Title
Salinas River: Historical context, maintenance, and biodiversity

Author
Gonzalez, Maria Fernanda

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MaFe Gonzalez*

*Graduate Student, MLA 3D, Restoration of rivers and stream (LA 227), Fall 2020, UC Berkeley

Abstract

The Salinas River is the longest river in the California central coast region and its valley is one of the most productive agricultural regions in the United States. Historically, the river was a dynamic and complex system with frequent flooding cycles and a broad range of habitat types. Currently, the river is densely surrounded by agricultural fields, disconnected from the floodplains, and restricted to a narrow strip of riparian vegetation. Despite all these transformations, the Salinas valley occasionally experiences some flooding events that affect the agricultural fields. In response to this, the Salinas River Channel Maintenance Program was developed in 2014 to allow regular maintenance activities along the channel. These activities mainly include the removal of vegetation to open secondary channels and decrease the risk of flooding. While the program has a goal of restoring the dynamics and complexity of the Salinas River, recovering elements of the past multi-channel condition, the removal of vegetation can have significant impacts on the narrow remnants of natural habitat. In November 2020, I conducted a rapid exploration of riparian habitats in three sites along the river near the town of Salinas. My intention was to learn more about the composition and structure of riparian vegetation. In the process of documenting the vegetation, I documented a lack of lateral connectivity in both ecological and social senses, and an overall low ecological quality of this narrow strip of vegetation. However, I observed spontaneous uses by local residents, and wildlife using the river corridor, which represents the only available habitat for many species. The Salinas River has been neglected and encroached upon for decades, yet even in its much-reduced state it still evinces tremendous ecological values. Investing just a little bit more in this place could have great potential to improve ecological, recreational, cultural, and water quality services to nearby communities. The current maintenance program can be improved to better balance restoration and flood conveyance.

Introduction

Riparian areas support unique and complex ecological communities. They are considered hotspots of biodiversity, even under high levels of fragmentation (Stella et al. 2013, Young-Mathews et al. 2010). They are the only available habitat for species susceptible to disturbance and are also ideal for more resilient species that take advantage of edge effects (such as pioneer species). They also allow continuous interactions between aquatic and upland terrestrial ecosystems through exchange of energy, nutrients, and species (Poff et al. 2012). They form important mosaics, communities and environments that together maintain the functional and structural connectivity within the larger landscape (Fernandes et al. 2010).

Riparian vegetation occupies a relatively small area in the world but is a key landscape element (Stella et al. 2013). Usually this vegetation composes elongated patches, with a wide range of sizes, along rivers and streams, composing corridors or islands rich in resources in the middle of homogeneous human-dominated landscapes. The most severe human impacts on riparian vegetation are from land-use conversion to agriculture, streamflow regulation, and climate change (Stella et al. 2013, Poff et al. 2012). Agricultural crops constitute the world's largest terrestrial biome, currently occupying ~40% of the Earth's land surface, and it is forecasted to undergo substantial intensification and expansion (Stehle and Schulz 2015). Agiculture can result in the degradation of adjacent streams and riparian ecosystems through impacts such as nutrient enrichment, groundwater depletion, sedimentation, pesticides, and deforestation (Hunt 2016, Matthaei et al. 2010). This makes agricultural landscapes one of the most important contexts for ecological restoration. Stream corridors can be managed to maintain ecological connectivity through the agricultural matrix to ensure processes such as dispersion, which lead to increased genetic diversity and consequently increased capacity for adaptation and resilience to disturbances.

Salinas River watershed includes 200,000 acres of irrigated agriculture. The climate and rich soil of the Salinas Valley are ideal to support the high productive agricultural industry that characterizes the region, known as the “Salad Bowl of the Nation.” Most of the United States lettuce, broccoli, artichokes, strawberries, and cauliflower are produced in the Salinas Valley (RCDMC 2020). After a century and a half of the valley bottom's conversion to agricultural and urban uses, the Salinas River's riparian corridor has been significantly narrowed and its diverse habitats have been altered and affected by fragmentation, irrigation, excessive discharge of nutrients and pesticides, and stabilization of water flows. So, along the river it is possible to observe eutrophication processes, patches of vegetation in early successional states, patches of invasive or introduced species such as *Arundo* and *Eucalyptus*, sections of the channel with interrupted lateral and longitudinal flows due to the construction of dams and levees, among others (Meyers 2018, MCWRA 2019, RCDMC 2020).

My goals with this project were to review the historical context and the current management program of the Salinas River, and to make a quick exploration about the composition and structure of the riparian vegetation. I conducted a literature review and surveyed plant cross sections in three zones to assess the current habitat conditions. The research problem I addressed was how the riparian vegetation had responded to the agricultural pression in this place. My research questions were: 1) What is the historical context of the Salinas River? 2) What are the current river management strategies? 3) What is the status (composition and structure) of the riparian vegetation in the Low Salinas River?

Methods

Study area

The Salinas River is the largest river in California's Central Coast Region. It is 170 miles long and drains an area of approximately 4,200 square miles. The headwaters of the Salinas river are in the La Panza Range in San Luis Obispo County. The Salinas River flows northwest through the Salinas Valley in Monterey County. The river drains to both the Salinas River Lagoon and the Moss Landing Harbor through the Old Salinas River Channel. They empty into the Monterey Bay National Marine Sanctuary (Figure 1).

Salinas River is a working river. It is mainly used to move the water from the Nacimiento and San Antonio reservoirs to all the towns and farms that are in the valley. These reservoirs are managed for the combined goals of flood protection, water conservation, Salinas Valley Water Project operation, and recreation with safety always being the primary consideration. Both dams and are owned and operated by the Monterey County Water Resources Agency (MCWRA). The operation of the reservoirs as related to flood control, water conservation, and recreation is guided by the Reservoir Operations Committee which provides recommendations to the MCWRA Board of Directors and the Salinas Valley Water Project Flow Prescription for Steelhead Trout in the Salinas River (MCWRA 2020). The riparian corridor along the river is simply a leftover in the agricultural landscape.

