documented along the Cosumnes River channel in 2005. While TNC does not actively manage for this species, suitable habitat is protected in the Preserve and includes wetlands and channels of the Cosumnes River and Delta waterways.

Legenere (*Legenere limosa*)
USFWS: Species of Concern, CNPS: List 1B.1

Legenere is an emergent aquatic, and terrestrial, annual herb in the bellflower family (Campanulaceae). When a waterbody dries, legenere's 10 to 30 cm long, delicate stems trail along the ground. The small, 2 to10 mm long, narrow leaves support flowers in the upper axils. The flower consists of an elongate inferior ovary, five triangular sepals, and a white, two-lipped corolla, about 5 mm long (corolla often absent). The entire flower (including the ovary) is less than 1 cm long (Hickman 1993).

Legenere is endemic to California and has been found in the northern part of the Central Valley, in the foothills from Stanislaus County to Shasta, and in San Mateo and Sonoma counties. It is currently believed to be extirpated in Sonoma and Stanislaus counties. Legenere grows in the bottoms of vernal pools and other wet depressions in grassland communities. It often grows with other rare plants such as dwarf downingia. Due to its small, delicate stature, legenere is often difficult to locate in dense vernal pool vegetation. It blooms April through June (Hickman 1993, CNDDB 2006, CNPS 2006). The legenere vernal pool habitat is primarily threatened by urban and agricultural development (CNPS 2006).

Twenty-one populations of legenere are documented on the Cosumnes River Preserve—seven on the Howard Ranch, nine on the Valensin Ranch, and five on the Schneider Ranch. TNC is not actively restoring habitat for this species, however, research is under way to look at the effects of grazing and burning on the vegetation of vernal pools, with a long-term goal of developing best management guidelines to maintain diversity in vernal pool grasslands.

Sandford's arrowhead (*Sagittaria sandfordii*)
USFWS: Species of Concern, CNPS: List 1B.

Sandford's arrowhead is a perennial, emergent, rhizomatous herb in the water-plantain family (Alismataceae). The emergent leaf blades are 14 to 25 cm, linear and 3-angled to narrowly ovate. This species does not have arrow-shaped leaves like other *Sagittaria*. It has white flowers in several whorls, located well below leaf ends, with recurved pedicels that thicken while in fruit. The lowest whorl of flowers has pistils but lacks stamens (Hickman 1993).

Sandford's arrowhead is endemic to California and known populations occur in wetland habitats of the Central Valley from Shasta to Fresno counties. Sandford's arrowhead grows primarily in freshwater marshes and wetlands between 0-610 meters in elevation and flowers in the summer months from late May to October (Hickman 1993). Today, *Sagittaria sanfordii* is known from fewer than 25 extant occurrences and population decline is primarily caused by human development, grazing and stream channel alteration (CNPS 2006).

In 1991 and in 2000, Sanford's arrowhead was reported on the Preserve in a wet spur of the Cosumnes River southwest of the Valensin Forest (May Consultants 2000). There are no other known occurrences of this species on the Preserve and while TNC does not actively manage it, TNC attempts to protect suitable wetland habitats in the Cosumnes River watershed.

4.2.1.3 Control and Removal of Non-native Invasive Plant Species

Invasive non-native plant species are plants that are not indigenous to this area and have the ability to successfully establish themselves in, and then overcome, otherwise intact, pre-existing native ecosystems. These species are a threat to native species and communities in the Cosumnes River Preserve. They can compete with and displace native plants and animals, alter

ecosystem functions and cycles, hybridize with native species and promote other invaders. Many plant invasions can be reversed, halted or slowed and in certain cases, even badly infested areas can be restored. Species selected for management by TNC are those invasive non-native plants found in the Preserve that are the fastest growing, most disruptive and affect the most highly valued habitats in the Preserve.

Each invasive plant species that threatens wildlands in California is evaluated by the California Invasive Pest Council (Cal-IPC) and assigned a rank. The rank is based on the plant's ecological impacts, invasive potential, and ecological distribution. Cal-IPC completed an evaluation to assess the ecological impacts of 69 of the 163 introduced species found on the Cosumnes River Preserve. As of November 2006, 9 species found on the Preserve were ranked as High (Table 4.5), 25 as Moderate, 18 as Limited, and 17 as Evaluated But Not Listed species (Cal-IPC 2006). Appendix E lists 17 invasive non-native plant species currently under management in the Preserve, their current range in the Preserve, current control actions, the habitat they invade, their impacts on the biological resources of the Preserve, and their Cal-IPC rank. Below are definitions of Cal-IPC's inventory ranking system:

- **High** – These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
- **Moderate –** These species have substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
- **Limited –** These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.
- **Evaluated But Not Listed -** Lack sufficient information to assign a rating or the available information indicates that the species does not have significant impacts at the present time.

Additionally, there are 5 highly invasive species that are on a "Red Alert" or watch list (Appendix E). Species on the Red Alert list have not been found on the Preserve but are known to adversely affect habitats similar to those found in the Preserve.

4.2.2 Wildlife

The Preserve supports a diverse array of wildlife habitats and species. Historically, the Central Valley supported the largest area of riparian and wetland habitat in the state. These rich bottomlands also proved to be valuable farmland, and as a result, some of the best wildlife habitat in the state was converted to agriculture, including the land that comprises the Preserve. Today, the Preserve Partners work to integrate agricultural operations with restoration of riparian bottomland habitat, creating a diverse landscape that supports a large assemblage of wildlife species.

4.2.2.1 **Native Wildlife Habitat**

The habitat descriptions in this section are adapted from the wildlife habitat classifications used in the California Department of Fish and Game's Wildlife Habitat Relationships System (Mayer and Laudenslayer 1988). These habitats are vital to many wildlife species found on the Preserve—from mountain lions to the smallest neotropical migrant song birds.

Valley Foothill Riparian

This may be the most important wildlife habitat on the Preserve. It provides food, water, migration and dispersal corridors, and escape, nesting, and thermal cover for an abundance of animals. Many are permanent residents, others are transient or temporal visitors. Nearly 200 birds species, 55 species of mammals and many amphibians and reptiles are know to use California's Central Valley riparian communities. Mountain lions have been seen in the Tall Forest. A high population of non-native black rats may be depressing the nesting success of certain native birds.

Valley Oak Woodland

Valley oak woodlands provide food and cover for many species of wildlife. Oaks have long been considered important to some birds and mammals as food resource (i.e., acorns and browse). Among the many species known to use valley oak woodland habitat on the Preserve are sandhill cranes, mule deer, coyote, and gray squirrel.

Blue Oak Woodland

Coyote, yellow-billed magpie, western gray squirrel, and California ground squirrel are among the dozens of species of birds and mammals (as well as reptiles and amphibians) that occur in this habitat type.

Annual Grassland

Many wildlife species use Annual Grasslands for foraging, but some require special habitat features such as cliffs, caves, ponds, or habitats with woody plants for breeding, resting, and escape cover. Characteristic reptiles include the western fence lizard, common garter snake, and western rattlesnake. Mammals typically found in this habitat include black-tailed jackrabbit, California ground squirrel, Botta's pocket gopher, western harvest mouse, California vole, badger, and coyote. Common birds are burrowing owl, horned lark, and western meadowlark. Grasslands are also important foraging habitat for turkey vulture, northern harrier, American kestrel, black-shouldered kite, and prairie falcon.

Perennial Grassland

Perennial Grasslands provide optimum habitat for many species, including common and western garter snakes, western kingbird, savannah sparrow, coast mole, and western harvest mouse. They are also important foraging habitat for turkey vulture, northern harrier, American kestrel, black-shouldered kite, and prairie falcon.

Fresh Emergent Wetland

These perennial wetlands are among the most productive wildlife habitats in California. They provide food, cover, and water for hundreds of species of birds, mammals, reptiles, and amphibians. These include the giant garter snake and wood ducks.

4.2.2.2 Managed Wetlands

Wildlife habitat in the lower Cosumnes River watershed and, in fact, the entire Central Valley, is very different from what existed in the early 1800s. Much habitat has been destroyed and some species, such as the grizzly bear, have been extirpated. However, not all the changes have been bad for wildlife. For example, rice fields are beneficial to many species of waterfowl, especially when they are flooded after harvest in the fall. Many of those fields are probably more valuable, per acre, to waterfowl than they were as natural habitat 200 years ago. That is also true of the intensively managed habitats on several state and federal waterfowl areas in the Central Valley, including the waterfowl ponds described below.

The intensively managed waterfowl ponds at the Preserve are in a three-mile radius of the Preserve's "Farm Center" at the junction of Bruceville and Desmond roads in south Sacramento

County. There are 900 acres of ponds (excluding adjacent upland habitat) in five wetland complexes—Lost Slough (west of Franklin Boulevard), Lost Slough East (north of Desmond Road), the Barn Ponds (south of Desmond Road and surrounding the TNC Barn), Willow Slough (behind the Visitor Center and east of Willow Slough itself), and Cougar Wetland (on the south side of the river off Orr Road). Lost Slough is the largest complex with 305 acres of Ponds; Willow Slough is the smallest with 40 acres.

Habitats in the wetland complex can be divided into permanent wetlands, seasonal wetlands, and adjacent upland nesting habitat. The latter is not included in the pond acreage calculations, but is, of course, important to waterfowl production. Mallard, gadwall, and cinnamon teal often nest within a few hundred yards of the permanent ponds. It is important for them to have a reasonably large area (at least a few acres) for nesting so they have a reasonable chance to avoid predators. If they nest on a narrow levee, it is likely a skunk, coyote, bull snake, or other predator will destroy the nest and may kill the hen. Nesting areas consist of annual grasses and weeds such as rye grass and curly dock.

The dominant vegetation in permanent wetlands is cattails and bulrush. Water primrose, spike rush, duck weed, and azola are also common. Because wetlands are rotated between permanent and seasonal, many of the species in seasonal wetlands are the same as those in the permanent wetlands. In a seasonal wetland the plants are mostly dead or dormant in late summer and through the fall and winter. In the spring, plants such as watergrass, smartweed, swamp timothy, and sprangletop come to life.

Management of the ponds focuses on the needs of three species: Sandhill Cranes, Northern Pintail Ducks, and the giant garter snake. Sandhill cranes start arriving in late August and leave in March with peak numbers of 1,000 to 5,000 on the Preserve from November through January. Pintail usually start arriving before the cranes and reach peak numbers of 10,000 to 50,000 later (December through early February). The giant garter snake has not actually been observed in the Preserve wetland complexes. However, the permanent wetlands in the area are potential habitat for the snake and are managed with the needs of the snake in mind.

The ponds were constructed in the 1990s from agricultural lands using heavy earthmoving equipment (dozers and paddle wheels). The result is shallow ponds, generally less than three

feet deep at the outlet water control structure and feathering to only a few inches deep on the higher side where water is pumped in. The ponds vary in size from 10 to 80 acres with 25 acres being about average.

Most of the ponds in a given year are seasonal, meaning they are dry in the summer and flooded in the fall to provide habitat for birds coming in from the north. Water is retained through the spring and summer in about 10% of the ponds to provide a place for the mother ducks to bring their young. These "brood ponds" also provide good potential habitat for giant garter snake, particularly when they are adjacent to sloughs and tidal wetlands as are the ponds in the Willow Slough complex.

The most difficult pond management challenge is the control of cattails. If shallow ponds remain permanently wet for just a few years, they will usually become overgrown with cattails and bulrush. To combat this, ponds are rotated from permanent to seasonal and back to permanent every two to five years. During the seasonal years, these areas are disked in May or June to increase the die back of cattails by letting the hot summer sun kill the exposed rhizomes. The process of rotation increases the productivity of the brood ponds and often enhances the seasonal ponds by providing limited cover in the fall and winter from the residual emergent vegetation.

Swales have been constructed in several of the ponds. These are expanded ditches that slope from the water inlet at the high end of the ponds through the low areas of the pond to the outlet. Water in the swale (but not the rest of the pond) during the summer provides a ribbon of water and emergent vegetation in an otherwise dry field. This greatly increases the diversity of the habitat and its attractiveness to a number of species, including waterfowl. In the fall when the pond is flooded, the tall emergent vegetation in the swale often provides cover for waterfowl and cranes.

The most important management techniques in the ponds are mowing and disking and the timing of flood up and draw down. Fire is potentially valuable for removing the vegetation from islands and controlling cattails. However, that technique is not used because it is difficult and expensive to meet the regulatory requirements for controlled burns. Almost all of the levees are mowed to facilitate access, reduce fire hazard, and expose rodent damage. Islands and the sides of levees in seasonal ponds are mowed to provide loafing areas for waterfowl. When the vegetation in a pond is thick and tall, 10–15% of it is mowed to open up landing areas for the waterfowl. This is often necessary in ponds that have been irrigated. Some undesirable plant species, such as umbrella sedge, can be controlled by disking. Disking is also used to create mudflats for shorebirds. Finally, the timing of the draw down in the spring can facilitate the growth of plants that produce waterfowl food. For example, a late drawdown (late March and April) encourages watergrass and smartweed. A February drawdown encourages swamp timothy. Seed production of all three of these plants can be increased by summer irrigation.

4.2.2.3 Compatible Agriculture

The Nature Conservancy and its Partners are pioneers in integrating agriculture and native habitats to create a diverse landscape for the benefit of a wide range of wildlife species.

Farming

Farming occurs on over 13,000 acres in the Cosumnes River Preserve, and approximately 2,000 acres of additional farmland have been protected through conservation easements. Of the total 13,000 acres in agricultural production, approximately 10,000 acres are managed to be compatible with wildlife, meaning that, in addition to being managed for agriculture, these areas are managed in a way that is consistent with many of the wildlife conservation targets identified by Preserve biologists. For example, post harvest treatments that include tillage and irrigation operations in corn and rice fields are managed to provide a mosaic of foraging and roosting habitat for wintering sandhill cranes and waterfowl. Row crops, irrigated pasture, and grasslands provide habitat for migratory waterfowl, Swainson's hawks and sandhill cranes. The biological diversity of vernal pool grasslands is maintained through grazing practices. Though the Preserve has converted some of its agricultural lands to riparian forest, managed wetlands, or other critical habitats, a majority of the lands in the Preserve are still used for agriculture and will remain in agricultural production as part of an overall wildlife management plan.

Lands kept in agricultural production provide income for restoration and management activities and serve as a link to the local agricultural community, which has both the equipment and knowledge to implement many conservation practices. Conservation of lands that support compatible agriculture has been achieved through fee acquisition and through conservation easements—where the Preserve Partners purchase the development rights on the property but permit the landowner to conduct compatible agriculture. The landowner benefits by receiving money for the sale of the development rights, a lower yearly tax payment, and the landowner is able to keep the land in agricultural production without the pressure to subdivide and develop the property.

Of the 13,000 farmland acres on the Preserve, 3,000 acres of agricultural lands are not managed in a wildlife-friendly way but are still recognized as having intrinsic benefits to wildlife largely by reducing the threat of residential development. In these areas, efforts to implement a wildlife-

friendly farming program have been difficult to achieve due to poor infrastructure, unclear long-term management goals, and competing priorities.

The following is a brief description of compatible agriculture in the Preserve. Descriptions include information on the number of acres planted in different crops, tillage, harvest, and irrigation operations, and highlight which species benefit from the farming activities. The types of compatible farming in the Preserve are:

- Grazing
- Wildlife-friendly farming
- Organic rice production

Grazing

Grazing currently occurs on nearly 3,000 acres of annual grasslands in the Preserve. In addition, well over 15,000 acres of vernal pool grassland are grazed on lands where one of the Preserve Partners holds a conservation easement. Grazing is considered not just compatible, but necessary for maintaining the native plant and aquatic diversity of vernal pools (Marty 2005). Grazing reduces thatch and limits encroachment of non-native annual grasses into vernal pools. These grasses can reduce species diversity in the pools by shading out diminutive native species and may alter the duration of inundation by increasing evapotranspiration in and around the pools, which can negatively impact certain aquatic invertebrate and vertebrate species (Marty 2005).

Wildlife Friendly Farming – Staten Island

Farming on Staten Island is focused on planning and managing operations with the combined goals of improving efficiency and profitability and enhancing wildlife values (Ivey and Herziger 2003a). Staten Island has 8,400 acres of farmable land. Three types of crops are grown on the Island, and include 76,700 acres of corn, 1,200 acres of winter wheat and 500 acres of tomatoes. These crops are managed to benefit a wide range of wildlife species but are primarily focused on creating habitat for sandhill cranes and waterfowl. These species have lost substantial habitat in

the Delta because of the conversion to permanent crops, such as vineyards, orchards, and asparagus. Table 4-5 summarizes the typical farming and wildlife activities on a month-by-month basis. However, farming activities may vary from year to year depending on field conditions, market conditions, and management considerations.

Two crop management practices used to enhance wildlife habitat are tillage and irrigation. Corn stalk chopping is used extensively on Staten Island in the fall. The layer of crop residue left on the ground contains residual grain and provides habitat for the growth of invertebrates—both food for wintering birds. Some flooding begins in harvested wheat fields in early September before the sandhill cranes arrive. Wildlife habitat increases as more cropland is harvested during the fall. Field flooding provides habitat for cranes, waterfowl, shorebirds. Water depths in flooded fields range up to about 2.5 feet, but the vast majority are less than one foot deep. Levels are sometimes drawn down in selected fields and then refreshed with new water to flush salts from the soil, provide high-quality water, and help manage potential bird disease outbreaks (such as avian cholera).

Organic Rice Production

In 1994, the Preserver Partners recognized that organic farming answered the question of how to manage about 1,000 acres of Cosumnes River bottomland bordering critical riparian habitats along the Preserve's waterways. The land had traditionally supported row crops, rice and pasture, which had considerable habitat value for sandhill cranes and waterfowl, but there was much room for improvement. Preserve Partners also wanted to retain and enhance the annual income from these lands to support ongoing management and restoration projects.

Allen Garcia of Living Farms worked with Preserve Partners to develop and implement a three-year transition to wildlife-friendly organic farming. This resulted in the first crop being harvested in 1996 and full production of over 3 million pounds of rice in 1999. After harvest, fields are flooded to attract waterfowl that feast on grain, crayfish, and invertebrates found in the fields. The birds assist with the breakdown of the rice straw and add fertilizer to the fields.

Table 4-5. Farming and Wildlife Activities

Month	Farming Operations	Wildlife Activities
January	Drawdowns begin mid-month at irrigated sites. Spraying for weed control. Waterfowl season ends.	Sandhill cranes begin northward migration. Core wintering period for waterfowl. Great horned owls initiate nesting activity. GGS hibernating in high ground.
February	Drawdown continues of irrigated sites. Spraying for weed control continues.	Sandhill cranes and waterfowl numbers decline significantly. Swainson's Hawks return to the region. Wintering burrowing owls leave the area.
March	Corn and tomato fields prepped for planting (disking, spraying). All irrigated sites dry.	Few cranes remain in early March. Mallards begin nesting. Early shorebirds arrive. Swainsons hawks begin nesting activities. GGS emerge from high ground and move to wetlands, sloughs and large ditches for feeding and summer cover.
April	Corn and tomatoes planting begins.	Potential Burrowing owl and short-eared owl nesting. All duck species and pheasants nesting. Local songbirds begin nesting
May	Corn and tomato planting continues. Irrigation of corn and tomatoes at end of month. Sheep grazing begins at end of month.	Duck and pheasant nesting and brooding. Songbird nesting
June	Irrigation of corn and tomatoes continues. Sheep grazing continues.	Duck and pheasant brooding. Songbird nesting.
July	Irrigation of corn and tomatoes continues. Sheep grazing continues. Wheat harvested mid-month.	Ducks and pheasant brooding and fledging. Songbird nesting.
August	Irrigation of corn and tomatoes continues. Sheep grazing continues. Tomato harvest begins mid- to late part of month (slowly).	Shorebirds move through.
September	Corn harvest begins including discing headlands. Tomato harvest continues. Sheep grazing continues. Corn chopping begins. Roost site flooding begins (wheat).	Cranes return, focus on feeding in harvested wheat fields. Large numbers of northern pintails and white-fronted geese return. No large numbers of pintail nor geese were seen.
October	Corn and tomato harvest ends. Sheep grazing ends. Corn chopping continues. Roost site flooding of corn and tomatoes continues . Selected fields disced in preparation for wheat planting. Waterfowl season begins.	Cranes continue to focus on feeding in harvested wheat fields. Most ducks and Canada and white geese return. Tundra swans arrive at end of month. Wintering burrowing owls begin to return to the area. GGS move to high ground, such as levees.
November	Corn chopping finished. Maintenance of roost sites. Pheasant season begins. Winter wheat planting.	Core wintering period for cranes and waterfowl. Cranes focus on new wheat fields and chopped corn. Tundra swan numbers increase.
December	Maintenance of roost sites. Some fields disced for weed control. Winter wheat planting possible. Pheasant season ends.	Core wintering period for cranes and waterfowl. Cranes focus on chopped corn.

Post harvest management consists of a combination of tillage and flooding. Prior to flood-up, fields are chopped, disked or left in their post harvest condition. Flood-up occurs in either November or December and water is maintained at a variety of depths until drawdown begins in late February, with the water drained off by March. Varying the tillage and flooding provides a diversity of habitat for a variety of species throughout the season. The wetland managers continue to monitor and adapt their management actions to the needs of the bird species that utilize the Preserve in winter.

4.2.2.4 Wildlife Species

The Preserve hosts a rich and wide variety of wildlife species that inhabit wetland, upland, vernal pool, grassland and riparian areas of the Preserve. There are 295 species known to occur at Preserve, including 247 species of birds (Appendix F), 30 species of mammals (Appendix G) and 18 amphibian and reptile species (Appendix G).

Many of the species that commonly occur at the Preserve are not specifically managed for, although these species benefit from habitat that is created, restored or preserved as part of the Preserve's projects and continued management. These species include black tailed deer (*Odocoileus hemionus)*, river otter (*Lutra canadensis*), California vole (*Microtus californicus*), beaver (*Castor canadensis*), American bittern (*Botaurus lentiginosus*), northern pintail (*Anas acuta*), redwing blackbird (*Agelaius phoeniceus*), western fence lizard (*Sceloporus occidentalis*), common kingsnake (*Lampropeltis getulus*), and desert cottontail (*Sylvilagus auduboni*).

The lower Cosumnes River watershed hosts a variety of special-status wildlife species that inhabit wetland, upland, vernal pool, grassland and riparian areas of the Preserve (Appendix H). Special-status species include those wildlife species that have been designated as endangered, threatened, species of special concern/species of concern, or are proposed for listing (i.e. candidate species) under the federal Endangered Species Act (FESA) or California Endangered Species Act (CESA). Management plans are developed for some special-status species whose ecological needs may not be met through general management of wildlife habitat alone. Some key special-status species for the Cosumnes River Preserve include greater sandhill crane, Swainson's hawk, valley elderberry longhorn beetle, and giant garter snake.

4.2.2.5 Management and Recovery of Special-Status Wildlife Species

The lower Cosumnes River watershed hosts a variety of special-status wildlife species (summarized in Appendix I). Special-status species include those wildlife species that have been designated as endangered, threatened, species of special concern/species of concern, or are proposed for listing (i.e., candidate species) under the federal Endangered Species Act (FESA) or California Endangered Species Act (CESA). Management plans are developed for some special-status species whose needs may not be met through general habitat management alone.

Some key special-status species for the Cosumnes River Preserve include:

- **Vernal pool fairy shrimp** (*Branchinecta lynchi*)
- **Vernal pool tadpole shrimp** (*Lepidurus packardi*)
- **Valley elderberry longhorn beetle** (*Desmocerus californicus dimorphus*)
- **California tiger salamander** (*Ambystoma californiense*)
- **Western pond turtle** (*Clemmys marmorata*)
- **Giant garter snake** (*Thamnophis gigas*)
- **Greater sandhill crane** (*Grus canadenis tabida)*
- **Swainson's hawk** (*Buteo swainsoni*)

Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federally listed as Threatened

This species occurs in a wide range of vernal pool habitats in the Central Valley of California, and in two vernal pool habitats within the "Agate Desert" area of Jackson County, Oregon. It is one of the most widespread of the endemic vernal pool crustaceans and can be found in vernal pools that occur on a variety of geologic landforms.

It is likely the historical distribution of this species coincides with the historical distribution of vernal pools in California's Central Valley and southern Oregon Holland (1978) estimated that roughly 1,618,700 hectares (4,000,000 acres) of vernal pool habitat existed in the Central Valley prior to the widespread agricultural development that began in the mid-1800s. He found that although the current and historical distribution of vernal pools is similar, vernal pools are now far more fragmented and isolated from each other than during historical times and currently occupy only about 25% of their former land area (Holland 1998). The current distribution of the vernal pool fairy shrimp in the Central Valley may be similar to its historical distribution in extent, but remaining populations are now considerably more fragmented and isolated than in pre-agricultural times.

The USFWS (2004) lists threats to this species as development including agricultural conversion. In addition, Changes in grazing management may degrade the vernal pool habitat for this species by allowing vegetation to overgrow in the pool basin. This excess vegetation growth may decrease open water habitat and alter the hydrology of the pools by increasing evapotranspiration (Marty 2005).

This species is found throughout the Preserve's vernal pool habitat and has been verified on the Valensin Ranch, Larkin property, Howard Ranch, and Forester Ranch (Marty unpublished data). Vernal pool fairy shrimp exist only in vernal pools or vernal pool-like habitats. Individuals have never been found in riverine, marine, or other permanent bodies of water. Vernal pool habitats form in depressions above an impervious soil layer or duripan. Due to local topography and geology, the depressions are part of an undulating landscape, where soil mounds are interspersed with basins, swales, and drainages. The vernal pool fairy shrimp occupies a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools (Eng *et al.* 1990, Helm 1998). Although the vernal pool fairy shrimp has been collected from large vernal pools, including one exceeding 10 hectares (25 acres) in area (Eriksen and Belk 1999), it tends to occur primarily in smaller pools (Platenkamp1998), and is most frequently found in pools measuring less than 0.02 hectare (0.05 acre) in area (Gallagher 1996, Helm 1998). The vernal pool fairy shrimp has been collected at water temperatures as low as 4.5 degrees Celsius (40 degrees Fahrenheit) (Eriksen and Belk 1999), and has not been found in water temperatures above about 23 degrees Celsius (73 degrees Fahrenheit) (Helm 1998, Eriksen and Belk 1999). Vernal pools are mostly rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, dissolved oxygen, and carbon dioxide (Keeley and Zedler 1998).

Habitat creation is not considered a viable option for this species or for vernal pool habitat in general even though vernal pool creation has been practiced for nearly 2 decades. In some instances, vernal pools can be restored in areas that once contained vernal pools where the claypan or hardpan is still in tact. The major limitation to these efforts is the lack of seed and cyst inoculum to restore the flora and fauna. Therefore, habitat preservation is the key strategy for conserving this habitat and species. The main goals for vernal pool habitat on the Preserve are to preserve at least 50,000 acres (guesstimate) of vernal pool habitat in Sacramento County and to ensure the long-term viability of these properties through the use of proper fire and grazing management.

Vernal pool tadpole shrimp (*Lepidurus packardi*)
Federally listed as Endangered

This species occurs in larger, deeper vernal pools in the Central Valley of California and in the San Francisco Bay area. Historically the vernal pool tadpole shrimp was probably distributed over most of the once vast vernal pool habitat in the Valley. However, surveys in southern portions of California have never revealed vernal pool tadpole shrimp populations, and the species probably did not occur historically outside of the Central Valley and Central Coast regions.

