Conceptual Habitat Restoration Plan for Great Valley Grasslands State Park Project

Great Valley Grasslands State Park
Merced County, California

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Prepared for:

California Department of Fish and Wildlife,

California States Parks, and

American Rivers

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EXECUTIVE SUMMARY

The Conceptual Habitat Restoration Plan (Plan) for the Great Valley Grasslands State Park (GVGSP) evaluates the habitat restoration potential and provides specific recommendations for 487 acres of GVGSP that is located on the northern bank of the San Joaquin River in Merced County (Figure 1). The 487 acre project site currently is dominated non-native grasses and remnant bands of native riparian vegetation clinging to the edges of the waterways traversing the site. Disconnection of river to its floodplain in the area has led to degradation of riparian habitat along the main and secondary channels that cross the project site.

The primary goals of this Plan are to enhance and restore riparian and adjacent upland habitat, as well as habitat connectivity that will have multi-species benefits and will serve as an important wildlife corridor, reduce impacts of climate change on the local ecosystem, while also maintaining future recreation opportunities. Target wildlife species for the Project include Federal- and State-listed endangered species such as the), least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis)*, Swainson's hawk (*Buteo swainsoni*), and Chinook salmon (*Oncorhynchus tshawytscha*). Additionally, the Project will target habitat for neotropical migrant songbirds, year-round resident and wintering water birds, waterfowl, raptors and deer. Other species expected to benefit from this restoration may include the riparian brush rabbit (*Sylvilagus bachmani riparius*), riparian brush rat (*Neotoma fuscipes riparia*), giant garter snake (*Thamnophis gigas*) and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). Habitat loss has been identified as a critical factor in the decline of these species.

A site evaluation examined native and invasive plant populations and distribution, hydrology, and past land use and current conditions. Based upon the site evaluation, the Plan identifies opportunities to plant and establish three plant associations and a native herbaceous layer in the Project area for the purposes of habitat restoration. The Plan identifies two additional restoration opportunities to improve the function of existing wetland and floodplain habitat. It also outlines implementation strategies and necessary permits. This plan serves as a framework to produce site-specific planting plans and identifies the required permitting, potential irrigation water sources, plant source material, restoration actions, and general timelines. This plan is intended to be a tool for future decisions and actions by individual agencies.

CONCEPTUAL HABITAT RESTORATION PLAN FOR THE GREAT VALLEY GRASSLANDS STATE PARK MERCED, CALIFORNIA

I. INTRODUCTION

A. Project Overview

The Restoration Plan (Plan) for the Great Valley Grasslands State Park Habitat Restoration Project (Project) describes the ecological design and implementation activities for restoring approximately 487 acres of riparian, wetland and grassland habitat on the floodplain along 2.5 miles of the San Joaquin River in Merced County (Figure 1). The Project benefits the San Joaquin River ecosystem and associated native wildlife species by improving riparian, floodplain, wetland and grassland habitat just west of Highway 165. The Project will also provide public benefit by enhancing recreational opportunities along the San Joaquin River.

Approximately 6% of the riparian forest community remains in the San Joaquin Valley (CalFed 1999). The San Joaquin River and its tributaries are all anthropogenically distressed ecosystems in which natural processes can no longer maintain riparian communities. Water diversion, flow regulation, floodplain leveling and clearing, sand and gravel mining, and invasive species function as major stressors on native plant and wildlife communities. Cumulative effects of these stressors are manifested in the numerous special status species currently under Federal or State protection that can only be found in these riparian ecosystems. The width of the riparian corridor adjacent to the San Joaquin River is greatly reduced or absent compared to historical levels, reducing the amount of quality upland habitat (forage and cover) available for riparian-obligate species. Most of the remnant riparian forest at the Project site is found along the banks of the main and secondary channels; typically in narrow bands (<50 feet wide).

B. Cooperative Relationships and Funding Sources

Funding for the Planning of this Project has been granted by the American Rivers.

The Plan is consistent with the common goals of the following landscape and regional conservation plans:

- Central Valley Joint Venture 2006 Implementation Plan
- Riparian Habitat Joint Venture Riparian Bird Conservation Plan (2004)
- California Partners In Flight Oak Woodland Bird Conservation Plan (2002)
- Restoration Objectives for the San Joaquin River Restoration Program
- California Water Action Plan 2016 Update

C. Project Goals and Objectives

This document presents a specific restoration plan for 487 acres along the San Joaquin River at the Great Valley Grasslands State Park, once implemented, and should meet the following objectives:

- Restore or improve high quality riparian, upland and wetland habitat on approximately 487 acres
- Increase habitat connectivity within the Project area relative to existing riparian habitat
- Provide habitat for Federal- and State-listed species including the, least Bell's vireo, southwestern willow flycatcher, western yellow-billed cuckoo, Swainson's hawk, valley elderberry longhorn beetle and support the efforts of the reintroduced spring run Chinook salmon to the San Joaquin River
- Provide habitat for other riparian-obligate wildlife and fish
- Establish self-sustaining native plant communities within a three-year period
- Plant approximately 149 acres with native trees and shrubs
- Plant approximately 338 acres with native grasses and forbs
- Reduce extent of existing invasive weeds, and increase community resistance to weed invasion by planting a dense herbaceous understory
- Increase landscape aesthetics and enhance recreational uses
- Use an adaptive management approach to ensure project success
- Build partnerships with Federal, State, and local entities

D. Summary of Special Considerations

The recommendations take into account the following considerations:

- Creating functional wildlife habitat, while maintaining the future utility of public access
- Establishing quality habitat on variable topography
- Avoiding or minimizing potential impacts to threatened and endangered species on site
- Considering the possible concerns of multiple stakeholders
- Aggressively controlling invasive plant species such as, perennial *pepperweed* (Lepidium latifolium), sesbania (*Sesbania punicea*) and yellow starthistle (*Centaurea solstitialis*) to reduce infestations and allow native vegetation to re-establish
- Designing a climate-smart restoration which considers potential climate change impacts and incorporates ecological redundancies robust enough to ensure against uncertain future conditions.

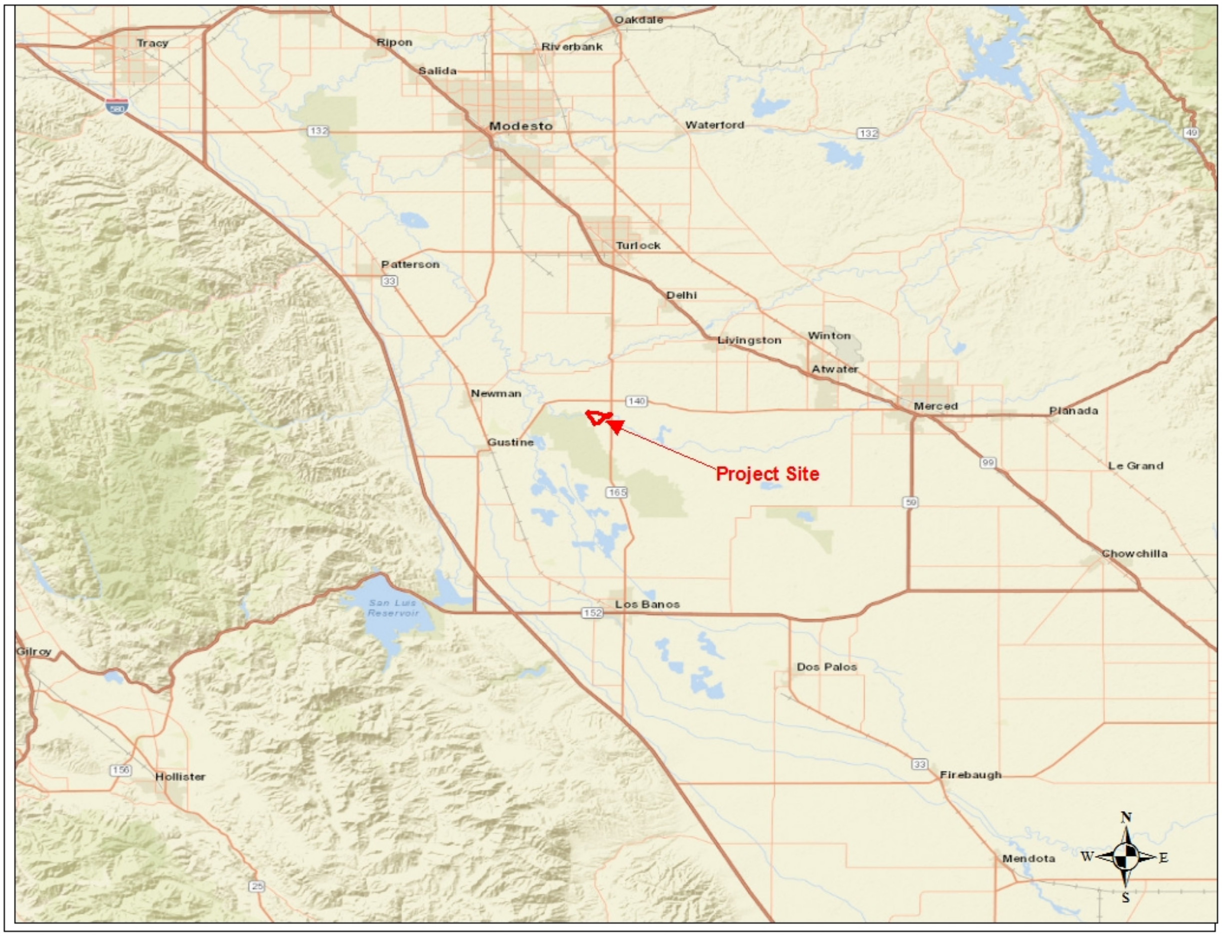

Figure 1. Project Site Location: Merced County, California

E. Purpose of the Habitat Restoration Plan

The purpose of the Plan is to:

- Identify project goals and objectives
- Summarize the site land-use history, soils, hydrology, vegetation, and wildlife
- Outline the current understanding of the physical and biological factors that influence site ecology (i.e., a conceptual site model)
- Describe the planting design and the rationale for its selection
- Describe the implementation process including field preparation, planting methods, irrigation design and schedule, and methods of weed control
- Identify required permits
- Outline general project timelines

II. SITE DESCRIPTION

A. Location

The Project is located in a portion of Great Valley Grasslands State Park (GVGSP), in northern Merced County, California (Figure 2). GVGSP is located in the San Joaquin Valley along the San Joaquin River and Salt Slough. Highway 165 runs in a north-south orientation along the eastern boundary of the Project area. Kesterson National Wildlife Refuge is located on the south and west. The San Luis National Wildlife Refuge is located further south. These areas together are referred to as the San Luis Refuge complex, managed by the U.S. Fish and Wildlife Service (USFWS).

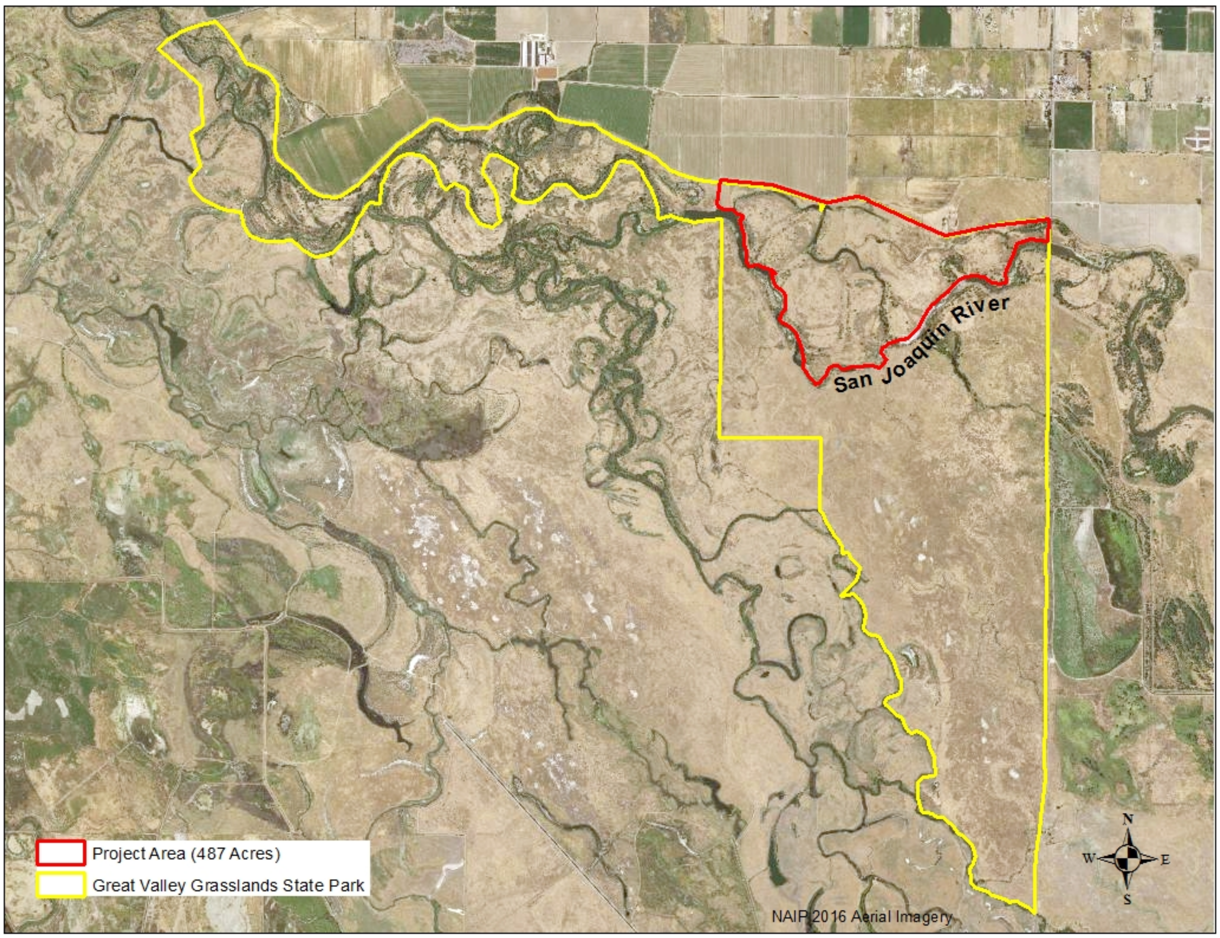

Figure 2. Project Site within Great Valley Grasslands State Park, Merced County, California

B. Land-use History

The Great Valley Grasslands State Park (GVGSP) was established in 1982 and contains some of the last remaining stands of unplowed grasslands in the central valley. The 2,826 acre park is located on a large parcel of land called San Luis Island due to its location between the San Joaquin River to the north and Salt Slough to the south and west, and is part of the 160,000 acres Grasslands Ecological Area (Solomeshch and Barbour 2005).

Historical records for the San Joaquin Valley suggest this region was inhabited for approximately 11,000 years, with the Miwok and Yokuts tribes having lowland occupations that began as early as 2,000 years ago (Pritzker 1998). These tribes formed small tribelets throughout the regions with a population estimate ranging from 20,000 to 50,000 in the early eighteenth century, making this region one of the highest population densities in aboriginal North America (Pritzker 1998). Cultural resources have been identified on the Project site so coordination with State Parks is necessary to avoid these known artifacts.

The Spanish and Mexican influences were felt by the native populations in this region but it was the gold rush and influx of large groups of people who had the biggest impact on their populations. Much of the land occupied by the native population was seen as valuable for both mining higher up in the river systems and for farming in the floodplains. With the introduction of several diseases the native population had little to no immunity against, their numbers plummeted and they were eventually removed from their lands. As the gold rush faded and California officially entered the United States, the transformation of the floodplain in this region was already well under way.

Early records indicate that water diversions were established between 1852 and 1854 and it was this ability to move water to the more arid regions for agriculture that had the biggest impact to the landscape (Outcalt 1925). Dam construction on the San Joaquin River in 1944 would further alter the hydrograph and continued river diversions would ultimately lead to portions of the river running dry for decades. In all but the wettest years, water that passes the Project site is not entirely from the San Joaquin watershed, which has already been diverted further upstream either at Gravelly Ford, the Mendota Pool, or the Sac Dam structure. Bear Creek, which enters the river approximately three miles upstream from the project, and agricultural return water provide the majority of flow seen in this stretch of the river. With the continued implementation of the San Joaquin River Restoration Program (SJRRP), including flow regulations, water quality and availability should improve.