Literature review

I researched the historical context based on the document "Historical ecology reconnaissance for the lower Salinas River" prepared by the San Francisco Estuary Institute for The Nature Conservancy Monterey County Project in 2009. This document included maps, photographs, textual documents, contemporary data, and aerial imagery related to the lower Salinas River. I conducted the research on maintenance activities by reviewing websites related to the Salinas River Stream Maintenance Program (California State University Monterey Bay, Resource Conservation District of Monterey County), and annual reports to Central Coast Regional Water Quality Control Board. I also interviewed Joanna Devers, Executive Director of the Salinas River Stream Maintenance Program.

Vegetation survey

For this study, I chose to sample the riparian vegetation at three sites (zone 1, zone 2 and zone 3, Figure 2) near the town of Salinas according to the following criteria: 1) site was on public property or on private property with access permission, 2) site was accessible on foot within a reasonable distance from the main roads, and 3) site was surrounded by agricultural fields.
I performed the vegetation survey on November 6, 7 and 8, 2020. My primary objective was to understand patterns of plant species (woody and herbaceous) richness, relative abundance, and

state of succession. I sampled one cross-section in each site to obtain a general idea about the riparian vegetation conditions. In total I conducted three cross-sections 200 feet/60 meters long, following the California Rapid Assessment Method for wetlands and riparian areas (CRAM 2012). At each site I estimated the water velocity (I measured the time it took an orange peel to move nine feet) and the channel depth. I also described soil conditions, slopes, understory and groundcover layers, evidence of disturbance or restoration projects, wildlife observations and spontaneous uses by locals.

I set the cross sections up using a 200-feet tape. For each plant registered in the section I took the following data on the field sheets: transect location, genus, species, collection number (ID), type (herb, shrub, tree), number of stems observed, diameter at breast height (DBH, if DBH greater than 0.4 inches) and height. I also registered invasive and aquatic plants. I took photos at each site, including channel banks, vegetation structure and key plant features. During the field work I identified the plants to families and genera, posteriorly I used the collected specimens to review the taxonomic keys available in *Jepson Manual* and photos available in digital collections (The University and Jepson Herbaria), databases (TROPICOS) and iNaturalist.

Due to time constraints, difficulties with access to information, interviews, and sampling sites, I was unable to produce a statistically rigorous data sample. So, I presented in this study a qualitative analysis, based on my own interpretations of the sites, and a quantitative analysis with the counts I made in each site. I included graphs, charts, and tables for the analysis of the results.

Results

Literature review - Historical context

Channel Morphology. Salinas River morphology was composed by sets of broad benches bounding the river. These benches were often called “bottomland”, clarifying the difference between “low bottoms” -immediately adjacent to the riverbed and subject to periodic flooding -, and higher terraces or “high bottoms” -representing previous floodplain levels of the river-

(Beller et al. 2009). The riverbed was a sandy, broad channel up to about a half mile wide, bare or sparsely vegetated with willows and grasses. The adjacent bottomland was well-vegetated by willows, cottonwoods, brush, grasses, and some oaks. The bottomland, older, higher terraces were covered by grasses, and in later years, by dense mustard. This complex set of terraces with different widths and heights would have experienced different frequencies and depths of inundation by river floods (Beller et al. 2009) (Figure 3). This morphology fit very well with agricultural needs, and therefore there have been a lot of tensions between the ecological and economic values of the Salinas Valley.

Channel Geometry. The historical riverbed elevation was well below the valley floor for a long time. Eighteenth-century explorers noted steep riverbanks along the river and some surveyors recorded riverbanks from 4 to 25 feet high (Beller et al. 2009). The width of the sandy riverbed varied widely across the river, from very narrow (less than 100 feet wide) to over 2,600 feet (Beller et al. 2009).

Channel Migration. The Salinas River is constrained by mountains on both sides of the valley and the alluvial fans of major tributaries, and its channel bed and floodplain were constantly scouring and rebuilding (Beller et al. 2009). Channel migration and meander cutoffs led to a diverse variety of riparian habitats, including riparian forest of different ages, and wetlands occupying abandoned channel segments. Currently, migration is confined to a relatively small portion of the Salinas Valley (Beller et al. 2009).

Riparian Habitats. Extensive and dense riparian vegetation along the Salinas River occurred on low bottomland benches adjacent to the sandy, high-flow river channel. These areas were composed predominantly by willows. Riparian forests were common along one or both sides of the river, commonly 500 to 3,000 feet wide (Beller et al. 2009) (Figure 4).

Riparian Species. Willows are the dominant tree species in many parts of the riparian corridor. However, many other species of trees, brushes, and grasses were associated with the riparian corridor. Fremont and black cottonwoods were repeatedly mentioned in narrative descriptions, sometimes even as a dominant species (Beller et al. 2009).

Flow. The Salinas River was subject to considerable seasonal variability in average flows, and inter-annual variability in maximum wet season flows and minimum dry season flows. During floods, the sediment-laden Salinas would overflow its banks onto the adjacent bottomland (Beller et al. 2009). There is little evidence that the river would dry up completely in the summer, however after groundwater pumping and surface diversions begun in the Salinas Valley, large areas of sand are exposed during the summer.

Flooding. Throughout the 20th Century the Salinas Valley experienced several floods that greatly impacted the surrounding towns and agricultural lands (Figure 5). In response, the Monterey County Water Resources Agency (MCWRA) obtained a master permit in 1995 allowing landowners and growers to perform maintenance work along the Salinas River to reduce the risks associated with flooding. In 2008, the permitting changed and the MCWRA was required to develop a new program and obtain new permits.