The species distribution has been greatly reduced from historic times as a result of widespread destruction and degradation of its vernal pool habitat. Vernal pool habitats in the Central Valley now represent only about 25% of their former area, and remaining habitats are considerably more fragmented and isolated than during historic times (Holland 1998). Vernal pool tadpole shrimp are uncommon even where vernal pool habitats occur. Helm (1998) found vernal pool tadpole shrimp in only 17% of vernal pools sampled across 27 counties, and Sugnet (1993) found this species at only 11% of 3,092 locations. This species has been recorded on only one property on the Preserve: the Howard Ranch, (Marty unpublished data).

Vernal pool tadpole shrimp occur in a wide variety of ephemeral wetland habitats (Helm 1998). The species has been collected in vernal pools ranging from 2 to 356,253 square meters (6.5 square feet to 88 acres) in surface area (Helm 1998). Vernal pool tadpole shrimp have been found in pools with water temperatures ranging from 10 degrees Celsius (50 degrees Fahrenheit) to 29 degrees Celsius (84 degrees Fahrenheit) and pH ranging from 6.2 to 8.5 (King 1996, Syrdahl 1993). However, vernal pools exhibit daily and seasonal fluctuations in pH, temperature, dissolved oxygen, and other water chemistry characteristics (Syrdahl 1993, Scholnick 1995, Wiggins 1995, Keeley 1998). Although the vernal pool tadpole shrimp is found on a variety of geologic formations and soil types, Helm (1998) found that over 50% of vernal pool tadpole shrimp occurrences were on High Terrace landforms and Redding and Corning soils. Plattenkamp (1998) found that vernal pool tadpole shrimp presence differed significantly between geomorphic surfaces at Beale Air Force Base, and was most likely to be found on Riverbank formation.

The USFWS (2004) lists threats to this species as development including agricultural conversion. In addition, changes in grazing management may degrade the vernal pool habitat for this species by allowing vegetation to overgrow in the pool basin. This excess vegetation growth may decrease open water habitat and alter the hydrology of the pools by increasing evapotranspiration (Marty 2005).

Habitat creation is not considered a viable option for this species or for vernal pool habitat in general even though vernal pool creation has been practiced for nearly 2 decades. In some instances, vernal pools can be restored in areas that once contained vernal pools where the claypan or hardpan is still in tact. The major limitation to these efforts is the lack of seed and cyst inoculum to restore the flora and fauna. Therefore, habitat preservation is the key strategy for conserving this habitat and species. The main goals for vernal pool habitat on the Preserve are to preserve at least 50,000 acres (guesstimate) of vernal pool habitat in Sacramento County and to ensure the long-term viability of these properties through the use of proper fire and grazing management.

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

Federally listed as Threatedned

The valley elderberry longhorn beetle is restricted to the Central Valley where the elderberry shrub (*Sambucus* spp.) is associated with riparian forests along rivers and streams. Suitable habitat is provided in shrubs with stems that are 1 inch or greater in diameter at ground level.

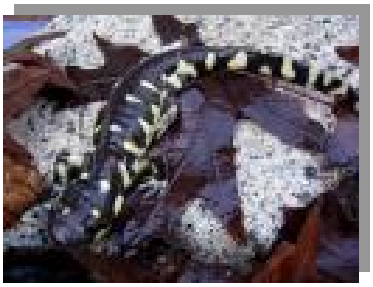
This species is associated with the elderberry shrub during its entire life cycle. Frequently, the only exterior evidence of the beetle is an exit hole created by the larva just before the pupal stage. Adult beetles eat the foliage of the shrub until they mate. Females lay eggs in the crevices of the bark, and the larvae tunnel into the shrub, consuming the interior wood as their only food source for the next 1–2 years.

Historically the beetle was found only in the Central Valley. Its current distribution is patchy throughout the remaining riparian forests of the Central Valley from Redding to Bakersfield. Population clusters are not evenly distributed across the Central Valley, persisting only in scattered localities along the Sacramento, American, San Joaquin, Kings, Kaweah, and Tule rivers.

The species was federally designated as *threatened* in its entire range in August of 1980 due to the loss of as much as 89% of California's riparian forest habitat for agriculture, urban and suburban development, fuel, and wood products. Extensive use of pesticides and grazing have also severely degraded and fragmented remaining riparian habitat that supports the beetle.

Although elderberry plants are found scattered throughout the Preserve along the Cosumnes River, Lost Slough, Cougar Wetlands, and Preserve wetland habitat, exit holes for the beetle have only been identified on the Castello and Shaw Properties (May Consulting Services 2000). Approximately 1,000 acres of riparian habitat have been restored by restoring a natural hydrologic regime, primarily through levee removal. In addition, riparian restoration projects continue in critical corridors, including the use of native species along river corridors, and passive restoration of elderberry shrubs. Riparian habitat restoration and management remain a long-term priority for the Preserve.

California tiger salamander (*Ambystoma californiense*)
Federally listed as Threatened / Endangered



This species occurs in larger, deeper vernal pools and seasonal wetlands including stock ponds in the southern Central Valley and in the San Francisco Bay area. The species is restricted to grasslands and low foothill regions with aquatic sites for breeding. They prefer natural ephemeral pools or ponds that mimic them (stock ponds that are allowed to go dry). Larvae require significantly more time to transform into juvenile adults than other amphibians such as the western spadefoot toad (*Scaphiopus hammondii*), a Species of Concern, and Pacific tree frog (*Pseudacris regilla*). Compared to the western toad (*Bufo boreas*) or western spadefoot toad, California tiger salamanders are poor burrowers. They require refuges provided by ground squirrels and other burrowing mammals in which to enter a dormant state called estivation during the dry months.

This species is restricted to California and does not overlap with any other species of tiger salamander. California tiger salamanders are restricted to vernal pools and seasonal ponds, including many constructed stockponds, in grassland and oak savannah plant communities from sea level to about 1,500 feet in central California. In the Coastal region, populations are scattered from Sonoma County in the northern San Francisco Bay Area to Santa Barbara County, and in the Central Valley and Sierra Nevada foothills from Yolo to Kern counties.

The primary cause of the decline of California tiger salamander populations is the loss and fragmentation of habitat from human activities and the encroachment of nonnative predators. Federal, state, and local laws have not prevented loss of habitat. All of the estimated seven genetic populations of this species have been significantly reduced because of urban and agricultural development, land conversion, and other human-caused factors. A typical salamander breeding population in a pond can drop to less than 20 breeding adults and/or recruiting juveniles in some years, making these local populations prone to extinction. California tiger salamanders therefore require large contiguous areas of vernal pools (vernal pool complexes or comparable aquatic breeding habitat) containing multiple breeding ponds to ensure recolonization of individual ponds.

A strong negative association between bullfrogs and California tiger salamanders has been documented. Although bullfrogs are unable to establish permanent breeding populations in vernal pools, dispersing immature frogs from permanent water bodies within 2 miles take up residence and prey on adult or larval salamanders in these areas during the rainy season. Louisiana swamp crayfish, mosquito fish, green sunfish and other introduced fishes also prey on adult or larval salamanders.

A deformity-causing infection, possibly caused by a parasite in the presence of other factors, has affected pond-breeding amphibians at known California tiger salamander breeding sites. This same infection has become widespread among amphibian populations in Minnesota and poses the threat of becoming widespread here.

Reduction of ground squirrel populations to low levels through widespread rodent control programs may reduce availability of burrows and adversely affect the California tiger salamander. Poison typically used on ground squirrels is likely to have a disproportionately adverse effect on California tiger salamanders, which are smaller than the target species and have permeable skins. Use of pesticides, such as methoprene, in mosquito abatement may have an indirect adverse effect on the California tiger salamander by reducing the availability of prey.

Various non-native subspecies of the tiger salamander in the Ambystoma tigrinum complex have been imported into California for use as fish bait. The introduced salamanders may out-compete the California tiger salamanders, or interbreed with them to create hybrids that may be less adapted to the California climate or are not reproductively viable past the first or second generation.

Changes in grazing management may degrade the vernal pool habitat for this species by allowing vegetation to overgrow in the pool basin. This excess vegetation growth may decrease open water habitat and alter the hydrology of the pools by increasing evapotranspiration (Marty 2005). Automobiles and off-road vehicles kill a significant number of migrating California tiger salamanders, and contaminated runoff from roads, highways and agriculture may adversely affect them.

The species distribution has been greatly reduced from historic times as a result of widespread destruction and degradation of its vernal pool habitat. Vernal pool habitats in the Central Valley now represent only about 25% of their former area, and remaining habitats are considerably more fragmented and isolated than during historic times (Holland 1998). California tiger salamanders are uncommon even where vernal pool habitats occur. This species has been recorded on only one property on the Preserve: the Howard Ranch, (Marty, unpublished data).

Habitat creation is not considered a viable option for this species or for vernal pool habitat in general even though vernal pool creation has been practiced for nearly 2 decades. In some instances, vernal pools can be restored in areas that once contained vernal pools where the claypan or hardpan is still in tact. The major limitation to these efforts is the lack of seed and cyst inoculum to restore the flora and fauna. Therefore, habitat preservation is the key strategy for conserving this habitat and species. The main goals for vernal pool habitat on the Preserve are to preserve at least 50,000 acres (guesstimate) of vernal pool habitat in Sacramento County and to ensure the long-term viability of these properties through the use of proper fire and grazing management.

Western Pond Turtle (*Clemmys marmorata*)

Federal and State Species of Special Concern

The Western pond turtle is a moderately sized brown or khaki-colored turtle that prefers slack or low velocity aquatic habitat with adequate basking locations. Juveniles require shallow water habitat with dense submerged or emergent aquatic vegetation. Western pond turtles dig their nest on slopes with clay or silt substrates up to 400 meters from their aquatic habitats.

The historic range for Western pond turtle was from Washington south to northwestern Baja California and is found in elevations that range from 0 to 5,300 feet. The California Department of Fish and Game (1994) lists nesting failure due to agriculture and grazing operations, juvenile predation by bullfrogs, fish and small mammals, and disease as contributors to the population decline of Western pond turtles.

Western pond turtles are found throughout the lower elevations of the Cosumnes watershed and in the lower Mokelumne River in river and slough channels, agricultural ditches and managed wetland ponds. There has been no research conducted specifically targeting Western pond turtles and therefore little is known about population trends on the Preserve. Anecdotally, there is some evidence that populations have decreased in recent years. There is likely suitable nesting locations throughout the lower Preserve, however, agricultural operations could cause nest disruption in the lower Mokelumne and in the middle reaches of the Cosumnes River. Bullfrogs and predatory fish species exist in large numbers throughout the Preserve lands and are likely affecting the Western pond turtle populations.

No specific Preserve management actions have targeted pond turtles and no long-term goals for the species have been set. Because pond turtles are a species of special concern whose population may have declined in recent years, the Preserve staff are looking at opportunities to research the local population and take management actions to protect and or enhance the turtle population.

Giant Garter Snake (*Thamnophis gigas*)

Federally and State listed as Threatened

This species is one of the most aquatic of garter snakes, preferring habitats that contain areas of permanent water. Suitable habitat includes streams and sloughs with mud bottoms, freshwater marshes, low-gradient streams with emergent vegetation, drainage canals, irrigation ditches, ponds and small lakes.

The snake is absent from large rivers and other waters with populations of large, introduced, predatory fishes, and from wetlands with sand, gravel, or rock substrates. Riparian woodlands do not provide suitable habitat because of excessive shade and inadequate prey. Giant garter snakes use mammal burrows and soil crevices in non-flooded uplands, especially on south- or west-facing slopes, for cover and refuge during the dormant season.

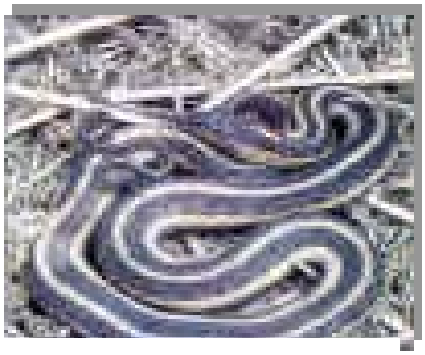


Photo Credit: George E. Hansen

Historically this species occurred throughout the Central Valley of California, but today it is both state and federally listed as threatened due to widespread habitat loss and degradation. The USFWS (1993) lists threats to this species as habitat loss, dewatering of habitat through water diversions and impoundments, flooding (in rice production areas), contaminants (e.g., selenium and salinity in North and South Grassland areas), agricultural and vegetation maintenance activities (e.g., on levees and canal borders), vehicular traffic (on levees and roads along canals), livestock grazing, and introduced predators (e.g., house cats, bullfrogs, perhaps bass).

The Preserve harbors one of thirteen significant populations of giant garter snake. This population is located at Snake Marsh, a permanent freshwater marsh located at the confluence of Badger and Willow creeks, just west of Highway 99. Despite numerous other surveys, giant garter snakes have not been found at any other location on the Preserve (Wylie et al. 1997, Hansen 2003).

The long-term goals for recovery of this species on the Preserve are (1) to assess current habitat conditions and population status at Snake Marsh to determine management needs, (2) to maintain and enhance the core habitat at Snake Marsh in good condition to support the current population, and (3) to restore additional habitat and aquatic corridors east of Snake Marsh to facilitate expansion of this population to historic habitat east of Highway 99. Potential restoration actions to be evaluated for efficacy and feasibility include providing supplemental water to maintain marsh habitat during the summer and control of invasive aquatic weeds (water primrose).

Greater sandhill crane (*Grus canadenis tabida)*

State listed as Threatened

The San Joaquin-Sacramento Delta is one of the two most important winter use areas for more than 61% of the Central Valley population of greater sandhill cranes (Ivey and Herziger 2003a). This subspecies winters primarily in the Sacramento/San Joaquin Valley.

Suitable winter habitat for sandhill cranes includes dry grasslands and croplands, especially near emergent wetlands (Grinnell and Miller 1944). When foraging, cranes prefer open treeless short grass plains, grain fields and open wetlands. Cranes will fly further to feed on newly flooded or planted areas to take advantage of terrestrial invertebrates, and rodents concentrated by flood waters. They feed on mostly cereal crops but will also feed on grasses and forbs. Cranes use their long bills to search for roots, tubers, seeds, grains and insects. They will also feed on larger prey such as mice, small birds, snakes, frogs and crayfish. Cranes prefers to roost at night in flocks standing in moist fields or shallow water, although they will also roost in expansive, dry grasslands, island sites and wide sandbars. Preferred breeding and nesting habitat includes wet meadows that are often mixed with emergent marsh lands. Staten Island, part of the Preserve, is one of the most important sites for sandhill cranes in California (Ivey and Herziger 2003a).

Historically, the Central Valley provided wintering habitat for upwards of 14% of the world's population of greater sandhill cranes (Pacific Flyway Council 1997). This species is a CESA listed *threatened* species due to widespread habitat loss and degradation due to urban and incompatible agriculture development of critical wintering and breeding grounds, predation, human disturbance, and power lines.

Created wetlands located near the Preserve barn, Lost Slough and Lost Slough East provide 1,000 acres for foraging and roosting habitat. The viability of the greater sandhill crane population is further enhanced by habitat created through wildlife-friendly agriculture such as nearly 9,000 acres on Staten Island (corn, wheat, and tomatoes) and 1,100 acres of organic rice on the lower Preserve (Ivey and Herziger 2003a). This species is found throughout the Preserve beginning in late August through mid-March, wherever emergent wetlands are being flooded, sloughs are filled, rice crops are irrigated, and when seasonal ponds are filled and managed.

As a long-term goal for recovery, the preservation of Staten Island as a feeding and roosting site for wintering sandhill cranes is imperative. In addition, continued management of wetland units and adjacent agriculture (e.g., rice crops) and grasslands at the Preserve must remain a priority.

Swainson's Hawk (*Buteo swainsoni*)

No special status designation

The Swainson's hawk is a neotropical migratory raptor that breeds in western North America and winters in South America and Mexico (reviewed by Woodbridge 1998, CDFG 2000). The Central Valley hosts 90% of California's population (estimated 1,000–1,100 pairs), with nesting concentrated in Yolo, Solano, San Joaquin and Sacramento counties. In 2006, an estimated 184–189 pairs were nesting in southern Sacramento County, including around the Cosumnes River Preserve (Estep, pers. comm., 2006). Over 85% of Swainson's hawk territories in the Central Valley are in riparian systems adjacent to suitable foraging habitats. Swainson's hawks often nest peripherally to riparian systems of the valley as well as utilizing lone trees or groves of trees in agricultural fields. They nest most commonly in valley oak, Fremont cottonwood, walnut, and large willow trees (average height 41–82 ft).

Swainson's hawks require large, open grasslands with abundant prey in association with suitable nest trees. Suitable foraging areas include native grasslands or lightly grazed pastures, alfalfa and other hay crops, and certain grain and row croplands (JSA 2005). Unsuitable foraging habitat includes crops such as vineyards, orchards, certain row crops, rice, corn and cotton crops. Prey availability fluctuates throughout the season depending on timing of different farming practices, such as mowing or irrigating of hay. Swainson's hawks nest and forage at the Preserve in the spring and summer.

The loss of agricultural lands to development is a serious threat (CDFG 2000). Additional threats are habitat loss due to riverbank protection projects, conversion from agricultural crops that provide abundant forage (voles and insects) to crops such as vineyards and orchards, shooting, pesticide poisoning of prey animals and hawks on wintering grounds, competition from other raptors, and human disturbance at nest sites.

Management needs are fairly well known for the Central Valley breeding population. These include ensuring the availability of suitable nesting and foraging habitat through preservation of riparian systems and of trees in agricultural fields, and maintenance of compatible (with the Swainson's hawk) agricultural practices in grasslands, pastures and croplands.

The Swainson's hawk is considered an indicator species of the health of the Cosumnes floodplain riparian system and surrounding agricultural landscape. This species should benefit from the Preserve's management of existing and restored riparian forest and grassland, as well as the surrogate habitat provided by annual croplands (e.g., alfalfa) and pasture in and around the Preserve.

4.2.2.6 Control and Removal of Non-Native Invasive Wildlife Species

Invasive non-native wildlife are animals that are not indigenous to this area and have the ability to successfully establish themselves in native ecosystems. Species targeted for management are those invasive non-native species found in the Preserve that are the fastest growing, most disruptive and affect the most highly valued habitats in the Preserve. They can compete with and displace native plants and animals, and promote other invaders. The Cosumnes River Preserve supports more than 295 wildlife species, but only three are considered for management actions. However, due to the difficulty of controlling these species, management has focused on studying their adverse effects on native species.

- **Black rat** (*Rattus rattus*)
- **Brown-headed cowbird** (*Molothrus ater*)
- **American bullfrog** (*Rana catesbeiana*)**)**

Black rat (Rattus rattus)

The black rat is usually associated with human dwellings such as buildings, barns and warehouses. It is believed that this species originated in Southeast Asia and in its native habitat it can be found in dry and wet forests with dense tree stands and grass cover over open areas. It is nocturnal and is often arboreal. Young are born in nests in protected sites in buildings or in other cover. In a suitable environment it will breed throughout the year, with a female producing three to six litters of up to ten young. Black rats can live for 2–3 years. Black rats are omnivorous and feed on both the eggs and adult songbirds. Snakes, hawks, owls, and most carnivorous mammals are potential predators of black rats.

Black rats have been linked to impacts on songbirds in the Preserve's mature riparian forests. Songbird monitoring by the Point Reyes Bird Observatory (PRBO) documented poor nesting success by several species that nest in mature riparian forest on the Cosumnes River Preserve (Haff et al. 2001). Further study in 2001-02 confirmed that black rats are both extremeley abundant and are the most significant egg predator at experimental nests (Whisson and Engilis 2004). Preliminary tests of control measures (poison bait) in 2003 suggested that rat populations can be reduced, but they may quickly rebound. Further study is needed to determine feasibility and whether bird populations respond. The black rats are likely coming from the surrounding agricultural lands, making it difficult to reduce or eradicate them without continual efforts.

Brown-headed cowbird (*Molothrus ater*)

This bird is 6–8" tall with the male being black with glossy brown head and the female plain gray-brown color. Both have a finch-like bill. It is usually found in agricultural fields, woodland edges, and suburban areas. Cowbirds are brood parasites with the female laying 4 or 5 white

eggs, lightly speckled with brown, in the nests of other songbirds. Once the famale chooses a nest, she removes one egg of the host's clutch, and deposits one of her own in its place. Some host species eject the unwanted egg; others lay down a new nest lining over it, but most rear the young cowbird as one of their own. The young cowbird grows quickly at the expense of the young of the host, pushing them out of the nest or taking most of the food.

Songbird monitoring by PRBO suggested that cowbirds were signficant nest predators (Haff et al. 2001), although nest camera monitoring indicates that black rats may be a more significant predator (Whisson and Engilis 2004). As with black rats, it would be difficult to control these non-native birds because they are abundant in the surrounding agricultural landscape. At the South Fork Kern River Preserve, managers have instituted a successful but intensive trapping program to control cowbirds.

American bullfrog (*Rana catesbeiana*)

Bullfrogs are large aquatic amphibians of the Genus Rana. The historic range of bullfrogs was eastern North America from Nova Scotia and New Brunswick southward to Florida. They populate a wide range of habitats, including ponds, marshes, stream margins and irrigation ditches. Eggs and larvae develop in stagnant or low velocity bodies of water over a period of 1-2 years. Adults are voracious predators that prey upon a wide of variety of vertebrates and invertebrates, while larvae eat aquatic invertebrates, algae and detritus.

Bullfrogs were introduced into the Western United States in the early 1900's, likely as a food source, as native frog populations declined. Adult bullfrogs have been known to prey upon native frogs and their larvae, juvenile Western pond turtles and native fish. Bullfrogs lack predators, are prolific reproducers and can travel great distances to relocate—all characteristics that contribute to their ability to successfully invade new habitats.

Bullfrogs inhabit the entire Preserve area, including river and slough channels, agricultural ditches, managed seasonal ponds and the floodplain during seasonal inundation.

Although bullfrogs are likely adversely affecting native species in the Preserve, there have been no management actions taken to control their population. Since tadpoles need permanent water to mature over a 1–2 year period, seasonal draining of managed wetlands can have an effect on the tadpole population. However, no single method has proved effective in eliminating them once they have invaded a system. Rotenone and other chemical treatments have been used in some locations, but bullfrogs simply relocate when treatments are applied. The Preserve does not have any long-term goals for eradicating bullfrogs from Preserve lands.

4.2.3 Aquatic Resources

This section describes aquatic habitats and aquatic species found in the Cosumnes River Preserve. It includes a summary of special-status species and provides a detailed account of those species targeted by TNC biologists for management and recovery activities, such as conservation and restoration of suitable habitat. It also includes a summary of non-native invasive aquatic species targeted for control or removal on the Preserve.

The boundaries of this aquatic assessment are defined as the Cosumnes River from Latrobe Falls (RM 41.5) down to the confluence with the Mokelumne River and on the Mokelumne River from the Cosumnes confluence down to the southern end of Staten Island.

4.2.3.1 **Aquatic habitats**

Aquatic habitats are divided into five segments—from Staten Island upstream to Latrobe Falls. Following the convention of fisheries biologists, description of aquatic habitats begins with the downstream section and progresses upstream to the foothill section of the river.

Segment I is entirely tidal glide habitat and includes the lower Mokelumne River from Staten Island to the Cosumnes confluence. This reach is characterized by leveed, deep open water channels with limited shallow water marsh-like habitat at the river margins. The levees banks are managed primarily for flood control, leaving many areas of the lower Mokelumne River without any riparian cover. The substrate is comprised of sand-silt-mud mixtures.

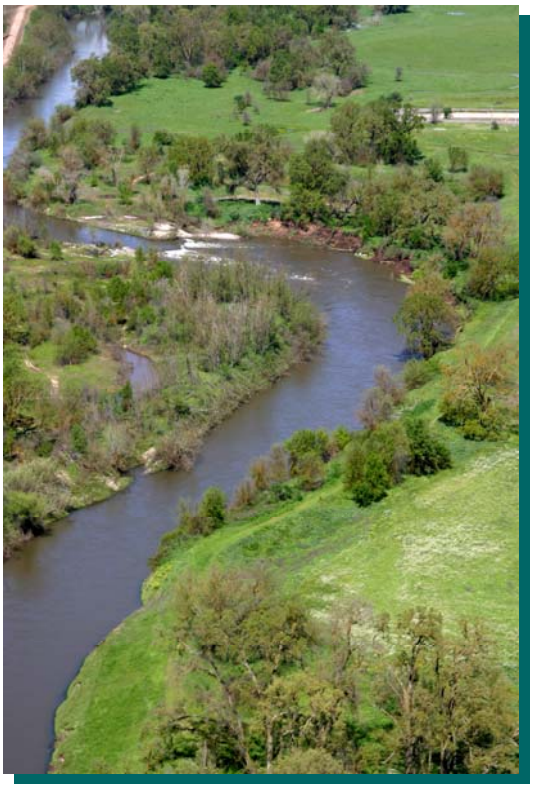
Segment II includes the portion of the Cosumnes from the Mokelumne confluence upstream to Twin Cities Road (RM 5), which is the upper limit of the tidal zone. This segment includes permanent aquatic habitats such as Laguna Creek, Dry Creek, Wood Duck Slough, Tuechemne and Lost sloughs and numerous agricultural ditches. These habitats typically contain shallow channels with stagnant or slow moving, highly turbid waters with mud, silt or sand substrates. This segment also contains seasonal habitats, including the Cosumnes floodplain and numerous lagunitas, which are small seasonal lagunas or sloughs that drain upland areas east of the river.

The Cosumnes floodplain in this segment of the river is a highly complex mosaic of habitats that include oak and willow-cottonwood forests of various successional stages, uplands, agricultural lands and a series of sloughs and ditches that all provide seasonal aquatic habitat for native and non-native fish species. In the mid-1980s, a new forest was created when floods accidentally breached a levee two miles downstream of Twin Cities Road (Swenson et al. 2001). In 1995, TNC purposely breached a levee near the original accidental breach and reconnected over 500 acres of floodplain. In January 1997, a second section of levee was breached upstream during floods. TNC and the U.S. Army Corps of Engineers constructed a setback levee and other improvements to allow the river to reconnect an additional 1,000 acres of floodplain. Subsequent studies have concluded that the newly created floodplain habitat provides excellent

spawning (Sacramento splittail) and rearing (Sacramento splittail, chinook salmon) habitat for native fish species during the spring months, although late spring flooding can result in isolated pools that provide habitat for non-native fish (Whitener and Kennedy 1998, Crain et al. 2004).

Segment III contains the portion of the Cosumnes River from Twin Cites Road upstream to Highway 99 (RM 10) and is characterized by multiple, shallow channels. This portion of the river is dominated by run habitat with limited pool and riffle habitat. The substrate in this segment is dominated by sand. Discontinuous low levees in this segment allow water to surge out of bank during high flows and create floodplain habitat. Flows in this segment typically become disconnected from tidewater by summer or early fall.

Segment IV contains the incised section of the river from Highway 99 upstream to Highway 16. This segment is dominated by long glide-pools and infrequent riffles in a channel that is incised by as much as 15 feet in some areas (PWA 1997). Some of these pools are in areas where the river has incised through a clay duripan, which allows them to stay wetted through the summer. The lower portion of this segment also becomes discontinuous during summer and early fall months. Historically, flows in segments III and IV regularly became disconnected from tidewater. However, this condition has been exacerbated by diversions and groundwater pumping (Mount et al. 2001), which has led to extended periods of no-flow conditions (Moyle et al. 2003). The upper portion of this segment used to have spawning habitat for salmon.