Levee construction adjacent to the Project site began in 1959 with the first of several section starting at the mouth of the Merced River and extending to just south of Sand Slough (Reclamation 1967). These actions disconnected the river from its historic floodplain causing the vegetation to proceed along a different trajectory. Without the influences of seasonal inundation and sediment deposition, natural recruitment of riparian species is severely limited.

C. Topography

The project site consists of a relatively flat lower floodplain terrace at approximately 64 feet to 66 feet above sea level and an upper terrace from 66 feet to just over 70 feet above sea level. The lower floodplain terrace would have historically been inundated frequently before construction of the Friant dam. The upper terrace is also relatively flat with two river channels crossing the area. These channels have steep banks, but are flanked by lower lying areas that typically are inundated with higher river flows.

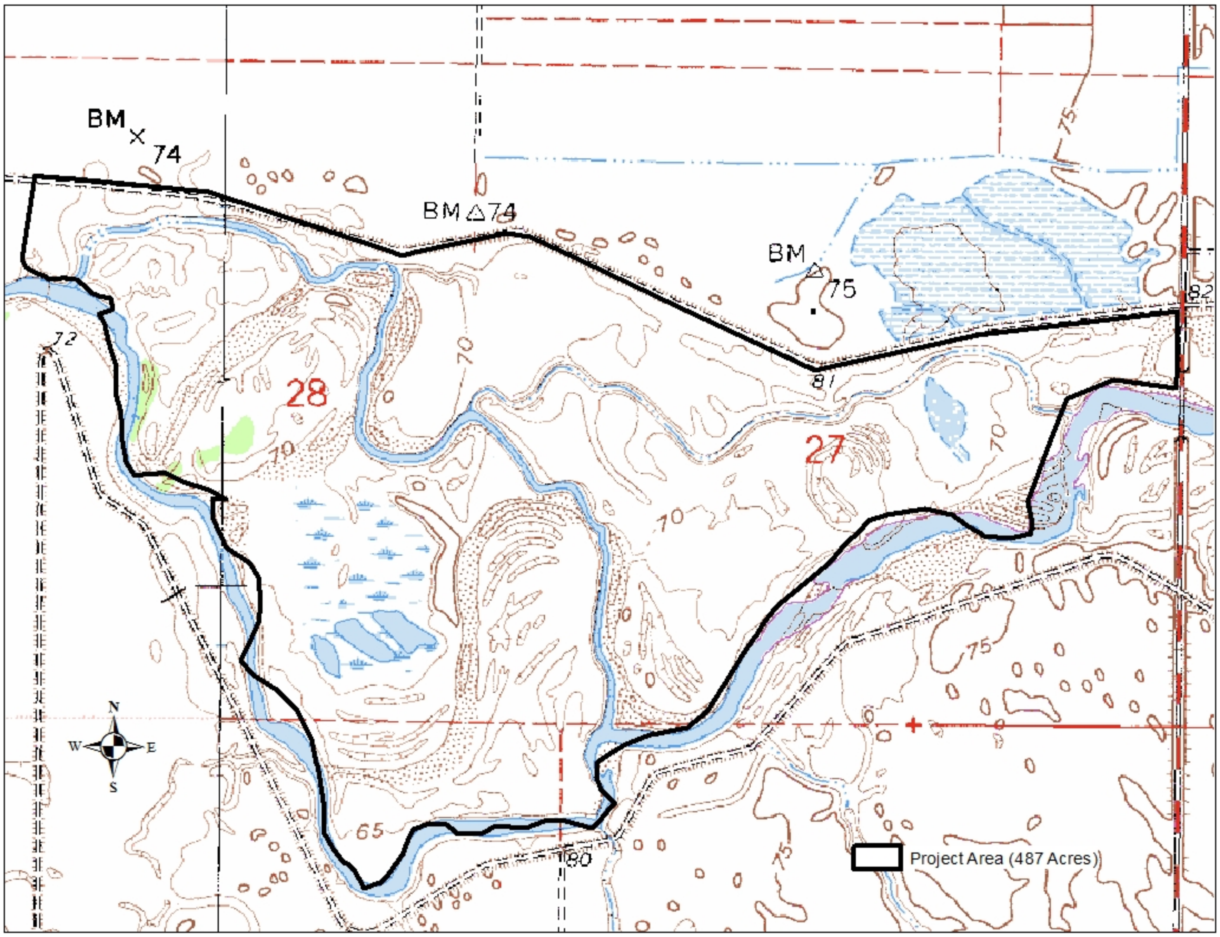

Figure 3. Topography: Project Area at Great Valley Grasslands State Park, Merced County, California.

D. Soils

Variable soil characteristics, created by dynamic river processes, greatly affect vegetation composition, structure, and patterns. For example, soil texture is influenced by flooding as slowly settling floodwaters deposit silts and sands across the floodplain sporadically, creating local zones of low water-holding capacity in the surface soil, encouraging the growth of drought-tolerant species. As these zones are enriched with organic matter by growth and decay of early pioneer species, they are able to hold more water and thus support the establishment of different (later seral) plant communities.

Over time, the process of flooding and sediment deposition creates complex mosaics of vegetation patterns across the floodplain, and these patterns continue to change with continued disturbance. Restoration designs must incorporate these soil factors as well as the depth to water table for successful plant establishment, growth, and long-term survival.

1. General Soil Series Information

The Project area includes eleven soil mapping units (SMUs) as delineated by the Natural Resources Conservation Service Web Soil Survey (2015)**.** Soils from the Grangeville, Hanford and Tujunga series make up the majority of the Project area. The Grangeville, Hanford, and Tujunga series are common soils in floodplains and alluvial fans in the eastern San Joaquin Valley. Both of these soil series include soils that are classified as “prime farm land” which makes them excellent soils for plant growth (Figure 5, Table 1). In general, they are 6 feet or more deep and are underlain by gravel and cobble lenses.

2. Soil Pit Information

The NRCS Web Soil Survey for Merced County identified ten soil types within the project boundary (Figure 4, Table 1). The survey identified Columbia soils profile as occupying majority of the project area (280 acres) with Temple clay loam soils occupying another 113 acres of the project area. Other soils identified in the survey included, Rossi Clay loam (25 acres), Waukena sandy loam (28 acres) and Hilmar loamy sand (0.1 acres). The Columbia soils are described as somewhat poorly drained and can range from non-saline to very slight salinity. The Temple soils are classified as prime farmland if irrigated, but also are somewhat poorly drained and can range from non-saline to moderately salinity. The Waukena soils consist of a fine sandy loam and are not considered prime farmland as they drain moderately quickly. These soils range from only slightly saline to moderately saline. This soil type is clay loam to sandy loam which can be saline in certain locations.

River Partners would recommend that soil pits also be excavated to determine depth to water table, soil texture and structure, and rooting depths of existing vegetation. Soil chemistry should also be tested to determine if salt accumulation might inhibit potential plantings. This process is fairly inexpensive and can provide useful information prior to planting. Salts may prove to be a challenge but with more frequent SJRRP flows, flood waters may help to flush salts out of the areas.

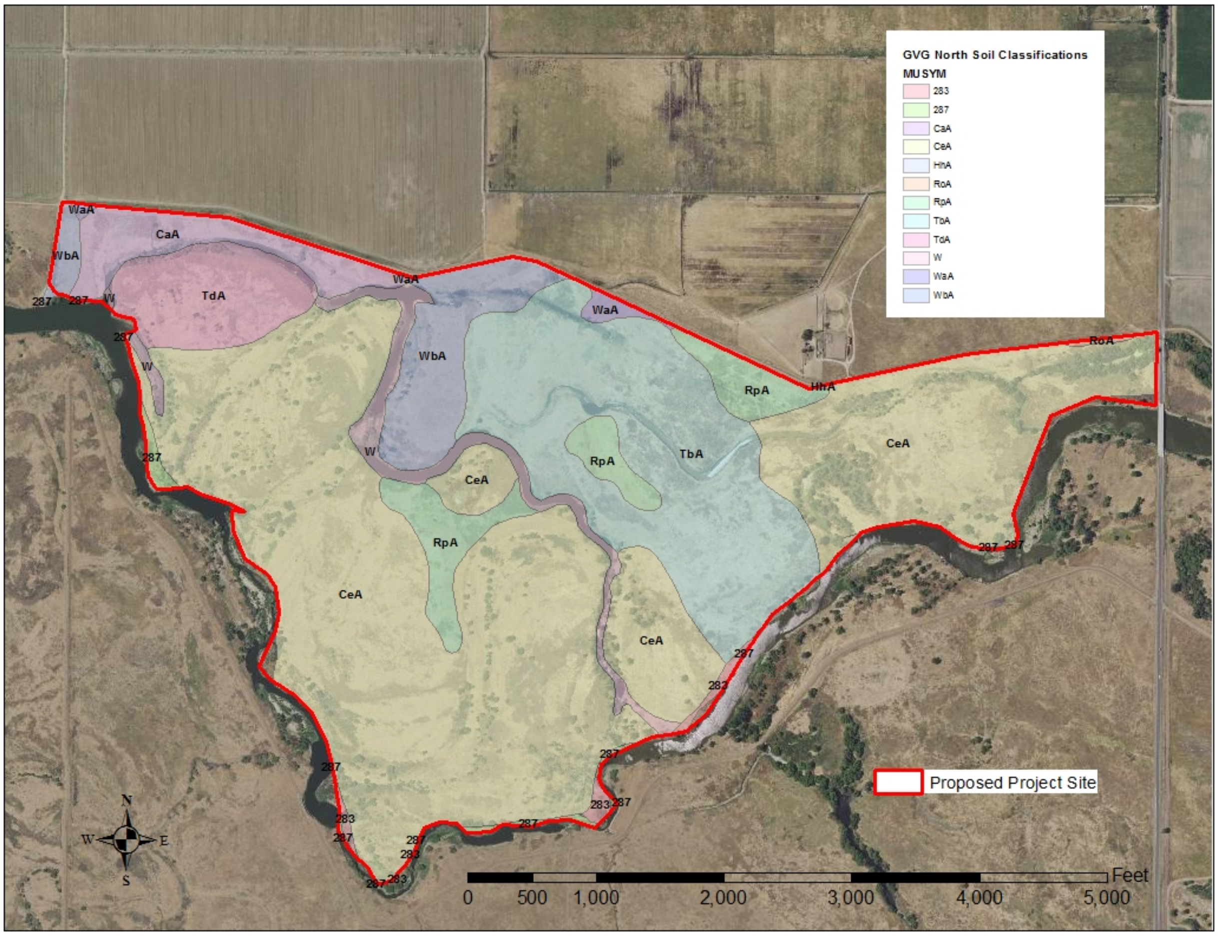

Figure 4. Soil Series: Project Site, Great Valley Grasslands State Park, Merced County, California.

Table 1. Summary of Typical Soil Conditions Found From Soil Survey of Merced County at Great Valley Grasslands State Park, Merced County, California.

Soil Series	Mapping Unit	% Slope	Texture	Drainage	Permeability	Limitations to plant growth
Xerofluvents, channeled	283	0 to 2%	Very fine to fine sandy loam	Poor	Moderately slow to rapid	Sandy surface layer
Columbia fine sandy loam, moderately deep and deep	CaA	0 to 1%	Fine sandy loam	Moderately well drained	Moderately rapid	None
Columbia soils, channeled	CeA	0 to 3%	Fine sandy loam	Moderately well drained	Moderately rapid	None
Hilmar loamy sand, slightly saline-alkali	HhA	0 to 3%	Loamy sand	Poor	Rapid to slow	Salt and alkali levels
Rossi clay loam, slightly saline, channeled	RoA	0 to1%	Clay loam	Poor	Slow	Salt and alkali levels
Rossi clay loam, moderately saline-alkali	RpA	0 to 1%	Clay loam	Poor	Slow	Salt and alkali levels
Temple clay loam	TbA	0 to 1%	Fine loamy clay	Poor	Moderately slow to slow	Salt and alkali levels
Temple clay loam, slightly saline, channeled	TdA	0 to 3%	Fine loamy clay	Poor	Moderately slow to slow	Salt and alkali levels
Waukena fine sandy loam, slightly saline-alkali	WaA	0 to 1%	Fine sandy loam	Moderately well to poor	Slow to very slow	Salt and alkali levels
Waukena fine sandy loam, moderately saline-alkali	WbA	0 to 1%	Fine sandy loam	Moderately well to poor	Slow to very slow	Salt and alkali levels
Water	W					

E. Hydrology

1. History and Current Conditions

Historically, flooding on the San Joaquin River was generally caused by rainfall runoff during late fall/winter and snowmelt during spring/summer. Prior to the completion of Friant Dam in 1942 northeast of Fresno, high flows in late spring and early summer declined gradually with low flows occurring in the fall and early winter. During flood events, tremendous volumes of water would flow through the Project area activating even the highest terraces. As the San Joaquin River reached the valley floor its velocity slowed as it meandered north through towards the confluence with the Merced River. This slower river flow velocity, coupled with the consequent sediment deposition, resulted in the channel meander patterns found on the project site. Historic aerial photographs from 1946 and 1958 show that this highly sinuous river was surrounded by an extensive floodplain including the river channels, oxbow lakes, sloughs, and sandbars prior to the construction of the flood control levees (Figures 5 and 6).

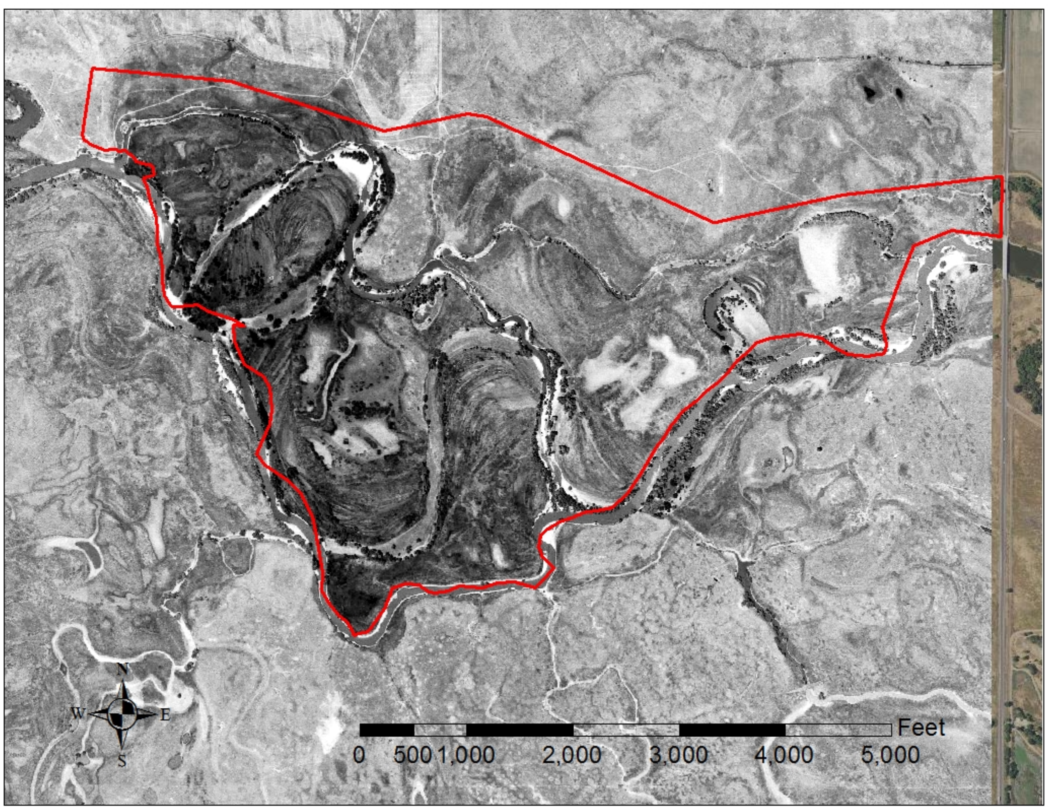

Figure 5. Aerial image from 1946 of Project outline and the San Joaquin River, Merced County, California.

