

YOLO COUNTY INTEGRATED REGIONAL WATER MANAGEMENT PLAN

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CHAPTER 6. ENVIRONMENTAL WATER RESOURCES IN YOLO COUNTY

6.1 INTRODUCTION

This Chapter provides background information from scientific reports and local experts about environmental water resources in Yolo County for use during future discussions about ways to improve water resource management to benefit the aquatic and riparian environment.¹ Yolo County's water resources benefit a variety of plant, fish, and wildlife species, from cottonwoods clustering along creeks to Chinook salmon migrating from the Delta in search of spawning habitat. This Chapter describes these "environmental water resources," while recognizing that these water resources are also used for agricultural, municipal, and recreational purposes.² It also identifies some key areas where additional information is needed to better understand Yolo County's environmental water resources.

Yolo County's most well-known environmental water resources include Cache Creek, Putah Creek, Willow Slough, the Colusa Basin Drain, the Yolo Bypass, and the Sacramento River. Smaller waterways include Buckeye Creek, Bird Creek, Oat Creek, Cottonwood Creek, Chickahominy Slough, Union School Slough, Dry Slough, and Dry Creek. Within and around these waterways, Yolo County's ground water and surface water support a network of aquatic ecosystems, including vernal pools, wetlands, and

¹ The term "aquatic and riparian environment" does not encompass all the ways in which water is used to benefit the environment in Yolo County, such as irrigation water applied to rice fields, seasonal wetlands, or tailwater ponds. The IRWMP will consider ways to improve water resources management for these water-related habitats as well.

² Information for this chapter is from published and unpublished reports listed in the bibliography at the end of the chapter, and from personal communications with local experts. While this list is not exhaustive, the information referenced in this chapter represents an overview of baseline information available about environmental water resources in Yolo County.

riparian habitat. Despite the importance of other water sources, the aquatic and riparian ecosystems of Yolo County's major waterways are the focus of this Chapter.

Development, flood control efforts, agriculture and other human endeavors have significantly altered Yolo County's aquatic ecosystems over the past 150 years. Dams, reservoirs and diversions – among other human activities - have contributed to changes in the flow regimes in the Sacramento River, Cache Creek and Putah Creek, as well as other, smaller waterways. Infrastructure necessary for navigation and public safety, such as bridges and levees, narrow the natural channels of these waterways as well, often forcing more water to flow through small spaces and resulting in channel incision and erosion. Flood control efforts transformed the Yolo Basin, a historical tule marsh and sometime inland sea, into a managed drainage system for floodwaters that sustains significant agricultural production and habitat for migrating waterfowl and anadromous fish.

Even after significant alteration, Yolo County's aquatic ecosystems are some of the most important in the Central Valley. The native fish assemblage upstream of Capay Dam on Cache Creek, for example, is one of the most diverse and healthy of any native fish assemblages in California (Peter Moyle, personal communication). Putah Creek provides habitat for six species of riparian nesting birds that are important to the Central Valley Riparian Habitat Joint Venture, as well as recovering populations of salmon and steelhead. The Yolo Bypass, a 59,000 acre leveed floodplain, provides diverse habitat for native fish and over 200 species of birds, as well as a wintering area along the Pacific Flyway for shorebirds and waterfowl. The Yolo Bypass Wildlife Area within the Bypass

(16,000 acres total, with 3,700 acres of restored wetlands) is one of the largest wetlands restoration projects in the western United States.

The systems described above show that it is possible for plants, fish and wildlife to thrive in highly altered habitats. It is impossible to restore the County's aquatic environment to its original condition, but improving water management in a manner that also benefits fish, plants, and wildlife is a reasonable goal.

6.2 ENVIRONMENTAL BENEFITS FROM AGRICULTURAL AND MUNICIPAL WATER USE

As previously discussed in Chapter 5, approximately 960,000 acre-feet of water are used annually in Yolo County for agricultural, municipal, and environmental purposes. Of these three categories, 90% of the water is used for agriculture. While diversions for agricultural and municipal uses have changed the historical flows of Yolo County's waterways, there are many ways in which agricultural and municipal water use benefits the environment. Many examples in Yolo County illustrate these benefits.

Yolo County Flood Control and Water Conservation District's (YCFCWCD) storage at both Clear Lake and Indian Valley Reservoir allows Cache Creek flows to continue longer through the summer than they would under natural conditions. In addition, during the YCFCWCD's irrigation season water in the slough system is almost wholly a function of agricultural deliveries and farm runoff. Scheduled releases of water stored in Lake Berryessa by the Solano County Water Agency have changed Putah Creek from an intermittent stream to a perpetual stream. This water provides wildlife habitat benefits that otherwise would not exist under a natural flow regime.

The water for the 400-acre Davis Wetlands, constructed by the City of Davis and adjacent to the city's wastewater treatment facility, is from wastewater (treated at the secondary level) and stormwater the city conveys directly to the wetlands. The wetlands environment is monitored continuously to ensure its quality, and provides permanent open water, seasonal wetland, native grassland, riparian woodland, and mudflats that benefit numerous wildlife species. In addition, treated wastewater effluent from UC Davis and tailwater from YCFCWCD's Willow Canal increases flows in Putah Creek, benefiting fish and wildlife.

The Cache Creek Nature Preserve utilizes agricultural drainage water for its 130-acre managed wetlands. Water is diverted from the YCFCWCD's East Adams Canal to the wetlands and eventually drains into Cache Creek. The Cache Creek Conservancy manages the Preserve for the benefit of plants, fish, and wildlife and depends on the agricultural drainage water to maintain its viability.

In the Yolo Bypass, the U.S. Army Corps of Engineers improved the existing agricultural irrigation system for the Yolo Bypass Wildlife Area. The California Department of Fish and Game partnered in these irrigation improvements, as well as maintain and operate the system. The system reuses agricultural water on the restored wetlands. In addition, municipal storm water enters the Yolo Bypass from the South Davis drain for use in the Yolo Bypass Wildlife Area. The Davis wastewater treatment plant may contribute water in the future.

6.3 ORGANIZATION

The Chapter describes each major Yolo County waterway separately, although they are all inextricably connected (**See Map 6-1**). Cache Creek, Willow Slough, the Colusa Basin Drain, and Putah Creek flow into the Yolo Bypass, which in turn is flooded by the upper Sacramento River during winter storms (and drains back into the lower Sacramento River as floods recede). The Chapter provides a description of each major waterway's physical setting, history, and the plant, fish, and wildlife species the waterway supports, one of the first efforts in the County to provide such a compilation. The descriptions of major waterways are followed by a more detailed report of what is known (and not known) about the waterway's contribution to the County's aquatic ecosystems.

For the purposes of this chapter, "aquatic ecosystems" includes riparian habitat. The structure and composition of aquatic stream habitat is affected by and affects the structure and composition of the riparian ecosystem. The riparian ecosystem affects the amount of light reaching the stream (thereby affecting stream temperature and productivity), provides organic litter and a food source for the aquatic community (i.e. invertebrates), provides streambank stability, and adds to aquatic habitat complexity in the form of large, woody debris (Northwest 2005).

6.4 CACHE CREEK

6.4.1 *Cache Creek: Physical Setting*

The Cache Creek watershed can be separated into the Upper Cache Creek watershed (above Capay Dam) and the Lower Cache Creek watershed (below Capay Dam to the

Cache Creek Settling Basin). The Upper Cache Creek watershed drains approximately 1,044 square miles of the Coast Range Mountains, much of it captured in Clear Lake and Indian Valley Reservoir in Lake County, and enters the Sacramento Valley floor near the town of Capay. The lower Cache Creek watershed drains approximately 1,139 square miles and enters the Yolo Bypass through the Cache Creek Settling Basin. For more information about gauging stations, streamflow estimation, flooding/flood control, and erosion/sedimentation, please see **Chapter 4**.

Cache Creek's water directly benefits the environment, agriculture, and recreation. No water is currently diverted from the creek for municipal purposes, although expanding urbanization in the rural areas of Yolo County may encourage such deliveries in the future. Water is diverted from Clear Lake for municipal purposes, and the municipalities of Woodland, Davis and Winters receive an indirect groundwater recharge benefit through creek percolation and the District's unlined canal system. As described in Chapter 4, the YCFCWCD possesses the rights to a maximum of 150,000 acre-feet of Clear Lake's water, which flows to Yolo County down Cache Creek. The District regulates the river's flow for agricultural water supply through the Clear Lake Dam, the Capay Dam, and associated irrigation canals. In addition, the District built the Indian Valley Reservoir on the north fork of Cache Creek to increase water storage (it collects water from the North Fork's watershed). It diverts water for agricultural uses into the West Adams Canal and the Winters Canal at the Capay Dam.