Segment V ranges from Highway 16 upstream to Latrobe Falls. JSA (2003) described this reach as having a relatively low-gradient slope, an unconfined and sinuous channel dominated by pool-riffle habitats with substrate compositions comprised of various sand-silt-gravel mixtures. This segment contains the only viable spawning gravel habitat in the Cosumnes River.

4.2.3.2 Aquatic Species

Available data indicate that 40 fish species are found in the Cosumnes River Preserve (Appendix H). The numbers of fish species occurring in the Mokelumne and Cosumnes River portions of the Preserve are 37 and 35, respectfully. The fish assemblages of the two rivers are comprised of a diverse variety of native and non-native species. Only 14 (35%) of the 40 species are endemic to California, of which 6 species have been given a special-status designation by

NOAA Fisheries, the U.S. Fish and Wildlife Service (USFWS), and/or CDFG due to concern over declining numbers. Two of the special-status species, hardhead and speckled dace, have likely been extirpated from the Cosumnes River. The remaining 26 (65%) fish species have been introduced to California water bodies, either intentionally or unintentionally.

The Cosumnes River from Latrobe Falls down to the confluence of the Mokelumne River hosts a diverse fish community that changes considerably from the foothills to the valley floor. The area below Latrobe Falls, historically dominated by native minnows such as hardhead, pikeminnow and roach, has been drastically altered by the introduction and dominance of red-eye bass and other introduced centrarchids (Moyle et al. 2003). The area of the Cosumnes River near the confluence hosts a mixed assemblage of native and non-native fishes, including Sacramento splittail, Sacramento suckers and largemouth bass (Harris 1996; Moyle et al. 2003). The Cosumnes River also has a remnant population of chinook salmon that migrate through the lower reaches of the Mokelumne and Cosumnes Rivers to spawn in the area below the natural passage barrier at Latrobe Falls, 41.5 miles upstream from the confluence with the Mokelumne River.

Harris (1996) and Moyle et al. (2006) found that the fish species composition of the Cosumnes River was skewed toward non-native taxa, which comprise 66% and 69%, respectively, of all species present. However, Whitener and Kennedy (1998) noted that the relative abundance of native fish on the Cosumnes floodplain during winter flooding was greater than that of non-native fish, comprising 77% of all fish documented. These studies also noted that fish species richness was greatest in the lower reaches of the Cosumnes River near the confluence with the Mokelumne River.

The Mokelumne River from the Cosumnes confluence down to the lower tip of Staten Island is a tidally dominated, open water habitat reach that contains 37 species, of which 13 (35%) are native and 24 (65%) are non-native. Merz and Saldate (2004) found that this portion of the Mokelumne River had the greatest overall species richness, both native and non-native, in the entire Lower Mokelumne River. Most of the 37 species found in the lower Mokelumne River are year-round residents. Several species, including Sacramento splittail, chinook salmon and steelhead, use this reach as a seasonal migration corridor to spawning habitats in the Mokelume and Cosumnes Rivers.

4.2.3.3 Management and Recovery of Special-Status Aquatic Species

The special-status fish species addressed in this section are summarized in Table 4-6. Special-status species include those aquatic species that have been designated as endangered, threatened, Species of Special Concern/Species of Concern, or are

proposed for listing (i.e., candidate species) under the federal Endangered Species Act (FESA) or California Endangered Species Act (CESA), and include:

- **Fall-run chinook salmon** (*Oncorhynchus tshawytscha*) Central Valley ESU
- **Steelhead** (*Oncorhynchus mykiss*)
- **Chum salmon** (*Oncorhynchus keta*)
- **Delta smelt** (*Hypomesus transpacificus*)
- **Sacramento splittail** (*Pogonichthys macrolepidotus*)
- **Hardhead** (*Mylopharodon conocephalus*)
- **Sacramento perch** (*Archoplites interruptus*)

Table 4-6. Special-Status Fish.

Common Name	Status		Presence		Habitat type used within the Preserve	Life history stage
	Federal	State	Lower Mokelumne	Lower Cosumnes		
Hardhead		SSC	Present	Historic Use	channel	all
Sacramento splittail	SC	SSC	Present	Present	channel, floodplain	spawning, rearing
Delta smelt	T	T	Present	Historic Use	channel	migration
Chinook salmon	SC	SSC	Present	Present	channel, riffles, floodplain	migration, spawning, rearing
Chum salmon		SSC	Opportunistic	Absent	channel	migration
Steelhead	T		Present	Opportunistic	channel	migration, rearing

Fall-run (and late fall-run) chinook salmon currently maintain self-sustaining populations in the Cosumnes and Mokelumne rivers, supplemented by stocking from the Mokelumne River Fish Hatchery. These salmon are part of the Central Valley Evolutionarily Significant Unit (ESU), a distinct population segment of fall-run chinook that was identified as a species of concern by NMFS (1999). Chinook salmon spawn in streams and rivers that are shallow with clear, cold water with sufficient spawning substrate of gravel and cobbles with limited or no fine sediments. Fry and smolts require complex instream or floodplain rearing habitat that contains adequate cover and food supply. Upstream migrating adults need channels that are free of barriers in order to reach their spawning grounds.

Central Valley ESU chinook salmon's historical range included the San Joaquin River and all of its major tributaries, including the Mokelumne, Tuolumne, and Merced rivers. Causes of decline of the Central Valley chinook salmon populations include significant altered hydrology as a

result of dams and water diversions, a 40-50% loss of spawning and rearing habitat, ocean and freshwater harvest rates and competition with hatchery production (NMFS 1999). On the Cosumnes River, population declines have been largely attributed to altered hydrology during the critical adult salmon migration period that has resulted in low-flow or non-flow passage conditions. These alterations have also exacerbated passage conditions at instream passage barriers. Insufficient and poor quality spawning habitat and limited juvenile rearing habitat have also likely contributed to the declines in the Cosumnes salmon population.

The Cosumnes River historically supported moderate size runs of chinook salmon, with escapement ranging from several hundred to more than 4,000 fish between 1953 and 1973 (Snider and Reavis 2000). In recent decades, however, annual runs have ranged from 0 to approximately 1,200 fish, but have typically been less than 500 (Kennedy, pers. comm., 2006). Adult immigration begins immediately upon hydraulic connection with the Mokelumne River, which occurs now in October or November). Spawning begins soon after fish reach suitable spawning reaches, which occurs from Highway 16 to Latrobe Falls, the upstream limit for salmonid migration. Latrobe Falls (RM 41.5) is a series of high gradient cascades near Latrobe Road. Fry emergence occurs through May and emigration from the Cosumnes River occurs into June, with early emigration apparently triggered by episodic flow events and later migration triggered by increases in water temperature (Snider and Reavis 2000). Extensive sampling indicates that reconnection of the Cosumnes River to its floodplain provides valuable rearing habitat for juvenile chinook salmon (Whitener and Kennedy 1998, Moyle et al. 2006).

Adult fall-run chinook salmon returning to the Cosumnes and Mokelumne migrate through the lower reach of the Mokelumne River from September into early January, with peak immigration occurring in November. Fry emergence from the upper Mokelumne occurs from January to April and a small portion of these fish may emigrate toward the Delta, through the lower Mokelumne reach as post-emergent fry. Smolt emigration from the lower reach of the Mokelumne River from both the Mokelumne and Cosumnes is usually complete by July.

Restoration and recovery of the Cosumnes River fall-run chinook salmon population has been the focus of numerous management actions at the Preserve. Preserve staff have partnered with The Fisheries Foundation, the Anadromous Fish Restoration Program, University of California at Davis, local agricultural entities, the OHWD, private landowners and fishery consultants to study and improve habitat conditions for chinook salmon. The Fisheries Foundation, in partnership with Preserve staff, completed a barrier-removal project in 1999 that greatly improved upstream migration. OHWD working with Robertson-Bryan, Inc. have further improved passage at various barriers. Preserve staff have breached several levees to create excellent rearing habitat on the restored floodplains of the lower Cosumnes. Research on the passage conditions for chinook salmon on the Cosumnes River has led to a regional partnership with Sacramento

County and the Southeast Sacramento County Agricultural Water Authority to study and enhance the local groundwater basin as a means to restore fall flows critical to adult migration.

The long-term recovery goal for chinook salmon in the Preserve is to maintain a self-sustaining population with an annual average escapement of at least 2,000 fish. To attain this goal the following management actions should occur: 1) maintain partnerships with State and federal agencies, water and agricultural entities and private landowners to assess and monitor the Cosumnes River salmon population and habitat conditions, 2) annually monitor passage barriers in the lower Mokelumne and Cosumnes Rivers to ensure viable adult passage, 3) seek additional locations to create seasonal rearing habitat, and 4) continue to improve spawning habitat.

Steelhead (*Oncorhynchus mykiss*)

Federally listed as Threatened; March 1998

Central Valley ESU steelhead currently maintain a population in the Mokelumne River but not in the Cosumnes River. Steelhead spawn from December through April in small streams and tributaries with cool, well oxygenated water that is available year round.

Historically, Steelhead ranged from Alaska southward to the Tijuana River in northern Baja California. Their current southern range extends southward only to Central California. Populations have declined significantly in recent decades, primarily due to habitat loss stemming from dam construction.

A study by Harris (1996) reports that the Cosumnes River historically supported runs of steelhead. The current seasonal hydrology is not conducive for supporting steelhead due to the ephemeral nature of the lower reaches. Juvenile steelhead require perennial flow, as they rear in their natal stream for a period of 1 to 3 years. A short reach of river extending from Highway 16 to Latrobe Falls flows year-round. Thus, a potential exists for steelhead from the Mokelumne River to make opportunistic use of the Cosumnes River and anecdotal evidence indicates that this may be occurring in some years; however, the probability of juveniles surviving the summer months is low due to such factors as elevated water temperatures, low dissolved oxygen levels, and predation.

The Mokelumne River supports a limited run of steelhead. However, in the Preserve boundaries steelhead habitat is limited to the river channels used for adult migration and smolt emigration and foraging. NOAA Fisheries designation for critical habitat includes all of the Mokelumne River downstream of Camanche Dam. The Cosumnes River was considered for critical habitat designation, but was excluded because it was concluded that the watershed has a “low conservation value.” Steelhead spawning migrations into the lower Mokelumne River begin as early as August, peak from late October through December, and extends into March (EBMUD, NOAA Fisheries 2002).

There have been no management actions taken for the benefit of steelhead. There are no Preserve recovery goals for steelhead.

Chum salmon (*Oncorhynchus keta*)

California Species of Special Concern

Chum salmon are the second most abundant salmon in the North Pacific. They are abundant in rivers north of Oregon and were once relatively abundant in the Klamath and Trinity rivers. Today, they occur infrequently in the Klamath, Trinity, and Smith rivers; however, observations of stray chum salmon have been documented in recent decades in the Sacramento River system, including the American and Yuba rivers (Moyle 2002). To date, two adult chum salmon have been documented in the Mokelumne River: one in 2003 and one in 2004 (Workman, pers. comm., 2006). These individual observations are believed to be stray fish and the Mokelumne River is not believed to support a self-sustaining population of chum salmon (Workman, pers. comm., 2006). Chum salmon have not been documented in the Cosumnes River.

No Preserve management actions have been directed at chum salmon and the Preserve has no long-term goals for chum salmon management.

Delta Smelt (*Hypomesus transpacificus*)

Federally listed as Threatened, March 1993

Delta smelt are small, slender-bodied euryhaline (i.e., occur in a wide range of salinities) fish endemic to the Delta. Delta smelt live in open waters near the surface and tend to form large schools. Adult spawning migrations begin in late winter and last through early summer. Spawning occurs in shallow waters of dead-end sloughs upstream of the brackish water in an estuary. Eggs sink to the bottom and adhere to the substrate. Adult fish die following spawning. Eggs incubate for 10–14 days and, following hatching, the planktonic (drift in the water column) larvae are transported downstream by currents to zones of freshwater-saltwater mixing from late March through July.

Delta smelt occur throughout the Delta, including the lower reaches of the Mokelumne River. They are captured infrequently in the lower Mokelumne River (i.e., downstream of the Cosumnes River confluence) during fish surveys conducted by EBMUD (Merz, pers. comm., 2005). Anecdotal information suggests that delta smelt may have historically occurred as far upstream as the Cosumnes River floodplain (Caywood 1974 as cited in Harris 1996); however, they apparently do not currently occur in the Cosumnes River. Critical habitat was designated December 19, 1994, and includes the area in the Preserve boundaries.

Currently, the Preserve staff takes no management actions related to protecting or enhancing the delta smelt populations that occur in the lower reaches of the Mokelumne River. The Preserve has no recovery goals for the Delta smelt.

Sacramento splittail (*Pogonichthys macrolepidotus*)

Federally and State listed as a Species of Special Concern

Sacramento splittail are large, relatively long-lived and highly fertile cyprinids (minnows). Splittail are found primarily in slow-moving sections of rivers and in sloughs and are most abundant in the Suisun Marsh and Bay region. Adults migrate upstream from brackish areas to spawn in freshwater. Splittail require flooded vegetation for spawning and rearing and as such they are frequently found in areas subject to seasonal flooding, such as river margins and floodplains.

Splittail are endemic to the Central Valley of California and historically ranged from Redding on the Sacramento River south to Friant Dam on the San Joaquin River. Today, splittail are only found in and near the Delta, in Suisun Marsh and Bay and in the Napa and Petaluma Rivers. Reasons cited for splittail population decline include 1) Altered estuarine hydraulics, especially reduced outflows, 2) modification of spawning habitat, 2) climatic variation, 4) toxic substances, 5) introduced species, 6) predation, and 7) over-fishing (Moyle et al. 1995).

Splittail utilize the river and slough channels of the lower Preserve for adult migration and some juvenile and young adult rearing (Crain et al. 2004, Harris 1996, Merz and Saldate 2004). The Cosumnes floodplain is primarily used for spawning and rearing (Crain et al. 2004). Splittail spawn in large numbers from January to June on flooded vegetation in the Cosumnes River floodplain (Whitener and Kennedy 1998, Moyle et al. 1995). Juveniles remain in the shallow near-shore areas with abundant vegetation, moving to deeper water as they grow. Juvenile emigration into the estuary begins in late winter (e.g., February) and continues throughout the summer.

Floodplain restoration through levee breaching has been an important management tool at the Preserve. Although initial restoration efforts targeted riparian communities, research has shown that the Cosumnes floodplain is important habitat for splittail and other native fish species. The Preserve staff have developed the goal of maintaining the Cosumnes floodplain in a manner that is productive for native fishes, while seeking additional opportunities to increase floodplain habitat.

Hardhead (*Mylopharodon conocephalus*)

California Species of Concern

Hardhead, a large cyprinid species, are found in relatively undisturbed low- to mid-elevation streams, rivers and reservoirs. The hardhead's historical range was limited to the Sacramento-San Joaquin drainages and the Russian River. In the past, the Cosumnes and Mokelumne Rivers likely supported large populations, although currently only small numbers are found in the lower reaches of the Mokelumne River (Merz and Saldate 2004, CRG 1999). Although one hardhead was captured on the Cosumnes floodplain (Whitener and Kennedy 1998) hardhead have likely been extirpated from the Cosumnes River (Moyle et al. 2003). Reasons for regional and local declines are thought to primarily be due to habitat loss/alteration and predation from non-native fish species (e.g., smallmouth bass, red-eye bass, green sunfish) (Moyle et al. 1995, Moyle et al. 2003).

There have been no management actions taken for the benefit of hardhead. Because red-eye bass and green sunfish occupy most of the suitable habitat for hardhead in the Cosumnes there is likely little opportunity for them to re-establish a population. The Preserve has no long-term recovery goals for hardhead.

Sacramento perch (*Archoplites interruptus*)

No special status designation

Sacramento perch is the only centrachid native to the Western United States. Historically Sacramento perch would have been found in ponds and lakes, in slow moving rivers and in the tidal channels of the Delta. They are currently found only in ponds and small lakes.

The Sacramento perch historic range included the Sacramento-San Joaquin Delta, the Pajaro and Salinas rivers and Clear Lake. Their current range is limited to a few small ponds and lakes located throughout Northern California. Sacramento perch have likely been extirpated from the Delta. Their population decline has been correlated with the introduction of non-native centrarchids, which actively compete with Sacramento perch for habitat and food resources.

Sacramento perch have been the focus of reintroduction efforts on the Preserve through a partnership with UC Davis. Researchers contend that the Preserve's dammed, interior sloughs may be the perfect habitat to rear introduced, juvenile Sacramento perch. If perch can successfully rear in the sloughs they can opportunistically disperse into the Delta during episodic high-water events. Pat Crain, a UC Davis researcher, has a Calfed grant to explore suitable locations for the re-introduction of Sacramento perch into the Delta. Early results from that research indicate that the Preserve may be one of the best locations for on-going attempts to re-introduce Sacramento perch.

Contra Costa County Mosquito Abatement District has been successfully raising small numbers of Sacramento perch for experimental use in mosquito abatement management. In 2005, the District, partnered with UC Davis and the Preserve to release approximately 400 excess perch into Wood Duck Slough. Subsequent monitoring in Wood Duck Slough has not resulted in the capture of any Sacramento perch.

It is the goal of the Preserve to maintain a self-sustaining population of Sacramento Perch in waters of the Preserve.

4.2.3.4 Control and Removal of Invasive Aquatic Species

Invasive non-native aquatic species are those species that are not indigenous to the area and have the ability to successfully establish themselves in, and then overcome, otherwise intact, pre-existing native ecosystems. These species are a threat to native species and communities in the Cosumnes River Preserve. They compete with and displace native plants and animals, alter the dynamics of aquatic ecosystems, hybridize with native species and promote other invaders. These species can also have significant effects on infrastructure. Heavy populations can impede water flow, block pumps and negatively impact boating and other recreational uses.

There are numerous non-native aquatic species known to occur in the Preserve's waterways (Appendix I). Species described in this section are those invasive non-native species found in the Preserve that are the fastest growing, most disruptive and affect the most highly valued habitats in the Preserve. However, due to the difficulty of control, little work has been done to manage these species in the Preserve. Details of these species, including range in Preserve, impacts, and current management are outlined below and include the following:

- **Centrarchids**
- **Asian clam** (*Corbicula fluminea*)

Centrarchids

Centrarchid is the second largest endemic fish family in North America with over 30 species. Only one member of the centrarchid family, Sacramento perch, is native to the Western United States. Centrarchids inhabit lakes, ponds, sloughs, backwaters, and slow moving rivers, including tidally influenced portions of the Delta.

Centrarchids have been intentionally introduced as sport fish into regions that lack large game species that appeal to fishermen. In California, striped bass, largemouth bass, and red-eye bass were all legally introduced by agencies. Once introduced, non-native centrarchids typically become well established and spread beyond their point of introduction. Because centrarchids are predatory they tend to have adverse ecological impacts on native aquatic systems and are likely responsible for the extirpation of native fish species throughout California.

Ten species of centrarchids are found in the waters of the Preserve and account for approximately 25% of the total number of fish species in the area. Centrarchids predate on native fish and invertebrates and populate the shallow water habitats that previously hosted native fish assemblages. Through competition and predation centrarchids have likely contributed to the decline of native fishes on the Cosumnes River (Moyle et al 2003). Red-eye bass are the most widely distributed invasive fish species in the Cosumnes River and are likely responsible for the extirpation of hardhead and speckled dace (Moyle et al. 2003).

There have been no management actions taken by Preserve staff to control centrarchids. The Fisheries Foundation, a non-profit partner of the Preserve, approached DFG about possibly using Rotenone in the middle reaches of the Cosumnes River as a means to control red-eye bass. DFG was not in favor of using Rotenone and no further attempts at controlling red-eye bass have been made. Chemical treatments, such at Rotenone, are occasionally used to control invasive fish but because centrarchids are so widely distributed on Preserve lands and throughout the greater Delta region there would be no chance of successfully eliminating them from the system. Floodplain restoration, which favors native over non-native productivity, has been effective at producing more native fish, but does not have any effect on controlling the spread of centrarchids.

The Preserve currently has no long-term goals for the control or removal of centrarchids.

Asian clam (*Corbicula fluminea*)

Asian clam is a freshwater and estuarine species native to southern and eastern Asia and Africa. Asian clams are currently found throughout the United States, including the Gulf States and Chesapeake Bay and locally in the Sacramento-San Joaquin Delta and San Francisco Bay. Asian clams inhabit the sandy substrates of rivers and bays. Their primary food source is phytoplankton. There is no definitive explanation as to how asian clams were introduced into California but possible options include the practice of dumping ballast water and intentional introduction as a food source.

Asian clams can modify benthic substrates, foul water systems, compete with native mussels and clams and have the potential to completely alter food webs. In the Delta and Bay, data has shown that the Asian clam has profoundly altered the food web. Studies are under way to determine what the effects to the ecosystem are from those changes.

Asian clams are found throughout the lower reaches of the Cosumnes River, the lower Mokelumne River and the sloughs and ditches of the lower Preserve.

The Preserve has taken no management actions to control the spread of Asian clams as there are no methods available for controlling Asian clams in open environments. The Preserve currently has no long-term goals for controlling Asian clams.

4.3 Cultural Resources

4.3.1 Introduction

This section provides an evaluation of the cultural studies in the 100-year floodplain of the Cosumnes River. The cultural study consisted of an archival records search of the planning area to identify any known archaeological, historical, or other cultural resources present; and to assess the potential for additional resources in portions of the planning area that have not yet been inventoried. All information presented here on archaeological sites and their locations is confidential and will not be made available to the public; it is provided for planning purposes only.

4.3.2 Records Search Methods

The archival records search for this report was conducted by Far Western Anthropological Research Group, Inc. senior staff archaeologist John E. Berg (M.A.), with assistance from Ryan Mitchell (B.S.). It included research at two Information Centers of the California Historical Resources Information System (CHRIS)—the North Central Information Center at CSU, Sacramento (for areas in Sacramento County).

At each of the Information Centers, the primary resources examined were USGS 7.5-minute quadrangle maps corresponding to the study area—the Buffalo Creek, Sloughhouse, Elk Grove, Galt, Bruceville, and Thornton. The extent of area examined on these maps included the rivers' combined 100-year floodplain and a 1/2-mile buffer around the floodplain. The CHRIS quad maps record previous surveys and other studies, locations of known cultural resources, and other pertinent information. The CHRIS Information Centers also keep on file copies of the surveys, excavations, and site records documented on their quad maps. These data were photocopied for the current study, as appropriate, and transferred to clean USGS topographic maps onto which the study area had been digitized.

Other sources of information consulted for this records search included old General Land Office (GLO) plats, historical maps, the National Register of Historic Places listings, the California Historical Landmarks listings, the Caltrans survey of bridges, and Historic Spots in California.

4.3.3 Records Search Results

According to the files at the North Central and Central California Information Centers, there have been 60 documented cultural studies done in the records search area over the last 20-30 years. This is a very small number and is no doubt the result of somewhat limited development of the region (when compared to nearby areas like Sacramento and Roseville, where large-scale development has caused literally hundreds of cultural studies to be done). Even with this small number of surveys and other studies, there are 179 known archaeological sites in the records

search area. Of these, 158 are prehistoric/ethnographic sites of Native American origin; 18 date to the historic period (including both archaeological remains and standing structures); and three are dual-component prehistoric/historic-period sites. There are five California Historic Landmarks in the study area.

Sites documented in the study area vary considerably. Prehistoric/ethnographic sites range from small, temporary camps with minimal artifact assemblages to large, stratigraphically complex mounds which were village sites and cemeteries and often contain house remains, midden deposits, and human burials, among other things. Historic-period resources vary from small mining-related camps to farming and ranching-related sites, transportation facilities, and even towns which remain in existence to this day. In some cases these sites may have been destroyed by more recent activities; in other instances, they may still exist, but with very little physical integrity. The scientific, social, educational, and (for native people) religious values in these sites (and thus their National Register significance and level of project constraint) will depend greatly on their current state of preservation.

4.3.4 Overview of Cultural Resources

The results of the archival records search must be interpreted cautiously, for several reasons. First, very little of the study area has been surveyed for cultural resources. Also, many of the surveys that have been done are decades old and do not meet current standards of completion. The earlier surveyors often did only "spot-checks" of their areas, and they usually ignored historic-period resources altogether. Until recently, most archaeologists never considered the potential for ancient sites buried under more recent alluvial deposits—a subject of some interest to the current staff of the State Office of Historic Preservation. In addition, many of the sites that were recorded in the past were misplotted, while still others have since been destroyed.

For all of these reasons, it is important to view the results presented here as a small and preliminary sample only, and requiring field confirmation. The study area is extremely sensitive for archaeological remains, particularly prehistoric and ethnographic-period Native American sites. As the planning process continues and specific projects are identified, it will be critical to conduct on-the-ground surveys of any areas where ground-disturbing activities (including inundation) are to occur. Such surveys should record any previously undocumented sites and re-visit known sites to confirm their locations and determine whether they remain intact. Any cultural resources found in a specific study area will require full compliance with Section 106 of the National Historic Preservation Act and/or relevant stipulations of the California Environmental Quality Act, as applicable.

4.4 Key Restoration Projects and Research Studies

Below is a brief summary of restoration projects and research studies that have influenced how Preserve biologists develop management strategies and implement restoration projects. There have been numerous studies and restoration projects carried out on the Preserve, and the project descriptions below represent only a small subset of the body of work carried out by Preserve staff and UC Davis researchers.

4.4.1 Riparian Forest Restoration by Planting

Restoration of valley oak riparian forest has been a goal of the Preserve since its inception. In 1988, the Preserve initiated the first large-scale replanting of a valley oak forest (Griggs 1991; Reiner 1996). Since then, over 500 acres have been planted with oaks, willows and other trees by volunteers and school children. A 1994 study of the oak planting program found that these activities have been particularly important for public education. However, even with the help of volunteers, hand planting proved expensive and some plantings failed or grew slowly. Furthermore, good natural regeneration of oaks was occurring in many areas of the Preserve, particularly where natural flooding and sediment deposition still occurred (Reiner 1996).

4.4.2 Floodplain/Riparian Restoration by Levee Breaching

While early efforts emphasized active and direct restoration through hand planting, the Preserve has also breached levees to restore the natural flooding process to floodplain lands downstream of Twin Cities Road (Swenson et al. 2001). This method has been sometimes termed "passive restoration" or "natural process restoration." The first levee breach occurred in 1985, when floodwaters accidentally breached the levee. In the depositional area, cottonwood and willows quickly germinated and grew to establish an "accidental forest." This forest is now a rich mosaic of tall cottonwood trees, Oregon ash, willow thickets, and some young valley oaks in the understory.

The "accidental forest" inspired TNC staff and other Preserve partners to explore opportunities to use natural flooding to restore riparian forest. Additional breaches in 1995 and 1997 have reconnected over 1,500 acres of floodplain to the river, creating seasonal wetland habitat for native fishes and waterfowl and initiating recruitment of riparian forest (Swenson et al. 2001). Together these projects have shown that passive restoration can be a successful tool at the Cosumnes River Preserve.

4.4.3 Managed Wetlands

As described earlier, there are 900 acres of managed wetland ponds on the Cosumnes River Preserve, concentrated along Lost Slough and Willow Slough. These ponds were constructed in the 1990s. Most of the ponds are seasonally flooded to grow forage plants and provide roosting

and foraging sites for wintering waterfowl and sandhill cranes. In the last few years, swales have been constructed in many ponds to increase habitat heterogeneity. BLM staff conduct periodic waterfowl survey during the winter months.