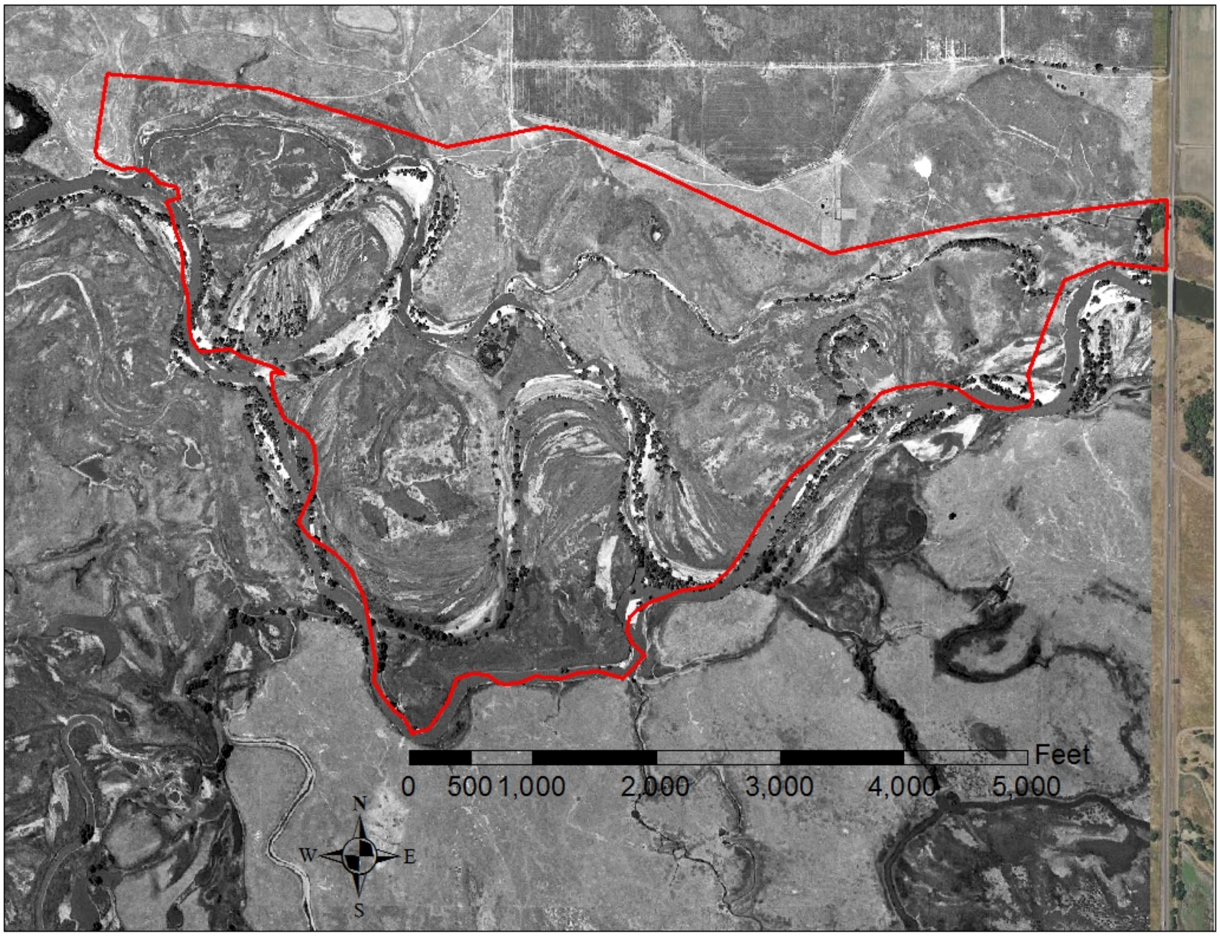

Figure 6. Aerial image of Project from 1958 prior to levee construction on the San Joaquin River, Merced County, California.

The USGS gauge below Friant Dam (USGS11251000) shows a highly variable peak flow prior to the completion of the dam and filling of Millerton Lake in 1945. From 1908 to 1943 the peak flow on the San Joaquin River exceeded 10,000 cfs in 25 of the 35 recorded years. By comparison, the river has only exceeded this flow in 6 out of the last 74 years (Figures 7 and 8).

The hydrology of the San Joaquin River has been significantly altered by flow regulation and water diversion for irrigation, power, and municipal uses. Dams have reduced the magnitude, duration, and frequency of high flows and increased the duration and frequency of lower flows. These dams can capture more than the average annual amount of runoff in a normal water year, leaving only the less common high water years to activate the floodplain. Continued channel-floodplain connectivity is critical for a healthy riparian ecosystem. This vital process was restricted at the project site with the construction of Flood Project levees in the early 1960's.

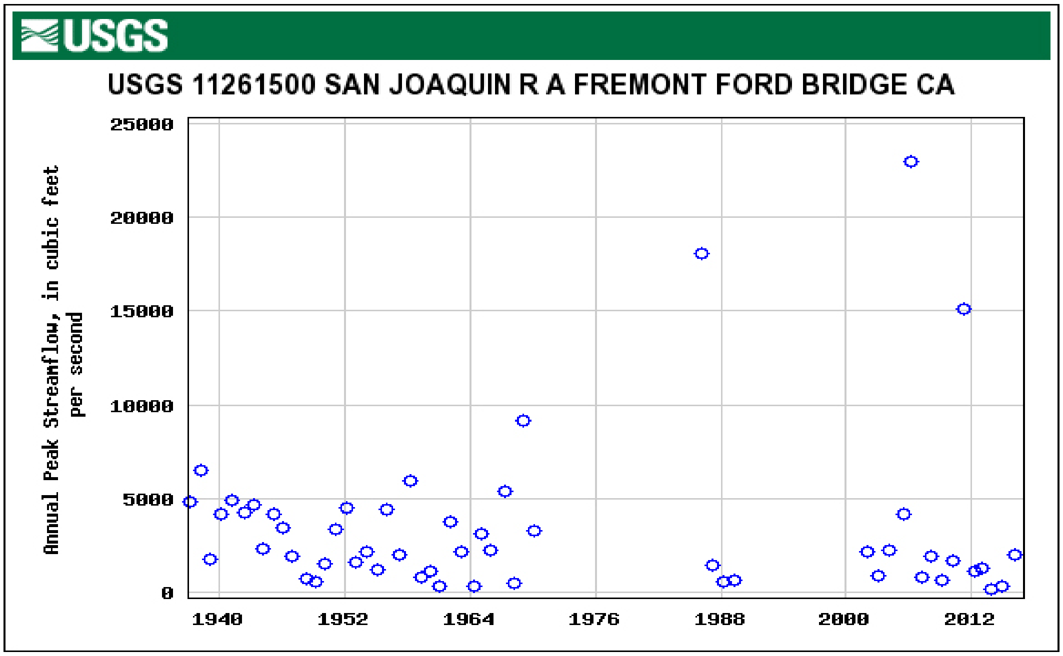

Figure 7. **USGS Gauge at the Highway 140 Bridge at Fremont Ford, Merced County, California.**

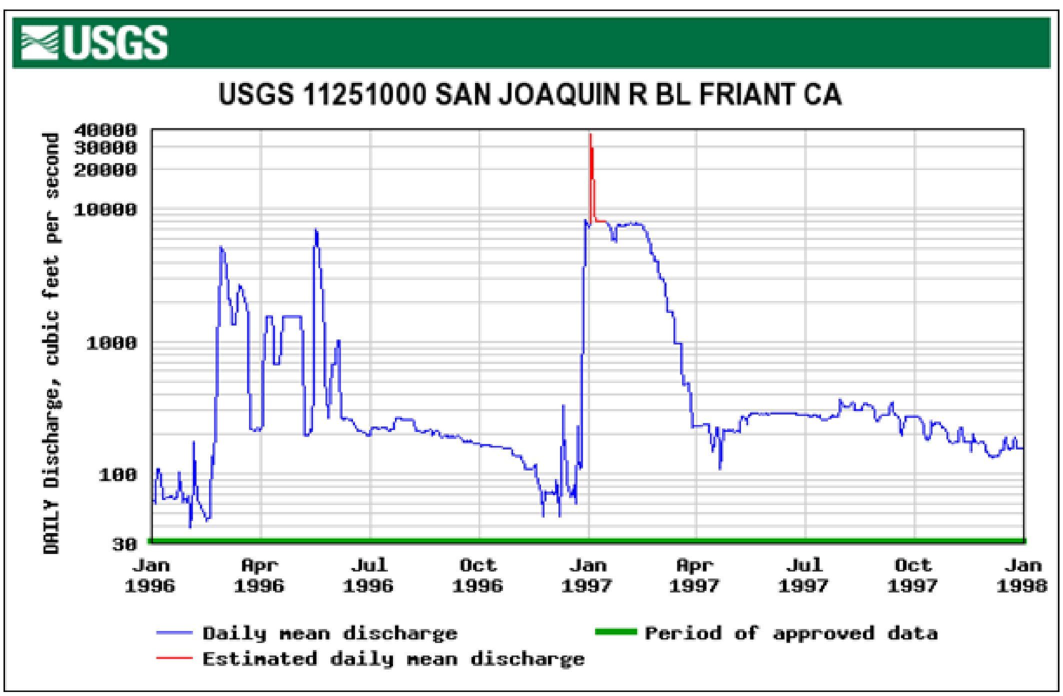

Figure 8. Hydrograph for Water Years 1996 - 1997, San Joaquin River Below Friant Dam, the Largest Flood Event on Record Post Dam Construction.

In its current regulated state, the San Joaquin River rarely exceeds its banks at the project area, maintaining the river in its current channel, with little opportunity for lateral migration. In this static condition, native riparian trees, especially those species adapted to a natural hydrograph (i.e. willows and cottonwoods), will rarely naturally recruit at this site. These species evolved to recruit and establish depending upon dynamic flow events at times coincident with seed-set and active scouring that would prepare mineral seedbeds for germination.

In addition to the main San Joaquin River channel, the Project area contains multiple wetland features, including several seasonal emergent wetlands and shallow freshwater ponds. Figure 9 displays all nationally mapped wetlands according to the US Fish and Wildlife Service's (USFWS) National Wetlands Inventory.

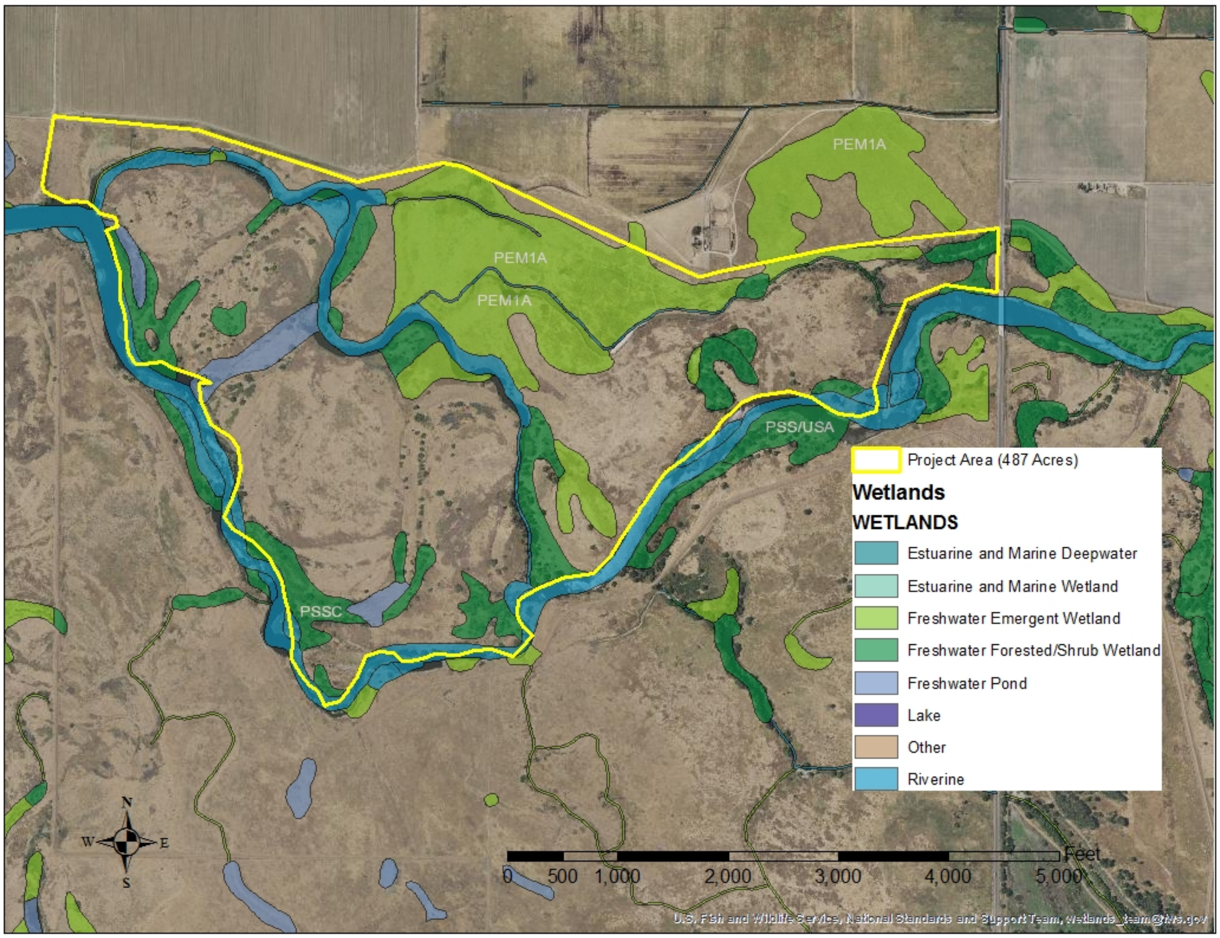

Figure 9. US Fish and Wildlife Service National Wetlands Inventory at the Project Site at the Great Valley Grasslands State Park, Merced County, California.

Due to the variation in depth, each pond and wetland hold water at different capacities. Not only do the wetlands and ponds hold water at different capacities compared to each other, the amount of inundation varies from year to year depending on precipitation and the stage of the river.

2. Designated Floodway

The entire Project site is within the Central Valley Flood Protection Board's designated floodway. It lies between certified federal levees on both sides of the San Joaquin River. The design flow in this reach of the river is 18,000 – 20,000 cfs which equates to a 100 year flood (DWR 2016).

3. Water Table Depth

Knowing the depth to the water table over time at a given site is critical for an accurate site assessment of riparian and associated communities. General assumptions can be made, however without actual data and analysis from monitoring wells, true water subsurface water movement and levels will not be known. Water table evaluation analysis could showed how ground water moves across the site and how the water table is also influenced by the stage of the San Joaquin River as well as local precipitation events.

F. Vegetation

Existing and historic vegetation was assessed by reviewing various sources. Historical accounts of riparian forests in the Central Valley are given by Kuchler (1977), Griggs et.al. (1992) and Holland (1986). Several historic photographs of the Project site were reviewed. Historical and ecological accounts of special-status plants in the region were obtained from the California Natural Diversity Database and California Native Plant Society. In 2005, The Department of Plant Sciences at UC Davis completed a vegetation management report of the GVGSP.

Based on soils, flooding frequency, and the proximity to the river, pre-development site conditions likely supported a mixed riparian forest with valley oak (*Quercus lobata*) dominating in more elevated areas and more mesic species such as Fremont cottonwood (*Populus fremontii*), sandbar willow (*Salix exigua*), black willow *(Salix goodingii)*, and Box elder (*Acer negundo*) occupying lower areas. Native grasses, forbs, and sedges likely dominated the understory. Aerial photos from 1946 show a landscape that was highly influenced by historical channel meander with a narrow band of riparian plants still persisting along the many sloughs and oxbows (Figure 5).

Grassland communities historically flourished in the park and the main reason for its creation was conservation of the largest remnant stand of unplowed grassland on the Central Valley floor with the rare plant community of alkali sacaton *(Sporobolus airoides)* (Solomeshch and Barbour 2005). This native perennial bunchgrass typically inhabited elevations in the park between 70-75 feet above sea level and were tolerant of occasional flooding. Lower portions of the park were covered in the perennial grass creeping wildrye *(Elymus triticoides)*, which is highly tolerant to the prolonged flooding that would occur in the park at elevations under 70 feet.

Based upon review of historic descriptions, native riparian forests and oak woodland communities were likely the dominant community types at the Project area prior to agricultural conversion, though the extent, density of plants, and diversity of species would have been much higher than it is today.