Cache Creek drains the Clear Lake, North Fork, and Bear Creek basins on the east side of the Coast Range mountains. The North Fork drains into Cache Creek approximately 8

miles downstream of the Clear Lake Dam in the 30-mile long Cache Creek canyon, known for its relatively undeveloped surroundings (CALFED 2000). When the creek passes out of the canyon into the Capay Valley, agriculture enters the riparian zone along the west bank and the slope of the creek's east bank becomes increasingly steep and erodible (Yates 2003a).

Below the Capay Dam for approximately seven miles, a wide, braided channel characterizes the creek. In-channel gravel mining occurred along the upper braided reach below Capay Dam until 1996. For the next five miles, the channel is very narrow and more densely vegetated. The final five miles of the creek are extremely narrow (near the town of Yolo) and is confined by levees (Linda Fiack, personal communication). The leveed reach terminates at a 6-square-mile basin at the lower end of the creek, called the Cache Creek Settling Basin (U.S. Army Corps 1996). The Settling Basin acts as a trap for Cache Creek's sediment, designed specifically to preserve the flood capacity of the Yolo Bypass. Cache Creek connects to the Sacramento River through the Yolo Bypass during unusually high-flow events. It also connects to the Sacramento River sometimes during low flows as a result of diversion into the Tule Canal/Toe Drain by Reclamation District 2035. Water that is not used by Reclamation 2035 for farming continues in the Tule Canal/Toe Drain through the Yolo Bypass and eventually enters the Sacramento River near Rio Vista.

6.4.2 Cache Creek: History

While many human endeavors contributed to the loss of riparian habitat and the changes to the creek basin's aquatic ecosystems over the last 150 years, the gravel mining industry's contribution to the decline was perhaps the most obvious. As a result of

increasing recognition of the continued impacts of gravel mining on Cache Creek's aquatic ecosystems (documented in three reports from 1975 to 1994), Yolo County adopted the Cache Creek Resource Management Plan (CCRMP) and its companion document, the Off-Channel Mining Plan (OCMP), in 1996. The OCMP governs the operations and reclamation of mining activities outside of the creek channel, and the CCRMP provides a framework for integrated management of the creek's resources. Together the CCRMP and the OCMP comprise the Cache Creek Improvement Program, covering the reach from the Capay Dam to Interstate 5.

With the adoption of the CCRMP, gravel companies discontinued commercial mining within the active creek channel and Yolo County established the following goals and objectives: 1) improve the stability of the channel; 2) minimize flood damage; 3) restore wildlife; 4) prescribe standards and regulations for initial channel smoothing and shaping; 5) recommend ongoing maintenance activities and creek restoration efforts; 6) provide year-round flows in many portions of the creek; 7) identify restoration project areas; and 8) provide buffers for existing and future agriculture from restoration and recreation areas. The CCRMP also resulted in the creation of the Cache Creek Technical Advisory Committee (TAC), whose main responsibilities include recommending stream management efforts, defining procedures and methodologies for stream monitoring and maintenance activities, and prioritizing projects for stream stabilization. The CCRMP requires the members of the TAC to be comprised of a geomorphologist, a hydrologist, and a riparian biologist (Aspen 2002).

Since the adoption of the CCRMP, riparian vegetation has naturally regenerated in areas that otherwise would have been exposed to in-channel mining. Some of this regeneration is the result of an aggressive program to remove invasive plant species implemented by the Cache Creek Conservancy, in partnership with the County of Yolo. The County of Yolo also annually conducts an aerial survey to monitor revegetation progress and trends with the assistance of the Cache Creek Conservancy. In addition, a number of reclamation projects have been implemented that have benefited the aquatic environment (Aspen 2002).

Mercury occurs naturally in the Cache Creek basin, and was once extracted for use in goldmining operations in the Sierra Nevada. These mines are now inactive, but continue to be a source of mercury into the creek. Researchers have found higher levels of mercury in Cache Creek fish than in almost any other waterway in the nation, causing concern for humans and wildlife that eat the fish. Some of the mercury in the creek accumulates with the sediment in the Settling Basin.

Inorganic mercury (commonly found in Cache Creek) does not pose a risk to human health. When inorganic mercury converts through natural processes to methylmercury, however, it easily crosses from water and sediments to algae, plants, fish, and humans – magnifying in concentration at every step of the way. At high enough levels in fish tissue and assuming significant levels of fish consumption, methylmercury can be toxic to birds, wildlife, and humans. The conditions under which inorganic mercury converts to methylmercury are not well understood, making it difficult to identify ways to reduce methylmercury production. The County of Yolo, in partnership with the Cache Creek

Conservancy, consistently monitors total mercury and methylmercury levels in fish tissue in the Cache Creek Nature Preserve and in the creek above and below the Preserve to determine the impacts of this wetlands environment on methylmercury concentrations in the creek. (Wetlands environments generally increase the conversion of total mercury to methylmercury.)

In February 2004, the Central Valley Regional Water Quality Control Board released a staff report in preparation for establishing a Total Maximum Daily Load (TMDL) for mercury in Cache Creek, Bear Creek, and Harley Gulch. The Board expects to submit language to amend the Basin Plan in June 2005, which will require some entities to take action to reduce the mercury loading (RWQCB 2004).

6.4.3 Cache Creek: Plant, Fish, and Wildlife Species

Although efforts to increase knowledge about Cache Creek's ecological resources have increased since the adoption of the CCRMP in 1996, the ecological resources of Cache Creek historically been studied far less than those of Putah Creek, the Sacramento River, the Yolo Bypass, or even Willow Slough (especially with respect to fisheries). Basic information on water temperatures, turbidity, and flows has not been consistently collected for Cache Creek and adequate surveys of fish species in the creek are lacking. The Cache Creek Resource Management Plan and associated technical studies, as well as a study by the U.S. Army Corps of Engineers in the mid-1990s, are the best summaries of available information.

The native fish assemblage upstream of Capay Dam on Cache Creek, for example, is one of the most diverse and healthy of any native fish assemblages in California (Peter

Moyle, personal communication). This assemblage includes the following: California roach, Sacramento pikeminnow, hardhead, speckled dace, hitch, Sacramento sucker, and rainbow trout (Moyle 2003). These native fish generally like cool water temperatures (with the exception of the California roach, which can survive in quite warm water) and a moderate to high dissolved oxygen content. Additional information is needed to determine whether conditions in Cache Creek are suitable for these species, although the presence of such a diverse assemblage of native fish suggests that conditions for these fish are favorable. Historically, anadromous fish – fall-run Chinook salmon, steelhead, Pacific lamprey, and river lamprey – were also found in Cache Creek. Cache Creek was historically an intermittent stream, however, so it probably never supported a large salmon run.

Barriers to fish passage at the Capay Dam and between the Tule Canal and the Cache Creek Settling Basin, as well as potentially inadequate habitat conditions and flows in the lower creek, prevent successful migration and spawning of anadromous fish today. As recently as 2000, however, three fall-run Chinook salmon were spotted in Cache Creek (Moyle, personal communication). There is unfortunately no evidence that these fish successfully spawned. Furthermore, additional information is needed to determine whether conditions for juvenile salmon in Cache Creek would permit them to grow and return to the Sacramento River and eventually to the Pacific Ocean.

Non-native fish species, such as carp, catfish, red shiner, small mouth bass, large mouth bass, bluegill, threadfin shad, white crappie, inland silversides, mosquitofish, green sunfish, and the bigscale logperch, are also present in Cache Creek. These fish species are

generally not affected by high turbidity, can withstand low dissolved oxygen values, and can thrive in waters with high organic content. Non-native fish species are less common above the Capay Dam, as Capay Dam provides a complete barrier to fish passage. Some non-native fish found in Clear Lake occur throughout the Cache Creek reach below the Clear Lake Dam, however. More complete studies are needed to better characterize native fish assemblages and learn more about habitat restoration opportunities or flow regime changes that could benefit them.

The following are special status species³ that are found in and around Cache Creek, or have the potential to be found: Swainson's hawk, bank swallow, tricolored blackbird, elderberry longhorn beetle, ancient ant, Valley oak ant, Sacramento anthicid beetle, giant garter snake, Northwestern pond turtle, golden eagle, northern harrier, prairie falcon, Cooper's hawk, white-tailed hawk, burrowing owl, loggerhead shrike, yellow warbler, double-crested cormorant, white-faced ibis, ringtail, and American badger. In addition, the following special status plant species are located – or have the potential to be located – in or around Cache Creek: deep-scarred cryptantha, palmate bird's beak, adobe-lily, woolly-headed lessingia, Heller's bush mallow, alkali milk vetch, and brittlescale (Aspen 2002). The Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Authority is in the process of developing a regional program (called a "Natural Community Conservation Plan") that mitigates for the loss of habitat for 26 endangered and threatened species caused by urban development in Yolo County, including many of the species listed above.

³ Special-status species include those that are listed or proposed for listing as rare, threatened, or endangered by either the California Department of Fish and Game or the U.S. Fish and Wildlife Service.