4.4.4 Research at the Cosumnes River Preserve

The Cosumnes Research Group is comprised of numerous researchers from UC Davis, UC Berkeley, and Point Reyes Bird Observatory. From 2001 to 2005, this interdisciplinary group collaborated in a series of wide-ranging studies (summarized in Cosumnes Research Group 2006). Geomorphologic (Florsheim and Mount 2002 and 2003), forest recruitment (Trowbridge 2002, Viers et al. 2006), and fisheries (Moyle et al. 2003, Crain et al. 2004) studies of Preserve sites restored to flooding by levee breaches provide insights on how to create and manage floodplain habitat for native fish and forest. Modeling of surface water and groundwater revealed the serious impacts from groundwater depletion in the lower watershed (Mount et al. 2001). GIS analysis of oak growth, soil, and flooding likelihood at various restoration sites will help focus future restoration at the best sites (Viers et al. 2006).

Since 1995, Point Reyes Bird Observatory has monitored songbird reproduction in natural and restoring riparian and floodplain habitats. They have documented the importance of a mosaic of successional stages in maintaining bird diversity, as well as reproductive failure of certain species (Haff et al. 2001). UC Davis researchers (Whisson and Engilis 2004) have since highlighted the threat of nest predation by non-native black rats, and have investigated potential control measures.

In vernal pool grasslands, TNC has been investigating the effects of grazing and prescribed burning on native plants and invertebrates. Marty (2005) concluded that disturbance from grazing or fire was essential to maintaining vernal pool hydrology and native species diversity. Finally, studies at Staten Island of sandhill cranes and their use of farmlands will improve wildlife-friendly agricultural practices on the Preserve and beyond (Ivey and Herziger 2003b).

4.4.5 Managing Surface Water-Groundwater to Restore Fall Flows in the Cosumnes River

This study investigated declining fall flows that are limiting the ability of the Cosumnes River to support large fall runs of chinook salmon (Mount et al. 2001). Management scenarios linking surface water and groundwater alternatives to provide sufficient fall flows were examined using groundwater flow and channel routing models. Results show that groundwater overdraft in the basin has converted the river to a predominantly losing stream, practically eliminating fall base flows. Management alternatives to increase net recharge (for example, pumping reductions) were examined along with surface water augmentation options. Using a minimum depth standard for fish passage, average surface water flow deficits were computed for the migration period of chinook salmon. Groundwater deficits were evaluated by comparing simulated current

groundwater conditions with conditions under various scenarios. Increases in net recharge on the order of 200 to 300 million m^3/year would be required to reconnect the regional aquifer with the channel and in turn re-establish perennial base flows. Options that combine surface water augmentation with groundwater management are most likely to ensure sufficient river flows in the short term and to support long-term restoration of regional groundwater levels.

4.4.6 Cosumnes River Flow Augmentation Project

The Cosumnes River Flow Augmentation Project supplements the flow of the Cosumnes River by releasing up to 5,000 acre-feet of water into the Cosumnes River from the Folsom South Canal. The project objectives are to:

- improve upstream fall migration of salmon, and
- evaluate groundwater recharge from the Cosumnes River channel.

The first objective would be accomplished by allowing the Cosumnes to connect to tidewater earlier in the fall and sustaining non-barrier flow conditions after initial connection. The second objective would be accomplished by making controlled releases into the river channel and monitoring the surface water-groundwater exchange processes along the length of the channel. In October 2005, a pilot study was conducted when 40 cfs was released from Folsom South Canal into the Cosumnes River.

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Appendix A

Cosumnes-Mokelumne Rivers Floodplain Reports and Studies

Cosumnes-Mokelumne Rivers Floodplain Reports and Studies

River	Date	Source	Title of Report
Delta	2002	Hammersmark, Schladow, Fleenor (UCD)	Habitat Enhancement of the McCormick Williamson Tract: An Evaluation of Proposed Scenerios with a Hydraulic Model and GIS
Delta	2002	Hammersmark, MS Dissertation (UCD)	Hydrodynamic Modeling and GIS Analysis of the Habitat Potential and Flood Control Benefits of the Restoration of a Leveed Delta Island
North Delta	1990	DWR	North Delta Program Environmental Impact Report.
North Delta	1994	DWR	Interim North Delta Program Memorandum Report: Hydrology Report (1) Two-Year Floodplain, North Delta Area. Sacramento,
North Delta	1995	DWR	Interim North Delta Program Memorandum Report: Hydrology Report (2) Low-Frequency Floods in North Delta Region. Sacramento,
Central Valley	1991	USGS-Bertoldi	Groundwater in the Central Valley, California. Washington, D.C., U.S. Geological Survey: 44. Sacramento, U.S. Department of the Interior.
Cosumnes River	1936	USACE	U.S. Army Corps of Engineers (1936). Preliminary Examination, Flood Control Sacramento and San Joaquin Valleys, California. Appendix H Mokelumne River Group. Sacramento, U.S. Army Corps of Engineers.
Cosumnes River	1961	USGS-Portfield	Sediment Transport of Streams Tributary to San Francisco, San Pablo, and Suisun Bays. Sacramento, U.S. Department of the Interior.
Cosumnes River	1965	USACE	U.S. Army Corps of Engineers (1965). Flood Plain Information Cosumnes River Basin. Sacramento, U.S. Army Corps of Engineers.
Cosumnes River	1979	USDOI	U.S. Department of the Interior (1979). Cosumnes River Division Reformulation Study Central Valley Project, California. Concluding Report, U.S. Department of the Interior Bureau of Reclamation, Mid-Pacific Region.
Cosumnes River	1991	USACE	U.S. Army Corps of Engineers (1991). Mokelumne River and Tributaries, California: Reconnaissance Report. Sacramento.
Cosumnes River	1995	Hart & Engilis	Middle Cosumnes River Watershed River Corridor and Vernal Pool/Grassland Study Areas, The Nature Conservancy of California.
Cosumnes River	1997	Phillip Williams & Associates	Analysis of Opportunities for Restoring a Natural Flood Regime on the Cosumnes River Floodplain, Volume 2: Technical Appendix. San Francisco, Phillip Williams and Associates, LTD.
Cosumnes River	1999	Krause, MS Dissertation UCD	Modeling the Flood Hydrology of Wetlands using HEC-HMS
Cosumnes River	1999	USACE	U.S. Army Corps of Engineers (1999). Sacramento and San Joaquin River Basins Post-Flood Assessment. Sacramento, U.S. Army Corps of Engineers, Sacramento District.

Cosumnes-Mokelumne Rivers Floodplain Reports and Studies

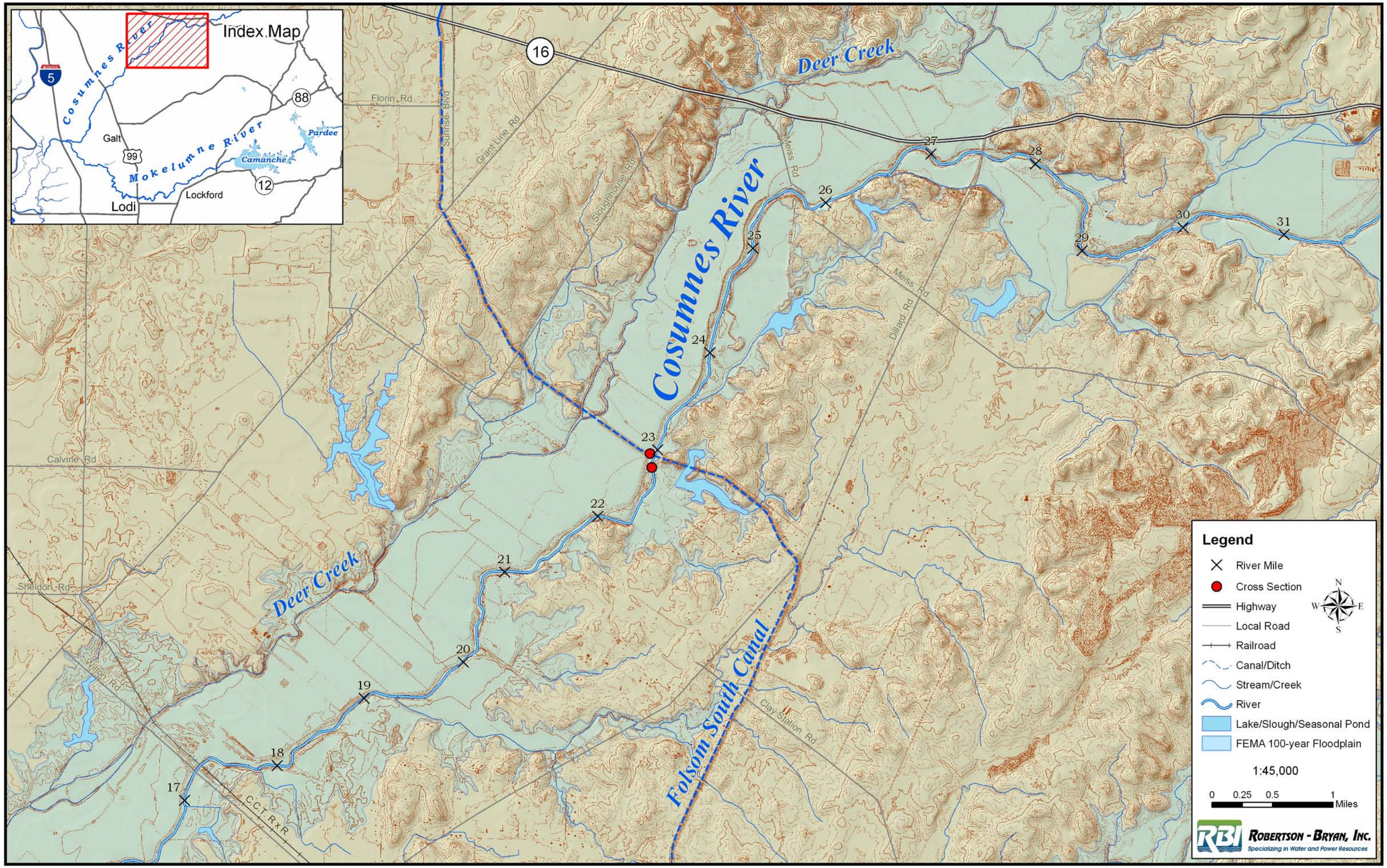
River	Date	Source	Title of Report
Cosumnes River	2001	Mount, Fogg, Kavvas (USFWS, ARP)	Linked Surface Water-Groundwatwer Model for the Cosumnes River Watershed: Hydrologic Evaluation of Management Options to restore Fall Flows
Cosumnes River	2002	Trowbridge PhD Dissertation (UCD)	The Influence of Restored Floodings on Floodplain Plant Distributions
Lower Cosumnes River	–	Constantine, Mount, Florsheim (UCD)	Geologic Control on Incision Processes and Channel Form in a Central Valley River – in review.
Lower Cosumnes River		Anderson, Kavvas, et al (UCD)	IGSM 3D Finite Mesh
Lower Cosumnes River		Anderson, Kavvas, et al (UCD)	1D Channel Routing Model
Lower Cosumnes River	1994	Swanson & Hart	The Cosumnes River Preserve Hydrologic Analysis of Planned Habitat Restoration from Interstate 5 to Twin Cities Road Crossing.
Lower Cosumnes River	1996	McGurk & Leavesley	Hydrologic characterization of the Cosumnes: evaluation of diversions using the USGS Modular Modeling System: final report. Arlington, The Nature Conservancy.
Lower Cosumnes River	1998	USGS-Guay, et al.	Flood-Inundation Map and Water -Surface Profiles of Selected Frequencies, Cosumnes River and Deer Creek, Sacramento County, California. U.S. Geological Survey. Sacramento, U.S. Department of the Interior.
Lower Cosumnes River	2001	Blake, MS Dissertation (UCD)	An Unsteady Hydraulic Surface Water Model of the Lower Cosumnes River, California, for the Investigation of Floodplain Dynamics; DEM, MIKE 11, HEC2
Lower Cosumnes River	2002	Mount, Florsheim, Trowbridge (UCD)	Restoration of Dynamic Floodplain Topography and Riparian Vegetation Establishment Through Engineered Levee Breaching
Lower Cosumnes River	2002	Geomorphology: 44	Restoration of floodplain topography by sand-splay complex formation in response to intentional levee breaches, Lower Cosumnes River, California
Lower Cosumnes River	2002	Environmental Science Associates (DWR)	Grizzly Slough Floodplain Restoration Feasibility Study- Initial Biological Resources Report
Lower Cosumnes River	2002	Robertson-Bryan	HEC-RAS Blodgett Dam Rehabilitation
Lower Cosumnes River	2003	Constantine, Mount, Florsheim (UCD)	The Effects of Longitudinal Differences in Gravel Mobility on the Downstream Fining Pattern in the Cosumnes River, California
Lower Cosumnes River	2003	Florsheim, Mount, Constantine (UCD)	Lowland River-Floodplain System Geomorphic Monitoring and Adaptive Assessment Framework: Sediment Continuity and Trends, Cosumnes River, California
Lower Cosumnes River	2003	Jones & Stokes, Northwest Hydraulic Consultants (Sloughhouse RCD and Cosumnes River Taskforce)	Cosumnes River Watershed Inventory and Assessment: Phase II Draft Report

Cosumnes-Mokelumne Rivers Floodplain Reports and Studies

River	Date	Source	Title of Report
Upper Cosumnes River	2003	Kavvas, Chein, Anderson (UCD)	39 subbasins modeled, rainfall-runoff, snow, water quality USGS models (MMS, WHEY)
Cosumnes, Mokelumne Rivers	2004	David Ford Consulting Engineers, Inc. (Sacramento County Dept of Water Resources)	Cosumnes and Mokelumne River Watersheds-Design Storm Runoff Analysis
Mokelumne River	1972	USGS-Simpson	Determination of Channel Capacity of the Mokelumne River Downstream from Camanche Dam. Menlo Park, U.S. Department of the Interior, Geological Survey Water Resources Division.
Mokelumne River	1993	EBMUD	Federal Energy Regulatory Commission and O.o.H. licensing (1993). Final Environmental Impact Statement. Proposed Modifications to the Lower Mokelumne River Project, California. Washington, D.C.
Mokelumne River	2003	Pasterneck, Wang, Merz (UCD)	Application of a 2D Hydrodynamic Model to Design of Reach-Scale Spawning Gravel Repleshment on the Mokelumne River, California
Lower Mokelumne River	1991	California DFG	Fish Management Plan
Lower Mokelumne River	1993	FERC	FERC Final Environmental Impact Statement. 1993. Proposed modifications to the lower Mokelumne River project, California. FERC Project Nr. 2916–004. Washington, D.C.
Lower Mokelumne River	2002	Wang, MS Dissertation (UCD)	Application of a 2D Hydraulic Model to Salmonid Spawing Gravel Replenishment in a Regulated River, Mokelumne River, California
Lower Mokelumne River	2002	Wheaton & Pasternack (UCD)	2D FESWMS Fed Hwy Admin -BYU
Lower Mokelumne River	2003	Wheatton, MS Dissertation (UCD)	Spawning Habitat Rehabilitation

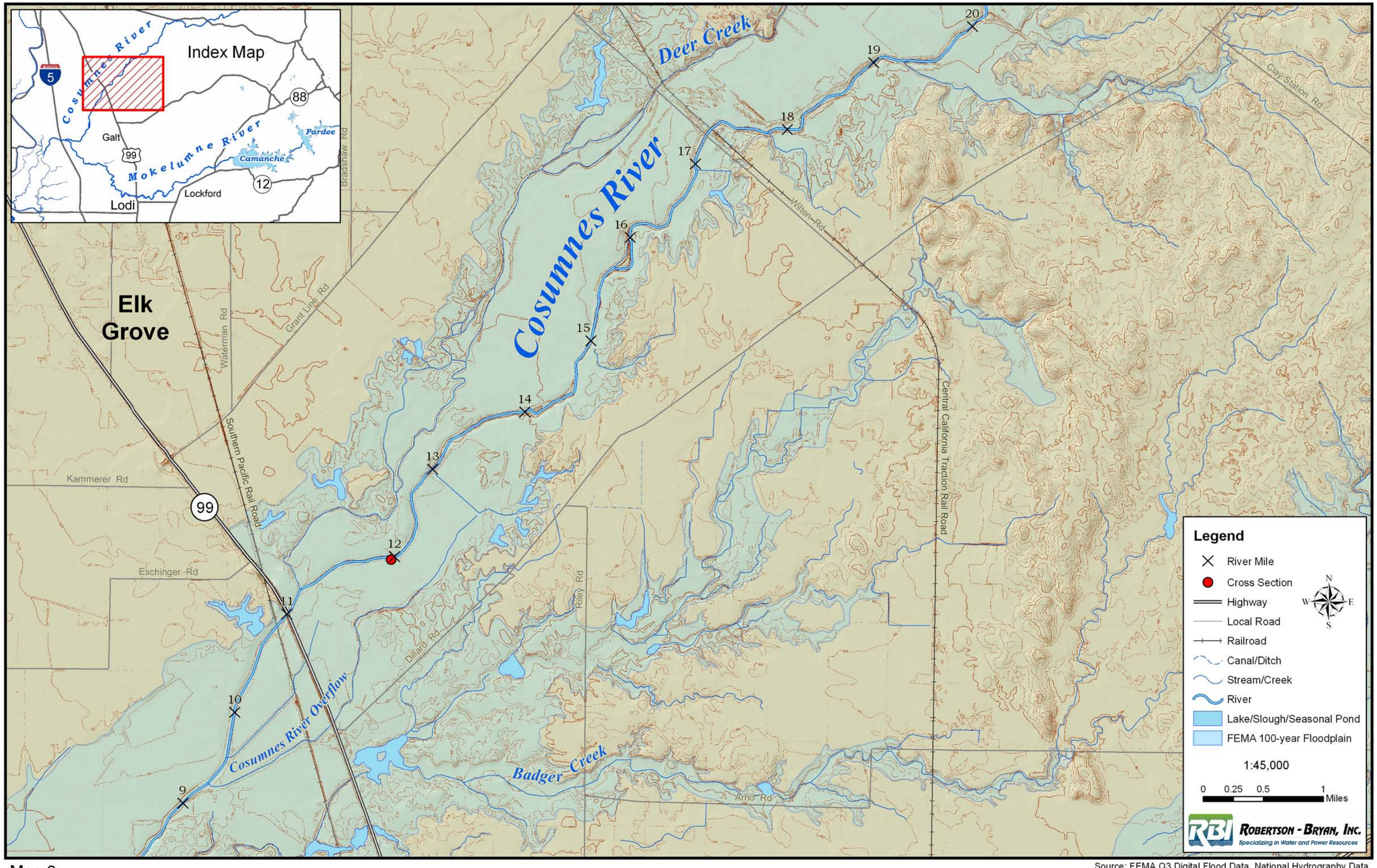
Appendix B

Cosumnes River Preserve Study Area Topographic Maps



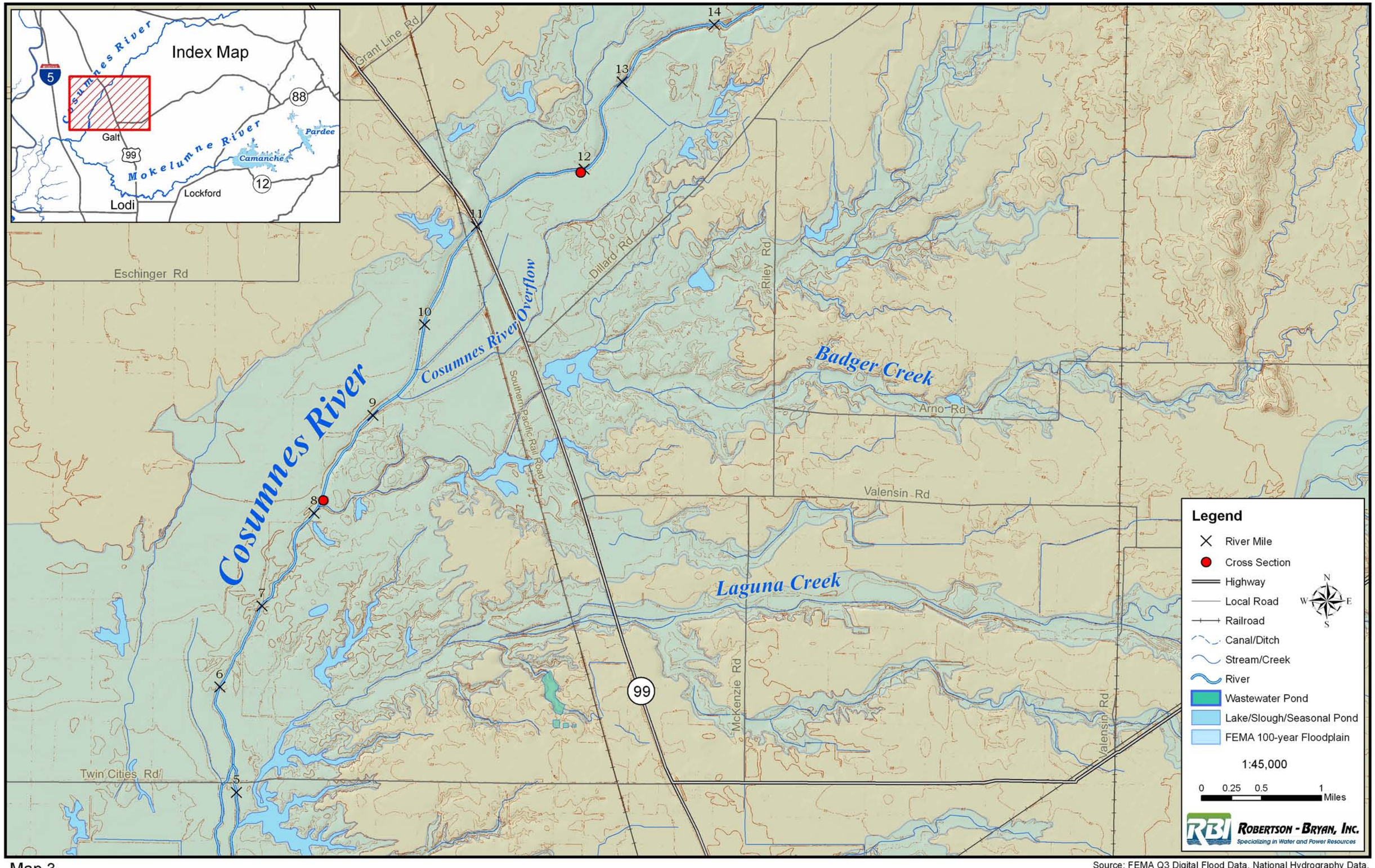
Map 1.

Source: FEMA Q3 Digital Flood Data, National Hydrography Data.



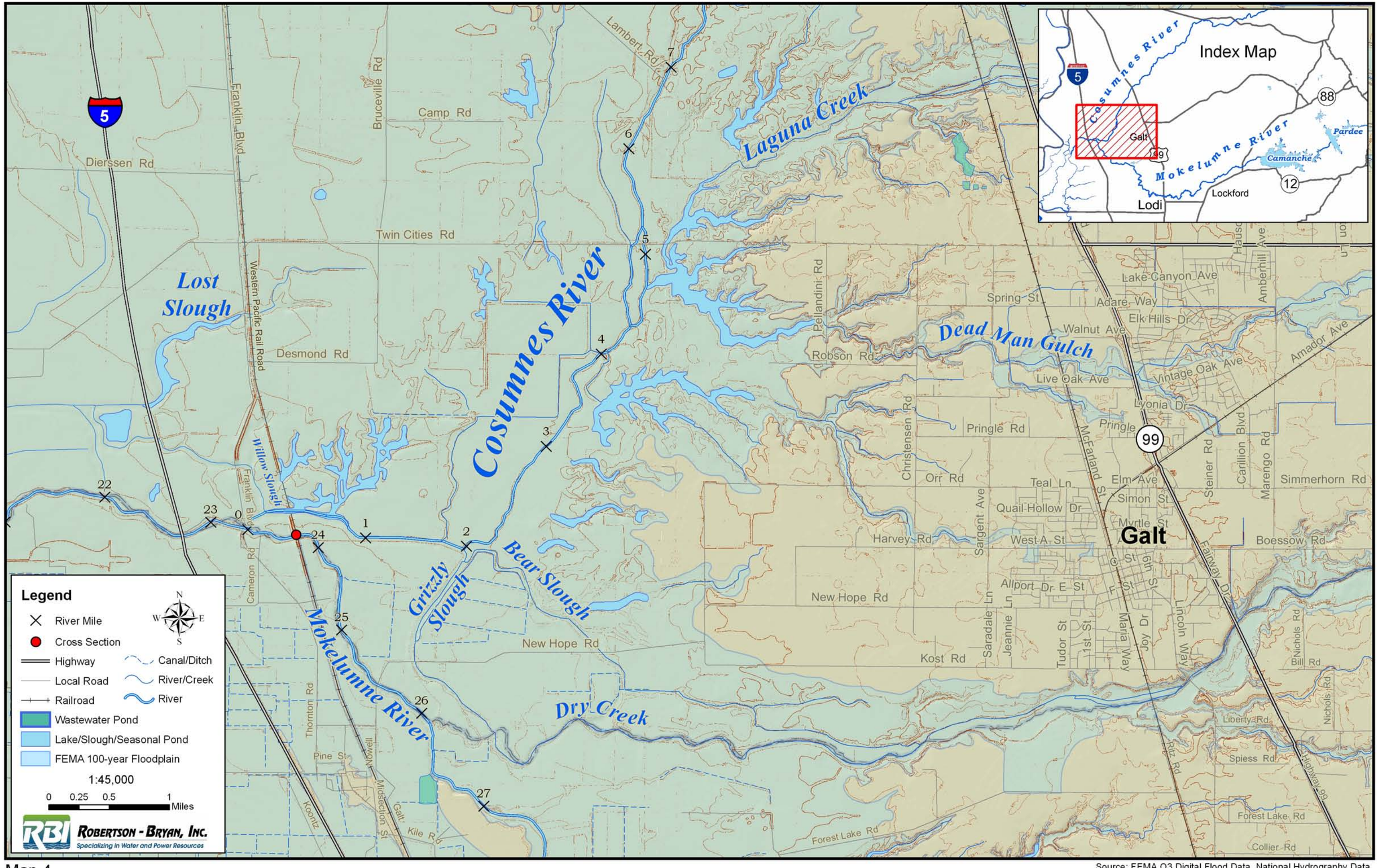
Map 2.

Source: FEMA Q3 Digital Flood Data, National Hydrography Data.