In its current state, most of the Project site has been disconnected from the river flows that helped influence the natural fluvial processes and a healthy riparian ecosystem. The site is now heavily invaded by exotic annual grasses and in many areas they have displaced the natives entirely. The lower elevations of the park that experience seasonal rain accumulation and seepage still have some areas of native creeping wildrye, but they are being slowly invaded by perennial pepperweed *(Lepidium latifolium)* and several other non-native species. Alkali sacaton can still be found on some of the higher terraces of the Project site with presumed higher salt content. Several other species of native threatened, endangered, or rare vegetation can still be found at the GVGSP, or in the immediate vicinity. A nine-quad search of the CNDDB database identified 28 species of plants, five of which are listed as threatened or endangered (Table 2). If ground disturbance is planned in areas likely to support these listed species, a through survey will be necessary to clearly establish avoidance areas.

Table 2. Threatened, Endangered, or Rare Plant Species Occurring on or near Great Valley Grasslands SP, Merced County, California.

Species	Status	Communities	Occurrence Potential
Plants - Vascular			
Sanford's arrowhead *(Sagittaria sanfordii)*	CA 1B.2	Freshwater Wetlands, wetland-riparian	Unlikely
Delta button-celery *(Eryngium racemosum)*	SE, CA 1B.1	Freshwater Wetlands, wetland-riparian	Likely
Spiny-sepaled button-celery *(Eryngium spinosepalum)*	CA 1B.2	Valley Grassland, Freshwater Wetlands, wetland-riparian	Unlikely
Parry's rough tarplant *(Centromadia parryi ssp. Rudis)*	CA 4.2	Wetlands, Riparian	Likely
Ferris' goldfields *(Lasthenia ferrisiae)*	CA 4.2	Valley Grasslands, Wetlands, Riparian	Likely
Coulter's goldfields *(Lasthenia glabrata ssp. Coulteri)*	CA 1B.1	Alkali Sink, Coastal Salt Marsh, Freshwater Wetlands, wetland-riparian	Likely
Wright's trichocoronis *(Trichocoronis wrightii var. wrightii)*	CA 2B.1	Freshwater Wetlands, wetland-riparian	Likely
Heckard's pepper-grass *(Lepidium latipes var. heckardii)*	CA 1B.2	Valley Grassland, wetland-riparian	Unlikely
Heartscale *(Atriplex cordulata var. cordulata)*	CA 1B.2	Shadscale Scrub, Valley Grassland, wetland-riparian	Likely
Crownscale (Atriplex coronata var.	CA 4.2	Shadscale Scrub, Valley Grassland, Freshwater Wetlands,	Likely

Species	Status	Communities	Occurrence Potential
coronate)		wetland-riparian	
Brittlescale *(Atriplex depressa)*	CA 1B.2	Shadscale Scrub, Valley Grassland, Alkali Sink, wetland-riparian	Likely
Lesser saltscale *(Atriplex minuscula)*	CA 1B.1	Shadscale Scrub, Valley Grassland, Alkali Sink	Likely
Vernal pool smallscale *(Atriplex persistens)*	CA 1B.2	Shadscale Scrub, Valley Grassland, Alkali Sink	Likely
San Joaquin spearscale *(Extriplex joaquinana)*	CA 1B.2	Shadscale Scrub, Valley Grassland	Unlikely
Hoover's spurge *(Euphorbia hooveri)*	FT, CA 1B.2	Valley Grassland, Alkali Sink, Freshwater Wetlands, wetland-riparian, Vernal Pools	Unlikely
Alkali milk-vetch *(Astragalus tener var. tener)*	CA 1B.2	Valley Grassland, Alkali Sink, Freshwater Wetlands, wetland-riparian, Vernal Pools	Likely
Northern California black walnut *(Juglans hindsii)*	CA 1B.1	Foothill Woodland, wetland-riparian	Unlikely
Merced monardella *(Monardella leucocephala)*	CA 1A	Valley Grasslands	Unlikely
Stinkbells *(Fritillaria agrestis)*	CA 4.2	Chaparral, Valley Grassland, Foothill Woodland, wetland-riparian	Unlikely
Succulent owl's-clover *(Castilleja campestris var. succulent)*	FT, SE, CA 1B.2	Valley Grassland, Foothill Woodland, wetland-riparian	Unlikely
Hispid salty bird's-beak *(Chloropyron molle ssp. Hispidum)*	CA 1B.1	Alkali Sink, Valley Grassland, wetland-riparian	Likely
Vernal barley *(Hordeum intercedens)*	CA 3.2	Valley Grassland, Freshwater Wetlands, wetland-riparian	Likely
Colusa grass *(Neostapfia colusana)*	FT, SE, CA 1B.1	Valley Grassland, Freshwater Wetlands, wetland-riparian	Unlikely
California alkali grass *(Puccinellia simplex)*	CA 1B.2	Valley Grassland, wetland-riparian	Unlikely
prostrate vernal pool navarretia *(Navarretia prostrata)*	CA 1B.1	Coastal Sage Scrub, wetland-riparian	Likely
San Joaquin Valley Orcutt grass *(Orcuttia inaequalis)*	FT, SE, CA 1B.1	Valley Grassland, Freshwater Wetlands, wetland-riparian	Unlikely
slender-leaved pondweed *(Stuckenia filiformis ssp. Alpine)*	CA 2B.2	Freshwater Wetlands, wetland-riparian	Unlikely
little mousetail *(Myosurus minimus ssp. Apus)*	CA 3.1	Valley Grassland, Coastal Sage Scrub, Freshwater Wetlands, wetland-riparian, Vernal Pools	Likely

Species	Status	Communities	Occurrence Potential

*FE - Federally Endangered *FT - Federally Threatened
*SE - State Endangered *ST - State Threatened
* CA 1A - Plants presumed extinct in California and rare/extinct elsewhere
*CA 1B.1 - Plants rare, threatened, or endangered in California and elsewhere; seriously threatened in California
*CA 1B.2 - Plants rare, threatened, or endangered in California and elsewhere; fairly threatened in California
*CA 2B.1 - Plants rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California
*CA 2B.2 - Plants rare, threatened, or endangered in California, but more common elsewhere; fairly threatened in California
*CA 3.1 - Plants about which we need more information; seriously threatened in California
*CA 3.2 - Plants about which we need more information; fairly threatened in California
*CA 4.2 - Plants of limited distribution; fairly threatened in California

Figure 10. Existing Vegetation Communities at the Project Site, Merced County, California.

Table 2. Vegetation Communities Types Found at the Project Site GVGSP, Merced County, California.

Vegetative community	Distribution	Description	Characteristic species	
Great Valley Mixed Riparian Forest	Floodplains of low gradient, depositional streams in the Great Valley, Usually below 500 feet. Formerly extensive in the San Joaquin Valley but now greatly reduced by agriculture and urbanization.	Tall, dense, winter-deciduous, broadleafed riparian forest. Canopy fairly well closed and moderate to densely stocked with several canopy and mid-story species.	*Acre negundo* *Juglans hindsii* *Platanus racemosa* *Populus fremontii* *Salix goodingii.* *Cephalunthus occidentalis* *Fraxinus latifolia*	Boxelder Black walnut Western sycamore Cottonwood Black willow Buttonbush Oregon ash
Valley Oak Woodland	Located on deep, well-drained alluvial soils, usually in valley bottoms. Intergrades with Valley Oak Riparian Forest near rivers.	Highly variable climax woodland typically forming an open canopy with grassy-understoried savanah rather than a closed woodland. Valley oak is usually the only tree present.	*Quercus lobate* *Elymus triticoides* *Toxicodendeon diversilobum*	Valley oak Creeping wildrye Poison oak
Non-native Grassland	Valley and foothills of most of California, formerly occupied large portions of the Central and Salinas Valleys in areas that are now in urban or agricultural use.	Dense to sparse cover of annual grasses with flowering culms to 1 meter tall. Often associated with numerous species of annual forbs.	*Centromadia sp.* *Phacelia sp.* *Vulpia microstachys*	Spikeweed Phacelia Fescue

From Holland 1986

Figure 11. Invasive Annual Grasses Currently Dominate this Floodplain Terrace Identified for Potential Riparian Restoration at the Project Site at GVGSP, Merced County, California.

G. Wildlife

The Project area has been disconnected from its historic floodplain and highly invaded by weeds but still provides valuable habitat to a host of listed species. A comprehensive list of wildlife species currently using the site has not been compiled, but would be useful. A recent nine-quad search of the California Natural Diversity Database (CNDDB) identified 39 species which held special status including 14 state or federally listed species (Table 3). Many of the listed wildlife species are either associated with riparian habitat, grasslands, vernal pools or other seasonal wetlands.

Table 3. Federal and State-listed Endangered, Threatened, and State Species of Special Concerns Occurring or Potentially Occurring at Great Valley Grasslands SP, Merced County, California.

Species	Status	Habitat Type	Occurrence Potential
Mammal			

Species	Status	Habitat Type	Occurrence Potential
Pallid bat *(Antrozous pallidus)*	SSC	Grasslands	Likely
Western mastiff bat *(Emops perotis californicus)*	SSC	Grasslands, Conifer and Deciduous Woodlands, Coastal Scrub, Chaparral, Desert Scrub, Urban	Likely
American badger *(Taxidea taxus)*	SSC	Open Areas within Most Shrub, Forest, and Herbaceous Habitats with Friable Soils	Unlikely
San Joaquin kit fox *(Vulpes macrotis mutica)*	FE, ST	Grasslands, Scrublands, Oak Woodland, Alkali Sink, Alkali Meadow, Urban, Oil Fields, Agricultural Lands,	Unlikely
Bird			
Tricolored blackbird *(Agelaius tricolor)*	SSC	Emergent Marsh, Grasslands, Agricultural Fields	Likely
Cooper's hawk *(Accipiter cooperii)*	WL	Oak Woodland, Riparian Forests	Observed
Burrowing owl *(Athene cunicularia)*	SSC	Sparsely Vegetated or Bare Arid and Semi-arid Lands	Likely
Swainson's hawk *(Buteo swainsoni)*	FT	Oak Woodland, Riparian Forests, Grasslands, Alfalfa	Observed
Northern harrier *(Circus cyaneus)*	SSC	Emergent Marsh, Grasslands, Agricultural Fields	Observed
California horned lark *(Eremophila alpestris actia)*	WL	Grasslands	Observed
Least bittern *(Ixobrychus exilis)*	SSC	Marsh	Likely
Mountain plover *(Charadrius montanus)*	SSC	Grasslands, Marsh	Likely
Loggerhead shrike *(Lanius ludovicianus)*	SSC	Open Woodlands, Grasslands, Riparian Forests	Observed
Double-crested cormorant *(Phalacrocorax auritus)*	WL	Lakes, Rivers, Ponds	Observed
Long-billed curlew *(Numenius americanus)*	WL	Grasslands, Marshes	Observed
Least Bell's vireo *(Vireo bellii pusillus)*	FE, SE	Early to Mid-successional Riparian Habitat	Unlikely
Yellow-headed blackbird *(Xanthocephalus xanthocephalus)*	SSC	Emergent Marsh	Likely
Reptile			
Western pond turtle *(Emys marmorata)*	SSC	Aquatic	Observed
Coast horned lizard *(Phrynosoma blainvillii)*	SSC	Open areas within Valley-foothill Hardwood, Conifer, and Riparian Woodlands, Grasslands	Likely
Northern California legless lizard	SSC	Oak Woodlands, Riparian Forests	Unlikely

Species	Status	Habitat Type	Occurrence Potential
(Anniella pulchra)			
Blunt-nosed leopard lizard *(Gambelia sila)*	FE, SE	Semiarid Grasslands, Alkali Sinks	Unlikely
Giant gartersnake *(Thamnophis gigas)*	FT, ST	Marshes, Sloughs	Likely
Amphibian			
California tiger salamander *(Ambystoma californiense)*	FT, ST	Grasslands and Low Foothills with Pools or Ponds	Likely
Western spadefoot toad *(Spea hammondii)*	SSC	Grasslands	Likely
Northern leopard frog *(Lithobates pipiens)*	SSC	Grasslands, Marshes, Wet Meadows	Unlikely
Fish			
Hardhead *(Mylopharodon conocephalus)*	SSC	Riverine	Unlikely
Riffle sculpin *(Cottus gulosus)*	SSC	Riverine	Unlikely
Sacramento hitch *(Lavinia exilicauda exilicauda)*	SSC	Riverine	Unlikely
Sacramento splittail *(Pogonichthys macrolepidotus)*	SSC	Riverine	Unlikely
Kern brook lamprey *(Entosphenus hubbsi)*	SSC	Riverine	Unlikely
Pacific lamprey *(Entosphenus tridentatus)*	SSC	Riverine	Unlikely
Central Valley steelhead *(Oncorhynchus mykiss irideus)*	FT	Riverine	Unlikely
Spring-run Chinook salmon *(Oncorhynchus tshawytscha)*	FT, ST	Riverine	Unlikely
Invertebrate			
Vernal pool fairy shrimp *(Branchinecta lynchi)*	FT	Vernal Pool	Likely
Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*	FT	Riparian and Upland Habitats with Elderberry Present	Likely

Species	Status	Habitat Type	Occurrence Potential
Vernal pool tadpole shrimp *(Lepidurus packardi)*	FE	Vernal Pool	Unlikely
Conservancy fairy shrimp *(Branchinecta conservation)*	FE	Vernal Pool	Likely
Longhorn fairy shrimp *(Branchinecta longiantenna)*	FE	Vernal Pool	Likely

*FE - Federally Endangered *FT - Federally Threatened

*SE - State Endangered *ST - State Threatened
*SSC - State Species of Special Concern

H. Infrastructure

1. Roads

No current roads exist within the Project site. Access to the site is limited to the levee road on the northern boundary of the Project and to a step dirt path to a former river pump on the western edge of the Project Site.

2. Utilities

Power lines previously bisected the Project area from east to west. This line was installed to power a now defunct river pump (Figure 14). River Partners contacted PG&E and verified that the line is still energized and could be used to re-establish a river irrigation pump. A new panel, meter, and connection are required.

Figure 12. Abandoned Electrical pole on Project Site at GVGSP, Merced County, California.

3. Irrigation infrastructure

Relics of an old river pump or water conveyance system can be found at the western portion of the Project site. A dirt access path still exists from the levee on the northern boundary of the Project site to the site of the old river pump.

III. TARGETED WILDLIFE SPECIES

Altered river hydrology, land clearing and leveling associated with agriculture and development, gravel and sand mining, overgrazing, and invasion by exotic species have critically degraded riparian habitat in California's Central Valley. A primary goal of the Conceptual Restoration Plan for the Project site is to design quality habitat for at-risk wildlife species. Target wildlife species for this project include the western yellow-billed cuckoo, least Bell's vireo, Swainson's hawk, San Joaquin kit fox, Central Valley spring-run Chinook salmon, as well as numerous State species of special concern and other riparian bird focal species. In order to develop a restoration strategy and recommendations for the Project site, habitat needs of the target wildlife species need to be considered (Table 4).

Several plans and reports provide important information about the habitat needs and conservation status of these target species. These plans include:

- RHJV Partners in Flight Landbird Conservation Plan
- California Partners in Flight Riparian Bird Conservation Plan
- Recovery Plan for Upland Species of the San Joaquin Valley, California
- California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California
- Draft Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (*Ambystoma californiense*)
- Draft Recovery Plan for the Least Bell's Vireo
- Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead

Understanding of the link between habitat characteristics and species needs for many of these species is incomplete. The following section provides a description of what we know about target species habitat requirements, and implications for riparian and upland restoration design.

1. Western yellow-billed cuckoo

The western yellow-billed cuckoo is a Neotropical migratory bird that is considered a common breeding bird in the Southeastern U.S., and rare or extirpated throughout much of its historic range in the west. It is declining throughout much of its range. It is a species of open woodland habitats with a large territory requirement. Their diet consists primarily of katydid and sphinx moth larvae. They nest in trees and large shrubs. In the western U.S., cottonwoods and willows are associated with cuckoo species feeding and nesting.

Restoration projects benefiting the western yellow-billed cuckoo should focus on restoring habitat patches a minimum of 20-40 ha (50-100 ac) in size. Because cuckoos in general tend to forage close to their nesting site, patch shape is an important consideration and minimum width of habitat should be 100-200 m (325-650 ft), which would provide marginal habitat. Optimal habitat for a pair would consist of a habitat patch greater than 80 ha (200 ac), with a width of greater than 600 m (1970 ft). Sites less than 15 ha (38 ac) in size and less than 100 m wide are unsuitable for the western yellow-billed cuckoo (RHJV 2004).

The western yellow-billed cuckoo relies on upland areas in addition to riparian areas for consistent food sources. The cuckoo's primary food sources hibernate underground and are not readily available in lowland floodplains during late-spring flooding. Therefore, upland refugia habitats for foraging in wet years should also be a component of cuckoo habitat restoration projects (RHJV 2004).