Riparian areas along Cache Creek are infested with the invasive weeds tamarisk and arundo, once planted by landowners to control erosion. Now known to actually increase erosion and make it more difficult for native plant species to survive, Yolo County and the Cache Creek Conservancy are removing these weeds through intensive efforts now underway. The proliferation of these invasive weeds is greatest in areas of intermittent flow and areas (such as Bear Creek) where the presence of boron and salinity stunt the growth of native species. In addition, tamarisk consumes a significant amount of water that could otherwise remain in the system.

The Cache Creek Conservancy and the County of Yolo are making significant strides towards eradicating tamarisk and arundo. More studies are needed to better understand the aquatic and riparian ecosystems of Cache Creek. Some of this information could be collected through the Cache Creek Resource Management Plan process, but additional studies are needed to address areas not covered by the Plan.

6.4.4 Cache Creek: Aquatic Ecosystems

Early researchers estimated that over 162,000 hectares of riparian vegetation once grew along Cache Creek, creating a riparian corridor approximately 5 kilometers wide. Today, Cache Creek retains a narrow fringe of approximately 650 hectares of riparian vegetation, most of which is either within or immediately adjacent to the creek. While the riparian habitat has been greatly reduced from historical levels, small pockets of relatively intact habitat remain in some areas. These areas continue to support important species that were once associated with relatively pristine riparian habitats (Truan 2004).

Some portions of Lower Cache Creek support well-developed riparian trees and shrubs that provide excellent wildlife habitat, while other portions support little established vegetation and are predominantly open gravel bars with little habitat value. Valley oaks form remnant stands of woodland or savanna, sometimes gradually merging with valley oak riparian forest along the fringe of the creek. The Cache Creek Settling Basin includes a 6 square-mile area of agricultural land, riparian vegetation (including cottonwoods and willows), and floodplain habitat. Most of the original native riparian forest, oak savanna, and perennial grassland have been replaced by agricultural crops, with remnants of native communities limited to small segments along the creek corridor (Aspen 2002). Cache Creek's biodiversity, however, appears highest at the site of the Cache Creek Nature Preserve (Truan 2004). The Nature Preserve was once the site of a gravel mining operation, but was restored to wetlands habitat.

While additional studies are needed, the natural vegetation along the creek appears to support a diverse array of resident and migratory wildlife, and the creek itself supports amphibians, reptiles, and resident and migratory fish. Wetlands along the creek attract waterfowl and colonial-nesting birds. The scattered oaks and remnant woodland/savanna also provide important nest sites, roosting habitat, and cover for raptors and other birds, as well as a food source for deer, squirrels, woodpeckers, and jays. The abundant agricultural habitat also provides important foraging habitat for mammalian and avian predators (Aspen 2002).

Riparian vegetation along Cache Creek includes, but is not limited to, habitats dominated by woody plant species. While one of the most prominent characteristics of the riparian

habitat along Cache Creek is its tendency towards rapid change, recognition of certain subtypes of riparian vegetation is useful for characterizing existing conditions and evaluating restoration opportunities. These subtypes include herbaceous riparian habitat (such as tules, cattails, rushes), mixed woody/herbaceous riparian habitat (areas in which woody species, such as western buttonbush, occur within herbaceous vegetation), willow thickets, and riparian forest (characterized by the presence of scattered emergent trees or of a continuous closed canopy of willows, Fremont cottonwood, and willows). Other elements of riparian habitat that are valuable to a variety of common and special-status species are eroding vertical banks, sand and gravel bars, snags, and downed woody debris (Northwest 1995).

Deforestation, water development, flood control measures, and mining activities have contributed to lower streamflows, increased water temperatures, increased turbidity, streambed siltation, and alteration of aquatic microhabitat in the creek. As a result, the aquatic environment in some reaches of Cache Creek is better suited for non-native fish species that can survive better in warm water with high turbidity (Northwest 1995). A diverse and healthy native fish assemblage exists above Capay Dam, however.

6.5 PUTAH CREEK

6.5.1 Putah Creek: Physical Setting

The Putah Creek watershed encompasses 710 square miles and drains the Macayamas Mountains (including Cobb Mountain) in Napa and Lake Counties. The creek flows 30 miles through Solano County and Yolo County (it forms the border between these two counties along much of its length) into the Yolo Bypass. Water from the creek then

flows south through the Toe Drain and enters the Sacramento River at Rio Vista. Most water in the creek is from rainfall in the winter, but natural levees created by the creek as it flowed across its alluvial fan prevent much of the surface water from adjacent land in the lower watershed from draining directly into the creek. For more information about gauging stations, streamflow estimation, flooding/flood control, and erosion/sedimentation, please see Chapter 4.

The Bureau of Reclamation built the Solano Project on Putah Creek in the 1950s, completing it in 1957 (Smith 1991). The centerpiece of the Solano Project is Monticello Dam, which impounds Berryessa Reservoir. Approximately 600 square miles of the watershed are upstream of Monticello Dam. The reservoir has a capacity of 1.6 million acre-feet and covers almost 14 miles of the original Putah Creek channel plus many tributaries. Water released from Berryessa Reservoir (on average at about 350 cfs) flows eastward in the creek channel for close to eight miles before it reaches Lake Solano and the Putah Diversion Dam, where most of the water is diverted south through the Putah South Canal to agricultural and municipal users in Solano County (Moyle et al 1998). Dry Creek is the only major tributary that enters Putah Creek below the Putah Diversion Dam near the town of Winters. Putah Creek then meanders down the gentle western slope of the Sacramento Valley, finally ending 20 miles further east in the Putah Sinks area of the Yolo Bypass.

Prior to construction of the Solano Project and changes resulting from other human activities, lower Putah Creek flooded frequently during the winter as rainfall ran off quickly into the creek. In the 1870s, farmers constructed of a new channel, the South

Fork of Putah Creek to reduce flooding in Davis. Since the mountains are too low to accumulate snow, summer flows were usually quite low (less than 20 cfs). High seepage rates along the reach between the present-day site of the Putah Diversion Dam and Winters often caused flow to cease in downstream reaches. This natural flow pattern was altered by the construction of Berryessa Reservoir. Average daily flows from Monticello Dam are high in the summer and low in the winter in all but the wettest years.

Even along intermittent reaches, there was always enough water in deep pools under pre-project conditions, however, to support a diverse fish assemblage. In the reach now flooded by Berryessa Reservoir, the stream was perennial. Other perennial reaches were found downstream of the site of Monticello Dam and a short segment near Stevenson Bridge (Moyle et al 1998).

6.5.2 Putah Creek: History

In 1987, a citizen's environmental group –Putah Creek Council - formed to protect the educational, recreational, aesthetic, and research values of the creek. After a major drought from 1987 to 1992 that dried up reaches of the creek in 1989 and contributed to major die-offs of fish, Putah Creek Council, UC Davis, and the City of Davis sued the Solano County Water Agency and other Solano Project member units for additional water.

The trial spanned five weeks in March and April 1996. The plaintiffs argued that Section 5937 of the California Fish and Game Code applied to Putah Creek. Section 5937 states that “the owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or

through the dam, to keep in good condition any fish that may be planted or exist below the dam.”⁴

At the conclusion of the trial, the judge ordered a 50% increase in the minimum release schedule from the diversion dam (approximately 10,000 additional acre-feet per year) to keep the creek flowing all the way to its mouth in the Yolo Bypass and to provide additional water for spawning and rearing of native fishes. After an appeal and a cross-appeal, a final settlement agreement (the Putah Creek Accord) provided additional water for anadromous fish. The agreement also formed the Lower Putah Creek Coordinating Committee, created a permanent streamkeeper and provided an annual budget for fish and wildlife monitoring and vegetation management in perpetuity.

Putah Creek Council spawned another environmental group, the Yolo Basin Foundation. The Foundation focused attention on the Putah Sinks area of the Yolo Bypass in the hope of restoring wetlands in the Bypass. Their efforts resulted in the construction of the Yolo Bypass Wildlife Area by the U.S. Army Corps of Engineers and Ducks Unlimited, described more in the section on the Yolo Bypass.

Gravel mining took place in Putah Creek in scattered locations, most intensively along a 2-mile reach below the Putah Diversion Dam, but was discontinued in the early 1970s. Soil and groundwater conditions in the mined reach of Putah Creek facilitated the regeneration of riparian vegetation – a phenomenon also observed on the mined reaches of Cache Creek – although Putah Creek has a 25-year head start on natural regeneration of vegetation (Yates 2003a).

⁴ The plaintiffs also relied on the Public Trust Doctrine and Section 2 of the California Constitution.

Prior to the construction of Monticello Dam, 5-year frequency flood events exceeded 50,000 cfs, enough to scour away most vegetation in the channel. Unregulated flows now occur only when the dam is full and excess water spills via the Glory Hole, an event that has occurs on average only once every 7 years. The change in frequency of flood flows has allowed riparian vegetation to flourish and encroach upon the low flow channel, cutting off flood plain access and otherwise interfering with natural stream processes.