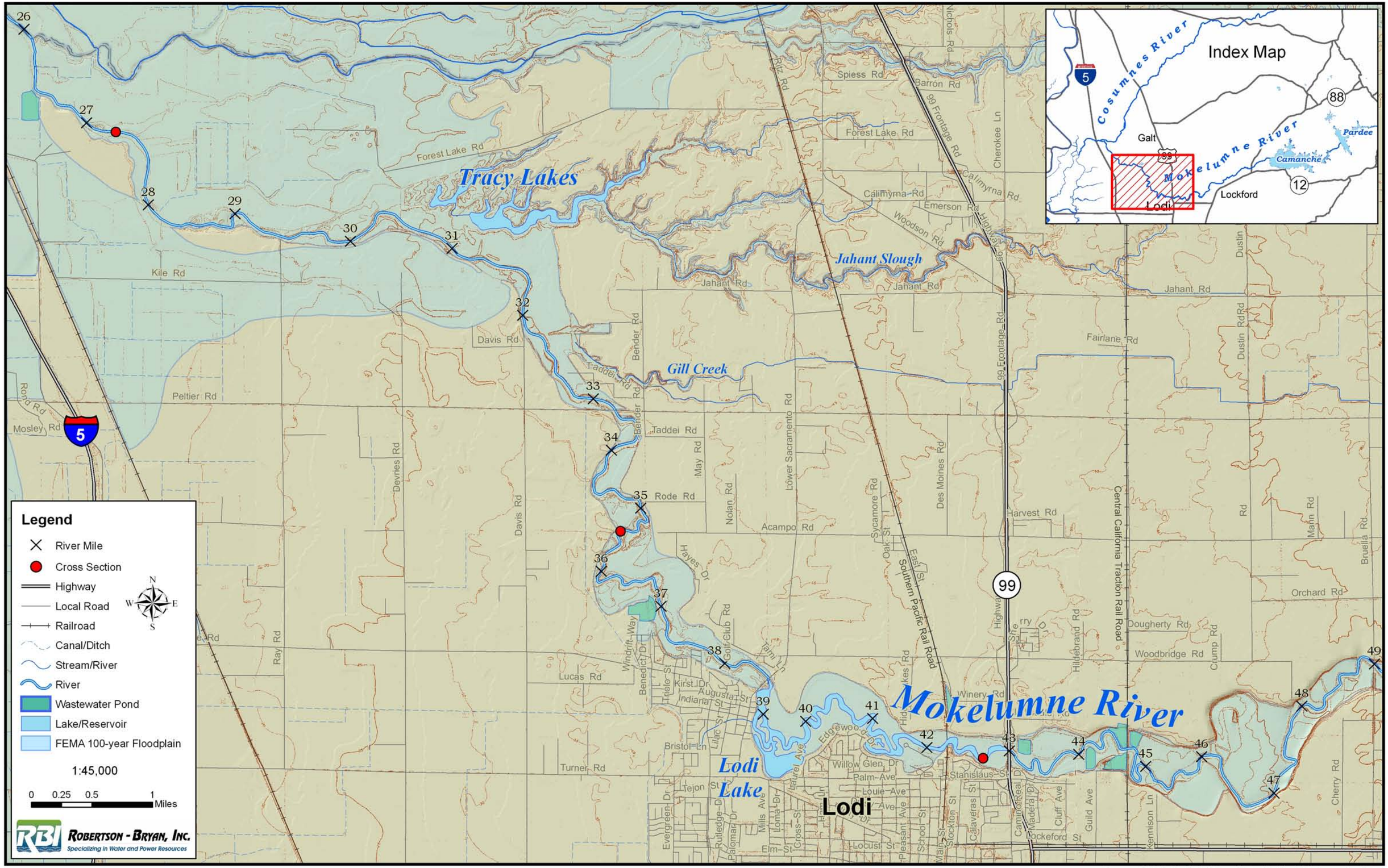
Map 3.

Source: FEMA Q3 Digital Flood Data, National Hydrography Data.



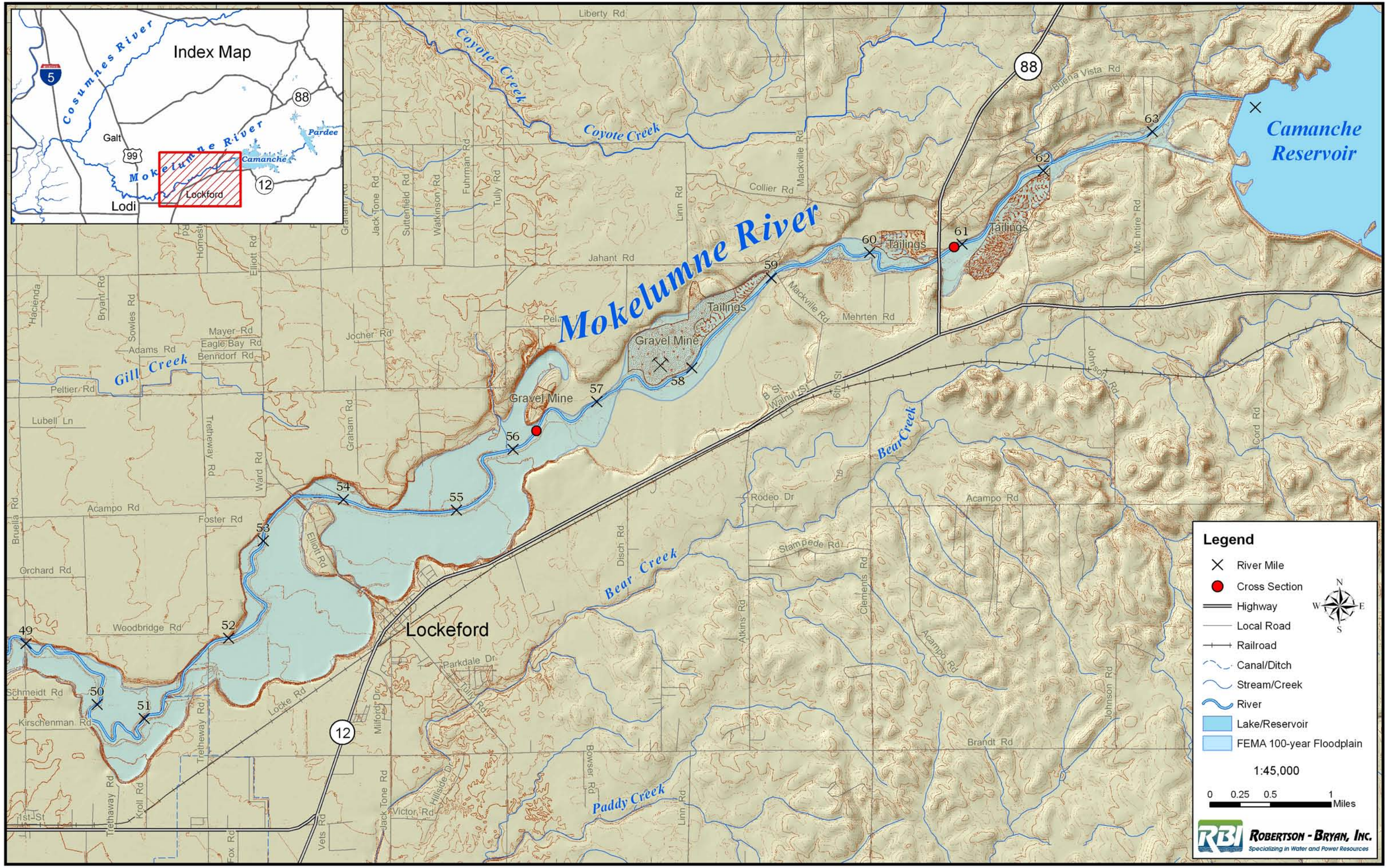
Map 4.

Source: FEMA Q3 Digital Flood Data, National Hydrography Data.



Map 5.

Source: FEMA Q3 Digital Flood Data, National Hydrography Data.

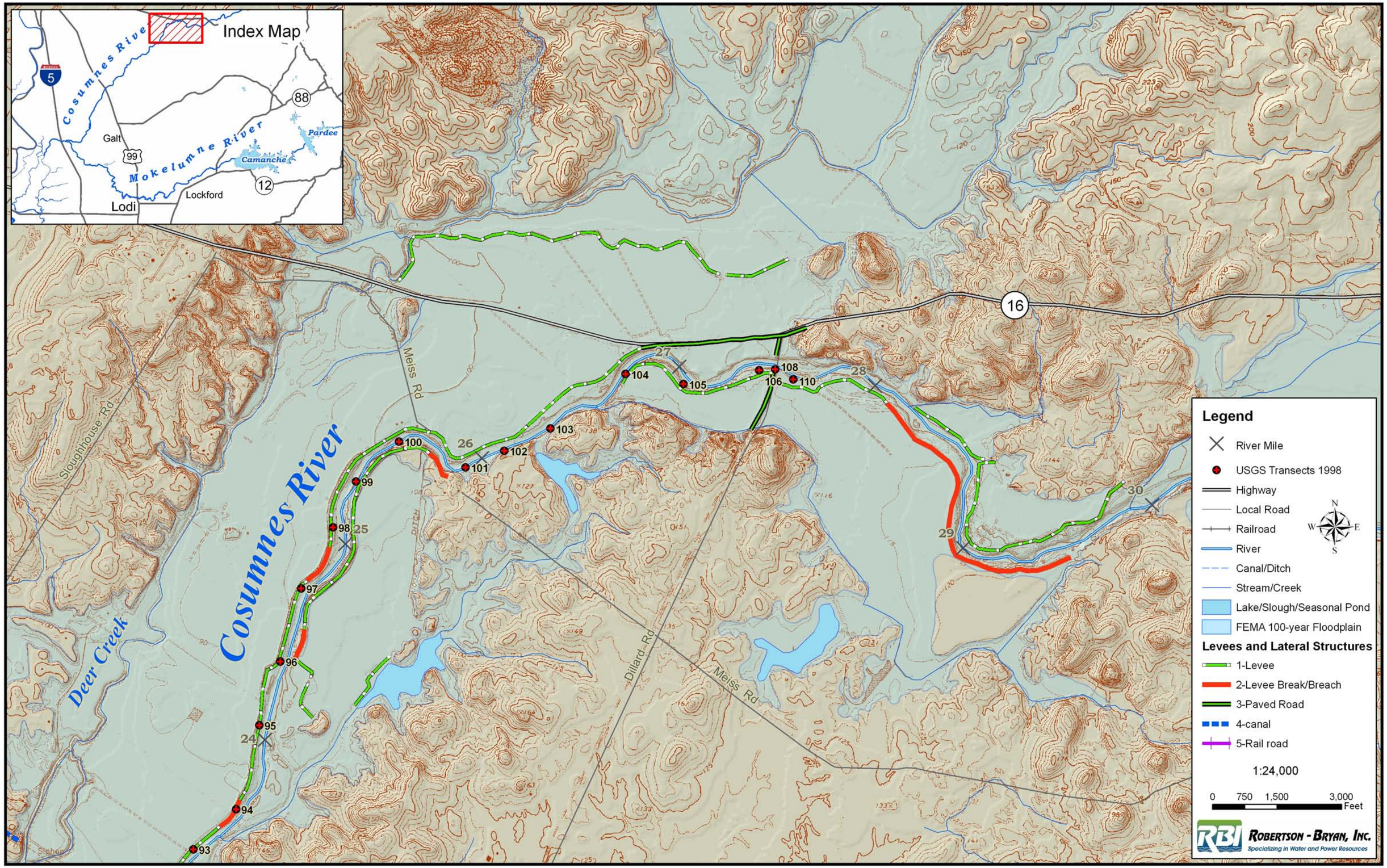


Map 6.

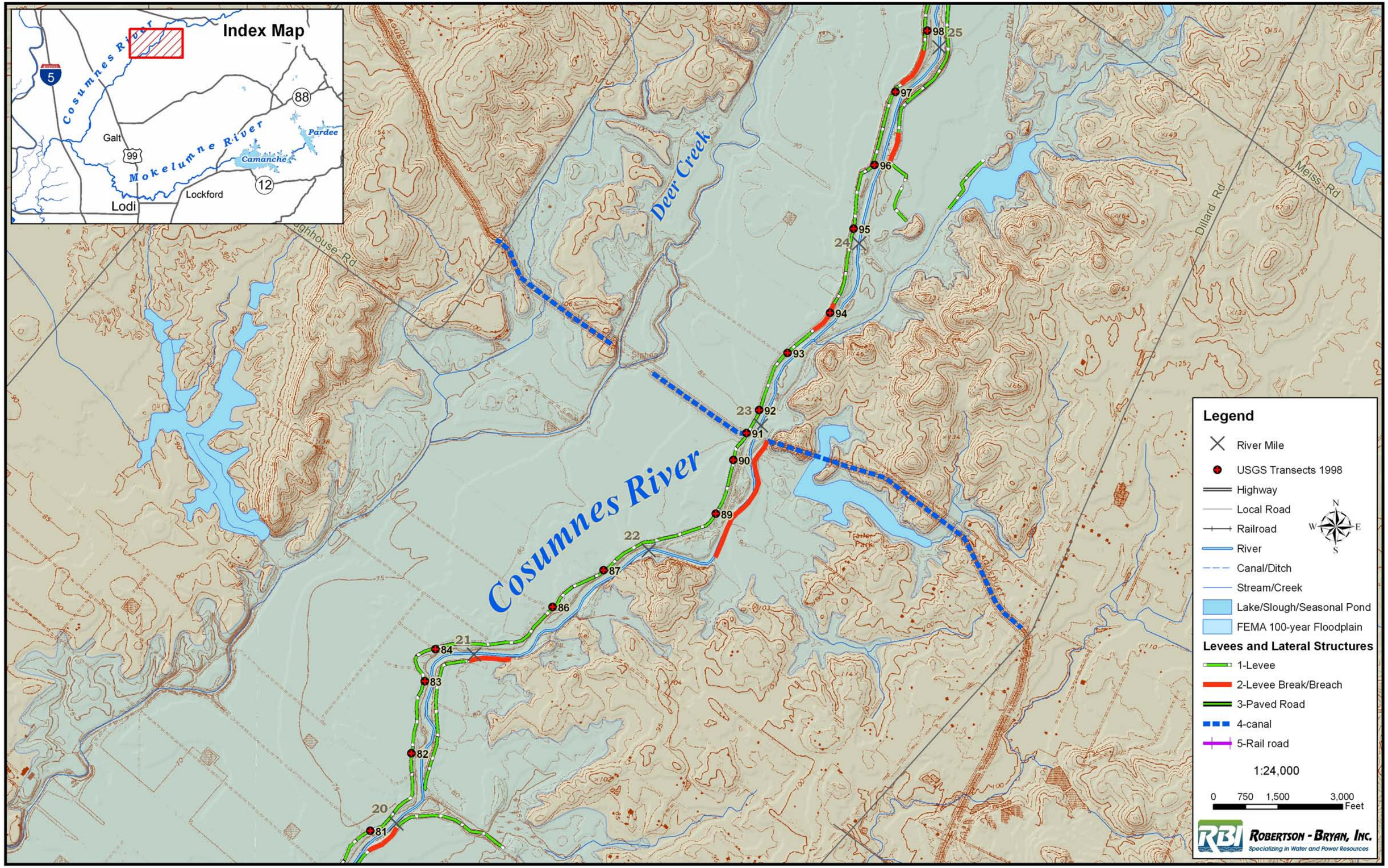
Source: FEMA Q3 Digital Flood Data, National Hydrography Data.

Appendix C

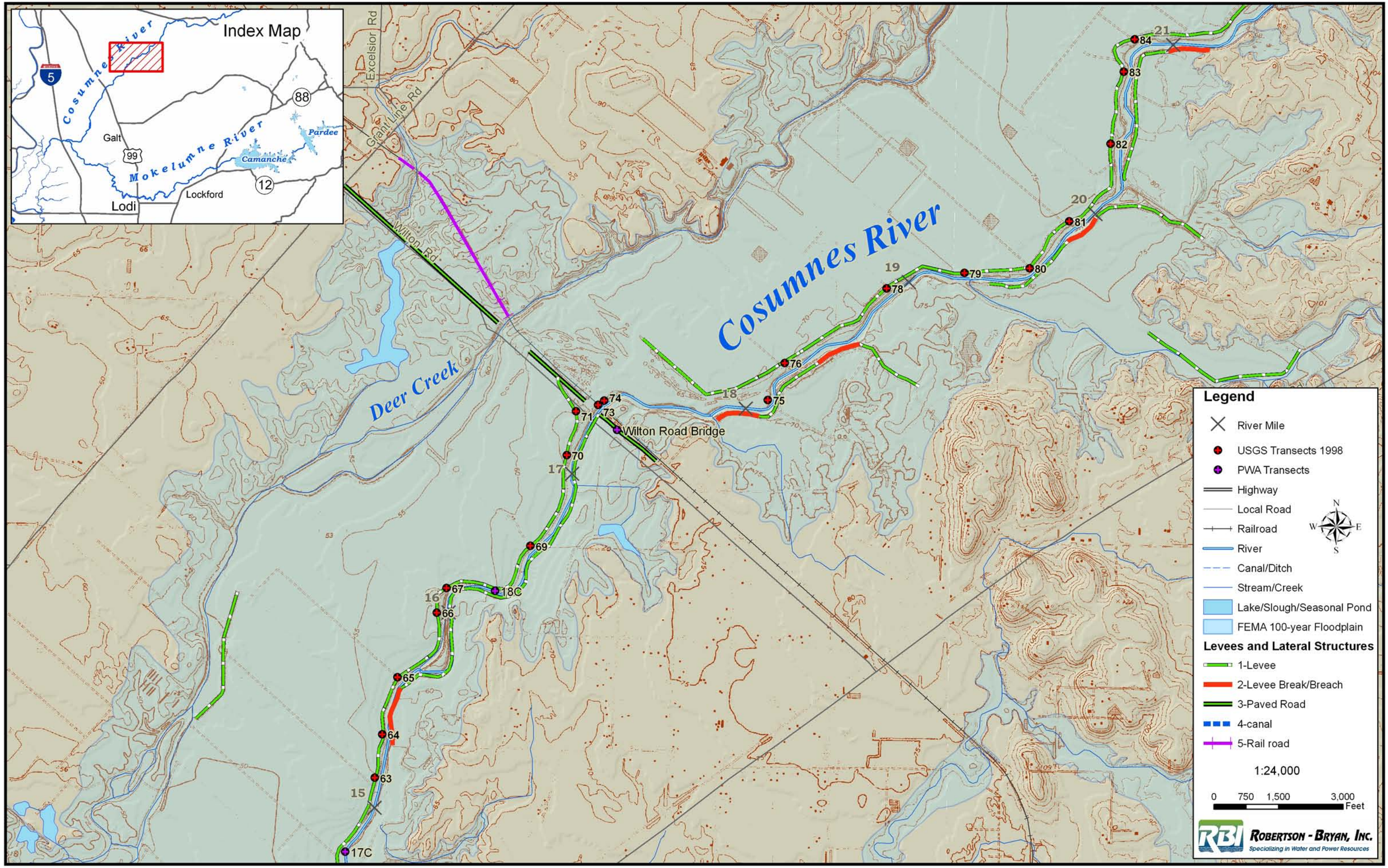
Cosumnes River Watershed Levees



Cosumnes River Levees



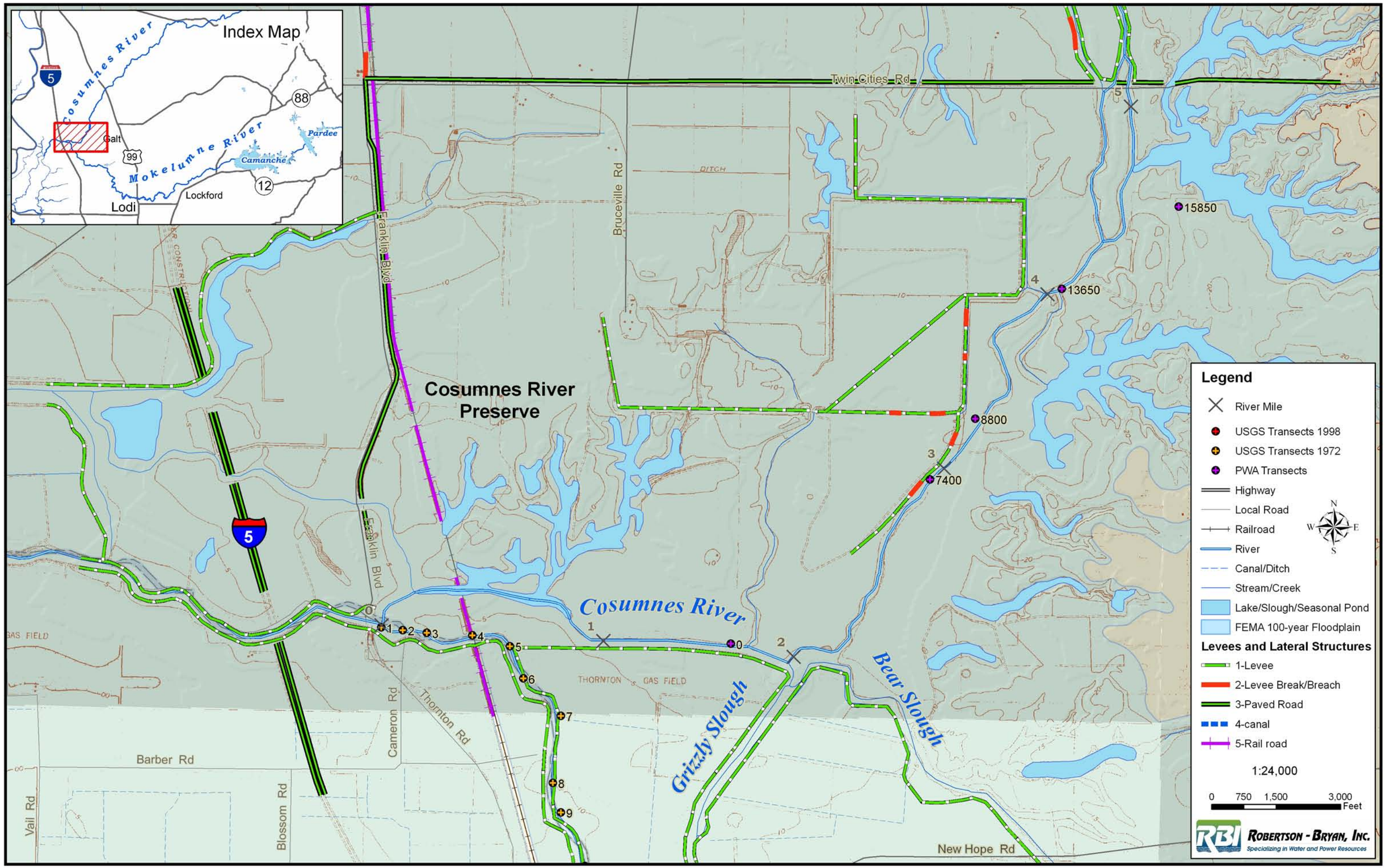
Cosumnes River Levees



Cosumnes River Levees

Cosumnes River Levees

Cosumnes River Levees



Cosumnes River Levees

Appendix D

Plant List for the Cosumnes River Preserve Study Area

Cosumnes River Plant List

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
Aceraceae					
	Acer negundo var. californicum	box elder	Native	Tree	Streamsides, bottomlands
Alismataceae					
	Alisma plantago-aquatica	water plantain	Native	Perennial herb	Wet, fresh water margins
	Echinodorus berteroi	burhead	Native	Perennial herb	Freshwater marsh
	Sagittaria latifolia	arrowhead	Native	Perennial herb	Ponds, slow streams, ditches
	Sagittaria montevidensis var. calycina	arrowhead	Native	Perennial herb	Ponds, ditches, rice fields
	Sagittaria sanfordii	Sanfords's arrowhead	Native	Perennial herb	Freshwater marsh
Amaranthaceae					
	Amaranthus albus	tumbleweed	Introduced	Annual herb	Waste places, roadsides, fields
	Amaranthus blitoides	pigweed, amaranth	Native	Annual herb	Waste places (prostrate)
	Amaranthus palmeri	amaranth	Native	Annual herb	Roadside ditches, fields
Anacardiaceae					
	Toxicodendron diversilobum	western poison oak	Native	Shrub	Woods
Apiaceae					
	Anthriscus caucalis	bur-chervil	Introduced	Annual herb, Vine	Generally shady places.
	Conium maculatum	poison hemlock	Introduced	Perennial herb	Disturbed places.
	Daucus carota	Queen Anne's lace	Introduced	Perennial herb	Roadsides
	Eryngium articulatum	button celery	Native	Perennial herb	Ditches, vernal pools, etc.
	Eryngium articulatum	Beethistle	Native	Perennial herb	Lake, stream margins, marshes.
	Eryngium vaseyi	Vasey's coyote-thistle	Native	Perennial herb	vernal pools
	Foeniculum vulgare	fennel	Introduced	Perennial herb	Roadsides, waste places
	Lomatium caruifolium	alkali parsnip	Native	Perennial herb	Foothill woodland
	Oenanthe sarmentosa	American oenanthe	Native	Perennial herb	Streams, ponds, often aquatic
	Sanicula bipinnatifida	purple sanicle	Native	Perennail herb	Grasslands
	Torilis arvensis	hedge parsley	Introduced	Annual herb	Disturbed places
	Yabea microcarpa	California hedge	Native	Annual herb	Grassy slopes, woodlands
Apocynaceae					
	Apocynum androsaemifolium	bitter dogbane	Native	Perennial herb	Open slopes, rocky places
	Apocynum cannabinum	Indian hemp	Native	Perennial herb	Moist places near streams
Asclepiadaceae					
	Asclepias fascicularis	narrow-leaf milkweed	Native	Perennial herb	Dry ground, valleys, foothills

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Asclepias vestita	woolly milkweed	Native	Perennial herb	Grasslands
Asteraceae					
	Achillea millefolium	yarrow	Native	Perennial herb	Grasslands
	Achyrachaena mollis	blow wives	Native	Annual herb	Common, grassy areas
	Ambrosia psilostachya	western ragweed	Native	Perennial herb	Roadsides, dry fields
	Anthemis cotula	chamomile	Introduced	Annual herb	Disturbed areas
	Artemisia douglasiana	mugwort	Native	Perennial herb	Open to shady places
	Aster aff. chilensis	California aster	Native	Perennial herb	Grasslands, salt marshes
	Aster subulatus var. ligulatus	annual saltmarsh aster	Native	Annual herb	Wet places; often akaline
	Baccharis douglasii	marsh baccharis	Native	Perennial herb	Moist ground, near streams
	Baccharis pilularis	coyote brush	Native	Shrub	Coastal bluffs to oak woodlands
	Bidens cernua var. cernua	nodding bur-marigold	Native	Perennial herb	Freshwater wetlands
	Bidens frondosa	sticktight	Native	Annual herb	Damp soil, disturbed places
	Blennosperma nanum	common blennosperma	Native	Annual herb	Valley grassland, Foothill woodland
	Calycadenia multiglandulosa	rosinweed	Native	Annual herb	Valley grassland, Foothill woodland
	Carduus pycnocephalus	Italian thistle	Introduced	Annual herb	Roadside weed
	Centaurea solstitialis	yellow star-thistle	Introduced	Annual herb	Pastures, disturbed places
	Chamomilla suaveolens	pineapple weed	Introduced	Annual herb	Disturbed sites
	Cichorium intybus	chicory	Introduced	Perennial herb	Roadsides, waste places
	Cirsium vulgare	bull thistle	Introduced	Perennial herb	Disturbed areas
	Conyza bilboana	conyza	Introduced	Tree	Disturbed urban sites
	Conyza bonariensis	hairy fleabane	Introduced	Annual herb	Disturbed areas
	Conyza canadensis	horseweed	Native	Annual herb	Waste ground
	Cotula coronopifolia	brass-buttons	Introduced	Perennial herb	Saline and freshwater marshes
	Euthamia occidentalis	western goldenrod	Native	Perennial herb	Ditches, marshes, meadows
	Filago gallica	cotton-rose	Introduced	Annual herb	Grasslands
	Gnaphalium luteo-album	everlasting	Introduced	Annual herb	Fields, waste places
	Gnaphalium palustre	dwarf cudweed	Native	Annual herb	Damp banks, streambeds
	Grindelia camporum	great valley gumplant	Native	Perennial herb	Fields, roadsides
	Helenium puberulum	sneezeweed	Native	Perennial herb	Streamsides, marshes
	Helianthus annuus	sunflower	Native	Annual herb	Disturbed places
	Helianthus bolanderi	Bolander's sunflower	Native	Annual, Perennial herb	Grasslands
	Hemizonia congesta	hayfield tarweed	Native	Annual herb	Grasslands, fallow fields
	Hemizonia congesta ssp. luzulifolia	tarweed	Native	Annual herb	Grasslands, fallow fields
	Hemizonia fitchii	spikeweed	Native	Perennial herb	Fields, open woodlands
	Hemizonia pungens	smooth tarplant	Native	Annual herb	Grasslands, depressions
	Hemizonia pungens ssp. Pungens	common spikeweed	Native	Annual herb	Low grasslands
	Hesperevax caulescens	hogwallow starfish	Native	Annual herb	Vernal pools