Currently, there is no suitable habitat at the Project area and it will likely not support nesting Cuckoos without restoration. Restoration and enhancement of riparian and upland habitats at the Project area would provide potential nesting and foraging habitat for western yellow-billed cuckoos. Over time, in conjunction with other conservation efforts in the region, restored habitat at the Project area could help support the species in the long term.

2. Least Bell's vireo

Least Bell's vireo (*Vireo bellii pusillus*) is a Neotropical migratory songbird that nests in the Central Valley of California during the summer. The historic range of the endangered least Bell's vireo (*Vireo bellii pusillus*) extended from Tehama County, California to Baja California in Mexico (Birds of North America 2009). Formerly abundant in riparian forests of the Central Valley of California, loss of habitat through conversion to agriculture and urban uses and invasion of California by the parasitic brown-headed cowbird (*Molothrus ater*) have contributed to its decline (RHJV 2004). Currently, least Bell's vireo are mainly located in eight counties in southern California (USFWS 1998). However, within the past decade, least Bell's vireo have been documented breeding on restoration sites planted by River Partners on the San Joaquin National Wildlife Refuge. Breeding habitat includes 3-5 year old willow thickets within a dense herbaceous understory (i.e., mugwort). Nests are usually low in a shrub or tree, near the edge of a thicket. A critical structural component is a dense shrub layer 0.6-3 meters above ground (TNC 2000).

Brood parasitism by brown-headed cowbirds is a significant threat to least Bell's vireo populations. Grazing in riparian areas has reduced the habitat preferred by the least Bell's vireo. Grazed areas, row crops, and orchards provide foraging habitat for the brown-headed cowbird (RHJV 2004). Vireos that are forced into fragmented or marginal nesting areas are more vulnerable to parasitism. Minimizing habitat patchiness may reduce rates of cowbird parasitism. Restoring quality breeding habitat and cowbird control have led to population recovery in some areas (Kus 1998, TNC 2000). Water availability, vegetation structure, and proximity to natural habitat were key components of restoration success and use by the least Bell's vireo (Kus 1998). Adequate breeding and nesting habitat for the least Bell's Vireo does not currently exist at the Project area. Restoration of riparian forests with dense understories would promote the conservation of least Bell's vireo.

3. Swainson's hawk

Swainson's hawks (*Buteo swainsoni*) breed throughout western North America and are long range migrants, overwintering throughout Mesoamerica and South America. Historically, their breeding range included most of the Central Valley. However, the conversion of their historical foraging grounds which included seasonal wetlands and grasslands is largely due to their decline in California (Bradbury 2009). At present, Swainson's hawks forage in open areas including alfalfa fields as well as other hay crops. They continue to utilize grasslands as forage areas, but to a lesser degree. During the breeding season, small mammals make up the majority of their diet, however they also prey upon birds, toads, crayfish and insects (Woodridge 1998). Swainson's hawks are not riparian obligate, but the majority in California utilize riparian areas for nesting, as long as the riparian areas are within reasonable distance of foraging grounds. Though Swainson's Hawks nest in a wide variety of trees species and locations, riparian forests and oak woodlands provide large trees which are the primary requisite for nesting substrate (Woodridge 1998).

Restoration projects benefiting Swainson's hawks should focus on restoring riparian forests for nesting habitat as well as restoring native grasslands and managing invasive vegetation in order to increase prey availability. Optimal habitat would include riparian forests which are not surrounded by intensive monoculture ag lands, but rather, hay crops or open grasslands.

Currently, the Project area contains narrow stringers of mature riparian forests along the waterways and highly invaded, non-native annual grasslands in the uplands. Restoration of riparian forests and native grasslands would provide additional potential nesting habitat and improved foraging habitat for Swainson's hawks.

4. San Joaquin kit fox

The San Joaquin Kit Fox historically inhabited most of the San Joaquin Valley including a multitude of habitat types. As with many species native to the San Joaquin Valley however, population decline was driven by the fragmentation and conversion of habitat to agricultural, industrial, and urban development. Though still found throughout the Valley in much fewer numbers, the San Joaquin kit fox continue to utilize a variety of habitats including native, non-native, agricultural and urban communities (Williams et al 1998). Within the central portion of their range, which includes Fresno County, kit fox inhabit several types of scrub communities as well as native and non-native grasslands where they feed predominately on white-footed mice, insects, ground squirrels, and kangaroo rats (Williams et al 1998). They have been found infrequently in eastern Fresno County. Active restoration of native grasslands at the Project area would enhance San Joaquin kit fox habitat by increasing floristic biodiversity, which would improve the food base for the kit foxes potential prey. Over time, in conjunction with other conservation efforts in the region, restored habitat at the Project area could help support the species in the long term.

5. Central Valley spring-run Chinook salmon

Chinook salmon (*Oncorhynchus tshawytscha*) are anadromous fish which were historically abundant throughout the Central Valley's rivers and creeks, utilizing the cold water from the Sierra Nevada's snowmelt for breeding and rearing of juveniles. However, populations of several Evolutionarily Significant Units (ESU) of salmon, including the Central Valley Spring-run ESU, have become threatened or endangered. Population declines are attributed to habitat loss and destruction caused historically by hydraulic mining and exacerbated more recently by water diversions, levees, and dams built to support agriculture and urbanization. These water projects have caused the loss of at least 48% (1,057 miles) of stream and river courses that were historically accessible to Chinook salmon (NMFS 2014). Native spring-run were extirpated from all San Joaquin River tributaries. However, the current reintroduction effort of the Central Valley spring-run being undertaken as part of the San Joaquin River Restoration Program provides new opportunity for rearing habitat in the Project Area.

Adult Central Valley spring-run chinook salmon typically return from the Pacific Ocean and migrate up the Sacramento River and its tributaries in late January to early February. Adults hold in deep pools with cold water, where they undergo sexual maturity before spawning in mid-August to early October (NMFS 2014). Juvenile spring-run then typically reside in the freshwater river system for 12 to 16 months before migrating out to the ocean.

Seasonally inundated floodplains have been shown to provide the best growing conditions for juvenile Chinook salmon (Jeffries et al 2008) and have been identified in the recovery plan as an essential habitat element for their recovery (NMFS 2014). Seasonally inundated floodplains can provide ample phytoplankton and algae production (Ahearn et al 2006), which in turn supports an abundance of zooplankton that juvenile salmon feed upon. Because of the water infrastructure in the valley (e.g. dams and levees), only 5% of historical floodplains currently remain.

In 2015, River Partners collaborated with researchers from CalTrout, UC Davis Center for Watershed Science, and the Department of Water Resources as an extension to their *Knaggs Ranch Experimental Agricultural Floodplain Habitat Investigation* which assessed the growth rates of juvenile salmon within flooded agricultural floodplains compared to juveniles in the Sacramento River. As an extension of the project, River Partners reared juvenile salmon on three acres of agricultural floodplain near the confluence of the San Joaquin and Tuolumne Rivers. The floodplain was artificially flooded using an existing river pump and juvenile salmon were reared for four weeks. After the four weeks, the salmon were measured and sent to the Department of Water Resources for gut-content analysis. Final results showed similar results to the Knaggs Ranch project site: salmon nearly doubled in length and increased five-fold in weight. The Knaggs Ranch Project also showed that salmon reared on the floodplain grew 700% faster than salmon in the river and that zooplankton was 14,900% greater per cubic meter of floodplain as compared to the river (CalTrout 2016).

Opportunities for seasonally inundated floodplain restoration exist at the Project area, specifically at the old worm farm. By manually flooding and maintaining the interconnected detention basins of the worm farm, seasonal floodplain habitat could be created and managed in non-flood years. If manual flooding and management is not an option, the walls of the detention basins could be removed and the topography could be graded down to ecologically significant height in which an area of floodplain would become inundated more frequently by natural flows and water releases. The detention basins should also be graded to positively drain flood water back into the river in order to prevent fish stranding.

6. Tricolored Blackbird

Tricolored blackbirds are native and permanent resident of California, with the Central Valley hosting over 90% of all breeding adults (Shuford et al 2008). They form breeding colonies in emergent marsh vegetation or the canopy of willows with nests typically 1.5 meters above water or ground. Tricolored blackbirds’ habitat requires accessible water, protected nesting substrate, and areas nearby by with plentiful insects for foraging. Grading and enhancement of the wetlands at the Project Site would increase the potential nesting habitat by increasing the amount of emergent marsh vegetation.

7. Yellow-headed Blackbird

Yellow-headed blackbirds breed throughout the western U.S. and migrate to western and northern Mexico to overwinter. As with many species in decline, loss of over 90% of wetlands in the Central Valley has greatly contributed to its decline (Shuford et al 2008). Yellow-headed blackbirds breed almost exclusively in tall, emergent marsh vegetation. Nests are generally located on the vegetative edges over deep water, ideally 30 cm or deeper. Grading and enhancement of the wetlands at the Project site would increase the potential nesting habitat by increasing the amount of emergent marsh vegetation with sufficient edge habitat.

8. Western Spadefoot Toad

Western spadefoot toads primarily inhabit grasslands throughout the Central Valley and foothills. They have a biphasic life cycle which requires both aquatic and terrestrial habitat. Adults live the majority of their life in underground burrows created by themselves. In order to reproduce, adult western spadefoot toads require shallow, temporary pools filled with winter rains. Adults' migration to their breeding habitat is associated with rains and high humidity, typically from late winter through March. Ideal habitat includes grasslands with shallow, rain-filled pools. Restoration of native grasslands at the Project area will create ideal upland habitat for the western spadefoot toad, while improving and maintaining the diversity of wetland depths will also help to create breeding pools during differing water years.

Table 3. Summary of Habitat Requirements for Targeted Federally and State-listed Wildlife Species at the Project Site, GVGSP, Merced County, California.

Target Species	Status	Habitat Requirements	Design Goals/Considerations
Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)	FT, SE	Riparian habitat dense with willow and cottonwood species.	Plant diverse vegetative structure, shrub clusters, willow thickets, and dense understory.
Least Bell's Vireo (*Vireo bellii pusillus*)	FE, SE	Structurally diverse riparian woodlands, including cottonwood-willow forests, oak woodlands, dense shrubs.	Restore suitable nesting habitat; Plant diverse vegetative structure, shrub clusters, willow thickets, and dense understory.
Swainson's Hawk (*Buteo swainsoni*)	FT	Riparian habitat with mature trees suitable for nesting sites adjacent to productive foraging habitat.	Restore suitable nesting habitat; Plant diverse vegetative structure, shrub clusters, willow thickets, and dense understory.
San Joaquin Kit Fox *(Vulpes macrotis mutica)*	FE, ST	Open areas of grasslands, scrublands, oak woodlands, alkali sinks, oil fields, agricultural and urban areas.	Control non-native annual grasses and invasive plants; Seed a diverse mix of native perennial grasses and forbs in upland areas outside of the floodplain.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	FT	Riparian and associated upland habitat in the Central Valley where blue elderberry, the beetle's host plant, grows.	Plant elderberry plants in riparian shrub habitat.
Central Valley Spring-run Salmon (*Oncorhynchus tshawytscha*)	FT, ST	Ephemeral floodplains for juvenile rearing.	Manage existing basins as floodplain habitat or grade basins to form naturally flooded rearing habitat.
Tricolored Blackbird (*Agelaius tricolor*)	SSC	Emergent marshes with open water and nearby areas for foraging.	Contour shallower slopes on the existing wetlands to increase suitable area for emergent marsh vegetation.
Western Spadefoot Toad (*Spea hammondii*)	SSC	Grasslands with shallow rain-filled pools for breeding.	Control non-native annual grasses and invasive plants; Seed a diverse mix of native perennial grasses and forbs in upland areas outside of the floodplain.

*FE - Federally Endangered *FT - Federally Threatened

*SE - State Endangered *ST - State Threatened

*SSC - State Species of Special Concern

9. Riparian Focal Species

Songbirds are excellent indicators of ecosystem health because they are abundant, distributed within and across habitats, and are sensitive to changes in food supply, vegetation cover, and predator densities. The Riparian Habitat Joint Venture has identified several species of birds as indicators of ecologically healthy riparian systems (RHJV 2004). These species are termed riparian focal species. These species utilize different areas on the floodplain (e.g., gravel bar, woodland, and wetland) and are found in different types of vegetation (e.g., dense shrubs, tree-tops, various understory structures; Figure 27). There is a wide range of spatial and structural habitat requirements among the species (Table 7). For example, the common yellow-throat can have a breeding and foraging territory as small as 0.5 ha (1 ac), while the yellow-billed cuckoo needs a minimum of 20 ha (50 ac). Some species are not compatible living adjacent to agricultural operations, while the blue grosbeak will nest along roadways and forage in certain types of cultivated crops.

Reproductive success on the breeding grounds, which is affected by many factors, is the primary factor limiting populations of migrant landbirds (RHJV 2004). The reproductive success of many bird species can be significantly reduced by high levels of brood parasitism by Brown-headed Cowbirds and nest predation by native and non-native species, both of which are heavily influenced by the structure and diversity of riparian vegetation (RHJV 2004). Avian productivity is also affected by the size and isolation of remnant riparian patches and surrounding land use (RHJV 2004). For example, densities of nest predators and brood parasitism can increase with the degree of habitat fragmentation and increase of habitat edges. These effects also depend on surrounding land use and are often stronger in agricultural landscapes (RHJV 2004).

Restoration efforts will provide high quality habitat for migratory and resident native wildlife species. River Partners specifically designs habitat features into the restoration based on the habitat needs of each target species.

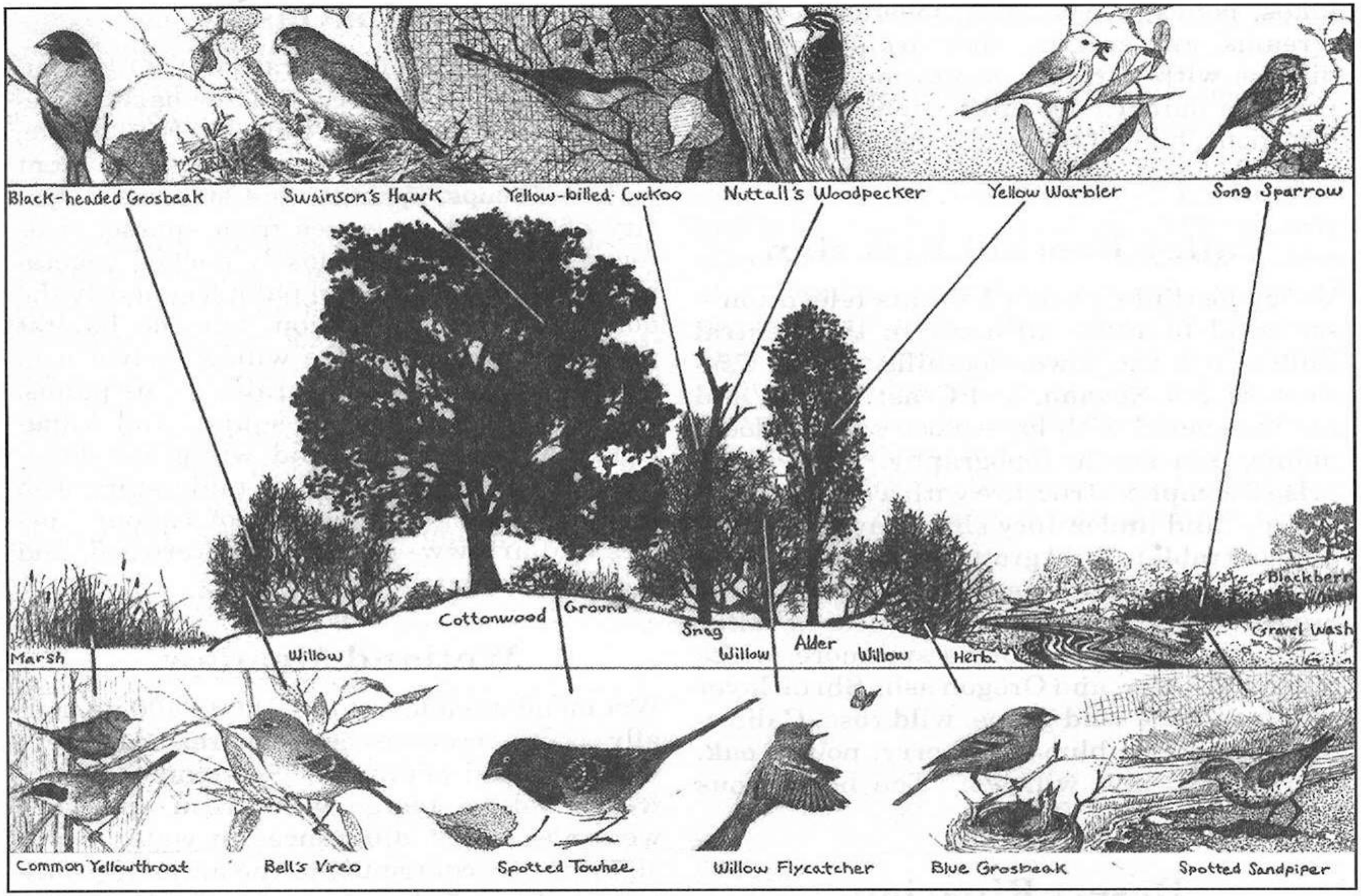

Figure 13. Riparian Songbirds and their Habitat Requirements (RHJV 2004).