Literature review - Maintenance program

The Salinas River Stream Maintenance Program (SMP) began in 2014 in response to flooding events in previous years that have damaged agricultural crops along the river corridor. The program is in practice and incorporates a cooperative planning and design process among technical experts, agencies, municipalities, landowners, and growers to establish a flood risk reduction and habitat enhancement approach for the majority of the Salinas River. This is achieved through vegetation maintenance, sediment management, and non-native vegetation (mainly Arundo) removal through mowing primarily in designated secondary or high flow channels outside of the low flow channel (Meyers 2018, MCWRA 2019) (Figure 6).

In 2014, a demonstration project of the SMP was initiated on two stretches of river near Chualar and Gonzales (south of the City of Salinas) comprising a total of 11.5 river miles. In 2016, the SMP expanded to include most of the river's length (92 miles) in Monterey County, and has since been operating annually. Participation in the program is voluntary, and the work is primarily funded by the participants (typically landowners, growers, and municipalities) with some supplemental grant funding (RCDMC 2020).

Although most of the documents in the program propose to reduce the risk of flooding while enhancing the habitat, the interview I conducted with Joanna Devers allowed me to understand more clearly the basis of the program. The entire program was motivated by the goal of avoiding economic losses in the agricultural industry. Protecting and enhancing ecological conditions of the Salinas River is a necessary requirement to permit the flood management actions. However, the removal of vegetation is accomplished with heavy machinery and herbicides, which can cause significant impacts on the narrow remnants of natural habitat.

SMP carries out on an annual basis habitat assessment surveys (transect surveys for special status species and their habitats) and pre-maintenance surveys (classifying vegetation types in Maintenance Areas, identifying and flagging wetlands and large native trees for avoidance, and looking for sensitive wildlife and their habitats). Effectiveness assessment includes longitudinal profiles, drone mapping, and drone overflights during high flows, annual photo points (Meyers 2018). SMP has a lot of data but it was difficult for me to access the information.

Vegetation survey

I founded 23 species of trees, shrubs, vines, and herbs, corresponding to 15 families and 121 individual observations (See Appendix A), in the three zones. The most abundant plant species were *Salix exigua* var*. hindsiana* and *Salix laevigata* (Figure 7). The most common types of habits were trees and herbs (Figure 8). The species with the highest biomass (DBH and high) were *Salix exigua* var*. hindsiana, Salix laevigata* and *Populus fremontii*. Seven non-native species were recorded: two catalogued as highly invasive (*Arundo donax* and *Brassica nigra*), two as naturalized (*Cyperus eragrostis* and *Foeniculum vulgare*), and three without any assigned category: *Dysphania ambrosioides*, *Erigeron sumatrensis* and *Melilotus albus.* I summarized the total number of species observed in each zone, and the shared and exclusive species for each zone in Table 1. The richness values were similar in all zones, however, zone 1 presented the lowest number of species.

Zone 1. Highway 68 (Figure 9, 10, 11, 12, 13). In this zone I observed that a part of the river is completely dry, the water is kept in isolated, disconnected pools. I recorded a water velocity of

0.16 feet per second (due to wind action), and a depth in the channel of 0.88 feet. There was a lot of accumulated sediment on the riverbank and the ground was covered with sand on the higher terraces. I noticed a restoration project in a small area that consisted of planting willows and cottonwoods. The trees planted are not in very good condition (many were dead), but all were marked with colored flags. I witnessed great egrets, red swamp crayfish, and several mammal footprints, including raccoons and bobcats. In this area I also observed spontaneous use by locals, there was a homeless settlement under the bridge, lots of graffiti and an art gallery. On the right bank (transect A) the vegetation was in an early state of succession, with many short individuals (2-4 feet) with DBH less than one inch; on the left bank (transect B) I observed a very mature remnant of vegetation with huge (up to 25 m high) cottonwood individuals. I recorded an *Arundo donax* clump in transect A.

Zone 2. Davis Road (Figure 14, 15, 16, 17). In this zone, I observed that that the channel was very narrow and there was some encroachment of vegetation. I recorded a water velocity of 0.05 feet per second, and a depth in the channel of 0.82 feet. There was a lot of accumulated dark sediment and garbage on the riverbank and the ground was covered with sand on the higher terraces. I witnessed big fishes (without identification) and raccoons. In this area I also observed spontaneous use by locals, there was a homeless settlement on the lower, less sloping terrace on one side of the river. On the right bank (transect C) the riparian zone was very narrow (less than 200 feet) and contained large, mature individuals of *Acer negundo* and *Salix laevigata.* On the left bank (transect D) the riparian zone was very wide. I observed an early state of succession, with many short individuals (2-4 feet) with DBH less than one inch. I noticed 3 old small sandy channels separating the thin layers of shrubs. I recorded an *Arundo donax* clump in both cross sections.

Zone 3. Blanco Road (Figure 18, 19, 20, 21). In this zone I observed that that the channel was wide, and the water was in constant movement. I recorded a water velocity of 0.2 feet per second, and the channel depth was 2.16 feet. There was no accumulated dark sediment on the riverbank and the ground was covered with abundant sand on the low and high terraces. I witnessed kingfishers and deer. In this area I did not observe spontaneous use by locals. On the right bank (transect E) the riparian zone narrow, but more extensive than 200 feet and contained large, mature individuals of *Salix laevigata.* On the left bank (transect F) the riparian zone was very narrow (less than 200 feet) and contained many short individuals (2-4 feet) with DBH less than one inch, in an early state of succession. I recorded an *Arundo donax* clumps in both cross sections.