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Holocarpha obconica	tarweed	Native	Annual herb	Grassland
	Holocarpha virgata	pitgland tarweed	Native	Annual herb	Grassland
	Hypochaeris glabra	smooth cat's ear	Introduced	Annual herb	Grasslands, vernal pools
	Hypochaeris radicata	annual cat's ear	Introduced	Perennial herb	Disturbed places, lawns
	Lactuca serriola	prickly lettuce	Introduced	Annual herb	Weed of disturbed places
	Lasthenia californica	goldfields	Native	Annual herb	Vernal pools
	Lasthenia fremontii	Fremont's goldfields	Native	Annual herb	Vernal pools
	Lasthenia glaberrima	smooth goldfields	Native	Annual herb	Wet places, vernal pools
	Lasthenia glabrata	goldfields	Native	Annual herb	Vernal pools, saline places
	Layia fremontii	tidytips	Native	Annual herb	Grassy slopes in heavy soil
	Leontodon taraxacoides	hawkbit	Introduced	Perennial herb	Grasslands, vernal pools
	Microseris acuminata	needle microseris	Native	Annual herb	Grasslands
	Microseris campestris	San Joaquin microseris	Native	Annual herb	Grasslands
	Microseris douglasii	Douglas' microseris	Native	Annual herb	Grasslands
	Picris echioides	bristly ox-tongue	Introduced	Annual, Perennial herb	Weed of waste places
	Psilocarphus brevissimus var. brevissimus	dwarf woolly-heads	Native	Annual herb	Vernal pools and flats
	Psilocarphus brevissimus var. brevissimus	delta woolly marbles	Native	Annual herb	Vernal pools and flats
	Psilocarphus oregonus	Oregon woolly marbles	Native	Annual herb	Vernal pools, rarely moist slopes
	Psilocarphus tenellus	slender wolly-heads	Native	Annual herb	Vernal pools
	Senecio vulgaris	common groundsel	Introduced	Annual herb	Farmlands, disturbed areas
	Silybum marianum	milk thistle	Introduced	Annual, Perennial herb	Roadsides, waste places
	Soliva sessilis	lawn burrweed	Introduced	Annual herb	Roadways, disturbed areas
	Sonchus asper ssp. asper	prickly sow thistle	Introduced	Annual herb	Weed in slight moist places
	Sonchus oleraceus	common sow thistle	Introduced	Annual herb	Weed in waste places
	Taraxacum officinale	dandelion	Introduced	Perennial herb	Lawn weed, meadows
	Xanthium spinosum	spiny cocklebur	Native	Annual herb	Disturbed areas
	Xanthium strumarium	cocklebur	Native	Annual herb	Disturbed area
Azollaceae					
	Azolla filiculoides	mosquito fern	Native	Perennial herb	Sluggish water, slow streams
Betulaceae					
	Alnus rhombifolia	white alder	Native	Tree	Along streams below 500 feet
Boraginaceae					
	Amsinckia menziesii var. intermedia	fiddleneck	Native	Annual herb	Dry grassy places
	Heliotropium curassavicum	heliotrope	Native	Perennial herb	Grasslands
	Plagiobothrys acanthocarpus	adobe popcorn flower	Native	Annual herb	Wet areas
	Plagiobothrys austiniae	Austin's popcorn flower	Native	Annual herb	Vernal pool edges
	Plagiobothrys bracteatus	popcorn flower	Native	Annual herb	Dry beds of pools, ditches
	Plagiobothrys fulvus	popcorn flower	Native	Annual herb	Grasslands

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Plagiobothrys greenei	green's popcorn flower	Native	Annual herb	Vernal pool edges
	Plagiobothrys leptocladus	alkali popcorn flower	Native	Annual herb	Vernal pools
	Plagiobothrys stipitatus	popcorn flower	Native	Annual herb	alkaline places, like vernal pools
	Plagiobothrys stipitatus var. micranthus	slender popcorn flower	Native	Annual herb	Grasslands and vernal pools
Brassicaceae					
	Barbarea orthoceras	winter cress	Native	Perennial herb	Banks of streams, wet meadows
	Barbarea vulgaris	common winter cress	Introduced	Perennial herb	Disturbed sites
	Brassica nigra	black mustard	Introduced	Annual herb	Disturbed sites, riparian
	Brassica rapa	field mustard	Introduced	Annual herb	Waste places
	Capsella bursa-pastoris	shepard's purse	Introduced	Annual herb	Common weed
	Cardamine oligosperma	few-seed bitter cress	Native	Annual, Perennial herb	Disturbed sites, roadway
	Cardamine pensylvanica	bittercress	Native	Perennial herb	Dry places
	Cardaria draba	hoary cress	Introduced	Perennial herb	Waste places, low elevations
	Cardaria pubescens	whitetop	Introduced	Perennial herb	Waste places, alfafa fields
	Descurainia sophia	tansy mustard	Introduced	Annual herb	Dry waste places
	Hirschfeldia incana	yellow mustard	Introduced	Perennial herb	Roadsides, creek bottoms
	Lepidium latifolium	peppergrass	Introduced	Perennial herb	Waste places
	Lepidium latipes	dwarf pepper-grass	Native	Annual herb	Wet areas
	Lepidium nitidum	shining peppergrass	Native	Annual herb	Alkaline soils, flats, slopes
	Lepidium strictum	peppergrass	Native	Annual herb	Common in hard beaten soil
	Raphanus raphanistrum	jointed charlock	Introduced	Annual, Perennial herb	Waste places
	Raphanus sativus	wild radish	Introduced	Annual, Biennial herb	Waste places
	Rorippa curvisiliqua	yellow water cress	Native	Annual, Perennial herb	Wet damp places
	Rorippa palustris var. occidentalis	yellow cress	Native	Annual, Perennial herb	Stream beds, sand bars
	Sibara virginica	rock cress	Native	Annual, Perennial herb	Borders of vernal pools, streambeds
	Sinapis arvensis	charlock	Introduced	Annual herb	Common weed
	Sisymbrium officinale	hedge mustard	Introduced	Annual herb	Waste places
Callitrichaceae					
	Callitriche heterophylla	water starwort	Native	Perennial herb	Wetlands
	Callitriche marginata	water starwort	Native	Annual herb	Drying mud of vernal pools
Campanulaceae					
	Downingia bicornuta	two-horned downingia	Native	Annual herb	Moist places and drying mud, vernal
	Downingia ornatissima	solano downingia	Native	Annual herb	Vernal pools
	Downingia pusilla	dwarf downingia	Native	Annual herb	Vernal pools
	Legenere limosa	legenere	Native	Annual herb	Vernal pools
Caprifoliaceae					
	Sambucus mexicana	blue elderberry	Native	Tree, Shrub	Open flats

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
Caryophyllaceae					
	Cerastium glomeratum	mouse chickweed	Introduced	Annual herb	Waste places
	Petrorhagia prolifera	pink grass	Introduced	Annual herb	Disturbed areas
	Sagina decumbens ssp. occidentalis	western pearlwort	Native	Annual herb	Wet areas, vernal pools
	Silene gallica	campion	Introduced	Annual herb	Fields, waste places
	Spergularia bocconei	sand-spurry	Introduced	Annual herb	Along paths, alkaline places
	Spergularia media	marsh sand-spurry	Introduced	Annual, Perennial herb	Low ground bordering salt marsh
	Spergularia rubra	purple sand-spurry	Introduced	Annual, Perennial herb	Waste places
	Spergularia villosa	sand-spurry	Introduced	Perennial herb	Sandy slopes, bluffs
	Stellaria media	common chickweed	Introduced	Annual herb	Common weed
Chenopodiaceae					
	Atriplex cf. patula	spear oracle	Native	Annual herb	Waste places
	Atriplex heterosperma	saltbush	Introduced	Annual herb	Open, disturbed places
	Chenopodium album	lambsquarters	Introduced	Annual herb	Waste places
	Chenopodium ambrosioides	Mexican tea	Introduced	Annual, Perennial herb	Waste places
	Chenopodium botrys	Jerusalem oak	Introduced	Annual herb	Disturbed sites
Convolvulaceae					
	Convolvulus arvensis	bindweed	Introduced	Perennial herb, Vine	Waste places
Cornaceae					
	Cornus glabrata	brown dogwood	Native	Shrub	Moist places
	Cornus sericea	American dogwood	Native	Shrub	Moist places
Crassulaceae					
	Crassula aquatica	water pygmy weed	Native	Annual herb	Salt marshes, vernal pools
	Crassula connata	red carpet	Native	Annual herb	Open areas
	Crassula tillaea	moss pygmy-weed	Introduced	Annual herb	Disturbed sites
Cuscutaceae					
	Cuscuta howelliana	Boggs Lake dodder	Native	Vine	Vernal pools
	Cuscuta pentagona	western field dodder	Native	Vine	Wet areas, floodplain
Cyperaceae					
	Carex barbarae	Santa Barbara's sedge	Native	Perennial herb	Valley flats in wet spring
	Carex ovalis	sedge	Native	Perennial herb	Boggy meadows
	Carex pachystachya	chamisso sedge	Native	Perennial herb	Dryish meadows, open forests
	Carex praegracilis	sedge	Native	Perennial herb	Moist places
	Carex tumulicola	splitawn sedge	Native	Perennial herb	Meadow grassy slopes
	Cyperus eragrostis	umbrella grass	Native	Perennial herb	Shallow water
	Cyperus erythrorhizos	redroot flatsedge	Native	Annual herb	Wet areas, floodplain
	Cyperus esculentus	yellow nutsedge	Native	Perennial herb	Wet areas, disturbed
	Cyperus involucratus	nutgrass	Introduced	Perennial herb	Ditches, shores

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Eleocharis acicularis	needle spikerush	Native	Perennial herb	Wet areas, vernal pools
	Eleocharis acicularis var. bella	least spikerush	Native	Perennial herb	Muddy riverbanks
	Eleocharis macrostachya	creeping spikerush	Native	Perennial herb	Marshes, ponds, ditches
	Eleocharis montevidensis	spikerush	Native	Perennial herb	Moist ground
	Scirpus acutus var. occidentalis	tule	Native	Perennial herb	Freshwater marsh
	Scirpus aff. maritimus	prairie bulrush	Native	Perennial herb	Marshes
	Scirpus californicus	California bullrush	Native	Perennial herb	Freshwater marsh
	Scirpus fluviatus	river bulrush	Native	Perennial herb	Freshwater marsh
Dipsacaceae					
	Dipsacus fullonum	teasel	Introduced	Perennial herb	Wet areas
Elatinaceae					
	Elatine californica	California waterwort	Native	Annual herb	Wetlands
	Elatine gracilis	water-wort	Native	Annual, Perennial herb	Wetlands
Euphorbiaceae					
	Chamaesyce ocellata	sandmat	Native	Annual herb	Dry disturbed places
	Chamaesyce serpyllifolia	thyme-leaved spurge	Native	Annual herb	Dry disturbed places
	Eremocarpus setigerus	turkey mullein	Native	Perennial herb	Grasslands, roadsides
Fabaceae					
	Gleditsia triacanthos	honey locust	Introduced	Tree	Riparian areas
	Glycyrrhiza lepidota	wild licorice	Native	Perennial herb	Moist places below 7500 feet
	Lathyrus jepsonii var. californicus	wild pea	Native	Tree, Shrub	Along watercourse, sandy slope
	Lotus corniculatus	bird's foot trefoil	Introduced	Perennial herb	Lawns, roadsides
	Lotus purshianus var. purshianus	Spanish lotus	Native	Annual herb	Dry fields, disturbed
	Lotus wrangelianus	Chilean bird's-foot trefoil	Native	Annual herb	Grassland
	Lupinus benthamii	spider lupine	Native	Annual herb	Rocky slopes, open areas
	Lupinus bicolor	miniature lupine	Native	Annual, Perennial herb	Sandy places below 3000 feet
	Medicago polymorpha	California bur-clover	Introduced	Annual herb	Grassy places
	Melilotus alba	white sweet clover	Introduced	Annual herb	Damp waste places
	Melilotus indica	yellow melilotus	Introduced	Annual herb	Damp waste places
	Trifolium bifidum	notchleaf clover	Native	Annual herb	Grassy places below 2000 feet
	Trifolium ciliolatum	foothill clover	Native	Annual herb	Grassland
	Trifolium depauperatum var. amplectens	ballon clover	Native	Annual herb	Moist alkaline places
	Trifolium dubium	little hop clover	Introduced	Annual herb	Waste places
	Trifolium fragiferum	strawberry clover	Introduced	Perennial herb	Roadsides, lawns
	Trifolium gracilentum	pinpoint clover	Native	Annual herb	Grassland
	Trifolium hirtum	rose clover	Introduced	Annual herb	Grassland, disturbed areas
	Trifolium microcephalum	smallhead clover	Native	Annual herb	Grassland
	Trifolium microdon	thimble clover	Native	Annual herb	Open valleys and slopes

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Trifolium obtusiflorum	clammy clover	Introduced	Annual herb	Moist places
	Trifolium pratense	red clover	Introduced	Perennial herb	Disturbed areas.
	Trifolium repens	white clover	Introduced	Perennial herb	Wet places
	Trifolium subterraneum	subterranean clover	Introduced	Annual herb	Grassland, disturbed areas
	Trifolium variegatum	white-tipped clover	Native	Annual herb	Moist places
	Trifolium willdenovii	tomcat clover	Native	Annual herb	Disturbed, heavy soils
	Vicia americana var. americana	American purple vetch	Native	Perennial herb, Vine	Riparian, wet areas
	Vicia benghalensis	purple vetch	Introduced	Annual herb, Vine	Grasslands
	Vicia sativa ssp. nigra	common vetch	Introduced	Annual herb, Vine	Grasslands
	Vicia sativa ssp. sativa	spring vetch	Introduced	Annual herb, Vine	Waste places
	Vicia villosa	hairy vetch	Introduced	Annual herb, vine	Grasslands
Fagaceae					
	Quercus douglasii	blue oak	Native	Tree	Foothill Woodlands
	Quercus lobata	valley oak	Native	Tree	Rich loam valley below 2000 ft.
	Quercus wislizenii	interior live oak	Native	Tree, Shrub	Valley & slopes below 5000 ft.
Gentianaceae					
	Centaurium muehlenbergii	centaury	Native	Annual herb	Mostly damp places below 1500
	Centaurium trichanthum	alkali centaury	Native	Annual herb	Grasslands
	Cicendia quadrangularis	Oregon timwort	Native	Annual herb	Vernal pool edges
Geraniaceae					
	Erodium botrys	broad-leaf filaree	Introduced	Annual herb	Grassy places
	Erodium brachycarpum	filaree	Introduced	Annual herb	Grassy places
	Erodium cicutarium	red-stem filaree	Introduced	Annual herb	Dry places below 6,000 ft.
	Erodium moschatum	white-stem filaree	Introduced	Annual herb	Loam, heavy soils low elevations
	Geranium carolinianum	Carolina geranium	Native	Annual herb	Grassy shady places
	Geranium dissectum	crane's bill	Introduced	Annual herb	Waste open places
Haloragaceae					
	Myriophyllum aquaticum	parrotfeather	Introduced	Perennial herb	Waterways
Hippocastanaceae					
	Aesculus californica	California buckeye	Native	Tree	Foothill Woodlands
Hypericaceae					
	Hypericum concinnum	goldwire	Native	Perennial herb	Grasslands
	Hypericum mutilum	hypericum	Introduced	Perennial herb	Streambanks, riparian woodland
	Hypericum perforatum	St. John's wort	Introduced	Perennial herb	Abandoned fields
Iridaceae					
	Sisyrinchium bellum	blue-eyed grass	Native	Perennial herb	Open grassy places below 3000
Isoetaceae					
	Isoetes howellii	quillwort	Native	Fern	Wetlands, vernal pools

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
	Isoetes nuttallii	Nuttall's quillwort	Native	Fern	Wetlands
	Isoetes orcuttii	Orcutt's quillwort	Native	Perennial herb	Vernal pools
Juncaceae					
	Juncus acuminatus	rush	Native	Perennial herb	Irrigated places
	Juncus balticus	Baltic rush	Native	Perennial herb	Moist places below 5000 ft.
	Juncus capitatus	capped rush	Introduced	Annual herb	Moist areas, vernal pools
	Juncus effusus	rush	Native	Perennial herb	Moist places
	Juncus mexicanus	Mexican rush	Native	Perennial herb	Moist places
	Juncus oxymeris	rush	Native	Perennial herb	Wet places below 7000 ft.
	Juncus uncialis	inch high dwarf rush	Native	Annual herb	Valley grassland, Foothill woodland
	Juncus xiphioides	iris-leaved rush	Native	Perennial herb	Moist places
	Navarrietia leucocophala ssp. leucocephala	toad Rush	Native	Perennial herb	Moist open places
Juncaginaceae					
	Lilaea scilloides	flowering-quillwort	Native	Annual herb	Muddy, marshes places
Lamiaceae					
	Lamium amplexicaule	henbit	Introduced	Annual herb	Waste places
	Lycopus americanus	bugleweed	Native	Perennial herb	Wet places below 2000 ft.
	Marrubium vulgare	horehound	Introduced	Perennial herb	Old fields
	Mentha arvensis	field mint	Native	Perennial herb	Moist places below 7500 ft.
	Mentha pulegium	pennyroyal	Introduced	Perennial herb	Low moist places
	Pogogyne douglasii	Douglas' mesamint	Native	Annual herb	Vernal pools
	Pogogyne serphylloides	thyme leaf mesamint	Native	Perennial herb	Open wet areas
	Pogogyne zizyphoroides	Sacramento mesa mint	Native	Annual herb	Vernal pools
	Stachys ajugoides	hedge nettle	Native	Perennial herb	Moist places
	Stachys ajugoides var. rigida	rigid hedge nettle	Native	Perennial herb	Moist places below 2500 ft.
	Stachys albens	hedge nettle	Native	Perennial herb	Moist places below 8000 ft.
	Trichostema lanceolatum	vinegarweed	Native	Annual herb	Grasslands, vernal pools
Liliaceae					
	Asparagus officinalis ssp. officinalis	garden asparagus	Introduced	Perennial herb	Low subsaline places
	Brodiaea coronaria	harvest brodiaea	Native	Perennial herb	Grasslands
	Brodiaea elegans	elegant brodiaea	Native	Perennial herb	Open wooded, wet meadows
	Brodiaea minor	dwarf brodiaea	Native	Perennial herb	Valley grassland, Foothill woodland
	Calochortus luteus	gold cups	Native	Perennial herb	Grasslands
	Chlorogalum angustifolium	narroleaf soap plant	Native	Perennial herb	Valley grassland
	Chlorogalum pomeridianum	dwarf soapwort	Native	Perennial herb	Chapparal, serpentine
	Triteleia hyacinthina	white hyacinth	Native	Perennial herb	Grasslands
	Triteleia laxa	Ithuriel's spear	Native	Perennial herb	Grasslands

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Limnanthaceae					
	Limnanthes alba	white meadowfoam	Native	Annual herb	Valley grassland
	Limnanthes douglasii	meadowfoam	Native	Annual herb	Valley grassland, vernal pools
Linaceae					
	Linum sp.	flax	Native	Herb	Valley grassland
Lythraceae					
	Ammannia coccinea	ammannia	Native	Annual herb	Low wet places
	Lythrum hyssopifolium	hedge-hyssop loosestrife	Introduced	Annual herb	Moist places
	Lythrum tribracteatum	loosestrife	Introduced	Annual herb	Dried rain pools
Malvaceae					
	Abutilon theophrasti	velvet leaf	Introduced	Annual herb	Disturbed places, cropland
	Hibiscus lasiocarpus	rose-mallow	Native	Perennial herb	Freshwater marsh
	Malva parviflora	cheeseweed	Introduced	Annual herb	Common weed
	Malvella leprosa	alkali-mallow	Native	Perennial herb	Disturbed places
	Sidalcea calycosa	checker mallow	Native	Annual herb	Vernal pool edges, grasslands
Marsileaceae					
	Marsilea vestita ssp. vestita	hairy pepperwort	Native	Perennial herb	Edge of ponds, vernal pools
	Pilularia americana	American pillwort	Native	Perennial herb	Heavy soils; esp. vernal pools
Molluginaceae					
	Glinus lotoides	glinus	Introduced	Annual herb	Seasonal wetlands
	Mollugo verticillata	Indian chickweed	Introduced	Annual herb	Waste places
Moraceae					
	Ficus carica	edible fig	Introduced	Tree	Riparian areas
	Maclura pomifera	osage orange	Introduced	Tree, Shrub	Riparian areas
Oleaceae					
	Fraxinus latifolia	Oregon ash	Native	Tree	Canyons, near streams
Onagraceae					
	Epilobium brachycarpum	fireweed	Native	Annual herb	Disturbed sites
	Epilobium ciliatum	willow-herb	Native	Perennial herb	Wet areas
	Epilobium ciliatum ssp. ciliatum	willow-herb	Native	Perennial herb	Marsh
	Epilobium cleistogamum	spike-primrose	Native	Annual herb	Vernal pools
	Epilobium densiflorum	dense-flower willowherb	Native	Annual herb	Wet areas
	Epilobium pygmaeum	smooth spike primrose	Native	Annual herb	Moist areas
	Epilobium torreyi	Torrey's willowherb	Native	Annual herb	Valley grassland
	Ludwigia hexapetala	six-petal water-primrose	Native	Perennial herb	Wetlands
	Ludwigia peploides	water primrose	Native	Perennial herb	Open areas
	Oenothera villosa ssp. Strigosa	evening primrose	Native	Perennial herb	Moist openings in forests.

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Oxalidaceae					
	Oxalis albicans ssp. Pilosa	wood sorrel	Native	Perennial herb	Open hills, brushy hillsides
	Oxalis corniculata	creeping wood sorrel	Introduced	Perennial herb	Common weed
Papaveraceae					
	Eschscholzia lobbii	frying pans	Native	Annual herb	Valley grassland
	Fumaria parviflora	fineleaf fumitory	Introduced	Annual herb	Riparian areas
Plantaginaceae					
	Plantago elongata	long leaf plantain	Native	Annual herb	Grasslands, vernal pools
	Plantago erecta	California plantain	Native	Annual herb	Grasslands
	Plantago lanceolata	English plantain	Introduced	Perennial herb	Moist waste places
	Plantago major	broadleaf plantain	Introduced	Perennial herb	Damp waste places
Poaceae					
	Aegilops triuncialis	barb goatgrass	Introduced	Annual herb	Grasslands
	Agrostis avenacea	Pacific bentgrass	Introduced	Perennial herb	Moist open places, vernal pool edges
	Agrostis exarata	spike bentgrass	Native	Perennial herb	Moist open places
	Agrostis gigantea	redtop	Introduced	Perennial herb	Moist places
	Aira caryophyllea	silver hairgrass	Introduced	Annual herb	Moist places, vernal pools
	Alopecurus carolinianus	Carolina foxtail	Introduced	Annual herb	Waste places
	Alopecurus saccatus	Sacramento Orcutt grass	Native	Annual herb	Vernal pools
	Avena barbata	slender wild oat	Introduced	Annual, Perennial herb	Waste fields
	Avena fatua	wild oat	Introduced	Annual herb	Common weed
	Beckmannia syzigachne	slough grass	Native	Annual herb	Wet places
	Briza minor	little quaking grass	Introduced	Annual herb	Grasslands, vernal pools
	Bromus alopecurus	weedy brome	Introduced	Annual herb	Grasslands
	Bromus carinatus	California brome	Native	Perennial herb	Open shrubland, woodland
	Bromus diandrus	ripgut grass	Introduced	Annual herb	Grasslands, woodlands
	Bromus hordeaceus	soft chess	Introduced	Annual herb	Grasslands, woodlands
	Crypsis schoenoides	swamp grass	Introduced	Annual herb	seasonal wetlands
	Crypsis vaginiflora	prickle grass	Introduced	Annual herb	Mud flats, sand bars
	Cynodon dactylon	Bermuda grass	Introduced	Perennial herb	Common weed
	Cynosurus echinatus	dogtail	Introduced	Annual herb	Waste places
	Deschampsia danthonioides	annual hairgrass	Native	Annual herb	Moist to drying open sites
	Digitaria sanguinalis	crabgrass	Introduced	Annual herb	Common weed
	Distichlis spicata	saltgrass	Native	Perennial herb	Wet areas
	Echinochloa crus-galli	barnyard grass	Introduced	Annual herb	Waste places, damp ground
	Elymus glaucus	blue wildrye	Native	Perennial herb	Wet grasslands, under canopy
	Eragrostis pectinacea var. pectinacea	tufted lovegrass	Native	Annual herb	Sandy places, ditches
	Gastridium ventricosum	nit grass	Introduced	Annual herb	Grasslands, vernal pools

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	Glyceria borealis	manna grass	Native	Perennial herb	Wet areas
	Glyceria occidentalis	manna grass	Native	Perennial herb	Swampy places
	Hordeum brachyantherum	meadow barley	Native	Perennial herb	Moist places below 11,000 ft.
	Hordeum depressum	barley	Native	Annual herb	Moist alkaline places
	Hordeum marinum ssp. gussoneanum	Mediterranean barley	Introduced	Annual herb	Mesic grasslands
	Hordeum murinum ssp. leporinum	foxtail barley	Introduced	Annual herb	Mesic grasslands
	Leersia oryzoides	rice cutgrass	Native	Perennial herb	Marshes, stream banks
	Leptochloa fascicularis	sprangletop	Native	Annual herb	Ditches
	Leymus triticoides	creeping wild rye	Native	Perennial herb	Grasslands
	Lolium multiflorum	Italian ryegrass	Introduced	Annual, Biennial herb	Lawn grass
	Lolium perenne	perennial ryegrass	Introduced	Perennial herb	Grasslands, wet areas
	Nassella pulchra	purple needlegrass	Native	Perennial herb	Grasslands
	Panicum acuminatum	panic grass	Native	Perennial herb	Moist places, marshes, streambanks
	Panicum dichotomiflorum	smooth witchgrass	Introduced	Annual herb	Moist places
	Paspalum dilatatum	dallis gras	Introduced	Perennial herb	Roadsides, ditches, wate place
	Paspalum distichum	knot grass	Native	Perennial herb	Along coast, interior ditches
	Phalaris lemmonii	Lemmon's canary grass	Native	Annual herb	Moist places below 2000 ft.
	Phalaris minor	littleseed canary grass	Introduced	Annual herb	Waste, disturbed places
	Phalaris paradoxa	canary grass	Introduced	Annual herb	Waste, disturbed places
	Phleum pratense	timothy	Introduced	Perennial herb	Cultivated waste places
	Pleuropogon californicus	semaphore grass	Native	Perennial herb	Wet places
	Poa annua	annual bluegrass	Introduced	Annual herb	Common weed
	Poa pratensis ssp. pratensis	Kentucky bluegrass	Introduced	Perennial herb	Everywhere
	Polypogon interruptus	ditch rabbit foot grass	Introduced	Perennial herb	Wet places
	Polypogon maritimus	Mediterranean beard grass	Introduced	Annual herb	Low wet and waste places
	Polypogon monspeliensis	annual rabbitfoot grass	Introduced	Annual herb	Waste places
	Scribneria bolanderi	Scribner's grass	Native	Annual herb	Grasslands
	Setaria viridis	bristly foxtail	Introduced	Annual herb	Waste places
	Sorghum halepense	Johnson grass	Introduced	Perennial herb	Low wet places
	Taeniatherum caput-medusae	medusa-head	Introduced	Annual herb	Grasslands
	Triticum aestivum	wheat	Introduced	Annual herb	Escape into waste places
	Vulpia bromoides	fescue	Introduced	Annual herb	Mesic grasslands
	Vulpia microstachys	small fescue	Native	Annual herb	Grasslands
	Vulpia myuros	rattail fescue	Introduced	Annual herb	Grasslands
Polemoniaceae					
	Navarretia intertexta	needle-leaf navarretia	Native	Annual herb	Grasslands
	Navarretia leucocephala	white-head navarretia	Native	Annual herb	Vernal pools
	Navarretia pubescens	purple navarretia	Native	Annual herb	Grasslands