Table 4. Summary of Neotropical Migrant Bird Habitat Requirements (RHJV 2004).

Bird Species	Territory/Patch Size	Proximity to Water	Vegetation Structure	Nesting	Species Presence
Least Bell's Vireo (*Vireo bellii pusillus*)	0.8-1.2 ha (2-3ac); >250m wide patch	Within 300m	Dense willow shrubs 3-5m tall; mugwort understory	Nest low, within 1m of ground	Extirpated Rare
Black-headed Grosbeak (*Pheucticus melanocephalus*)	200m x 50m	50-300m	Vertical complex - Cottonwood, willows, wild grape	Nest height 3-4m	Breeding Common
Blue Grosbeak (*Guiraca caerulea*)	----	In riparian zone	Low herbaceous, upright stems, open canopy	Nest height 0.6-3m	Breeding Rare
Common Yellow-throat (*Geothlypis trichas*)	0.4-2 ha (1-5 ac)	In riparian zone	Tall emergent wetland edges	Nest height 0-0.6m	Breeding Fairly Common
Song Sparrow (*Melospiza melodia*)	Variable	Near, within 50m	Open canopy; dense herbaceous layer; gumplant, evening primrose	Low to ground; <1m	Breeding Common
Swainson's Hawk (*Buteo swainsoni*)	Variable, depending on proximity to foraging habitat	Not riparian obligate	Tall trees in riparian zone near open foraging areas	Nest in tall trees	Breeding Fairly Common
Warbling Vireo (*Vireo gilvus*)	1.2 ha (3 ac)	Associated with streams	Large trees with semi-open canopy	Variable height	Breeding Fairly Common
Willow Flycatcher (*Empidonax traillii*)	<1.0 ha (<2.5 ac)	Nests near water	Dense willows; 0-3m height of dense cover, low tree cover	Nests near water; height 0.6-3m	Breeding Rare
Wilson's Warbler (*Wilsonia pusilla*)	0.4-1.2 ha (1-3 ac)	Nests near water	Willow, alder, and shrub thickets	Usually nests on ground	Breeding Fairly Common
Yellow-breasted Chat (*Icteria virens*)	<5 ha (<12 ac)	Prefers near wetlands	Dense thickets of willows and blackberries	Nests in vines and shrubs	Probable Breeder Rare
Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)	8-40 ha (19.8-98.8 ac)	Nests near or over water	Willow-cottonwood thickets	Nest 1.3-13m high	Extirpated Rare
Yellow Warbler (*Setophaga petechia)*	0.06-0.75 ha	Wet areas	Willows, cottonwoods, early Successional	----	Probable Breeder Fairly Common

IV. CONCEPTUAL SITE MODEL

This conceptual site model provides a synthesis of the site information and describes our current understanding of the physical and biological factors that influence the ecology of the site.

A. Past Environmental Conditions

Prior to the construction of Friant Dam in the 1940's, the Project area was still influenced by seasonal flooding. Lateral meander is evident by the deposition across the site. Remnants of a riparian corridor are visible along the river channel, but after the construction of Friant Dam, changes in hydrology reduced the connection of native vegetation to the water table and damaged floodplain connectivity. With the construction of the dam the river remained fixed over time in its current channel and native vegetation has not been able to endure on the majority of the Project area.

B. Likely Successional Patterns without Restoration

The San Joaquin River has been dammed and much of its flows are diverted into irrigation canals or pulled out for irrigation along the entirety of the river. Many riparian plant species rely upon seasonal flooding for mineral substrate deposition, seed dispersal, and seed germination. Because of the lack of flooding, natural regeneration of riparian forests at the Project area is limited. In addition, the uplands have been invaded by non-native annual grasses and weeds, which tend to outcompete native grasses by germinating sooner, extracting near-surface moisture, and creating a thick layer of mulch after setting seed which prevents most native species from receiving sunlight. Without the control of non-native annual grasses, the majority of the Project area will not be able to sustain the regeneration of native plants.

Without restoration, the site will provide unsuitable conditions and poor habitat for riparian obligate species, including the species being targeted by this conceptual design. In the absence of restoration, succession is likely to follow the pattern we have observed on abandoned floodplains on many Central Valley Rivers. Aggressive non-native species, such as pepperweed, sesbania, yellow star thistle, and annual grasses would compete for sunlight and moisture and competitively exclude native seedlings.

If restoration does not occur, the remnants of the riparian corridor will likely further recede without natural recruitment, and the extent and health of the existing plants would decline. The extent of riparian habitats would limit the number of avian species using the site for reproduction and migration. The patchy arrangement of mature tree specimens could facilitate avian nest parasitism by brown-headed cowbirds that would prevent expanded use of the site by listed or sensitive bird species such as the least Bell's vireo. Because brown-headed cowbirds prefer nest sites along the edges of forests, the fragmented patches of remnant habitat and thin bands of native forest types have created ample edge habitat which facilitates nest parasitism by the cowbird.

C. Comparison to Nearby Vegetation (Reference sites)

A fundamental component of a habitat opportunities analysis is the identification of reference sites. These sites act as guides for developing the list of species to be planted and their pattern across the restoration site. Due to the long history of human modifications to flow patterns and topography, undisturbed reference sites near Project site are virtually non-existent. Narrow bands of mature vegetation including Valley oak, sycamore, willows, and cottonwoods are found along the river's edge both up and downstream from the Project area. Most of the river's floodplain had already been used for agriculture by the early 1900's so it is difficult to determine plant composition.

Today, native riparian vegetation at the Project area occurs in narrow bands along the edge of water features. Sparse occurrences of valley oaks and native forbs are still found spread throughout the upper terrace. Stands of mixed willows and mulefat can still be found around certain low lying areas that hold water during spring and early summer. However, fewer native plants exist further away from water features. The plant communities of nearby lands contain similar vegetation as they have undergone similar histories.

D. Restoration Strategies

River Partners recommends the following strategies to implement habitat restoration on the Project site:

1. Employ active restoration techniques

Passive restoration involves minimal input to restore riparian forests including site preparation and managed flooding to mimic the historic recession limb of the annual hydrograph. Unfortunately, the natural hydrology of the San Joaquin River will never fully be restored. Additionally, non-native weeds germinate and rapidly outgrow tree seedlings, slowing their growth and eventually killing them through shading effects and competitive water use. This passive method has not been successful in the Central Valley for large-scale riparian restoration projects. The logistics of weed control in large-scale passive restoration would be prohibitively complex and expensive. Passive restoration typically results in forests of low species and structural diversity, which would limit wildlife value compared to a more diverse forest, composed of several species of trees and shrubs.

River Partners' active restoration technique employs modern farming techniques to efficiently and rapidly establish riparian vegetation. This type of restoration has been successful on over 8,000 acres of restored floodplain riparian habitats in the Sacramento and San Joaquin Valleys. Tasks include site preparation, native plant species propagation and planting, on-going weed control, and irrigation throughout the growing season for three to five years. Advantages of this method include the ability to conduct large-scale restoration resulting in diverse riparian vegetation and high quality wildlife habitat in a relatively short number of years. Since this method uses essentially the same techniques as those used to establish commercial orchards, overall costs can be reduced and local farmers, community groups, and volunteers can be used to carry out portions of the implementation, creating a great outreach benefit. River Partners' techniques have been adaptive and improved over time; for example, planting is in rows to allow efficient cultivation, but the rows are curvilinear so that the mature forests do not look like an agricultural orchard.

2. **Recognize current site conditions and management objectives**

The riparian vegetation to be restored is suggested with consideration of the current physical and biological site conditions (i.e., altered hydrology, weed pressure, etc.), wildlife needs, and plowing concerns. The target vegetation is not a “historical” endpoint, but is based on a pragmatic assessment of current site conditions (i.e., altered hydrology and weed pressure). Based on these conditions, approximately 149 acres of the site are suited for the rapid establishment of native riparian woody species and herbaceous understory species through active restoration and enhancement and 338 acres are suitable for native grassland restoration with scattered groves of drought resistant shrubs.

3. **Link existing habitat patches with restoration plantings to increase habitat connectivity**

Currently, the majority of available habitat is in thin bands along the main channel of San Joaquin River, as well two secondary channels that remain on the Project site. By enhancing this remaining habitat (weed treatment) and restoring areas between the remaining habitats, anthropogenic disturbance and edge effect will be reduced. This will enhance the quality of wildlife habitat.

4. **Consider multiple timeframes**

The restoration planting can have long- and short-term successional endpoints. For example, in the long run (greater than 30-80 years) some areas planted to mixed riparian forest will convert to oak woodland. In the meantime, the fast growing, but relatively short-lived plants (willows, coyote brush) will provide important habitat to threatened and endangered species (i.e. structure, cover, etc), while eventually the more shade-tolerant oaks will replace the more short-lived plants.

5. **Develop a phased planting plans based on multiple management objectives**

The phased planting plans are intended to provide a diversity of high quality habitat for targeted wildlife and reduce competition from invasive non-native species.

6. **Use an adaptive management approach for implementation of the project.**

River Partners recommends an adaptive management approach (River Partners 2008) to provide a framework to evaluate project progress and respond to new information. These practices have resulted in high plant survival rates, accelerated natural recruitment of native species (through changes in microclimate and presence of seed sources), and documented wildlife benefits in short periods of time (three years).

V. RESTORATION POTENTIAL

A. Ecological Benefits

Bird species expected to benefit from the restored habitat include multiple federally and state listed species such as the yellow-billed cuckoo, least Bell's vireo, Swainson's hawk. Enhancing vegetative cover and the moist microclimate necessary for invertebrates and herbaceous vegetation will create the niche that riparian obligate nesting bird species like the least Bell's vireo require. Adjacent uplands used by resident and migratory wildlife will also experience increased population levels with the increased diversity of floral species within a native grassland and oak woodland which may be used by the federally and state-listed San Joaquin kit fox by providing potential foraging and breeding habitat. Frequently inundated floodplains may provide abundant food resources and rearing habitat for juvenile Chinook salmon.

B. Design Considerations

The Project site will have four distinct components: enhancement of existing remnant riparian forests, restoration of native grassland communities, enhancement of wetland function, and improved floodplains for the rearing of juvenile Chinook salmon. Within the narrow band of remnant riparian forest, vegetation is sparse, and in some places it is currently being supplanted by invasive species. Desirable riparian vegetation can be established in areas where non-native vegetation will be removed, and in areas where natural regeneration is lacking. This could consist of tree, shrub, or grassland species, depending on the location and extent of surrounding vegetation. Revegetation of existing wetlands could improve their function by decreasing invasive nonnative vegetation and increasing wildlife habitat value. Enhancing native vegetation and removing non-native species within the floodplain should improve availability of food sources for rearing habitat of Central Valley spring-run Chinook salmon.

This site-specific planting design represents a synthesis of project objectives and site assessment. Based on the available information, the most influential factors on the design are:

- Depth to groundwater for riparian areas
- Existing remnant riparian vegetation
- The potential presence of riparian obligate and arid grassland wildlife

Table 5. Design Considerations for Habitat Restoration at the Project Site at GVGSP, Merced County, California.

Objective/Factor	Design Considerations
Comprehensive Objectives	
Provide immediate (< 3 years) and long term habitat benefits	**Lower terrace and along stream banks**: Mimic and supplement early successional riparian habitat (fast growing dense riparian forest) that typically follows large flood events. Plan for succession of slower growing species that mature into high canopy riparian forest, or replace senescent sycamores, willows and cottonwoods. **Upper terrace**: Provide rapid establishment of a mosaic of native

Objective/Factor	Design Considerations
	grasses. Maintain native broadleaf herbaceous species currently on site.
Provide habitat benefits that are compatible with passive recreation	Minimize disturbance during critical life stages for target wildlife species. For example, limit tree trimming for trail maintenance in the riparian areas to the bird non-breeding season (September – February) to reduce potential nest destruction.
Maintain general flood flow conveyance patterns and capacities	Orientation of planting rows will be parallel with the flow of flood waters.
Wildlife Objectives	
Maintain high plant species and vegetative structural diversity	Vary density across the site to allow light gaps and create structural differences (grouping trees together will create pockets of shade and light gaps), create vegetation patches (grouping small shrubs together will mimic larger plants and may attract desirable wildlife species faster than if they were grown apart), and install herbaceous plantings in the understory.
Improve habitat for Yellow-billed Cuckoo	Restore large tracts of suitable habitat. Promote large scale riparian habitat restoration.
Improve habitat for Least Bell's Vireo	Promote dense vegetation with low stature such as mule fat and various willow species. An understory of mugwort, gumplant and other herbaceous perennials are preferential to non-native annual grasses and annual weeds.
Improve habitat for Swainson's hawk	Protect mature native riparian trees. Restore riparian forests that will eventually increase potential nesting habitat. Control non-native invasive plants and restore native grasslands to improve foraging habitat.
Improve habitat for San Joaquin kit fox	Provide patches of dense coverage of grasses and shrubs in the upper terrace to promote denning. Activities which promote rodent populations will support San Joaquin kit fox populations.
Improve habitat for Central Valley spring-run Chinook salmon	Increase areas of frequently inundated floodplain in order to provide ideal rearing conditions for juvenile salmon. Potentially manage water levels in existing basins which connect directly to the river as rearing habitat for hatchery-raised juvenile salmon.
Improve habitat for tricolored blackbirds	Contour wetland slopes to a shallower grade in order to increase suitable space for emergent marsh vegetation.
Improve habitat for western spadefoot toad	Control non-native invasive plants and restore native grasslands to improve foraging habitat while maintaining varying depths of the wetlands in order to provide shallow pools during variable water years.
Improve habitat for neotropical songbirds.	Vary planting density across the riparian restoration areas to allow light gaps and create structural differences (create cover and open areas for bird species), create vegetation patches (grouping small shrubs together will mimic larger plants and may attract desirable species faster than if they were grown apart).

C. Proposed Plant Communities

The proposed plant communities for this project are based on the vegetation communities described by Holland (1986). The plants listed in a vegetation community type are closely tied to a common set of soil and hydrologic factors. Based on the site assessment, the Project area can support a variety of Mixed Riparian Forest and Native Grassland communities (Figure 14). Existing native species on site should be preserved wherever possible. Native perennial herbaceous plants found scattered throughout the project area that can be considered for collection and seeding to compete with invasive weeds.