The reduced frequency of high flow events also has created steeper hydraulic gradients of the tributaries to mainstem Putah Creek in most years when the Glory Hole is not spilling. The steeper gradient has resulted in higher flow velocities and accelerated downcutting and bank erosion on tributaries such as Dry Creek. Protection and enhancement of riparian vegetation depends on measures to stabilize stream banks and reduce flow velocities with in-stream structures such as rock weirs and rock vanes. The narrow canyons of Putah Creek and Cache Creek provide occasional surpluses of natural rock in the form of rock slides that could be used for bank stabilization and habitat enhancement projects.

6.5.3 Putah Creek: Plant, Fish, and Wildlife Species

Putah Creek once supported populations of all native resident fishes of the Sacramento Valley in a series of assemblages that changed with elevation (Moyle 1976). Populations of native fish have declined in the creek, but are still an important component of the aquatic ecosystem and are a primary focus for restoration efforts (CALFED 2000). Anadromous fish also were present historically in low numbers, mainly steelhead, fall-run Chinook salmon, and Pacific Lamprey (Shapolov 1947). The Solano Project virtually

eliminated these anadromous fish runs, but occasionally small numbers of salmon (presumably hatchery-raised salmon or confused wild salmon that got lost in the Yolo Bypass as a result of false attraction flows from floodwaters) were spotted in Putah Creek (Moyle, personal communication). Since the settlement agreement, salmon attraction flows have succeeded in bringing salmon and steelhead back to Putah Creek.

Prior to the settlement agreement, Putah Creek was an intermittent stream that partially dried up in most years. Despite only minimal releases of water from the Putah Diversion Dam, native fish managed to persist along lower Putah Creek in a few isolated pools downstream of the Putah Diversion Dam during the post-Solano Project era. These pools were sustained by subsurface flow, groundwater, irrigation tailwater (some imported from the neighboring Cache Creek watershed by the YCFCWCD), and effluent from a sewage treatment plant and agriculture operations on the UC Davis campus. The settlement agreement provided perennial flows in Putah Creek in part to offset reduced groundwater recharge associated with agricultural and urban development.

Each year from 1996 to 2003, researchers identified juvenile salmon in the spring from the lower creek, usually in small numbers (sometimes just one or two). In 2003, however, about 60-70 spawning salmon ascended the creek in late November, using every available patch of gravel. They came up the creek in response to the release of a pulse flow from the Putah Diversion Dam that was coordinated with the lowering of another small dam in the Yolo Bypass Wildlife Area that historically may have blocked salmon from entering Putah Creek. The pulse flow release is a result of coordinating between the Department of Fish and Game, Putah Creek Council, and the Solano Water Agency as

agreed to under the Putah Creek Accord. Juvenile salmon were numerous in the creek the following spring. Salmon also spawned in 2004, except that 35-40 spawning salmon trickled upstream for about a month, rather than coming up all at once (Moyle, personal communication).

Putah Creek also contains a significant number of non-native fish species, such as largemouth bass, smallmouth bass, carp, bluegill, and red shiner. In addition, the New Zealand mud snail has recently been found in the creek in rapidly expanding numbers. The snail is a non-native species that may reduce the food supply for fish, including juvenile salmon. A non-native Asian clam and three species of non-native crayfish also reside in Putah Creek. The clams are abundant below Dry Creek, but their impact on the aquatic ecosystem has not yet been documented.

Beavers are very much at home in and along Putah Creek. Beavers constructed over 20 dams along lower Putah Creek during the 1987-1992 drought, resulting in ponded flow conditions and warmer water temperatures. High flows in the mid-1990s washed out almost all of the dams, and lowered the water level in the creek by about three feet in many places (Yates 2003a). A beaver dam in 2004 blocked spawning salmon from ascending the creek, and was punctured by a couple of dedicated volunteers to allow passage. Timely breaching of beaver dams may extend salmon attraction flows by releasing impounded water (Rich Marovich, personal communication). Otters, muskrats, deer, and even mountain lions and black bear have been sighted on the creek.

Non-native mice and rats dominate most habitats along Putah Creek, including the dusky-footed woodrat, the common house mouse, the western harvest mouse, and the deer

mouse. These rats and mice can have negative effects on plant and wildlife populations through herbivory, competition, and predation (Truan 2004).

Birds are also common along Putah Creek. In 2003, researchers documented 161 species of birds along Putah Creek (Engilis 2004). According to the Yolo Audubon Society, over 325 species of birds are found in Yolo County, so approximately half can be found along lower Putah Creek (Engilis 2004). Birds that used nest boxes along Putah Creek included the tree swallow, the ash-throated flycatcher, the house wren, the western bluebird, the oak titmouse, and the house sparrow. The 2003 survey also documented the following sensitive species in lower Putah Creek: Swainson's hawk, yellow warbler, common yellowthroat, song sparrow, black-headed grosbeak, and blue grosbeak.⁵ This survey is part of an ongoing effort to monitor birds, mammals, and vegetation in Putah Creek, and these initial results are deemed "incomplete" by the study's authors.

Riparian vegetation is dense along most of lower Putah Creek, although native vegetation often loses out to non-native species, such as arundo, tamarisk, eucalyptus, tree of heaven, Himalayan blackberry, yellow star thistle, and others. Regeneration of native willows and cottonwoods is limited by the lack of high flows and fresh, bare gravel bars (Yates 2003a).

Early researchers estimated that between 9,000 and 26,000 hectares of riparian vegetation once grew along Putah Creek, which terminated in multiple riparian cloaked channels emptying into the tidally influenced tule marshes of the Yolo Basin. This would have

⁵ According to the study, sensitive species are "special status species and obligate or facultative riparian birds." Obligate species are those that are only found in riparian habitats. Facultative species prefer riparian habitats, but are less specialized and can survive elsewhere.

resulted in an average riparian corridor width of about 2.5 kilometers. Today, only about 500-800 hectares of riparian vegetation remain along the creek, comprising a narrow corridor of approximately 70 to 300 meters in width. While the riparian habitat has been greatly reduced from historical levels, small pockets of relatively intact habitat remain in some areas. These areas continue to support important species that were once associated with relatively pristine riparian habitats (Truan 2004).

6.5.4 Putah Creek: Aquatic Ecosystems

In the channel, the streamflow improvements as a result of the Putah Creek Accord have greatly improved the aquatic ecosystems by providing a more permanent connection between the mouth of the creek and the Delta, although an agricultural diversion dam remains a barrier from April to November. In addition, the releases from Berryessa Reservoir are cold and conducive to native fish survival.

Inadequate spawning gravel continues to limit salmon and steelhead spawning in the creek, especially in the upper reach below Putah Diversion Dam. Monticello Dam and Putah Diversion Dam block gravel and sediment that the creek used to deposit in this reach. Invasive weeds – especially Himalayan blackberry, arundo and tamarisk – stabilize gravel bars impeding natural replenishment of sediment. Currently the only sources of gravel are deposits in the previously mined reach, in-channel bars and terraces, and Dry Creek. A survey during 2002 found that gravels are a common substrate along lower Putah Creek, but in most places the gravels only occur as a relatively thin veneer over a clay-silt substrate (Yates 2003b). Also, most of these gravels are too small to support viable salmon egg nests.

6.6 COLUSA BASIN DRAIN

6.6.1 *Colusa Basin Drain: Physical Setting*

The Colusa Basin watershed covers approximately 1 million acres in Glenn, Colusa, and Yolo counties. The Colusa Basin Drain is designed to convey drainage flows from agricultural lands and 32 ephemeral streams during the irrigation season to the Knights Landing outfall gates and stormwater flows during the winter. The Drain has two major canals, the Colusa Basin Drain and the Knights Landing Ridge Cut. For more information about gauging stations, streamflow estimation, flooding/flood control, and erosion/sedimentation, please see Chapter 4.

The Colusa Basin Drain drains approximately 1,620 square miles in the Sacramento Valley, and includes portions of Glenn, Colusa, and Yolo counties. The Canal starts in Glenn County northeast of the city of Willows and runs in a southerly direction for 70 miles to Knights Landing in Yolo County. Farmers built the canal in the 1920s as rice production in the Valley expanded. Without a drain, leftover irrigation water would spill into fields of neighboring farmers, resulting in a raft of lawsuits (Leavenworth 2004).

Between the Colusa Basin and the Yolo Basin to the south, a ridge exists that was formed by sediments washing down Cache Creek (the same sediments that are caught by the Cache Creek Settling Basin to preserve the integrity of the Yolo Bypass). The Army Corps of Engineers, partnering with the State of California, cut a 7-mile canal through the ridge to transport water into the Bypass in 1930, called the Knights Landing Ridge Cut.