In general, all sites had a high biodiversity of plants and wildlife. I observed a good longitudinal connectivity along the river, with just few interruptions in the surface water flow, a lack of lateral connectivity in both ecological and social senses since the river is surrounded by fences and levees, and some informal and spontaneous uses as homeless camps, graffiti, and art gallery. In the process of documenting the vegetation, I noticed and overall low habitat quality. However, even being a leftover in the landscape, this riparian corridor still has high biodiversity, and contains different habitats, with different succession states. This corridor represents the only available habitat for many species.

Discussion

Historical context

By comparing the historical context and the active state of the Salinas River, I observed that longitudinal connectivity was maintained through the narrow strip of vegetation that accompanies the river for most of its length. Looking at satellite images and conducting field explorations I could observe the imposing green corridor along the river that stands out in the homogeneity of the extensive crops. However, I observed in zone 1 an interruption in the water flow that caused the formation of isolated pools during the drought season (Figure 22). This condition is difficult to observe through satellite images because the dry areas are located under the bridge of Highway 68. This interruption in the flow supports historical data about the extent of drought after pumping out groundwater for crop irrigation (Beller et al. 2009). In these pools the flow rate was mainly due to strong winds. Without a doubt, more research is needed to understand changes in summer flow conditions as well as summer connectivity and inter-annual flow variability.

On the other hand, I observed that lateral connectivity was interrupted by levees to protect agricultural fields from flooding, which does not allow the deposition of sediments and nutrients in the floodplain from annual flooding (Beller et al. 2009) (Figure 23).

One aspect that I would like to highlight is the lack of social connectivity in the Salinas River. In the review of the document “Historical ecology reconnaissance for the lower Salinas River” I did not find any allusion to uses of the riparian zone as a place of recreation and inspiration for human beings. During the field work I noticed that the river is surrounded by fences, has no places of access and the people of the surrounding cities have no relation to it. I did notice some informal and spontaneous uses as homeless camps and art gallery (Figure 24). While I was sampling the vegetation, I was also surprised and impressed by the beauty and resilience of these highly degraded habitats, by the exuberance of the vegetation and by all the traces of wildlife. I thought about the great potential that the river would have as a park or recreational and educational site, as a place of meditation, spirituality, and connection with nature.

With the fieldwork I was also able to corroborate the historical data on channel morphology and geometry. In the transects it is evident the differences in the slopes that suggest terraces with different amplitudes and elevations, covered mainly with willows, cottonwood, and grasses. It is also evident the location of the riverbed with respect to the terraces, being the riverbed at a lower height than the valley. The migration of the channel was more difficult to observe in the field, since it is a longer process that includes observations at different times of the year. The only thing that I could deduce regarding this condition is that the river channel is very limited by levees, which makes the migration process of the channel difficult. However, in zone 3 I could see traces of three different secondary channels in a wide and low sand bank covered by willows in early succession stage.

Maintenance program

According to SMP, the potential impacts of channel alterations are habitat degradations that could impact multiple special status species as steelhead trout, California red-legged frog, California tiger salamander, Southern sea otter, San Joaquin kit fox, bank swallow, least Bell’s vireo, and multiple special status plant species (Meyers 2018, MCWRA 2019). Also, the removal of riparian vegetation and increased water flow could increase erosion potential (CSUMB 2020). On the other hand, the benefits consist of avoiding damage to agricultural crops (a $4 billion-dollar annual industry), food safety risks (flood waters can transport pathogens to crops, vegetation growing near agricultural lands is a potential threat to food safety because it creates habitat for wildlife), damage to infrastructure (wastewater treatment facilities, city buildings and services including access to clean water), and loss of Jobs (CSUMB 2020).

Considering the tremendous potential for the Salinas River to provide ecological, recreation, cultural, and water quality services to nearby communities, a rethinking of priorities for management of the river corridor would be justified. To date, the nearby communities have turned their backs on the Salinas River, and the river has been fenced off. Increasing access to the riverbed itself (consistent with legal requirements under the Public Trust Doctrine) and allowing greater ecological development within the riparian corridor through conservation easements or acquisition could result in a linear park that could provide benefits for ecology and society, while also conveying floodwaters to reduce the frequency of flooding adjacent fields. The river management and restoration program should be based more on the river's ecological context, with the goal to protect the riparian zone that still exists and improve the condition of the habitat. The recommendations echo concerns expressed about the SRM Program from many environmental groups, who were concerned with the impacts of vegetation removal and dredging to special status species, such as impacts on steelhead trout migration routes (CSUMB 2020).

A reference point for the design of programs with a stronger ecological approach could be the Carmel River Management Program. This program has focused on sediment management, reestablishing a tighter range of dynamic stream functions, and enhancement of steelhead fishery habitat. Any flood benefits are incidental and not a stated goal. The main intention of this program is to restore degraded areas, improve riparian habitats and channel stability while mitigating the effect of diversion upstream. The program has a significant investment of both public and private resources (Hampson, 2010).

Vegetation survey

The purpose of this survey was to stablish a reference baseline for riparian vegetation along Salinas River, since there was not possible to access to a detailed plant inventory for the area. My field data supported the recorded information in the "Historical ecology reconnaissance for the lower Salinas River" on riparian habitats and their associated plant species. According to the reconnaissance willows and cottonwoods were the dominant tree species in many parts of the riparian corridor with many other not specified associated species (Beller et al. 2009). Similarly, I also found that the most dominant species in the three areas sampled were *Salix exigua* var. *hindsiana, Salix laevigata* (willows) and *Populus fremontii* (cottonwoods). I included detailed information on associated species, recording 20 additional species of trees, shrubs, and herbs, including native and non-native species. I also could observe some drastic differences in the composition of the upper terraces, now mainly covered by agricultural fields and in the reduction of the width of the riparian zone, previously between 500 to 3,000 feet wide (Beller et al. 2009) and currently between 100 to 1,000 feet wide (Google Earth Pro, 2020).