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	Navarretia tagetina	marigold navarretia	Native	Annual herb	Grasslands
	Navarrietia leucocophala ssp. leucocephala	white-flowered navarrietia	Native	Shrub	Vernal pools
	Navarrietia squarrosa	skunk weed	Native	Annual herb	Dry flats and fields
Polygonaceae					
	Polygonum amphibium	polygonum	Native	Perennial herb	Moist places
	Polygonum amphibium var. emersum	polygonum	Native	Perennial herb	Moist places
	Polygonum arenastrum	prostrate knotweed	Introduced	Annual, Perennial herb	Disturbed areas
	Polygonum argyrocoleon	knotweed	Introduced	Annual herb	Abandoned fields
	Polygonum hydropiperoides	waterpetter	Native	Perennial herb	Most places
	Polygonum lapathifolium	smart weed	Native	Annual herb	Moist places
	Polygonum persicaria	lady's thumb	Introduced	Annual herb	Moist waste places
	Polygonum punctatum	water smartweed	Native	Perennial herb	Moist places
	Rumex acetosella	sheep sorrel	Introduced	Perennial herb	Disturbed places
	Rumex conglomeratus	dock	Introduced	Perennial herb	Low moist places
	Rumex crispus	curly dock	Introduced	Perennial herb	Common weed
	Rumex pulcher	fiddle dock	Introduced	Perennial herb	Waste places
	Rumex salicifolius	willow dock	Native	Perennial herb	Moist places
Portulacaceae					
	Calandrinia ciliata	red maids	Native	Annual herb	Open grassy places
	Claytonia perfoliata	miner's lettuce	Native	Annual herb	Shaded moist areas
	Montia fontana	water chickweed	Native	Annual herb	Rain pools
Portulaceae					
	Portulaca oleracea	common purslane	Introduced	Annual herb	Disturbed places
Potamogetonaceae					
	Potamogeton sp.	pondweed	Native	Perennial herb	Open water
Primulaceae					
	Anagallis arvensis	scarlet pimpernel	Introduced	Annual herb	Common weed
	Centunculus minimus	chaffweed	Native	Annual herb	Vernal pools
	Samolus parviflorus	water pimpernel	Native	Perennial herb	Moist places
Ranunculaceae					
	Delphinum sp.	larkspur	Native	Perennial herb	Grasslands
	Myosurus minimus	tiny mousetail	Native	Annual herb	Moist places
	Ranunculus alismifolius	water plaintain buttercup	Native	Perennial herb	Muddy banks, ditches
	Ranunculus bonariensis var. trisepalus	Carter's buttercup	Native	Annual herb	Vernal pools
	Ranunculus californicus	California buttercup	Native	Perennial herb	Vernally moist slopes
	Ranunculus muricatus	spiny-fruit buttercup	Introduced	Annual, Perennial herb	Moist places
	Ranunculus pusillus	low spearwort	Native	Annual herb	Shallow, marshy places
	Ranunculus sceleratus	cursed buttercup	Native	Annual herb	Lake borders, marshes

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
Rosaceae					
	Prunus cerasifera	cherry plum	Introduced	Tree, shrub	Riparian areas
	Pyrus calleyana	Bradford pear	Introduced	Tree	Riparian habitats and homesteads
	Pyrus communis	common pear	Introduced	Tree	Riparian habitats
	Rosa californica	wild rose	Native	Shrub	Fairly moist places
	Rubus discolor	Himalayan blackberry	Introduced	Shrub	Road sides, ditches, waterways
	Rubus ursinus	California blackberry	Native	Vine, Shrub	Waste places
Rubiaceae					
	Cephalanthus occidentalis var. californicus	buttonbush	Native	Shrub	Streamside
	Galium aparine	bedstraw	Native	Annual herb	woodland and grassland
Salicaceae					
	Populus fremontii	Fremont's cottonwood	Native	Tree	Moist places
	Salix exigua	narrow leaf sandbar willow	Native	Tree, Shrub	Wet places
	Salix gooddingii	Gooding's or black willow	Native	Tree	Streambanks
	Salix laevigata	red willow	Native	Tree	Along streams
	Salix lasiolepis	arroyo willow	Native	Tree, Shrub	Streambanks, beds
	Salix lucida ssp. Lasiandra	shining willow	Native	Tree	Riparian
Scrophulariaceae					
	Castilleja attenuata	valley tassels	Native	Annual herb	Grasslands
	Castilleja campestris	Indian paintbrush	Native	Annual herb	Vernal pools
	Castilleja lineariloba	paint brush	Native	Annual herb	Moist places
	Cordylanthus pilosus	bird's beak	Native	Annual herb	Dry open hillsides
	Gratiola ebracteata	hedge hyssop	Native	Annual herb	Muddy places
	Gratiola neglecta	hedge hyssop	Native	Annual herb	Wet or muddy places
	Kickxia elatine	sharppoint fluvellin	Introduced	Perennial herb	Old fields
	Limosella acaulis	mudwort	Native	Annual herb	Muddy shores
	Lindernia dubia	false pimpernel	Native	Annual herb	Wet areas
	Mimulus guttatus	yellow monkey flower	Native	Perennial herb	Common in wet places
	Mimulus pilosus	downy monkey flower	Native	Annual herb	Wet areas
	Mimulus tricolor	tricolor monkey flower	Native	Annual herb	Drying vernal pools
	Parentucellia viscosa	yellow glandweed	Introduced	Annual herb	Grasslands
	Triphysaria eriantha	butter and eggs	Native	Annual herb	Grasslands
	Triphysaria pusilla	owl's clover	Native	Annual herb	Grasslands
	Triphysaria versicolor	yellow owl's clover	Native	Annual herb	Grasslands
	Verbascum blattaria	moth mullein	Introduced	Perennial herb	Waste places
	Verbascum thapsus	woolly mullein	Introduced	Perennial herb	Disturbed areas
	Veronica peregrina ssp. xalapensis	purlsane speedwell	Introduced	Annual herb	Moist places
	Veronica persica	corn speedwell	Native	Annual herb	Waste places

Family	Scientific Name	Common Name	Nativity	Lifeform	Habitat
Simaroubaceae					
	Ailanthus altissima	tree-of-heaven	Introduced	Tree	Riparian areas
Solanaceae					
	Datura stramonium	jimson weed	Introduced	Annual herb	Waste places
	Nicotiana acuminata	many flower tobacco	Introduced	Annual herb	Disturbed places, riparian
	Physalis philadelphica	tomatillo	Introduced	Annual herb	Waste places, cult. fields
	Solanum aff. americanum	nightshade	Native	Annual herb	Open, often disturbed places
	Solanum nigrum	black nightshade	Introduced	Annual herb	Waste places; fields
Typhaceae					
	Typha angustifolia	narrow-leaf cattail	Native	Perennial herb	Freshwater marshes
	Typha latifolia	broad-lead cattail	Native	Perennial herb	Freshwater marshes
Urticaceae					
	Urtica dioica ssp. holosericea	stinging nettle	Native	Perennial herb	Low dwamp places
	Urtica urens	dwarf nettle	Introduced	Annual herb	Gardens, orchard weed
Verbernaceae					
	Phyla nodiflora	mat grass	Native	Perennial herb	Moist places
	Phyla nodiflora var. nodiflora	mat grass	Native	Perennial herb	Moist places
Verbernaeae					
	Verbena bonariensis	blue vervain	Introduced	Annual, Biennial herb	Waste places
	Verbena hastata	verbena	Native	Perennial herb	Moist waste places
Violaceae					
	Viola pedunculata	California golden violet	Native	Perennial herb	Grasslands
Viscaceae					
	Phoradendron macrophyllum	big leaf mistletoe	Native	Shrub	Typically on Fraxinus and Populus
	Phoradendron villosum	oak mistletoe	Native	Shrub	Mostly on Quercus
Vitaceae					
	Vitis californica	wild grape	Native	Vine, Shrub	Streambanks
Zygophyllaceae					
	Tribulus terrestris	puncture vine	Introduced	Annual herb	Waste places

Appendix E

Invasive Non-native Plant Species Managed at the Cosumnes River Preserve

Invasive Non-native Plant Species Managed at the Preserve

Cal-IPC Rank	*Scientific Name*	Common Name	Habitat Type	Current Range within Preserve	Control Activities	Goals	Impacts	Notes
Terrestrial Plant Species Currently at Cosumnes River Preserve								
High	*Arundo donax*	Arundo giant cane	Riparian areas	Found on Mokelumne river. One population found on Shaw property in 2000. Unable to relocate.		Eradicate populations	Develops dense monocultures, displaces native vegetation.	
High	*Foeniculum vulgare*	fennel	Grasslands, scrub, disturbed areas	Limited to county roadsides and wetland pond edges. Some isolated populations have occurred near riparian forests.	Herbicides are used to eradicate isolated populations of this species near key resource areas.	Eradicate isolated populations. Monitor roadsides.	Develops monocultures, displaces native vegetation,	
High	*Centaurea solstitialis*	yellow star-thistle	Grassland	Found in small patches of varying density throughout the Preserve grasslands. Also found on mowed roads and disturbed areas.	Limited herbicide applications on isolated populations. Prescribed mowing to discourage growth.	Manage populations within grassland areas to limit impacts to target species. Manage roadsides to limit spread.	Dense populations may impact foraging opportunities for Swainson's hawks and sandhill cranes	
High	*Lepidium latifolium*	Perennial pepperweed peppergrass	Wetlands, riparian areas, grasslands, agricultural lands	Found throughout the Preserve wetlands, riparian areas, floodplain, adjacent to organic rice fields. Found in limited areas in Preserve grasslands.	Currently under study by UC Davis Information Center for the Environment.	Goals to be determined upon completion of UCD research project. Likely will involve the eradication of isolated populations and reduction of populations within floodplain.	Develops monocultures, displaces native vegetation, alters soil composition,	
High	*Myriophyllum aquaticum*	parrotfeather	Wetlands	Found in Preserve wetlands, including Badger Creek.	None	None	Develops monocultures	

Invasive Non-native Plant Species Managed at the Preserve

Cal-IPC Rank	*Scientific Name*	Common Name	Habitat Type	Current Range within Preserve	Control Activities	Goals	Impacts	Notes
High	*Taeniatherum caput-medusae*	medusa-head	Grasslands	Preserve grasslands	Prescribed burning.	Reduce the impacts of this species on native diversity.	Develops monoculture, poor forage for native herbivores.	
High	*Rubus discolor*	Himalayan blackberry	Riparian Forest	All riparian forests	Herbicide control is currently underway within the Valensin Forest	Eradicate populations within the Valensin Forest	Develops monocultures, displaces native vegetation, may alter fire return interval, hybridizes with native blackberry.	
Moderate	*Carduus pycnocephalus*	Italian thistle	Grasslands, forest, scrub, woodlands	Patchy	Manual control is being carried out by volunteers at the Barn Ponds, Lost Slough ponds and the western portion of the south Moyer slough unit.	Manage populations to limit impacts	Displaces more desirable forage and cover plants.	
Moderate	*Cirsium vulgare*	bull thistle	Riparian, marshes, meadows	Patchy, often under oak trees in grazed areas.	Manual control is being carried out by volunteers at the Barn Ponds, Lost Slough ponds and the western portion of the south Moyer slough unit.	Manage populations to limit impacts.	Displaces more desirable forage and cover plants.	

Invasive Non-native Plant Species Managed at the Preserve

Cal-IPC Rank	*Scientific Name*	Common Name	Habitat Type	Current Range within Preserve	Control Activities	Goals	Impacts	Notes
Moderate	*Ficus carica*	edible fig	Riparian Forest	Preserve riparian forests	Herbicide control of all known populations has been underway since 1995	Eradicate all populations within riparian forests	Develops monoculture, displaces native vegetation, may be allelopathic, provides little nesting or forage value.	
Moderate	*Ailanthus altissima*	tree-of-heaven	Riparian Forest, grasslands, oak woodlands	Castello Forests	Herbicide control of all known populations has been underway since 2000	Eradicate all populations within riparian forests	Develops monoculture, displaces native vegetation, may be allelopathic, provides little nesting or forage value.	
Limited	*Silybum marianum*	blessed milk thistle	Grasslands, riparian scrub. Spreading rapidly, impacts may become more important in future.	Patchy, often under oak trees in grazed areas.	Manual control is being carried out by volunteers at the Barn Ponds, Lost Slough ponds and the western portion of the south Moyer slough unit.	Manage populations to limit impacts.		
Limited	*Prunus cerasifera*	cherry plum	Riparian habitats, chaparral woodland	Highly invasive in the Shaw forest. Limited numbers elsewhere.	Herbicide control of populations within Shaw forest has been underway since 2003	Treat all trees of reproductive age within the Shaw forest by 2010.	Aggressively spreads within riparian forests. Dense infestations may reduce understory diveristy.	
Limited	*Gleditsia triacanthos*	honey locust	Riparian	Older infestations along river on western edge of Orr forest. New infestations within floodplain east of tall forest.	Experimental control of Orr forest populations in 1995. Control of all known locations is currently underway	Eradicate all known populations	Can develop dense stands, may alter soil composition. Limited nesting and forage value.	

Invasive Non-native Plant Species Managed at the Preserve

Cal-IPC Rank	*Scientific Name*	Common Name	Habitat Type	Current Range within Preserve	Control Activities	Goals	Impacts	Notes
Limited	*Robinia pseudo-acacia*	black locust	Riparian	Isolated patches along the river.	Herbicide control of known populations	Eradicate all known populations	Can develop dense stands, may alter soil composition. Limited nesting and forage value.	
not ranked	*Sorghum halepense*	Johnson grass	Agriculture, riparian	Isolated patches along the river above Twin Cities. Does not tolerate flooding.		Eradicate populations within restoration sites, work with farm operators to manage on ag lands within Preserve.	Develop dense monospecific stands. May impede restoration. Toxic forage when under drought or frost stress.	
Aquatic Plant Species Currently at Cosumnes River Preserve								
High	*Ludwigia hexapetala*	six-petal water-primrose	Wetlands, Aquatic	Found in Preserve wetlands	None	Research impacts to GGS and appropriate control measures	Reduces open water area, reduces available oxygen in dense infestations. May impact giant garter snake	Undergone recent population expansion
High	*Ludwigia peploides*	water primrose	Wetlands, Aquatic	Found in Preserve wetlands	None	Research impacts to GGS and appropriate control measures	Reduces open water area, reduces available oxygen in dense infestations. May impact giant garter snake	This native species is included for management as an invasive non-native species because of confusion regarding the taxonomy of L. peploides and L. hexapetala

Invasive Non-native Plant Species Managed at the Preserve

Cal-IPC Rank	*Scientific Name*	Common Name	Habitat Type	Current Range within Preserve	Control Activities	Goals	Impacts	Notes
High	*Eichornia crassipes*	water hyacinth	Aquatic habitats	Lost Slough	Removal of plants.	Manage impacts	Large populations in Lost Slough clog wetland and agricultural pumps. Reduces open water and may reduce available oxygen.	This extremely fast growing floating species currently drifts in from the Delta and reinvades Lost Slough. Eradication is unlikely.
High	*Egeira densa*	Brazilian egeria; common waterweed	Aquatic habitats	Full range within Preserve is not known. Populations have been identified in Teuchemne slough.	None	None	Aggressively invade aquatic environments, displace native aquatic vegetation by forming dense stands or large subsurface mats and alter the dynamics of aquatic ecosystems (J.DiTomaso,2003)	

Invasive Non-native Plant Species Managed at the Preserve

"Red Alert" Species Not Currently Documented at Cosumnes River Preserve				
High	Sesbania punicea	red sesbania	Riparian areas	American river is heavily infested
not ranked	Cuscuta japonica	Japanese dodder	Unknown	A parasitic vine with 70 known locations in Sacramento county. Parisitizes oak trees.
Moderate	Dittrichia graveolens	stinkwort	Grasslands, riparian scrub. Spreading rapidly, impacts may become more important in future.	Found along roadsides in Sacramento county. May invade vernal pool grasslands.
Moderate	Centaurea calcitrapa	purple starthistle	Grasslands. Impacts regionally variable. Distribution relatively limited.	Found in vernal pool grasslands in Solano county.
High	Senecio mikanioides syn Delairea oderata	Cape ivy	Riparian areas, coastal scrub	Currently found in coastal environments. Greenhouse experiments suggest plants are able to survvive in moist shaded areas of the Central Valley (R.Robison 2006)

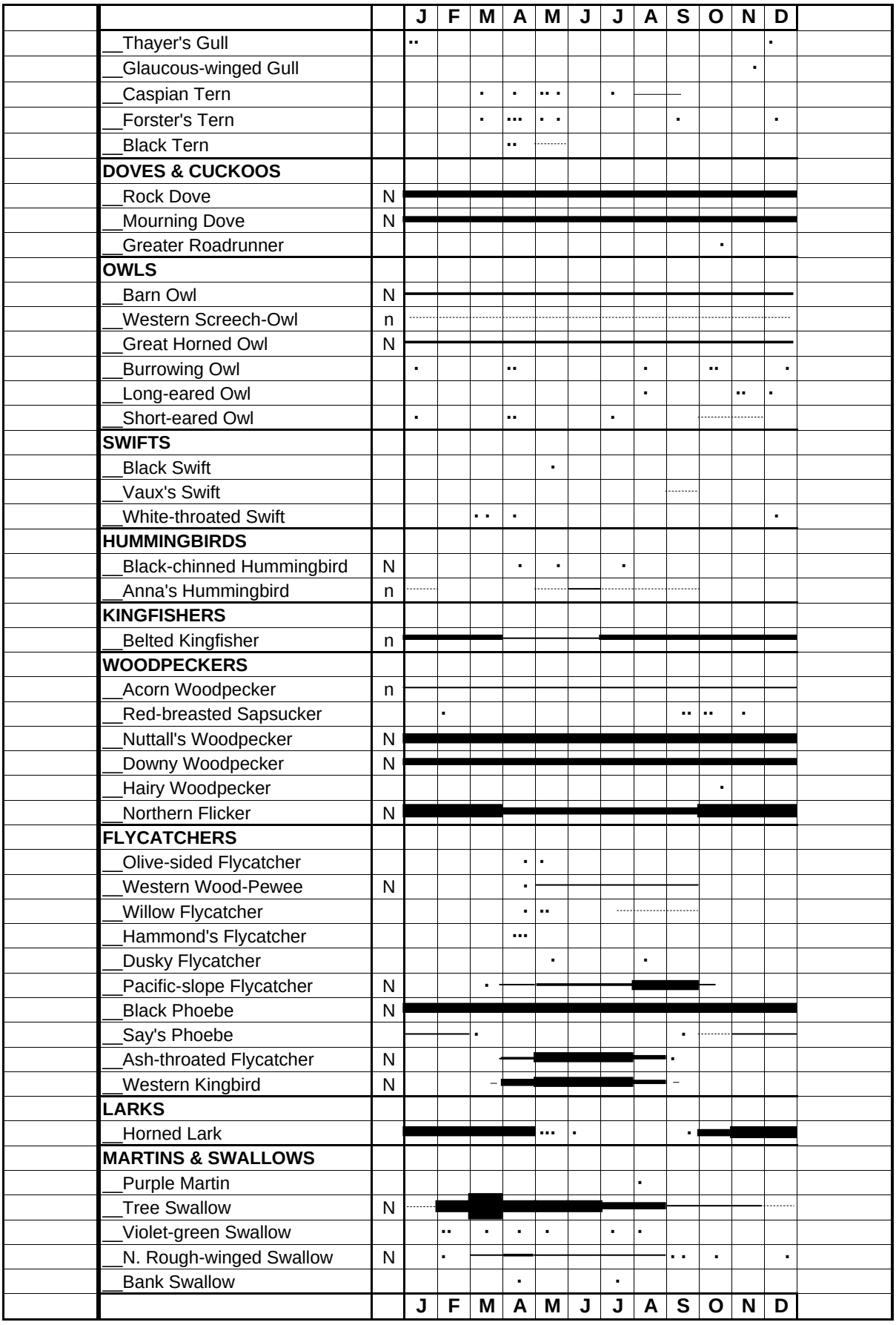
Appendix F

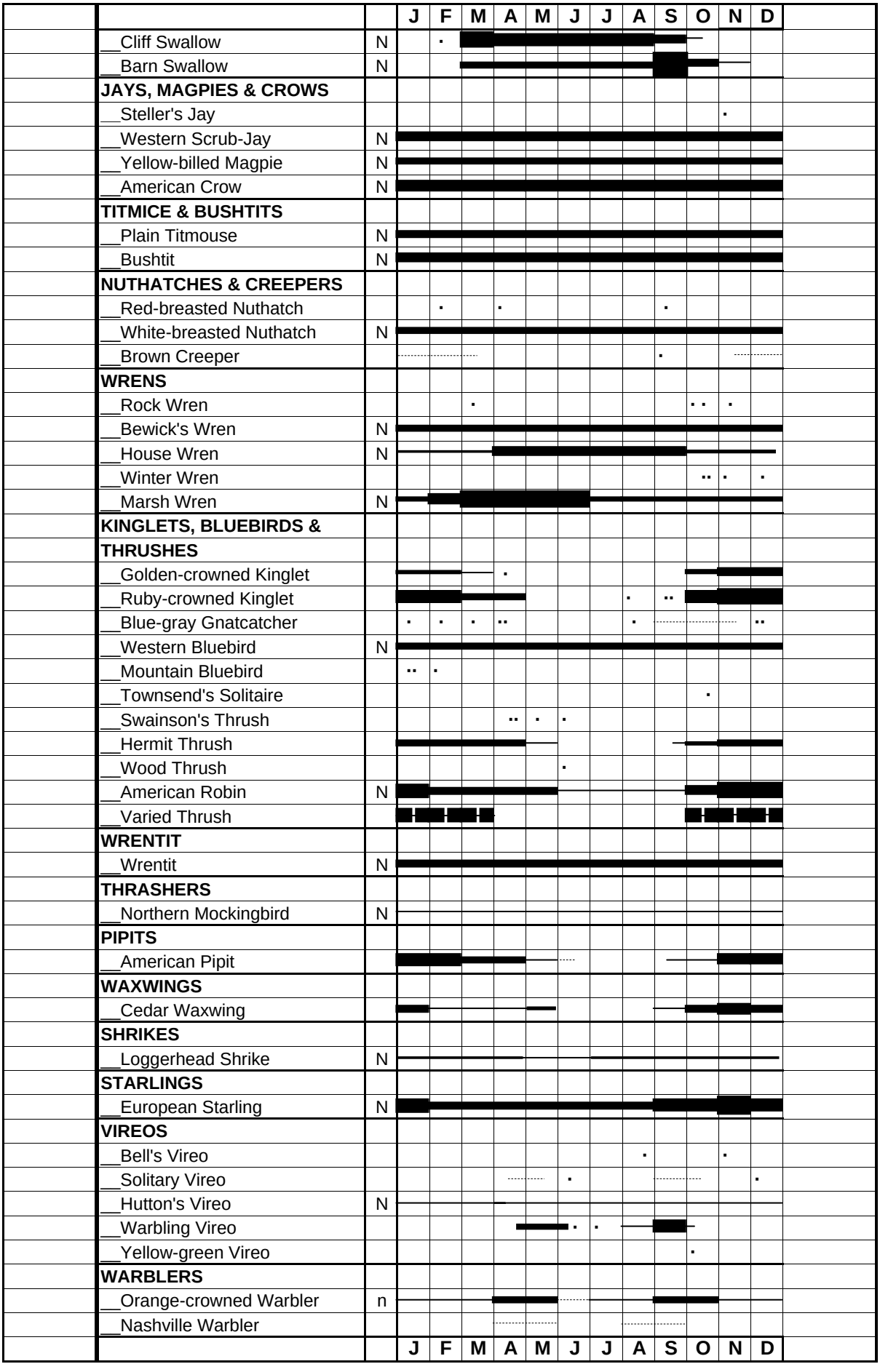
Bird Species Known to Occur in the Cosumnes River Preserve Study Area

Species Abundance by Month

		J	F	M	A	M	J	J	A	S	O	N	D
GREBES													
__Pied-billed Grebe	N												
__Eared Grebe													
PELICANS & CORMORANTS													
__American White Pelican													
__Double-crested Cormorant	N												
HERONS & BITTERNS													
__American Bittern	N												
__Great Blue Heron	N												
__Great Egret	N												
__Snowy Egret	N												
__Cattle Egret					·								
__Green Heron	N												
__Black-crowned Night-Heron	N												
IBISES													
__White-faced Ibis													
SWANS, GEESE & DUCKS													
__Tundra Swan													
__Greater White-fronted Goose										·			
__Snow Goose													
__Ross' Goose												·	·
__Canada Goose	n												
__Wood Duck	N												
__Green-winged Teal													
__Mallard	N												
__Northern Pintail	N												
__Blue-winged Teal	n	·							·	·		··	· ·
__Cinnamon Teal	N												
__Northern Shoveler													
__Gadwall	N												
__Eurasian Wigeon					·							·	···
__American Wigeon							·						
__Canvasback						··					·		
__Redhead			·	· ·									
__Ring-necked Duck								·					
__Tufted Duck			·										
__Lesser Scaup		·	·		·				·				
__Common Goldeneye													
__Barrow's Goldeneye		·	·										
__Bufflehead							·						
__Hooded Merganser		·	·	·		·						·	·
__Common Merganser							·						
__Ruddy Duck	N												
VULTURES													
__Turkey Vulture	N												
HAWKS & ALLIES													
__Osprey	n					·	· ·						
__White-tailed Kite	N												
__Bald Eagle			·	··									
__Northern Harrier	N												
__Sharp-shinned Hawk													
		J	F	M	A	M	J	J	A	S	O	N	D