When the Sacramento River is low, water from the Colusa Basin Drain discharges into the Sacramento River through a set of gates at Knights Landing that are operated to

maintain for irrigation a relatively constant water level elevation of 25 feet above the U.S. Army Corps of Engineers datum on the upstream (drain) side (Yolo Bypass Working Group 2001). When the Sacramento River stage exceeds 25 feet, however, the gates close and all Colusa Basin Drain water is shunted through the Knights Landing Ridge Cut into the Bypass. A berm is constructed every spring at the Bypass end of the Knights Landing Ridge Cut to regulate flow into the Bypass for irrigation, but overflows occur in summer sometimes.

Land in the Colusa Basin watershed is devoted primarily to agriculture, including irrigated row crops, orchards and vineyards in the valley and sheep and cattle grazing in the foothills (Navigant Consulting 2004).

6.6.2 Colusa Basin Drain: History

In the 1980s, Sacramento residents started complaining about odd tastes and odors in their drinking water. Later, those problems were traced to rice herbicides flowing from the Colusa Drain and others in the rice belt. Rice growers responded by switching herbicides and holding their water longer in their fields. Those practices reduced herbicide levels in the river but have not eliminated them, according to tests by the Central Valley Regional Water Quality Control Board and the U.S. Geological Survey (Leavenworth 2004).

In 1987, the State Legislature formed the Colusa Basin Drainage District after landowners recognized the need to address flooding, drainage, and subsidence problems in the Basin. The District's territory encompasses 600,000 acres of the Colusa Basin watershed, and its primary mission is to reduce future flood-related damage. In the floods

of 1995 and 1998, for example, the three counties straddled by the District suffered approximately \$100 million in damages.

In 2004, the Northern California Water Association and a number of urban and agricultural water agencies undertook a study of water quality in the Colusa Basin Drain and the Knights Landing Ridge Cut. Urban water agencies that draw water from the river below the Knights Landing outfall gates hypothesize that the water from the Drain entering the Sacramento River is high in total organic carbon (TOC), but low in pesticides. The presence of TOC in water increases drinking water treatment costs, but is not harmful to agricultural crops or wetland habitat. Depending on the quality of the water, these agencies believe that a “win-win” re-operation proposal is possible. If more water from the Drain is diverted into the Knights Landing Ridge Cut to farmers and for use in the wetlands or floodplain habitat of the Yolo Bypass, their water treatment costs will decline. The results of the study are pending.

6.6.3 Colusa Basin Drain: Aquatic Ecosystems

The Colusa Basin is a resting stop for millions of migrating waterfowl along the Pacific Flyway (Navigant 2000). In addition, the Knights Landing Ridge Cut supports some marsh habitat (Jones & Stokes 1992). Additional information about the aquatic ecosystems supported by water in the Colusa Basin Drain or the Knights Landing Ridge Cut was not available, and it appears additional studies are needed to determine the value of habitats along the Drain.

6.7 YOLO BYPASS

6.7.1 *Yolo Bypass: Physical Setting*

The Yolo Bypass is a leveed 59,000-acre floodplain engineered to convey flood flows from the Sacramento, American, and Feather rivers (and their tributary watersheds) to the Delta. The width of the 41-mile long Bypass varies; it is 1.6 miles wide at the north end and reaches as much as 3 miles wide. It extends from the junction of the Sacramento and Feather rivers to just north of the city of Rio Vista, where it rejoins the Sacramento River (Yolo Bypass Working Group 2001). Tributaries to the Yolo Bypass include the Knights Landing Ridge Cut, Cache Creek (via the Settling Basin), Willow Slough, the Conaway Canal (a private diversion canal for agricultural uses on the Conaway Ranch), and Putah Creek. For more information about gauging stations, streamflow estimation, flooding/flood control, and erosion/sedimentation, please see Chapter 4.

The Fremont Weir, located at the upstream end of the Yolo Bypass, is a fixed concrete wall three miles long that parallels the south bank of the Sacramento River near Knights Landing. High flows in the Sacramento River spill over the weir and enter the Bypass, then flow south. These spills are from high flows in the Sacramento River, the Sutter Bypass, or the Feather River, all of which converge at the north end of the Bypass (Jones and Stokes 1994).

The Sacramento Weir is a 2-mile long channel that conveys floodwaters in a westerly direction from the Sacramento River into the east side of the Yolo Bypass. The floodgates of the weir are operated manually, and are only opened in extremely high flow situations.

The Sacramento Deep Water Ship Channel is a 22-mile-long channel, approximately 200-300 feet wide, that parallels the east side of the Bypass from near Rio Vista to West Sacramentot. Its purpose is to allow ships to travel to the Port of Sacramento in West Sacramento. Construction of the channel reduced the flood conveyance capacity of the Yolo Bypass by eliminating the easterly, downstream portions of the Bypass (Jones and Stokes 1994).

The Tule Canal and the Toe Drain are the two major internal drains of the Yolo Bypass. These drains convey low flows south to the outlet of the Yolo Bypass at Cache Slough near the Little Holland Tract.

The Yolo Bypass is unusual in that it does not wholly isolate the floodplain from the river. While the aquatic ecosystems of the Bypass can be improved, many of the original ecosystem functions and processes were preserved. The success of the Yolo Bypass as a floodway and as an ecologically favorable conveyance system makes it a valuable model for other flood control projects.

Many activities are severely impacted by even moderate flooding within the Yolo Bypass. Agricultural activities may be curtailed depending on the timing and duration of flooding, resulting in significant economic impacts. Any flood event also severely impacts the Yolo Bypass Wildlife Area. The Wildlife Area is closed during periods of flooding as a result of an operating agreement with the U.S. Army Corps of Engineers, preventing visitors (including school children) from accessing the wetlands.

6.7.2 *Yolo Bypass: History*

As a result of severe flooding of agricultural land and urban areas in the late 1800s, the U.S. Army Corps of Engineers built the Sacramento River Flood Control Project, of which the Yolo Bypass and the 18,000-acre Sutter Bypass are key components. These two bypasses convey floodwaters around the developed areas of the lower Sacramento Valley. Construction of the levees and weirs that bound the Yolo Bypass began in 1917, and much of the Sacramento River Flood Control Project was completed by the early 1930s.

Floodflows in 1986 and 1997 corresponded to a 70-year flood event, and approximately equaled the capacity of the Bypass. In spite of these large flood events, none of the Bypass levees have ever failed.

The State of California holds permanent flood easements on all lands inside the levees of the Bypass and its tributaries. These easements vary in their conditions, but generally allow the State to use lands in the Bypass to store and convey floodwaters 365 days a year (Dave Ceppos, personal communication). The levees and floodway are maintained by the Department of Water Resources according to standards set by the U.S. Army Corps of Engineers.

The Yolo Basin Foundation has successfully consolidated communication among landowners and stakeholders in the Yolo Bypass through regular meetings of the Yolo Bypass Working Group. The Yolo Bypass Working Group offers the opportunity for landowners and stakeholders to discuss important issues in the Yolo Bypass with the assistance of a professional facilitator. Any proposed projects affecting the livelihood of

the landowners or the primary flood protection mission of the Bypass are discussed in this forum.

6.7.3 Yolo Bypass: Plant, Fish, and Wildlife Species

The Bypass provides valuable aquatic habitat to at least 42 resident and seasonal fish species, 15 of which are native. It supports state and federally listed species (delta smelt, steelhead trout, spring-run and winter-run Chinook salmon) as well as game fish (white sturgeon and striped bass).

The Bypass also provides migratory and nesting habitat for shorebirds along the Pacific Flyway. They are abundant in the Yolo Bypass for much of the year, with migrants arriving in July and departing for northern nesting areas in March. Many of the wetlands in the Yolo Bypass Wildlife Area are managed specifically for shorebirds.

Waterfowl are the most visible component of the avifauna in the Yolo Bypass. Massive numbers of ducks, geese and swans provide dramatic viewing opportunities for thousands of travelers along Interstate 80 during the winter months. This spectacle is the result of year-round management of seasonal wetlands and careful preparation of agricultural fields following the harvesting of crops such as rice and corn. Water depth is a critical ingredient of this management practice and it is imperative that the shallow depths of less than six inches be maintained for dabbling ducks and shorebirds.

The Bypass is an important wintering area for numerous species of raptors including Red-tailed Hawks, Peregrine Falcon, Prairie Falcon and northern species such as the Ferruginous Hawk and Rough-legged Hawk. Resident birds of prey include Northern Harrier, Red-tails, and American Kestrel. The Swainson's Hawk nests regularly in the

Bypass and forages in great numbers in summer irrigated seasonal wetlands. Over 200 species of birds are found in the Yolo Bypass and the area is becoming increasingly important for Neotropical migrant birds who use the area when traveling between their northern breeding areas and the wintering grounds of tropical America. Otters, Beaver, muskrat and mink abound in the wetlands of the Yolo Bypass. Land mammals include deer, Gray Fox , skunk, opossum, and many species of rodents.