The cross sections I performed indicated a high variation (composition, structure, and state of succession of the flora) within and between the sites. I found that the composition and structure of the vegetation was surprisingly heterogeneous, in each cross section I recorded unique species and the shared species presented different conditions of abundance and age (Table 1, Figure 13, 17, 21). I observed the states of early succession in the sand banks associated with the low terraces. Possibly this is related to the flood cycles that during the rainy season, with the increase in water flow, can naturally remove the vegetation and maintain a continuous process of regeneration. On the contrary, I observed the late stages of succession on the high terraces with steep slopes.

Some limitations of the CRAM method I followed for this study were the registration of invasive plant species and priority conservation species. However, with the additional notes I took it was possible to have a good record of the presence of invasive species, especially *Arundo donax*. The registration of species with conservation priorities is more complicated, because the target species identified for this area are very small (Monterey spineflower, *Chorizanthe pungens* var. *pungens*) and it is difficult to find populations following the method of sections and / or transects (MCWRA 2019). For the identification of rare and threatened species populations it is necessary to follow other methods that are more focused on the registration of small and difficult to find species.

Conclusions

It is necessary to try to solve the tension between economic and ecological value in the Salinas River valley by enhancing the high potential in the riparian corridor to improve habitat quality and ecological functions. Salinas River has been neglected and encroached upon for decades, yet even in its much-reduced state it still evinces tremendous ecological values since it is the only habitat available for wildlife (Figure 25).

Investing just a little bit more in this place could have great potential to improve ecological, recreational, cultural, and water quality services to nearby communities. In addition to the maintenance program, it would be ideal to have a publicly-privately funded program for the conservation and restoration of the river. The Salinas river needs restoration projects that respond not just to the threat of flooding in the agricultural fields, but also to the necessity of maintain this biological corridor in the middle of homogeneous human-dominated landscapes. This river provides essential and heterogeneous ecosystem functions, mainly related to water quality, microclimates, wildlife habitat, primary producer recruitment, bank stabilization, and energy base for food webs.

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Table and Figure Captions

Table 1. Species richness and abundance by zone

Species	Zone 1	Zone 2	Zone 3	Grand Total
Acer negundo	1	3		4
Arundo donax	2	2	3	7
Baccharis pilularis	3			3
Brassica nigra		2		2
Cyperus eragrostis	1	1	1	3
Dysphania ambrosioides			1	1
Equisetum hyemale	1	1	1	3
Erigeron sumatrensis	1	4	2	7
Foeniculum vulgare		2		2
Helenium puberulum		1		1
Heterotheca grandiflora	5	1	1	7
Melilotus albus	1			1
Parietaria pensylvanica			1	1
Persicaria punctata		1		1
Populus fremontii	4	2		6
Rubus ursinus		3	2	5
Salix exigua var. hindsiana	4	9	15	28
Salix laevigata	4	10	13	27
Schoenoplectus californicus	1	2	2	5
Solidago velutina ssp. californica	2			2
Toxicodendron diversilobum	1			1
Typha latifolia			1	1
Urtica dioica	2			2
Grand Total	33	44	43	120

Figure 1. Map of the Salinas River watershed (Wikipedia 2020)

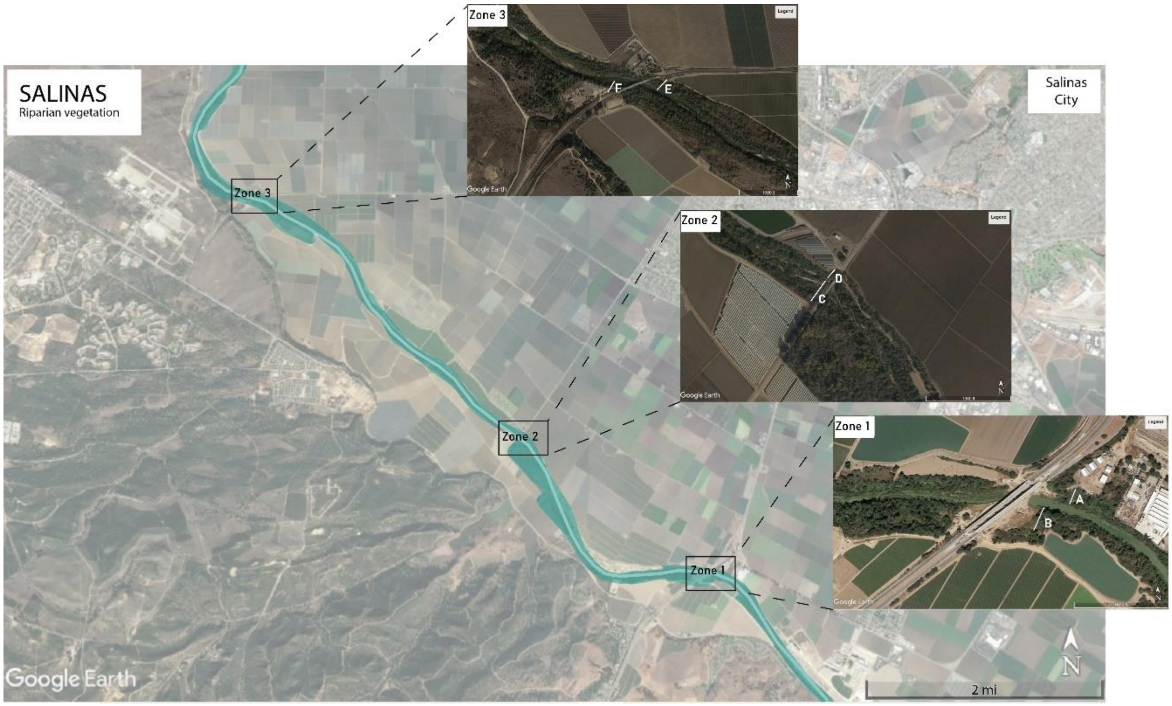

Figure 2. Map with zone and sites where I sample the vegetation.