		J	F	M	A	M	J	J	A	S	O	N	D
__Cooper's Hawk	n												
__Red-shouldered Hawk	N												
__Swainson's Hawk	N												
__Red-tailed Hawk	N												
__Ferruginous Hawk													
__Rough-legged Hawk													
__American Kestrel	N												
__Merlin													
__Peregrine Falcon													
__Prairie Falcon													
QUAILS & PHEASANTS													
__Ring-necked Pheasant	N												
__Wild Turkey													
__California Quail	N												
RAILS & COOTS													
__Virginia Rail	n												
__Sora	n												
__Common Moorhen	N												
__American Coot	N												
CRANES													
__Sandhill Crane													
SHOREBIRDS													
__Black-bellied Plover													
__Semipalmated Plover													
__Killdeer	N												
__Black-necked Stilt	N												
__American Avocet	N												
__Greater Yellowlegs													
__Lesser Yellowlegs													
__Willet													
__Solitary Sandpiper													
__Spotted Sandpiper													
__Whimbrel													
__Long-billed Curlew													
__Marbled Godwit													
__Western Sandpiper													
__Least Sandpiper													
__Baird's Sandpiper													
__Pectoral Sandpiper													
__Dunlin													
__Ruff													
__Short-billed Dowitcher													
__Long-billed Dowitcher													
__Common Snipe													
__Wilson's Phalarope	n												
__Red-necked Phalarope													
GULLS & TERNS													
__Bonaparte's Gull													
__Mew Gull													
__Ring-billed Gull													
__California Gull													
__Herring Gull													
		J	F	M	A	M	J	J	A	S	O	N	D

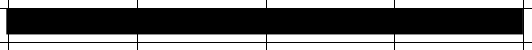

J F M A M J J A S O N D
__Thayer's Gull
__Glaucous-winged Gull
__Caspian Tern
__Forster's Tern
__Black Tern
DOVES & CUCKOOS
__Rock Dove N
__Mourning Dove N
__Greater Roadrunner
OWLS
__Barn Owl N
__Western Screech-Owl n
__Great Horned Owl N
__Burrowing Owl
__Long-eared Owl
__Short-eared Owl
SWIFTS
__Black Swift
__Vaux's Swift
__White-throated Swift
HUMMINGBIRDS
__Black-chinned Hummingbird N
__Anna's Hummingbird n
KINGFISHERS
__Belted Kingfisher n
WOODPECKERS
__Acorn Woodpecker n
__Red-breasted Sapsucker
__Nuttall's Woodpecker N
__Downy Woodpecker N
__Hairy Woodpecker
__Northern Flicker N
FLYCATCHERS
__Olive-sided Flycatcher
__Western Wood-Pewee N
__Willow Flycatcher
__Hammond's Flycatcher
__Dusky Flycatcher
__Pacific-slope Flycatcher N
__Black Phoebe N
__Say's Phoebe
__Ash-throated Flycatcher N
__Western Kingbird N
LARKS
__Horned Lark
MARTINS & SWALLOWS
__Purple Martin
__Tree Swallow N
__Violet-green Swallow
__N. Rough-winged Swallow N
__Bank Swallow
J F M A M J J A S O N D


J F M A M J J A S O N D
__Cliff Swallow N
__Barn Swallow N
JAYS, MAGPIES & CROWS
__Steller's Jay
__Western Scrub-Jay N
__Yellow-billed Magpie N
__American Crow N
TITMICE & BUSHTITS
__Plain Titmouse N
__Bushtit N
NUTHATCHES & CREEPERS
__Red-breasted Nuthatch
__White-breasted Nuthatch N
__Brown Creeper
WRENS
__Rock Wren
__Bewick's Wren N
__House Wren N
__Winter Wren
__Marsh Wren N
KINGLETS, BLUEBIRDS &
THRUSHES
__Golden-crowned Kinglet
__Ruby-crowned Kinglet
__Blue-gray Gnatcatcher
__Western Bluebird N
__Mountain Bluebird
__Townsend's Solitaire
__Swainson's Thrush
__Hermit Thrush
__Wood Thrush
__American Robin N
__Varied Thrush
WRENTIT
__Wrentit N
THRASHERS
__Northern Mockingbird N
PIPITS
__American Pipit
WAXWINGS
__Cedar Waxwing
SHRIKES
__Loggerhead Shrike N
STARLINGS
__European Starling N
VIREOS
__Bell's Vireo
__Solitary Vireo
__Hutton's Vireo N
__Warbling Vireo
__Yellow-green Vireo
WARBLERS
__Orange-crowned Warbler n
__Nashville Warbler
J F M A M J J A S O N D

		J	F	M	A	M	J	J	A	S	O	N	D
__Yellow Warbler	n												
__Yellow-rumped Warbler													
__Black-throated Gray Warbler													
__Townsend's Warbler													
__Hermit Warbler													
__Palm Warbler													
__Black-and-white Warbler													
__MacGillivray's Warbler													
__Common Yellowthroat	N												
__Wilson's Warbler													
__Yellow-breasted Chat	n												
TANAGERS, GROSBEAKS &													
BUNTINGS													
__Western Tanager													
__Black-headed Grosbeak	N												
__Blue Grosbeak	N												
__Indigo Bunting	n												
__Lazuli Bunting	N												
TOWHEES & SPARROWS													
__Spotted Towhee	N												
__California Towhee	n												
__Chipping Sparrow													
__Vesper Sparrow													
__Lark Sparrow	N												
__Savannah Sparrow													
__Grasshopper Sparrow													
__Fox Sparrow													
__Song Sparrow	N												
__Lincoln's Sparrow													
__Swamp Sparrow													
__White-throated Sparrow													
__Golden-crowned Sparrow													
__White-crowned Sparrow													
__Dark-eyed Junco													
BLACKBIRDS, COWBIRDS &													
ORIOLES													
__Red-winged Blackbird	N												
__Tricolored Blackbird	N												
__Western Meadowlark	N												
__Yellow-headed Blackbird	N												
__Brewer's Blackbird	N												
__Brown-headed Cowbird	N												
__Hooded Oriole													
__Bullock's Oriole	N												
FINCHES													
__Purple Finch													
__House Finch	N												
__Pine Siskin													
__Lesser Goldfinch													
__American Goldfinch	N												
OLD WORLD SPARROWS													
__House Sparrow	N												
		J	F	M	A	M	J	J	A	S	O	N	D

ABUNDANCE CATEGORIES

= abundant



= common

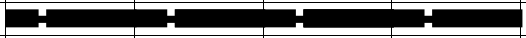
= fairly common

= uncommon

= rare

= very rare or casual

= isolated records



= annual abundance

varies as shown

NESTING INFORMATION

N	=	confirmed nester
n	=	suspected nester

Appendix G

Animals Known to Occur in the Cosumnes River Preserve Study Area

Animals Known to Occur at the Cosumnes River Preserve

By John Trochet

Updated November 2002

Common Name	Scientific Name	Origin	Presence*
Amphibians			
Western Spadefoot Toad	*Spea hammondii*	native	C
Western Toad	*Bufo boreas*	native	C
Pacific Tree Frog	*Hyla regilla*	native	C
Bullfrog	*Rana catesbiana*	introduced	C
California Tiger Salamander	*Ambystoma californiense*	native	C
California Slender Salamander	*Batrachoseps attenuatus*	native	P
Reptiles			
Eastern Box Turtle	*Terrapene*	introduced	C
Western pond turtle	*Clemmys marmorata*	native	C
Painted Turtle	*Chrysemys picta*	introduced	C
Slider	*Pseudemys scripta*	introduced	C
Gilbert Skink	*Eumeces gilberti*	native	E
Western Fence Lizard	*Sceloporus occidentalis*	native	C
Western Whiptail	*Cnemidophorus tigris*	native	P
Southern Alligator Lizard	*Elgaria multicarinata*	native	C
Racer	*Coluber constrictor*	native	C
California Whipsnake	*Masticophis lateralis*	native	C
Sharp-tailed Snake	*Contia tenuis*	native	P
Ring-necked Snake	*Diadophis punctatus*	native	P
Common Kingsnake	*Lampropeltis getulus*	native	C
Gopher Snake	*Pituophis catenifer*	native	C
Giant Garter Snake	*Thamnophis gigas*	native	C
Common Garter Snake	*Thamnophis sirtalis*	native	C
Western Rattlesnake	*Crotalus viridis*	native	C
Mammals			
Virginia Opossum	*Didelphis virginiana*	introduced	C
Ornate Shrew	*Sorex ornatus*	native	C
California Mole	*Scapanus latimanus*	native	C

Animals Known to Occur at the Cosumnes River Preserve

Common Name	Scientific Name	Origin	Presence*
Pallid Bat	*Antrozous pallidus*	native	E
Silver-Haired Bat	*Lasionycteris noctivagans*	native	E
Red Bat	*Lasiurus borealis*	native	E
Hoary Bat	*Lasiurus cinereus*	native	C
California Myotis	*Myotis californicus*	native	E
Yuma Myotis	*Myotis yumanensis*	native	E
Mexican Free-Tailed Bat	*Tadarida brasiliensis*	native	C
Coyote	*Canis latrans*	native	C
Gray Fox	*Urocyon cinereoargenteus*	native	C
Red Fox	*Vulpes fulva*	introduced	P
Domestic Cat	*Felis cattus*	introduced	C
Bobcat	*Lynx rufus*	native	C
Mountain Lion	*Puma concolor*	native	C
River Otter	*Lontra canadensis*	native	C
Western Striped Skunk	*Mephitis mephitis*	native	C
Long-Tailed Weasel	*Mustela frenata*	native	E
Mink	*Mustela vison*	native	C
Badger	*Taxidea taxus*	native	C
Ringtail	*Bassariscus astutus*	native	P
Raccoon	*Procyon lotor*	native	C
Mule Deer	*Odocoileus hemionus*	native	C
Western Gray Squirrel	*Sciurus griseus*	native	C
Eastern Fox Squirrel	*Sciurus niger*	introduced	C
California Ground Squirrel	*Spermophilus beecheyi*	native	C
Beaver	*Castor canadensis*	native	C
Botta's Pocket Gopher	*Thomomys bottae*	native	C
Heermann's Kangaroo Rat	*Dipodomys heermanni*	native	C
California Vole	*Microtus californicus*	native	C
Muskrat	*Ondatra zibethica*	introduced	C
House Mouse	*Mus musculus*	introduced	C
Black Rat	*Rattus rattus*	introduced	C

Animals Known to Occur at the Cosumnes River Preserve

Common Name	Scientific Name	Origin	Presence*
Norway Rat	*Rattus norvegicus*	introduced	C
Dusky-Footed Woodrat	*Neotoma fuscipes*	native	P
Brush Mouse	*Peromyscus boylei*	native	P
Deer Mouse	*Peromyscus maniculatus*	native	P
Western Harvest Mouse	*Reithrodontomys megaloti*	native	C
Black-Tailed Hare	*Lepus californicus*	native	C
Desert Cottontail	*Sylvilagus auduboni*	native	C

* Code:
C = confirmed
E = expected
P = possible

Extirpated Species:

Gray Wolf	*Canis lupus*
Tule Elk	*Cervus elaphus nannodes*
Pronghorn	*Antilocapra americana*

Sequence and scientific names follow Wilson, D.E. and D.M. Reeder (eds.). 1993. *Mammal Species of the World.* Smithsonian Institution Press.

Appendix H

Special-Status Wildlife Species Known to Occur in the Cosumnes River Preserve Study Area

Special-status Wildlife Species Known or Potentially Occurring in the Study Area

Species	Status: State Federal	Habitat	Cosumnes River	Potential for Occurrence in the Study Area
Invertebrates				
Branchinecta lynchi Vernal pool fairy shrimp	None FT, FX	Vernal pools throughout California west of the Sierra.	Known	Known to occur within the floodplain.
Branchinecta mesovallensis Midvalley fairy shrimp	None FSC	Vernal pools in only a handful of counties within the Central Valley, including Sacramento, Solano, Merced, Madera, San Joaquin, Fresno, and Contra Costa counties.	Potential	Known occurrences in Elk Grove, Galt, and Lockeford USGS quads.
Lepidurus packardi Vernal pool tadpole shrimp	None FE, FX	Vernal pools in the Central Valley containing clear to highly turbid water.	Known	Known to occur within the floodplain.
Desmocerus californicus dimpoohus Valley elderberry longhorn beetle	None FT	Elderberry shrubs throughout the Central Valley and foothills below 3,000 feet elevation.	Known	Known to occur within the floodplain.
*Hydrochara ricksecker*i Ricksecker's water scavenger beetle	None FSC	Shallow aquatic habitat.	Potential	Known occurrence in the Bruceville USGS quad.
Amphibians				
Ambystoma californiense California tiger salamander	None FT/FE	Needs underground refuges, especially ground squirrel burrows, and vernal pools or other seasonal water sources for breeding.	Known	Known to occur within the floodplain.
Rana aurora draytonii California red-legged frog	None FT	Breeds in quiet streams and permanent, deep, cool ponds with overhanging and emergent vegetation below 4,000 feet elevation. Known to occur adjacent to breeding habitats in riparian areas and heavily vegetated streamside shorelines, and non-native grasslands.	Potential	May occur where appropriate habitat is present.
Rana boylii Foothill yellow-legged frog	None FSC	Breeds in rocky streams with cool, clear water in a variety of habitats, including valley and foothill oak woodland, riparian forest, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadows; occurs at elevations ranging from 0 to 6,000 feet.	Known	Known to occur within the floodplain.
Spea hammondii Western spadefoot toad	None FSC	Requires vernal pools and seasonal wetlands below 4,500 feet that lack predators for breeding. Also occurs in grassland habitat and occasionally in valley-foothill oak woodlands and orchards.	Known	Known to occur within the floodplain.
Reptiles				
Clemmys marmorata Western pond turtle	None FSC	Perennial wetlands and slow moving creeks and ponds with overhanging vegetation up to 6,000 feet; suitable basking sites such as logs and rocks above the waterline.	Known	Known to occur within the floodplain.
Anniella pulchra pulchra Silvery legless lizard	None FSC	Burrows in loose, sandy soil, in areas vegetated with oak or pine-oak woodland, or chaparral; also wooded stream edges. Often found in leaf litter, under rocks, logs, and driftwood.	Unlikely	Unlikely to occur, outside the distribution of this species.

Special-status Wildlife Species Known or Potentially Occurring in the Study Area

Species	Status: State Federal	Habitat	Cosumnes River	Potential for Occurrence in the Study Area
Phrynosoma coronatum frontale California horned lizard	None FSC	Exposed sandy-gravelly substrate with scattered shrubs, clearings in riparian woodlands, and annual grasslands. Occur at elevations ranging from sea level to 4,000 feet.	Potential	Within range of species, may occur where appropriate habitat is present.
Thamnophis gigas Giant garter snake	ST FT	One of the most aquatic of gartersnakes, inhabits streams and sloughs, usually with mud bottoms. Riparian woodlands do not provide suitable habitat because of excessive shade and inadequate prey resources.	Known	Known to occur within the floodplain.
Birds				
Phalacrocorax auritus Double-crested cormorant	SSC None	Yearlong resident along the entire coast of California and on inland lakes, in fresh, salt, and estuarine waters. Requires undisturbed nest-sites on islands or near water. Typically nests on rock ledges or cliffs, steep slopes, or large dead trees.	Known	Common winter resident in appropriate habitat.
Plegadis chihi White-faced ibis	None FSC	In the Central Valley, ibises preferentially selected foraging sites close to emergent vegetation.	Known	Uncommon to rare in appropriate habitat.
Branta canadensis leucopareia Aleutian Canada goose	None FD	Migration and wintering habitats include marshes, pastures and croplands, harvested agriculture fields and flood-irrigated and nonirrigated land.	Known	Potential winter migrant in appropriate habitat.
Elanus leucurus White-tailed kite	None FSC	Open woodland, marshes, partially cleared lands and cultivated fields, mostly in lowland situations. Nests in trees, often near a marsh, usually 6-15 m above the ground in branches near the top of a tree.	Known	Uncommon breeder, known occurrences at the Cosumnes River Preserve.
Accipiter cooperii Cooper's hawk	SSC None	Nests in riparian areas and oak woodlands, forages at woodland edges.	Known	Species is known to occur in the Elk Grove USGS quad.
Buteo regalis Ferruginous hawk	FSC	Winter migrant in open grasslands or croplands.	Potential	Potential winter migrant in appropriate habitat.
Buteo Swainsoni Swainson's hawk	ST None	Uncommon breeding resident and migrant in the Central Valley, Klamath Basin, Northeastern Plateau, Lassen County, and Mojave Desert. Riparian woodlands, juniper-sage flats, and oak woodlands for nesting. Grasslands and agricultural areas for foraging.	Known	Species is an uncommon breeder with occurrences documented in the Bruceville, Clements, Elk Grove, Galt, Lodi North, Sloughhouse and Thornton USGS quads.
Haliaeetus leucocephalus Bald eagle	SE FPD, FT, FE	Local winter migrant to various California lakes. Most of the breeding population is restricted to more northern counties. Possible winter migrant.	Known	Uncomon winter migrant in appropriate habitat.
Falco peregrinus anatum American peregrine falcon	SE FD	Breeds in woodlands, forests, coastal habitats, and riparian areas near wetlands, lakes, rivers, or other water on high cliffs, banks, dunes, or mounds.	Known	Uncommon breeding resident or uncommon migrant in appropriate habitat.

Special-status Wildlife Species Known or Potentially Occurring in the Study Area

Species	Status: State Federal	Habitat	Cosumnes River	Potential for Occurrence in the Study Area
Grus canadensis tabida Greater sandhill crane	ST None	Roosts at night along river channels, on alluvial islands of braided rivers, or natural basin wetlands. A communal roost site consisting of an open expanse of shallow water is a key feature of wintering habitat. Often feeds and rests in fields and agricultural lands.	Known	Likely to occur during migration in fields and agricultural lands.
Charadrius montanus Mountain plover	FSC	Wintering grounds include heavily grazed grasslands and fields.	Potential	Potential migrant in appropriate habitat.
Numenius americanus Long-billed curlew	None FSC	Lakes and river shores during migration.	Known	Rare migrant in appropriate habitat.
Limosa fedoa Marbled godwit	None FSC	Marshes and flooded plains; in migration and when not breeding also on mudflats and beaches and open shallow water along shorelines.	Potential	Very rare migrant in appropriate habitat.
Coccyzus americanus occidentalis Western yellow-billed cuckoo	SE FC	Nests in dense foliage, deciduous trees and shrubs especially willow, in broad riparian forests.	Potential	Single observation reported at the Cosumnes River Preserve in 2004.
Athene cunicularia hypugaea Western burrowing owl	None FSC	Yearlong resident of open, dry grassland and desert habitats and in grass, forb, and open shrub stages of pinyon-juniper and ponderosa pine habitats up to 5,300 feet.	Known	Known occurrences documented by the Cosumnes River Preserve.
Chaetura vauxi Vaux's swift	FSC	Prefers redwood and Douglas-fir habitats with nest sites in large, hollow trees and snags, especially tall, burned-out stubs. Forages over moist terrain and habitats, preferring rivers and lakes.	Potential	Rare late-summer migrant in appropriate habitat.
Selasphorus rufus Rufous hummingbird	None FSC	Winter migrant found in meadows and forest edges, or gardens with hummingbird feeders.	Known	Uncommon migrant in California.
Melanerpes lewis Lewis' woodpecker	None FSC	Open forest and woodland, often logged or burned, including oak, coniferous forest, riparian woodland and orchards, less commonly in pinyon-juniper.	Known	Uncommon resident with patchy distribution in California.
Empidonax traillii brewsteri Willow flycatcher	SE None	Wet meadow and montane riparian habitats from 2,000 to 8,000 feet. Most often occurs in broad, open river valleys or large mountain meadows with lush growth of shrubby willows.	Potential	Rare breeder in appropriate habitat.
Lanius ludrovicianus Loggerhead shrike	None FSC	Open habitats with sparse shrubs and trees (or other suitable perch sites) and bare ground and/or low, sparse herbaceous cover; oak woodlands for nesting.	Known	Uncommon to rare breeder in appropriate habitat.
Riparia riparia Bank swallow	ST None	Sporadic colonial breeder, frequently near flowing water. Nests in steep sand, dirt, or gravel banks, in a burrow dug near the top of the bank, along the edge of inland water or in gravel pits, road embankments, etc.	Known	Rare to casual in appropriate habitat.

Special-status Wildlife Species Known or Potentially Occurring in the Study Area

Species	Status: State Federal	Habitat	Cosumnes River	Potential for Occurrence in the Study Area
Agelaius tricolor Tricolored blackbird	SSC FSC	Breeds near freshwater, preferably in emergent wetland with tall dense cattails or tules, but also in willow, blackberry, wild rose, and tall herbs. Forages in grassland and cropland in the Central Valley and on the coast.	Known	Species is known to occur in the Bruceville, Clements, Elk Grove, Galt, Lockeford, Lodi North and Sloughhouse USGS quads.
Carduelis lawrencei Lawrence's goldfinch	FSC	Oak woodland, chaparral, riparian woodland, pinyon-juniper association, and weedy areas in arid regions but usually near water. Often nests in dense foliage in conifers, 1-12 m above ground.	Potential	Uncommon breeder or uncommon migrant in appropriate habitat.
Mammals				
Corynorhinus townsendii townsendii Pacific western big-eared bat	None FSC	Occurs from low desert to mid-elevation montane habitat in rural settings, oak woodland and low to mid-elevation mixed forest.	Potential	Uncommon in California, may occur in appropriate habitat.
Euderma maculatum Spotted bat	None FSC	Habitats range from arid deserts and grasslands through mixed conifer forests up to 10,600 feet. Feeds over water and along marshes.	Unlikely	Not likely to occur. Little is known about the distribution of this species in California.
Myotis ciliolabrum Small-footed myotis bat	None FSC	Occurs in a wide variety of habitats, primarily in relatively arid wooded and brushy uplands near water up to 8,900 feet.	Unlikely	Not likely to occur. Outside geographic range of this species.
Myotis yumanensis Yuma myotis bat	None FSC	Common and widespread in California except in the Mojave and Colorado desert. Found in a wide variety of habitats, especially open woodlands and forests with water, up to 11,000 feet.	Known	Common and widespread in California, likely to occur in appropriate habitat.
Eumops perotis californicus Greater western mastiff bat	None FSC	Open, semi-arid to arid habitats including conifer and deciduous woodlands, annual and perennial grasslands and urban areas. Requires open areas for foraging.	Unlikely	Not likely to occur. Outside geographic range of this species.
Sylvilagus bachmani riparius Riparian brush rabbit	SE FE	Riparian forest with a dense shrub layer; dense thickets (e.g., wild rose, willows, blackberries).	Unlikely	Unlikely to occur. One remnant population occurs in Caswell State Memorial Park in the San Joaquin Valley.
Neotoma fuscipes riparia Riparian woodrat	None FE	Wooded riparian areas. Typically in densely wooded areas with heavy undergrowth; riparian woodlands.	Unlikely	Unlikely to occur. Occurs in one location in the San Joaquin Valley (Vernalis).
Neotoma fuscipes Dusky-footed Woodrat	FT	Heavy Chaparral, streamside thickets and deciduous or mixed woods	Potential	

Special-status Wildlife Species Known or Potentially Occurring in the Study Area

Species	Status: State Federal	Habitat	Cosumnes River	Potential for Occurrence in the Study Area
Perognathus inornatus San Joaquin pocket mouse	None FSC	Dry, open, grassy or weedy ground. Arid annual grasslands, savanna, and desert-shrub associations with sandy washes or finely textured soil.	Potential	Not likely to occur, prefers arid habitats.
Taxidea taxus American badger	SSC	Dry, open stages of most shrub, forest, and herbaceous habitats, with friable soils.	Potential	Low potential for occurrence in appropriate habitat.
Felis concolor Mountain lion	None	Inhabit a large variety of habitat types including rugged mountains forests and swamps	Known	Known to occur on the Cosumnes River Preserve

Legend

State Status

CFP = California Fully Protected
CSC = California Species of Special Concern
SE = State Endangered
ST = State Threatened

Federal Status

FC = Candidate Species
FE = Federal Endangered
FPE = Federally proposed for listing as endangered
FT = Federal Threatened

Appendix I

Fish Species Known to Occur in the Cosumnes River Preserve Study Area

Fish Species Known to Occur in the Cosumnes River Preserve Study Area

Family	Common Name	*Scientific Name*	CA Native	Status*		Presence	
				Federal	State	Lower Mokelumne	Cosumnes
Atherinopsidea	Inland silverside	*Menidia beryline*				X	X
Catostomidae	Sacramento sucker	*Catostomus occidentalis*	X			X	X
Centrarchidae	Black crappie	*Pomoxis nigromaculatus*				X	X
	Bluegill	*Lepomis macrochirus*				X	X
	Green sunfish	*Lepomis cyanellus*				X	X
	Largemouth bass	*Micropterus salmoides*				X	X
	Redear sunfish	*Lepomis microlophus*				X	X
	Redeye bass	*Micropterus coosae*				X	X
	Smallmouth bass	*Micropterus dolomieui*				X	X
	Spotted bass	*Micropterus punctulatus*				X	X
	Warmouth	*Lepomis gulosus*				X	X
	White crappie	*Pomoxis annularis*				X	X
Clupeidae	American shad	*Alosa sapidissima*				X	X
	Threadfin shad	*Dorosoma petenense*				X	X
Cottidae	Prickly sculpin	*Cottus asper*	X			X	X
	Riffle sculpin	*Cottus gulosus*	X				X
Cyprinidae	Common carp	*Cyprinus carpio*				X	X
	Fathead minnow	*Pimephales promelas*					X
	Golden shiner	*Notemigonus crysoleucas*				X	X
	Goldfish	*Carassius auratus*				X	X
	Hardhead	*Mylopharodon conocephalus*	X		SSC	X	EX
	Hitch	*Lavinia exilicauda*	X			X	X
	Sacramento blackfish	*Orthodon microlepidotus*	X			X	X
	Sacramento pikeminnow	*Ptychocheilus grandis*	X			X	X
	Sacramento splittail	*Pogonichthys grandis*	X		SSC	X	X
	Speckled dace	*Rhinichthys osculus*	X				EX
Embiotocidae	Tule perch	*Hysterocarpus traski*	X			X	X
Gobiidae	Yellowfin goby	*Acanthogobius flavimanus*				X	
Ictaluridae	Black bullhead	*Ameiurus melas*				X	X
	Brown bullhead	*Ameiurus nebulosus*				X	X
	Channel catfish	*Ictaluruspunctatus*				X	X
	White catfish	*Ameiurus catus*				X	X

Fish Species Known to Occur in the Cosumnes River Preserve Study Area

Family	Common Name	*Scientific Name*	CA Native	Status*		Presence	
				Federal	State	Lower Mokelumne	Cosumnes
Moronidae	Striped bass	*Morone saxatilis*				X	X
Osmeridae	Delta smelt	*Hypomesus transpacificus*	X	T	T	X	O
	Wakasagi	*Hypomesus nipponensis*					X
Percidae	Bigscale logperch	*Percina macrolepida*				X	X
Petromyzontidae	Pacific lamprey	*Lampetra tridentata*	X			X	X
Poeciliidae	Western mosquitofish	*Gambusia affinis*				X	X
Salmonidae	Chinook salmon	*Oncorhynchus tshawytscha*	X	SC	SSC	X	X
	Chum salmon	*Oncorhynchus keta*	X		SSC	O	
	Steelhead	*Oncorhynchus mykiss*	X	T		X	O

* Status codes: E = Endangered T = Threatened SSC = Species of Special Concern SC = Species of Concern
EX = Likely Extipated
O = Opportunistic use only
Sources: Merz and Saldate 2004, Harris 1996, Crain et al. 2004, Moyle et al. 2003, Moyle et al.2006.