6.7.4 Yolo Bypass: Aquatic Ecosystems

Urbanization, flood control efforts, and other human endeavors have significantly degraded or diminished the Central Valley's aquatic ecosystems, so the aquatic and riparian habitat of the Yolo Bypass has exceptional biological value for many native aquatic and wildlife species.

The Bypass provides a myriad of habitats for fish and wildlife, including riparian habitat, valley oak woodland, uplands, open water, and natural and managed wetland habitats (Yolo Bypass Working Group 2001). The Yolo Bypass provides significantly better habitat for juvenile salmon than the Sacramento River (Sommer et al 2001). Mean salmon size increased significantly faster in the seasonally inundated Yolo Bypass floodplain than in the Sacramento River. This could be in part because of higher water temperatures in the Bypass as a result of the shallower depth and because food resources are better. It also provides foraging habitat from agricultural land. Corn, tomatoes, safflower, alfalfa, hay, and rice are the primary crops grown in the Bypass (Jones & Stokes 1994).

In more than half of all water years (October 1st to September 30th), excess floodwaters enter the Yolo Bypass from the main river channel. This inflow of water from the Sacramento River redistributes shallow water habitat for shorebirds and dabbling ducks to the western edge of the bypass while flooding east side wetlands with deep water. As the water level rises, this shallow water on the west disappears and wildlife species using the Bypass shifts to diving duck species such as Canvasback and Scaup. It is at this time that anadromous native fish such as White Sturgeon and Splittail utilize the newly inundated floodplain.

Flood events create up to 59,000 acres of vital shallow water habitat for native fish. In other (below-normal to critically dry) years, there is little or no floodplain inundation and poor connectivity between the Yolo Bypass and the Sacramento River. During these years, salmon and splittail populations decline due to an inability to reach spawning and rearing habitat. Shorebird abundance also decreases in correspondence with low availability of shallow water foraging habitat. In the absence of flooding, however, shorebird habitat is managed within the constructed wetlands and agricultural fields of the Yolo Bypass.

6.8 WILLOW SLOUGH

6.8.1 Willow Slough: Physical Setting

Willow Slough drains the 164 square mile watershed between Cache Creek and Putah Creek. It includes the eastern slope and low-lying foothills of the Inner Coast Range and the relatively flat alluvial plain of the southern Sacramento Valley in Yolo County. The watershed is divided into five major landform units: the upper watershed draining the

eastern slope of the Inner Coast Range, the low hills at the foot of the range, the alluvial plains of the Sacramento Valley, a band of undulating hills known as the Plainfield Ridge, and the low-lying basin west of the ridge (Jones and Stokes 1996). For more information about gauging stations, streamflow estimation, flooding/flood control, and erosion/sedimentation, please see Chapter 4.

Waterways in the Willow Slough watershed that extend up to the crest of the Rocky Ridge include, from north to south, Lamb Valley Slough, Cottonwood Creek (Cottonwood Slough in its lower reaches), Union School Slough, and Dry Slough. Salt Creek and Pine Creek become Chickahominy Slough just below their confluence, and Chickahominy Slough becomes the main tributary to Dry Slough.

The U.S. Army Corps of Engineers constructed the Willow Slough Bypass in the 1960s, approximately ¼ mile east of Highway 113 to the north of the city of Davis, to divert all flood flows in downstream Willow Slough to a lower elevation of the Yolo Bypass. The Bypass improved gravity flow, therefore more rapidly draining the flood flows. The average annual flow and annual peak discharge entering the Bypass is unknown (Jones & Stokes 1996), but peak flows have been estimated through rainfall-runoff modeling. The remnant Willow Slough channel continues northeast and enters the Yolo Bypass at the Conaway Ranch.

In the upper watershed and foothills area, the locations and shapes of the stream channels are approximately the same as they were before development. On the valley floor, however, most of the channels have been realigned. In addition, artificial waterways to supply irrigation water interconnect with the natural channels in many places. Water can

move back and forth among natural, artificial, and altered channels, especially during floods.

The Willow Slough watershed is sparsely populated, as agriculture dominates the land use. The principal towns include Winters and the unincorporated communities of Esparto, Madison, and West Plainfield. The City of Davis wastewater treatment plant discharges treated effluent into the lower end of the Willow Slough Bypass.

6.8.2 Willow Slough: History

Willow Slough and its major tributary Dry Slough are ephemeral streams, named when the U.S. Army Corps of Engineers built the Sacramento River Flood Control Project in the first quarter of the twentieth century. Called the “Laguna de Santos Calle” and “Deep Arroyo” in the 19th century respectively, Willow Slough and Dry Slough ran completely dry in the summers after winter and spring rains, as well as runoff from the foothills, subsided (Robins 1995).

Historically, Willow Slough has always been a discrete waterway, although it merged with other sloughs during floods. Parts of Willow Slough were as much as 50 yards across and 75 feet deep. Willow Slough also was fed in several places by underground springs that ran year round. It ended among the tules of the marshes created west of the Sacramento River when it overflowed during winter storms. Dry Slough was not historically described as connected to Willow Slough, although it may have been at one time (Robins 1995).

Extensive alterations took place over time to Willow Slough, Dry Slough, and its tributaries. In addition to clearing the sloughs of vegetation in many places, local

landowners also modified the path of the slough. For example, one local landowner rerouted the slough around his fields and created highline ditches to bring water westward to other fields on his ranch (Robins 1995).

6.8.3 Willow Slough: Plant, Fish, and Wildlife Species

Trees found along the slough include valley oaks, willows, cottonwoods, and black walnut. Understory species include wild rose, poison oak, blackberry, mugwort and sandbar willow. Some landowners are restoring the riparian habitat along their property by planting more of these native species (Robins 1995).

Trees and other riparian vegetation along the slough provide roosting and nesting opportunities for birds that forage the surrounding agricultural habitat, including the Swainson's Hawk. Other species that may benefit from Willow Slough include the valley elderberry longhorn beetle, white-faced ibis, giant garter snake, and western pond turtle. The yellow-billed cuckoo, California yellow warbler, and bank swallow generally require more extensive riparian vegetation (Yates 2003a), although Willow Slough may provide such habitat if extensive habitat restoration occurs.

Willow Slough does not support anadromous fish or large populations of resident native fish, although non-native fish adjusted to warm water temperatures are sometimes found in the slough.

6.8.4 Willow Slough: Aquatic Ecosystems

Much of the riparian habitat that existed in the Willow Slough watershed in the pre-settlement era has been lost to agricultural and urban development. All that remains are narrow strips – often only one tree canopy wide – of riparian vegetation along some

slough reaches (Jones and Stokes 1996). The channel east of Road 99 to the Yolo Bypass is nearly pristine, however, supporting a healthy population of old and young valley oaks, willows, cottonwood, black walnut, and other riparian tree species (Robins 1995).

The upper Willow Slough watershed (above an elevation of 300 feet) contains a mixture of blue oak woodland, grassland, and chaparral. The Willow Slough watershed also provides grasslands habitat, woodlands habitat, wetlands habitat and riparian habitat along sloughs and canals. While the habitats of the Willow Slough watershed have been significantly altered over the last 150 years, opportunities exist to restore or enhance some habitat (Jones and Stokes 1996).

Agricultural habitat dominates the valley floor, consisting of seasonally flooded, irrigated, and dry-farmed cropland. Except for some use of cover crops in orchards and crop rotation, the agricultural fields are managed as a monoculture with narrow strips of uncultivated vegetation along roads and between fields. Pasture and alfalfa are the most common crops in the watershed, providing good foraging habitat for the endangered Swainson's Hawk. Vegetable and grain crops, rice fields, and orchards also provide habitat for wildlife.

Streamflow in Willow Slough under pre-settlement conditions probably was not high and sustained enough to support anadromous fish or large populations of resident or native fish (Yates 2003a). Summer flow in many of the segments on the valley floor is currently boosted by the use of those channels to deliver irrigation water diverted by Cache Creek. In addition, carriage water and return flows maintain flows in Willow

Slough throughout the summer. Because of warm temperatures during the summer, most of the fish species present in the slough are probably non-native species.

The perennial presence of water provides a distinct benefit to riparian vegetation and wildlife, however. Most of the benefits are derived from the presence of water and might not increase substantially with increased flows (Yates 2003a). The amount of riparian and wetland habitat in the watershed is much less than under predevelopment conditions, and wildlife populations dependent on those habitats are declining. Many opportunities for improving habitat conditions are described in the Willow Slough Watershed Management Plan (Jones and Stokes 1996), however, and will be further discussed in the completed Integrated Regional Water Management Plan.

6.9 SACRAMENTO RIVER

6.9.1 Sacramento River: Physical Setting

The Sacramento River forms the eastern border of Yolo County. The meandering, single-channel river is 327 miles long and drains a watershed of 24,000 square miles (Mount 1995). Levees and channels have significantly altered the original pattern of the Sacramento River, but major portions in the lower reaches still retains their meandering characteristics.