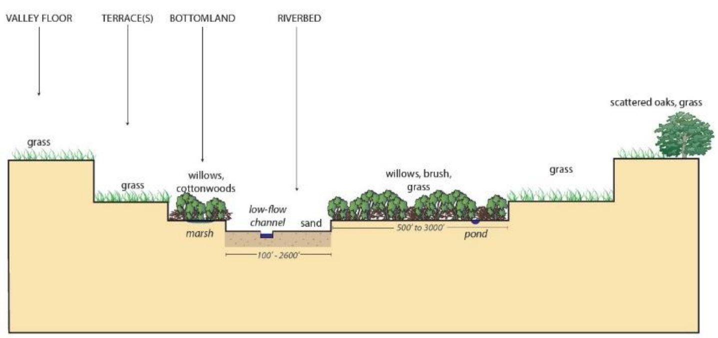

Figure 3. Preliminary conceptual model of channel morphology and riparian habitat along the Salinas River (Beller et al. 2009)

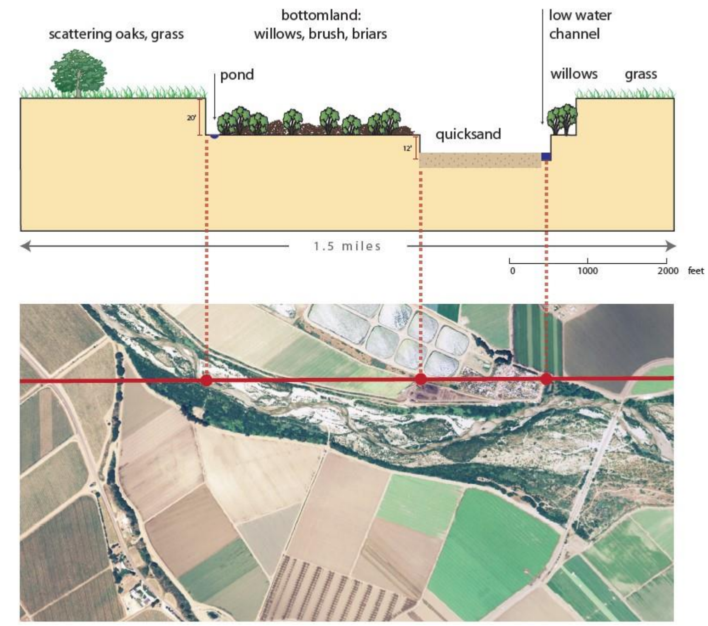

Figure 4. Riparian habitats in the Salinas River, southwest of Gonzalez, 1855 (Beller et al. 2009)


Figure 5. Flooding in the Salinas River (Meyers 2018)

Figure 6. Proposed secondary channels in a section of the Salinas Rivers. Secondary channels are typically 0.25-0.75 miles long and connect with the main stem of the river at their upstream and downstream ends (RCDMC 2020).

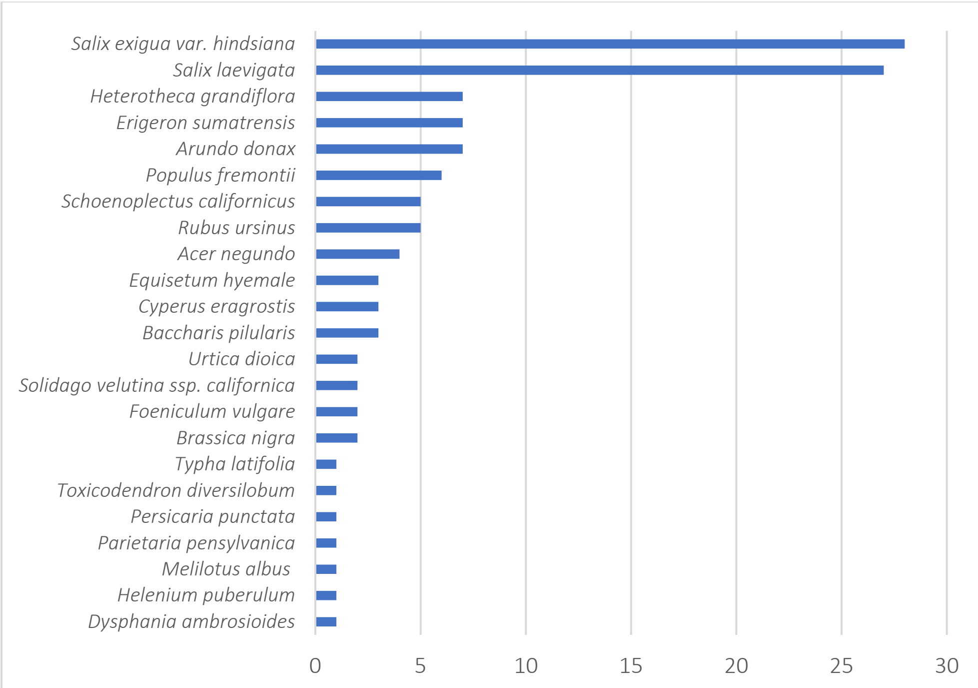

Figure 7. Relative species abundance in all zones.