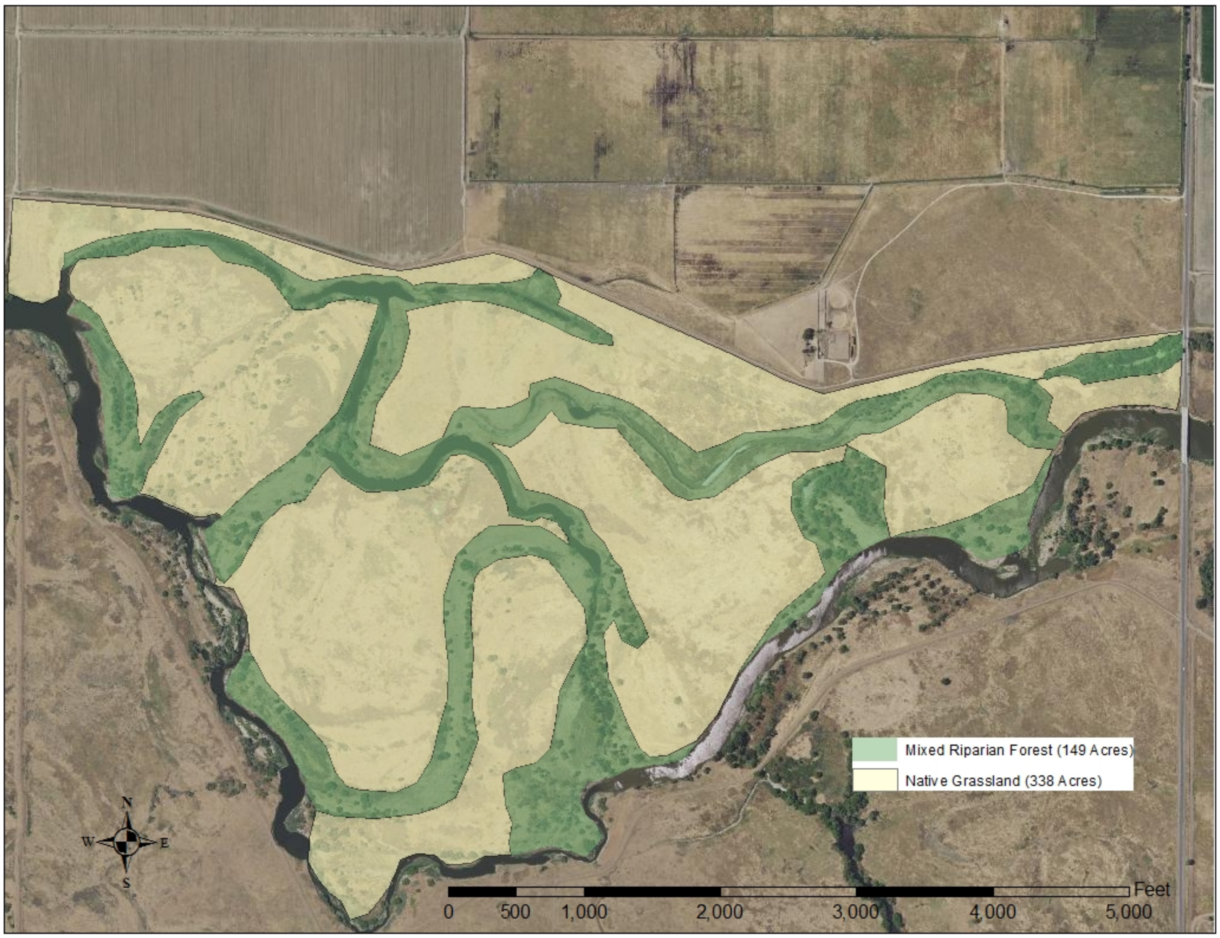

Figure 14. Potential Habitat Restoration Communities at Project Site at GVGSP, Merced County, California.

For the purpose of this Conceptual Design the targeted plant communities are defined based on broad descriptions. Prior to actual restoration work, the communities listed herein will be broken down into smaller subsets of the entire community as defined by Sawyer and Keeler-Wolf (1995), which will be called plant associations. For example, the Mixed Riparian Forest community could be subdivided into multiple related associations with differing plant design depending on site characteristics and management goals such as an arroyo willow thicket association that promotes nesting habitat for least Bell's vireo. More refined plant associations allow for more site-specific objectives to be reached, and better matches between plant species and local soil and hydrology information.

1. Great Valley Mixed Riparian Forest

Great Valley Mixed Riparian Forest occurs in remnant stands along the main San Joaquin River and side channels that cross the site as well seasonal ponds and wetlands. These areas experience the highest water table and the most surface water fluctuation, which is critical for the natural establishment of riparian vegetation. Historical aerial imagery shows that Great Valley Mixed Riparian Forest was denser around the wetlands, however, current conditions include large amounts of die-off most likely caused by the recent five-year historic drought.

Planting target trees and shrubs is the primary objective for this community type, however, establishment and management of understory grasses and herbs is also critical to success. The following table lists the overstory and understory species that may be used in restoration of this community type. It is not designed to be a comprehensive list of all species that may be used for restoration, but to provide suggestions for species trials. In the absence of flooding or other natural disturbance, regeneration will not occur naturally in this area. Restoration plantings should be designed to promote community succession from fast-growing willows and cottonwoods toward a sycamore-, valley oak-dominated stand in later years.

Table 6. Species composition for Great Valley Mixed Riparian Forest community at the Project Site at GVGSP, Merced County, California.

Overstory		***Understory***
Overstory composition	**Recommended density: 227 (16' x 12') plants per acre**	***Drought-tolerant***
8%	Valley oak (*Quercus lobata*)	Milkweed (*Asclepias fascicularis*)
6%	Western Sycamore *(Platanus racemosa*)	Coyote melon (*Cucurbita palmate*)
8%	Fremont's cottonwood (*Populus fremontii*)	California brome (*Bromus carinatus*)
5%	Black willow (*Salix gooddingii)*	Spikeweed (*Centromadia pungens*)
3%	Red willow (*Salix laevigata)*	Saltgrass (*Distichlis spicata*)
10%	Arroyo willow (*Salix lasiolepis)*	Deergrass (*Muhlenbergia rigens*)
4%	Oregon ash (*Fraxinus latifolius)*	Yellow monkey flower (*Mimulus guttatus*)
6%	Mulefat (*Baccharis salicifiolia*)	Jimsonweed (*Datura wrightii*)
8%	Quailbush (*Atriplex lentiformis*)	Gumplant (*Grindelia camporum*)
8%	California rose (*Rosa californica*)	Telegraph weed (*Heterotheca grandiflora*)
8%	California blackberry (*Rubus ursinus*)	Purple needlegrass (*Stipa pulchra*)

10%	Blue elderberry (*Sambucus mexicanus*)	Dove weed (*Croton setiger*)
8%	Buttonbush (*Cephalanthus occidentalis*)	Evening primrose (*Oenothera elata)*
8%	Coyote brush (*Baccharis pilularis*)	California poppy (*Eschscholzia californica*)
		Requires irrigation
		Mugwort (*Artemisia douglasiana*)
		*Santa Barbara sedge (*Carex barbarae*)
		*Goldenrod (*Euthamia occidentalis*)
		Creeping wildrye (*Elymus triticoides*)
		California melic (*Melica imperfecta*)
		One-sided bluegrass (*Poa secunda*)

*requires much irrigation – reserve for use in particularly wet or shady areas

2. Valley Needle Grassland

The restoration of Valley Needle Grassland is an important component to the conceptual restoration design for the Project site because of the proximity of listed fauna which utilized native grasslands and the threats of non-native grasses and invasive weeds. These weeds tend to out-compete native species and form monotypic stands with little value as wildlife habitat. Weed control and management activities during the restoration process will prevent these invasive species from re-establishing in the grasslands.

Seeding a dense and species-diverse grassland is the primary objective for this community type, as native grasses enhance wildlife habitat and reduce hazardous fire conditions. Table 10 lists the seeding rates for native grasses which should be planted with a no-till drill or broadcasting with racking in November or December for the first rains. It also lists species which should be planted as plugs. Plugs are an especially important method for cultivating plants that do not reproduce well by seed. The following list is not designed to be a comprehensive list of all species that may be used for restoration, but to provide suggestions for species trials.

Table 7. Species composition for Valley Needle Grassland at The Project Site at GVGSP, Merced County, California.

Seeding Rate (PLS)	Grassland seeds	Grassland plugs	Planting Density (plugs per acre)
3	Blue wildrye (*Elymus glaucus*)	Deergrass (*Muhlbergia rigens*)	435
4	Purple needlegrass (*Stipa pulchra*)	Saltgrass (*Distichlis spicata*)	435
3	One sided bluegrass (*Poa secunda*)		

D. Proposed Floodplain Enhancement Activities

The Project site at GVGSP offers a unique opportunity to improve floodplain off-channel rearing habitat for juvenile Central Valley spring-run Chinook salmon, which would directly support the San Joaquin River Restoration Program's effort to restore this species in the San Joaquin River. Seasonally inundated floodplains have been shown to provide the best growing conditions for juvenile Chinook salmon (Jeffries et al 2008) and have also been identified in the Chinook salmon recovery plan as an essential habitat element for their recovery (NMFS 2014). Seasonally inundated floodplains can provide ample phytoplankton and algae production (Ahearn et al 2006), which in turn supports an abundance of zooplankton that juvenile salmon feed upon. Opportunities for seasonally inundated floodplain restoration exist at the Project site, specifically along the main channel and both side channels (Figure 20).

1. Side Channels

Side channel habitats are generally small watered remnants of major river meanders across the floodplain. The presence of side channels, especially a series of side channels in various stages of succession, increases the diversity of aquatic habitat available within a stream corridor. Side channels have been found to provide critical habit for juvenile salmonids (Peterson 1982). Also, during flood events, side channels frequently offer aquatic species refuge from adverse mainstem conditions.

Similar efforts have already been underway on the Sacramento and San Joaquin rivers. Cal Trout, the UC Davis Center for Watershed Science, and the Department of Water Resources have been rearing juvenile salmon on agricultural fields since 2012 as part of the *Knaggs Ranch Experimental Agricultural Floodplain Habitat Investigation*, which assesses the growth rates of juvenile salmon within flooded agricultural floodplains compared to juveniles in the main stem of the river channel. Through this project, tens of thousands of juvenile salmon have been reared in rice fields which are designed in the same layout as the worm farm--basins which are interconnected by water checks which eventually drain into the river.

The Knaggs Ranch Project demonstrated that salmon reared on the floodplain grew 700% faster than salmon in the river and that zooplankton which juvenile salmon feed on was 14,900% greater per cubic meter of floodplain as compared to the river (CalTrout 2016). Research shows that salmon reared on floodplains have higher rates of growth and ultimately lead to a higher rate of survival as they migrate to the ocean (Sommer et al 2001). Not only could the flooded detention basins provide superior rearing habitat for juvenile salmon, a cost analysis could be performed to evaluate the cost effectiveness of raising salmon as compared to maintaining juveniles in the hatchery.

2. Floodplain Inundation

In order for the floodplains on the Project site to be ecologically significant for juvenile salmonids they would need to be graded down to an elevation which would be inundated for a minimum of three weeks between the months of January and May, when juvenile salmon are typically rearing (Merz et al 2013). This duration allows sufficient time for phytoplankton and subsequent food-web development needed for juvenile salmon to feed. Additionally, the floodplain should be at an elevation which inundates at least one out of every three years in order to ensure rearing habitat is available within the typical life cycle of Chinook salmon. The floodplain could be planted with native grasses and forbs that are adapted to frequent flooding such as creeping wildrye and mugwort.

In order to design an excavated floodplain, a hydraulic analysis would need to be completed to provide technical engineering design and evaluation. The analysis would need to model historical river flows at the project area in order to determine the elevation which would inundate during the rearing season, for the desired duration, and the desired frequency. This approach requires heavy inputs upfront, but would require minimal management over time.

VI. RESTORATION DESIGN

Riparian areas are critically important habitats that harbor a disproportionately high number of wildlife species and perform a greater number of ecological functions compared to most upland habitats. Riparian corridors connect all other habitats and are likely the single most important wildlife corridor in California.

As stated earlier in this document, the quality of the corridor habitat is not only dependent on the width of the corridor, but also the length, connectivity to larger patches of habitat, isolation from other quality habitat, and surrounding land use. Our restoration recommendations are based on habitat requirements currently known for the target wildlife species and an in-depth site evaluation. General recommendations for restoring the riparian corridor:

- Continuous corridors are better than fragmented corridors
- Wider corridors are better than narrow corridors
- Structurally diverse corridors are better than corridors with little structural diversity
- Diverse native grasslands provide better habitat than non-native annual grasslands

A. Restoration Priorities

Limited resources make prioritization of restoration important. Several factors influence the priorities for restoration and most are typically geographical in scope, revolve around permitting needs, or are based on implementation costs. They include:

- Proximity to remnant riparian habitat
- Security of water supply, matching irrigation demands to restoration plans while minimizing irrigation costs
- Amount of resources and time needed to permit restoration actions;
- Ensuring the conceptual restoration design does not interfere any of the potential recreation
- Ensuring restoration activities can be demonstrably successful

Riparian communities targeted in this Plan require irrigation for establishment (3-5 years). Two water supplies options exist for this Project (i.e. river or shallow well), however either source would require the installation of a new pump as well as a reconnection to the electrical lines. Restoration planning must proceed with consideration of water supply rights, availability, and cost efficiency in pumping, piping, and other irrigation infrastructure. Phasing of the restoration will be necessary to overcome this limitation.

B. Restoration Design

This Plan combines site investigations of hydrology, prior land use, disturbance regimes, soils, current and historic vegetation patterns, current and historic wildlife communities, and recreation objectives of the GVGSP to provide a comprehensive strategy for habitat restoration. Potential obstacles were identified and are presented in the implementation section below. Successful restoration of habitats at the Project site will require additional efforts in funding, planning, and coordination amongst conservation organizations, agency personnel, California Department of Fish and Wildlife and the California State Parks.

Restoring a riparian corridor along the waterways crossing the Project area would provide 149 acres of new habitat for a suite of threatened riparian-dependent species. Promotion of species habitat should be done in concert with responsible management of current and future public recreation on or around the site.

Restoring and enhancing a native grassland community would provide 238 acres of new habitat and offer a unique opportunity to promote conservation of an ecosystem that could provide the opportunity for future recreation opportunities.

Additionally, weed control efforts would minimize the spread of non-native species throughout the project area, which would complement any active restoration activities.

C. Restoration Benefits

1. Conservation ecology

A number of threatened and endangered species stand to benefit greatly from restoration proposed in this Plan. The habitat types targeted for restoration have been restricted in their extent by altered hydrology and weed pressure. They support communities of threatened wildlife species who synergistically benefit from aptly designed restoration plantings. The conceptual restoration design presented here includes considerations for multiple special status wildlife species, and may provide additional benefits non-target residential and migratory wildlife (See Section 3).

2. Climate change

Restoration of the riparian corridor and native grasslands of the Project area will enhance a migratory corridor for wildlife that will become even more critical as global temperatures continue to rise. Additionally, tree growth sequesters carbon, leading to reductions in atmospheric carbon dioxide, a greenhouse gas. River Partners has been working with the US Fish and Wildlife Service and Winrock International to determine rates of carbon sequestration for planted riparian tree species (Pearson et.al. 2008). The carbon offset from restoration may be leveraged to gain additional funds for restoration in the form of carbon credit sales or revenues.

3. Regional conservation efforts

The Project site is situated within the GVGSP and Grasslands Ecological Area, which supports the largest remaining block of wetlands in the Central Valley, containing 70,000 acres of private wetlands and 53,000 acres of state and federal lands. These wetlands and associated grasslands, complemented by two national wildlife refuges and four state wildlife areas, comprise over 160,000 acres and are collectively known as the Grasslands Ecological Area (GEA).

The GEA is extremely important to Pacific Flyway populations of 19 species of ducks and 6 species of goose.

4. Recreation

GVGSP allows for low impact outdoor recreation for park visitors in the form of hiking, wildlife viewing, fishing, boating and other day use activities. Enhanced wildlife habitat along and adjacent the San Joaquin River will improve recreation opportunities at the Project site, as well as the surrounding areas.

VII. PROJECT IMPLEMENTATION

Ideal implementation of restoration would be rapid and large scale. Rapid, large scale projects benefit from economies of scale in that costs to mobilize, permit, and plan are expended once as opposed to many times. Rapid and large scale projects benefit wildlife populations by creating large blocks of contiguous habitat faster than piecemeal, smaller efforts. The response of wildlife, especially riparian songbirds, to large scale restoration has been documented by Point Reyes Bird Observatory Conservation

Science over years of restoration monitoring on the Sacramento and San Joaquin Rivers (Gardali et.al. 2005). They report incredible species response within just one to two years of restoration. Large scale implementation, however requires large amounts of capital at once, and suffers from limited ability to learn from previous mistakes. The realities of water management, permitting, current land uses and funding opportunities at the project site demand that restoration be undertaken in several phases. Larger, more comprehensive restoration projects are preferred to small ones; however all restoration efforts guided by this Plan will be beneficial to wildlife and people. Implementation strategies identified for this Plan are provided below.

A. Permitting

Restoration of wildlife habitats is generally exempt from the California Environmental Quality Act (CEQA) and the National Environmental Protection Act (NEPA) under standard or categorical exemptions related to minor disturbances and beneficial uses. The proposed restoration involves a wide area and a number of project elements that may trigger CEQA or NEPA review/initial studies/negative declarations, prior to discretionary approval of the project or its funding.