The Sacramento River is the largest river in California, and provides most of the water to the Sacramento-San Joaquin Delta, as the majority of the San Joaquin River's water is diverted before it reaches the Delta. Much of this water is pumped through the Delta to supply irrigation water to San Joaquin Valley farmers and drinking water to residents of Southern California.

6.9.2 *Sacramento River: History*

During the pre-settlement era, the Sacramento River was free-flowing without restrictions from dams or diversions. Flows varied dramatically. Late summer flows were low in contrast to today's summer flows, probably averaging about 3,000 cubic feet/second. Flows fluctuated widely during the winter in response to winter rains. The high winter and spring flows resulted in over-bank flooding, often over extensive reaches of the valley floor. Open expanses of emergent marsh and dense areas of riparian vegetation covered these floodplains. Some accounts place the riparian band as extending up to 4 to 5 miles along each side of the river and encompassing at least a half million acres (USFWS 2001).

The forces of bank erosion and river meander continued unimpeded during the pre-settlement era. As one bank eroded, the opposite bank experienced sediment accretion and riparian vegetation colonization. Some of the meanders became cut off from the river, forming oxbow lakes and other broad, highly diverse channel overflow areas. Erosion also resulted in the input of large volumes of woody debris. The fish, wildlife, and riparian vegetation of the river were in a dynamic equilibrium, dependent on the cycle of erosion, deposition, and changing channel patterns (USFWS 2001).

The natural levees of the Sacramento River supported riparian forest, including valley oak woodland. Beyond the forest lay vast seasonal marshlands in the basin areas. Rapid development of the Sacramento Valley began in the 1850s, and settlers cleared the trees along the river for lumber and fuel, particularly cordwood for steamboats. Since then, water development projects, dam and levee construction, bank protection, streamflow

regulation, agricultural conversion, and housing construction have significantly altered the riparian corridor (SRCAF 2003).

In addition, hydraulic mining in the foothills contributed to significant damage to the river from an influx of mining debris and sediment. At one point, so much sediment accumulated in the river that steamboats could no longer pass in the river. While much of this debris was washed down the river and through the Delta, much like a flood wave, over the course of many years, significant amounts of debris remain behind dams and stored in terraces and floodplains. This material is being slowly reworked and added to the sediment load of the mountain rivers, which eventually drain in the Sacramento River (Mount 1995).

The response of residents in the Central Valley to the increase in hydraulic mining debris was to build higher and stronger levees, which had significant impacts on riparian habitat. In addition, the construction of levees increased the velocity and erosive power of the water in the river, leading to the scouring of the Sacramento River channel. To prevent additional erosion, engineers used rip-rapping techniques that further degraded fish and wildlife habitat, as described in a later section.

To provide flood protection and to capture water for drinking water supply, Shasta Dam was built on the Sacramento River as part of the federal Central Valley Project in the 1930s. Dozens of other dams also control flow on the main stem and many tributaries. These changes worked in concert with the impacts of hydraulic mining and other anthropogenic impacts to reduce overbank flooding events which provide essential

floodplain habitat for native fish species. They also reduced riparian vegetation that provided essential habitat for wildlife.

6.9.3 Sacramento River: Plant, Fish, and Wildlife Species

Fish species listed for protection under the California and/or Federal Endangered Species Act found in the Sacramento River in the vicinity of Yolo County include winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and Sacramento splittail. Biologists are concerned about sturgeon populations, but the sturgeon is not listed right now. While this reach of the Sacramento River serves as a migratory corridor for juvenile and adult salmonids, and also as potential rearing habitat for salmon fry, better rearing habitat is available in the nearby Yolo Bypass (Sommer et al. 2001). Spawning of adult Chinook salmon and steelhead is not common in this reach of the Sacramento River because of the absence of spawning gravel.

According to a 2001 Biological Opinion, the U.S. Fish and Wildlife Service feels that the Sacramento splittail is not recovering, primarily because of habitat loss and changed hydraulics/hydrology in the Sacramento River. The Service also determined that environmental contaminants and the presence of introduced species impact the ability of splittail to survive and reproduce (USFWS 2001).

6.9.4 Sacramento River: Aquatic Ecosystems

The reach of the Sacramento River that passes through Yolo County has been studied far less from an ecosystem perspective than other portions of the river, in part because the quality of the habitat for fish and wildlife is not as high as in other areas. Decades of

efforts to provide flood protection to Sacramento has resulted in a highly channelized, heavily rip-rapped reach.

Rip-rapping, or the placement of a covering of large stone along a river bottom, embankment, or levee, was often used in the past to control erosion without concern for its impact on fish and wildlife habitat. As a result, the leveed sections of the river that border Yolo County provide less fish and wildlife habitat. In addition, as described above, channel scouring and the construction of levees have negatively impacted the riparian habitat.

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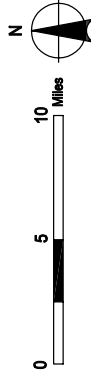
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Chapter 6

Maps

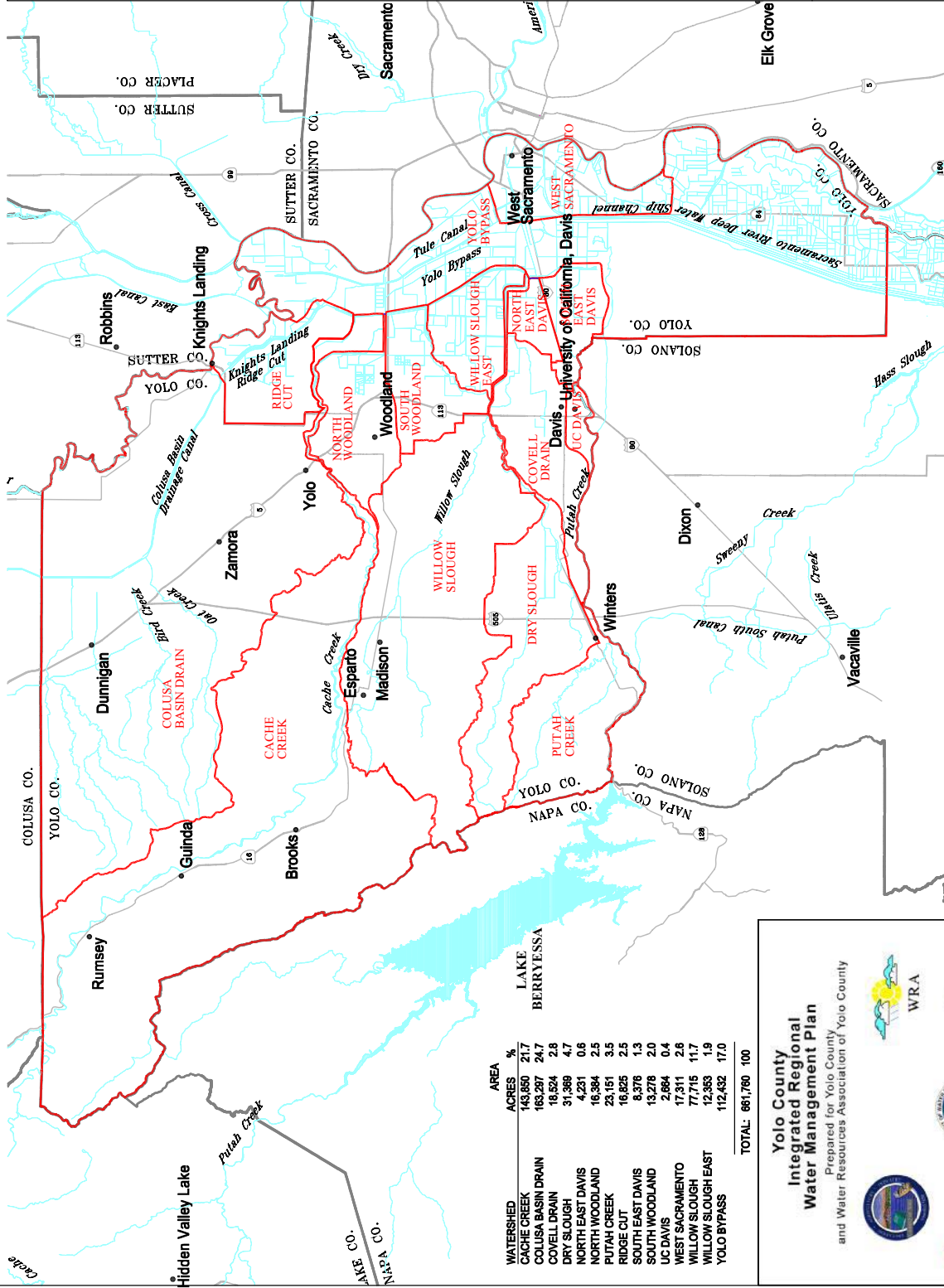
Map 6-1 Yolo County Principal Watersheds

- Watershed or Subwatershed Boundary
- County Boundary
- Major Roads



Projection:
NAD83, CA State Plane, Zone II, Feet.