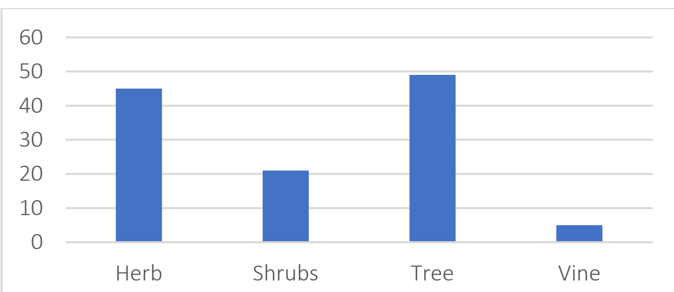

Figure 8. Relative species abundance per type in all zones.


Figure 9. Zone 1, general view.

Figure 10. Zone 1, wildlife observations.

Figure 11. Zone 1, transect A (right bank) photocollage.

Figure 12. Zone 1, transect B (left bank) photocollage.

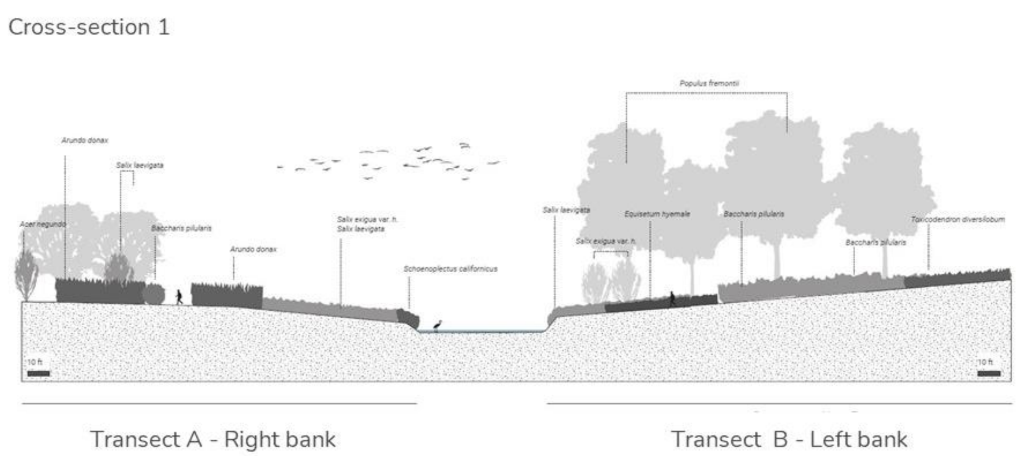

Figure 13. Zone 1, Cross section 1.


Figure 14. Zone 2, general view.

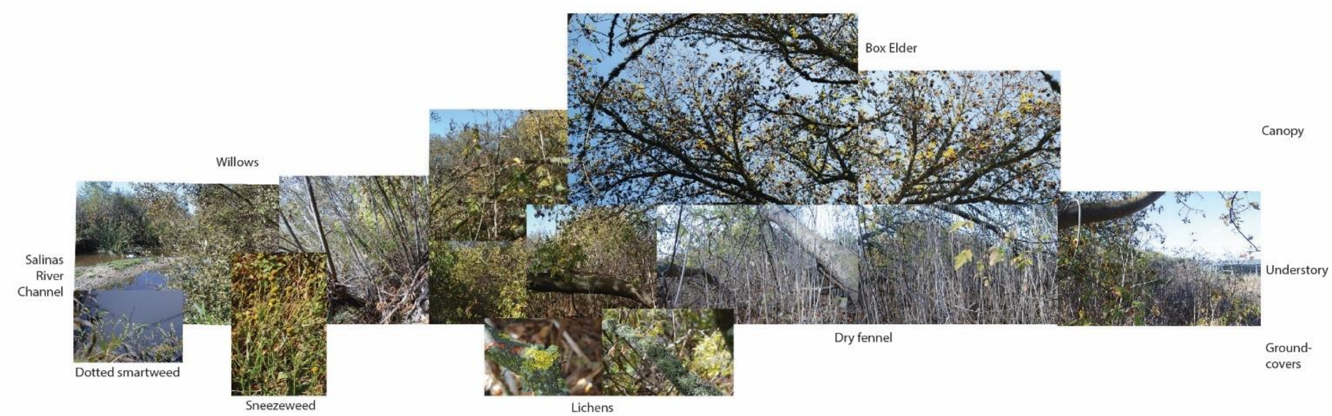

Figure 15. Zone 2, transect C (right bank) photocollage.

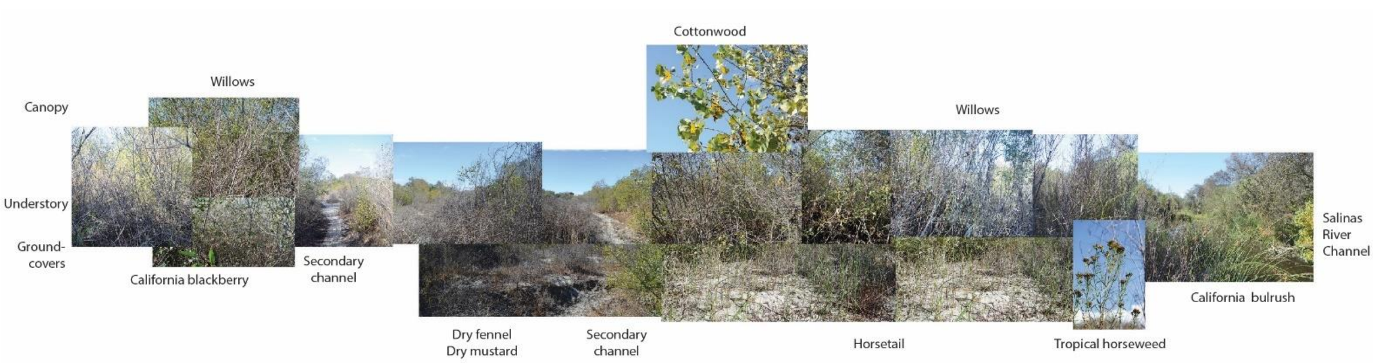

Figure 16. Zone 2, transect D (left bank) photocollage.