Restoration work done within the active stream channel or along other Jurisdictional Waters of the U.S. (e.g. ponds and wetlands) is subject to review by the US Army Corps of Engineers under Section 404 of the Clean Water Act (CWA), and the Regional Water Quality Control Board under Section 401 of the CWA. Generally restoration actions are allowed without permits so long as they do not impact (directly or indirectly) Waters of the U.S. or Waters of the State. However, if contouring is performed along wetland or pond edges, impacts would occur.

Restoration work done within the banks of the river, or within remnant riparian areas is subject to review by the California Department of Fish and Wildlife under Section 1600 of the Fish and Wildlife Code. Generally, restoration actions are allowed so long as they do not negatively impact the existing high-quality habitat. A 1600 agreement may be required for any streambed alteration, however the agreement’s requirements may be less rigorous if there are no negative impacts on existing habitat.

Restoration work done within the designated floodway requires concurrence with the Central Valley Flood Protection Board, and likely an encroachment permit. The entire Project site is located within the designated floodway and an encroachment permit is necessary for plantings in this area. Plantings done within the designated floodway must be demonstrated to the Flood Board to cause no impediment to the conveyance of flood flows across the site. Alternative planting designs, species selection and planting densities would be reviewed by a civil engineer to determine the effects of restoration work on flood conveyance. Researchers at UC Davis have studied the effects of some native riparian species on flood flows in an experimental flume. They have found that certain species (specifically California blackberry, California rose, and sandbar willow) provide no impediment to flood conveyance under high velocities (Kavvas et.al. 2009). Additionally, plantings that run parallel to flood flows and plantings that maintain a low plant density have less likelihood of obstruction flood flows. Detailed plans would be written to accommodate flood flows in the designated floodway.

Any activities that may impact federal or state protected species or their habitats must go through consultation with US Fish and Wildlife Service, and/or CDFW. The San Joaquin River Restoration Program is working to restore Chinook salmon within the river and restoration activities may require concurrence from the National Marines Fisheries Service.

B. Site Specific Planting Plans

Site specific planting plans will be prepared for the individual projects that contribute toward restoration of the Project area. Site specific planting plans will require a review of soil, hydrology, and vegetation data, especially if the current drought conditions continue. Each site-specific planting plan will include the following pieces of information: goals, planning considerations (ecological, permitting, target wildlife species, implementation challenges), project area, planting layout, scheduled plant establishment activities, adaptive management approach, monitoring plan, reporting requirements, and post-project maintenance. Table 9 summarizes the components of a restoration plan.

C. Site Preparation

Various site preparation tasks are necessary for restoration on a typical site. The entire planting site would typically be disked to a depth of 12 inches, to bury the weed mulch. However, to maintain the intergrety of the Project site a burn and mowing strategy would be adopted to inhibit non-native grasses and weeds from outcompeting native species. Additionally, River Partners recommends that a qualified archeologist conduct a cultural resource investigation prior to any ground-disturbing activities.

Table 8. Components of a Typical Restoration Plan.

Restoration Plan Component and Description
Plant Design - The planting palette is defined for various target plant communities. The planting design includes field layouts showing the locations of various target plant communities throughout the project site, the species composition of each planting community (target percentage of species in each community), and the planting layout for each community. Understory seeding and planting is described for each community including the target seeding rate and species composition as well as propagule type and local source availability / collection capacity considerations for each species.
Plant Establishment Plan - Scheduled plant establishment recommendations include anticipated weed control and irrigation strategies depending upon current site conditions. Contingencies for unforeseen circumstances should be addressed.
Monitoring Plan - The monitoring plan includes sufficient detail to allow researchers to revisit the plantings and collect the necessary data to report significant performance metrics for the site. Typical performance metrics include species survivorship, species growth (canopy width and height), and absolute and relative cover of understory species.

Restoration Plan Component and Description
• The monitoring plan may include surveys for target wildlife species that serve as indicators of ecosystem function (i.e. neotropical migratory songbirds and resident riparian-dependent bird species) or that are targeted by regional or local recovery plans (i.e. threatened or endangered species). Wildlife surveys are generally performed by qualified conservation organizations, endangered species recovery programs, or university researchers.
Timeline – A typical timeline for restoration is included as a basic guide in this plan. Target dates for site assessment, field preparation, irrigation installation, plant procurement, planting, plant establishment, and monitoring are presented (Table 15).

D. Irrigation Design

The layout of planting rows and irrigation system should be designed to allow flood flow conveyance to pass through the restoration site without raising water elevations while also accommodating equipment needs, such as the width of the mower that will control weeds in the aisles. All woody trees and shrubs should be planted in rows that will be oriented parallel to flood flows, roughly north to south. Planting rows should be spaced 16 feet apart, while plants within each row should be planted at 12 foot spacing. However, rows should be installed in a curvilinear design in order to prevent the mature plantings form looking like an orchard. Plants should be irrigated utilizing a drip irrigation system with inline emitters. Each plant should have three 0.5 gph emitters spaced at 18 inches in order to ensure an adequate wetted area for root establishment.

E. Plant Material Collection and Propagation

Native materials collected locally should be used for all habitat restoration at the Project site. Native genotypes are adapted to local conditions and are more suited to the ecosystem at the Project area than generic nursery stock. Native planting material for many of the plant species can be collected on-site with minimal impact to the remnant vegetation. Table 10 summarizes the recommended propagation method for many of the species in this conceptual restoration plan.

Table 9. Recommended Propagation and Planting Methods for Native Plant Material at The Project Site at GVGSP, Merced County, California.

Species	Propagule source and recommended planting method
Mugwort (*Artemisia douglasiana*)	Preserve-collected seed or plugs, broadcast or planted
Milkweed (*Asclepias fascicularis*)	Preserve-collected seed, broadcast
Quailbush (*Atriplex lentiformis*)	Preserve-collected cuttings, seed grown out in containers
Coyote brush (*Baccharis pilularis*)	Preserve-collected seed, grown out in containers
Mulefat (*Baccharis salicifolia*)	Preserve-collected seed, grown out in containers
Spikeweed (*Centromadia pungens*)	Preserve-collected seed, broadcast
Buttonbush (*Cephalanthus occidentalis*)	Preserve-collected cuttings
Saltgrass (*Distichlis spicata*)	Preserve-collected plugs

Species	Propagule source and recommended planting method
Goldenrod (*Euthamia occidentalis*)	Preserve-collected seed, broadcast
Oregon ash (*Fraxinus latifolius*)	Preserve-collected seed, grown out in containers
Gumplant (*Grindelia camporum*)	Preserve-collected seed, broadcast
Evening primrose (*Oenothera elata*)	Preserve-collected seed, broadcast
Western sycamore (*Platanus racemosa*)	Preserve-collected live green cuttings, grown out in containers
Fremont's cottonwood (*Populus fremontii*)	Preserve-collected cuttings
Valley oak (*Quercus lobate*)	Locally collected seed, grown out in containers
California rose (*Rosa californica)*	Preserve-collected seed, grown out in containers
California blackberry (*Rubus ursinus*)	Preserve-collected seed, grown out in containers
Black willow (*Salix gooddingii)*	Preserve-collected cuttings
Red willow (*Salix laevigata)*	Preserve-collected cuttings
Arroyo willow (*Salix lasiolepis)*	Preserve-collected cuttings
Blue elderberry (*Sambucus mexicanus)*	Preserve-collected seed, grown out in containers

Plants should be installed with consideration of anticipated management. For example, weeds respond to localize moisture conditions (such as those around a drip emitter) and require weed control. Hand pulling of weeds around planted trees and shrubs is laborious and inefficient. Planting tree and shrub saplings or cuttings with a disposable protector (such as a milk carton) allows the use of localized herbicide application without damaging the plant. Mulch or the use of weed mat materials can be effective at minimizing weed growth around the drip emitters as well. Additionally, planting trees and shrubs with enough space between to drive a riding mower allows for efficient application of a repeated mowing regime which can be very effective against annual weeds, promoting the growth of desirable native perennials, or repeated herbicide applications which can be very effective against annual grasses while minimizing soil disturbance.

Understory plantings have been broken into two categories in this Analysis: drought tolerant and requires irrigation. Species that are drought tolerant may be seeded into the areas outside the influence of the drip irrigation system. They should be seeded onto a raked planting bed to promote contact with mineral soil. Seeding should occur following the first rains to benefit from natural irrigation. Areas seeded should be treated with repeated mowing's or targeted herbicide applications to decrease competition with annual grasses and weeds. Species identified as requiring irrigation should be planted or seeded within the influence of drip emitters. This may require mulching around desirable plants. Plants can also be protected with a milk carton to allow for herbicide application within this area. Considerations for efficient weed management with installation of understory plants are critical to success of understory plantings. It is expected that as trees and shrubs grow over time, their shade will promote favorable moisture conditions for the expansion of understory plantings into the spaces between plants, thus the diversity and spatial arrangement of plantings will not remain as planted for many years following restoration.

F. Maintenance

1. Irrigation

Because of the dry summers typical of the climate in the area, irrigation will be required. Irrigation will be applied with the goal that plants will become self-sufficient after the third growing season. Irrigation for the plantings should be designed with efficiency in cost and operation in mind. Drip emitters at each plant are efficient in water and power usage. Water could be pumped from the river if water rights are available. Pumps could be run if power could be power lines adjacent the Project area. Project-specific details of irrigation and power supply should be laid out in a site-specific planting plan.

In the first growing season, the rapidly growing seedlings have roots only in the surface (the top 1-2 feet) of the soil profile. The rooting zone must be kept moist through the season to ensure optimum growth and survival. On loam soils, a frequency of once every 7 days is sufficient; irrigation on sandy soils may need to be more frequent. The intervals between irrigations are dependent upon soil texture, depth to water table, the weather conditions, and plant water stress. Because a mixture of species with different water demands is proposed, the plants would be carefully observed to maintain a balance of soil moisture that is acceptable for xeric species like valley oak and elderberry as well as more mesic species like sandbar and red willow.

The strategy for the second and third year is to train the roots to grow deep toward the water table. Roots at depth (15-20 feet) may be able to tap into the water table on the site and out-compete more shallow-rooted weeds. Less frequent deep watering will encourage roots to grow deeper, well below the roots of the weeds, allowing the woody species exclusive use of available deep moisture. As the tree’s roots grow deeper, the time between irrigations become longer, allowing the soil surface layers to dry, and thereby reducing weed vigor.

2. Weed control

Weed control is the largest challenge facing restoration practitioners today. The Project site currently host several problematic weeds including pepperweed, cocklebur, yellow star thistle, sesbania, as well as several non-native grass species. To control these weeds, an initial controlled burn would be suggested and the adoption of a mowing regime to control the ability of the weeds and non-native grasses from going to seed for the two-three growing seasons to allow the newly planted vegetation communities to become established.

3. Plant protectors

Plant protectors that protect young plants from herbicide spray can greatly enhance cost efficiencies by allowing for quick application of herbicides to recruiting weeds. Often misprinted milk cartons can be used for this purpose. Milk cartons should be stapled to a wooden stake and driven into the ground around a newly planted individual. The milk carton is fully biodegradable making collection and disposal unnecessary. Milk carton plant protectors provide little protection from large herbivores like cattle and deer. Approximately 4 inches of wood shavings can be applied as mulch around each plant to hold soil moisture and minimize weed growth.

4. Herbivore Control

Herbivores can have a large impact on young plants. A number of measures can help control or minimize their effects (Table 11). Cultural practices such as mowing or spraying can discourage most of these herbivores. One of the advantages of active restoration is that typically, more plants are planted than the herbivores can eat. Mortality of plants is expected to occur over time and is built into the planting design. Some damage by herbivores is tolerable and will not necessarily impact the success of the planting.

Table 10. Summary of herbivore control methods.

Herbivore	Type of Damage	Comment on measure(s) or plant response
Voles (*Microtus californicus*)	Eat bark and cambium at the base of sapling, usually girdling the entire stem. Dig-up and eat recently planted acorns.	Saplings resprout, unless vole population is high. Voles live only in dense herbaceous (weed) cover and never stop moving when in the open to avoid predators. Remove dense weed cover through herbicides or mowing. Installation of raptor perches can encourage predation and keep vole populations under control.
Pocket Gophers (*Thomomys bottae)*	Eat root systems (probably killing more saplings than any other vertebrate pest).	Control of weed cover allows predators to hunt gophers. However, gophers can persist in an open, weed-free field. A variety of birds will prey on gophers if given the opportunity. Raptor perches and owl boxes may increase predation.
Ground Squirrels (*Otospermophilus beecheyi*)	Dig up and shred plants and protectors.	Flooding or disking can reduce populations.
Rabbits and Hares	Browse early spring growth.	Plant protectors will keep the browsing on new plants to a minimum. Plants should resprout with light browsing.
California Mule Deer (*Odocoileus hemionus*)	Browse new plant growth.	New plantings should resprout with light browsing. If excessive damage persists control measures will need to be addressed.

5. Monitoring

Monitoring and recording management activities and plant response is critical in the adaptive management framework. It is important to respond to new information and changing conditions in order to “close the loop” between monitoring and Project implementation. All specific planting plans for the Project site should include a monitoring and reporting component to address the implementation of the restoration (survivorship, growth, and plant response to management).

6. Adaptive Management

Adaptive management is critical in the effective implementation of this project. From grant writing to weed control, being adaptive in project management requires paying careful attention to successes and failures, and learning from those mistakes. Figure 15 presents a general overview of the adaptive management process. Table 12 provides a general timeline for implementation of a typical 3-year restoration project.

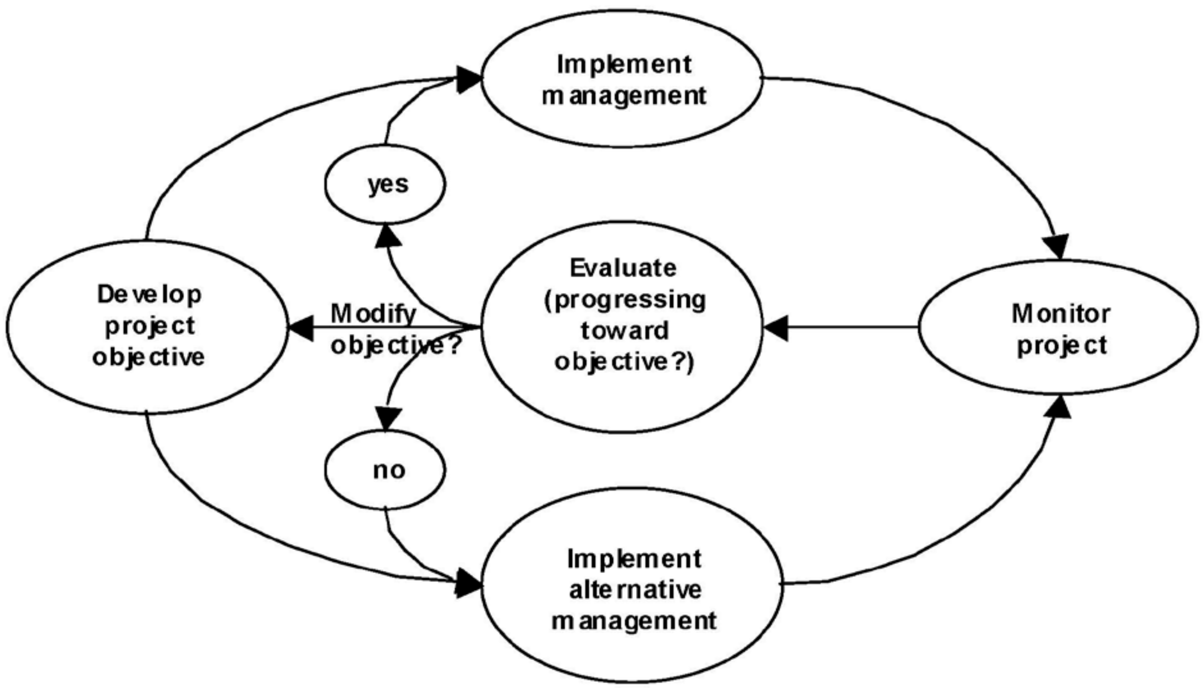

Figure 15. Adaptive Management Model

Table 11. General timeline for restoration implementation

Task	Year 1				Year 2				Year 3			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Planning/Permitting												
Field Preparation												
Planting												
Plant establishment												
Monitoring												
Project Management												

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