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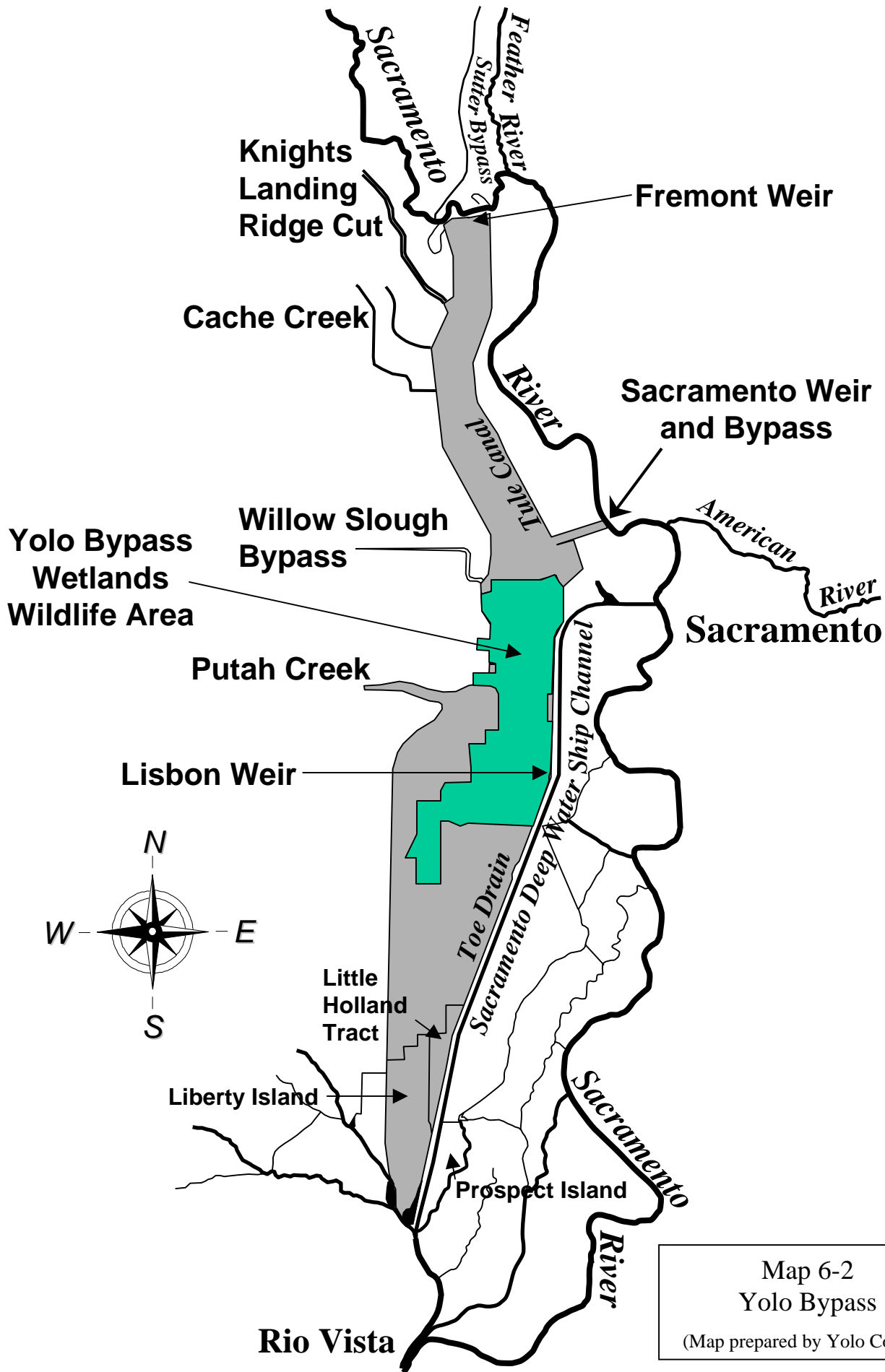


WATERSHED	ACRES	%
CACHE CREEK	143,860	21.7
COLUSA BASIN DRAIN	163,297	24.7
COVELL DRAIN	18,524	2.8
DRY SLOUGH	31,389	4.7
NORTH EAST DAVIS	4,231	0.6
NORTH WOODLAND	16,394	2.5
PUTAH CREEK	23,151	3.5
RIDGE CUT	16,825	2.5
SOUTH EAST DAVIS	8,376	1.3
SOUTH WOODLAND	13,278	2.0
UC DAVIS	2,664	0.4
WEST SACRAMENTO	17,311	2.6
WILLOW SLOUGH	77,715	11.7
WILLOW SLOUGH EAST	12,353	1.9
YOLO BYPASS	112,432	17.0
TOTAL:	661,760	100

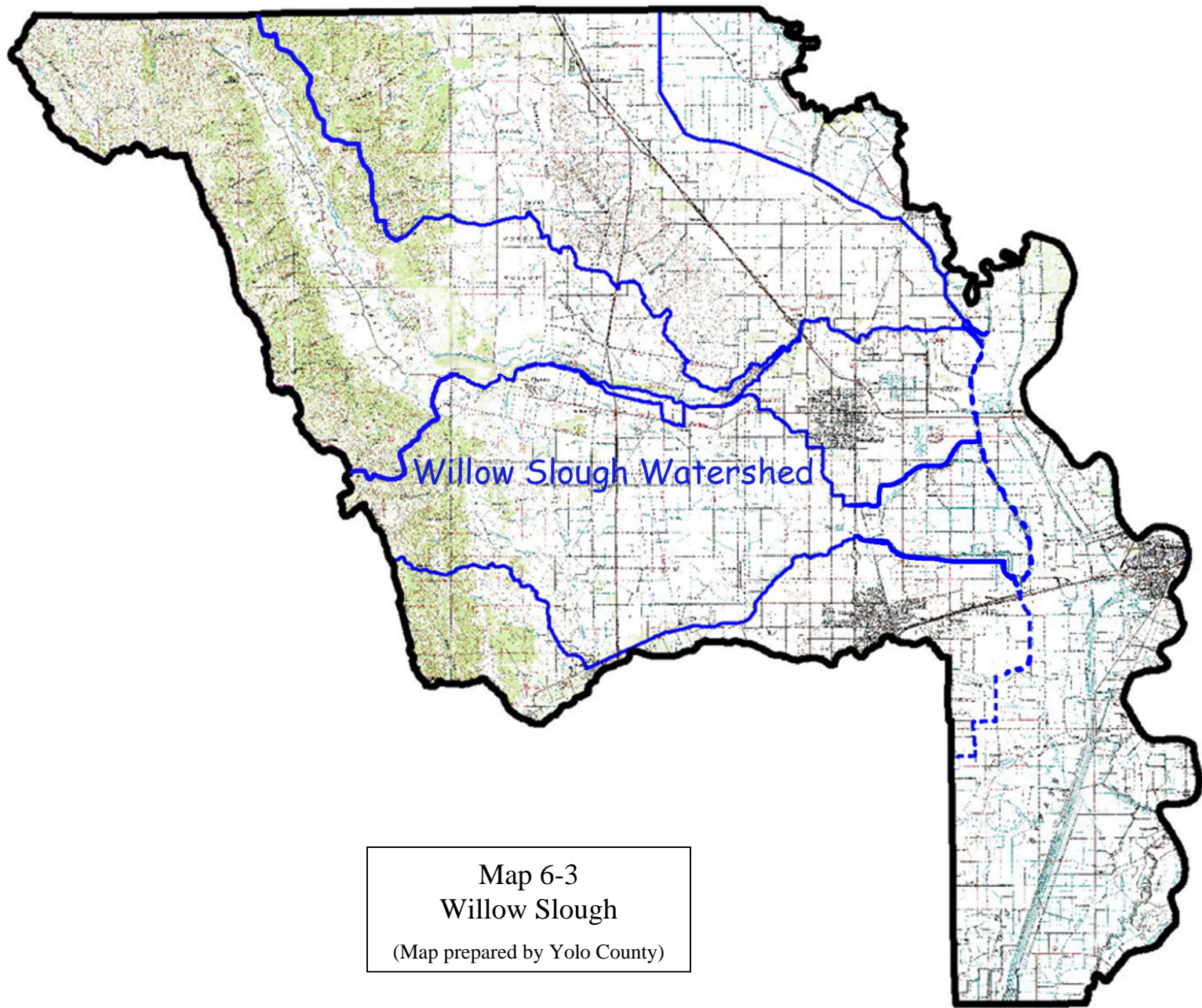
Yolo County Integrated Regional Water Management Plan

Prepared for Yolo County
and Water Resources Association of Yolo County





Map 6-2
Yolo Bypass
(Map prepared by Yolo County)



Map 6-3
Willow Slough
(Map prepared by Yolo County)