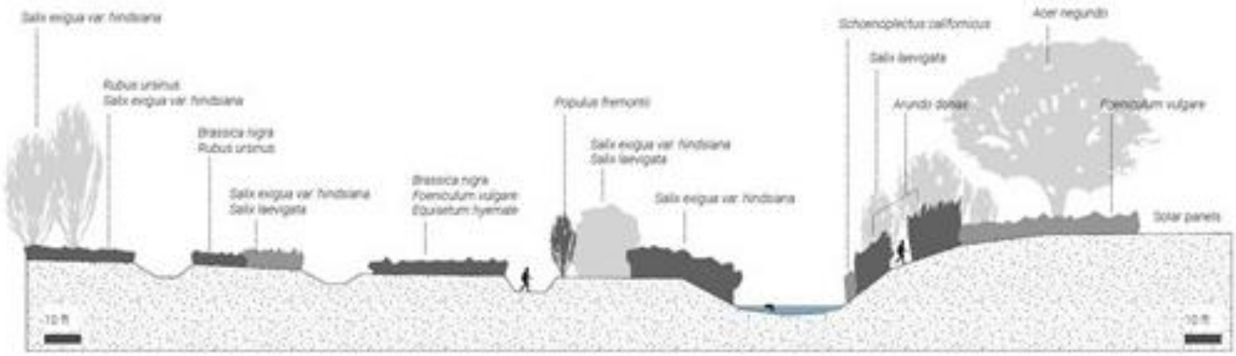

Figure 17. Zone 2, Cross section 2 drawing.

Figure 18. Zone 3, general view.

Figure 19. Zone 3, transect E (right bank) photocollage.

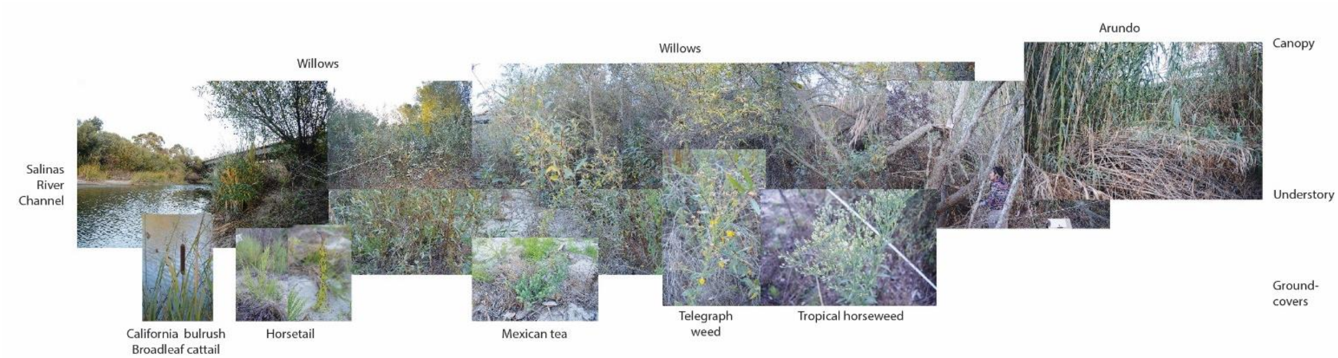

Figure 20. Zone 3, transect F (left bank) photocollage.

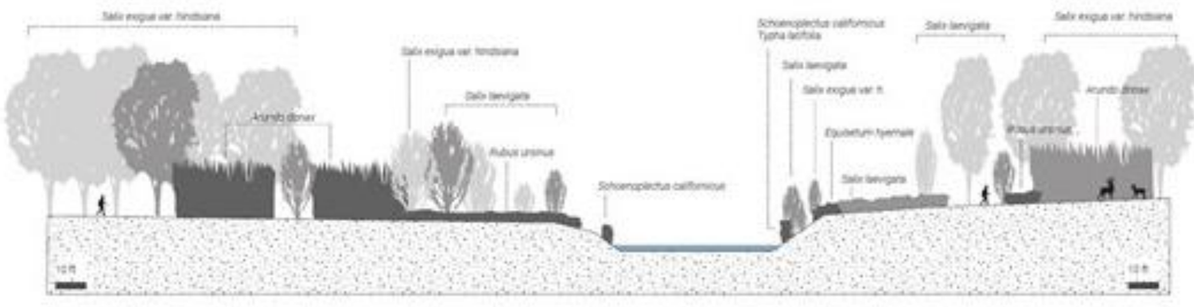

Figure 21. Zone 3, Cross section 3 drawings.

Figure 22. Interrupted flow of surface water.

Figure 23. Levees and fences next to the fields.

Figure 24. Art gallery and graffiti.

Figure 25. Salinas River Riparian corridor.

Appendix A

Cross-sections vegetation data

Zone	Cross-Section	Position (feet)	ID	Layer	Type	Family	*Scientific Name*	Common name	Height (feet)	DBH (inches)	Status
3	E	0-3	1-1	Ground cover	Herb	Cyperaceae	*Schoenoplectus californicus*	California bulrush	5.00		Native
3	E	0-4	Sand bank								
3	E	4-12		Ground cover	Herb	Poaceae		Grass 1	1.00		
3	E	12-60	1-2	Understory	Vine, shrub	Rosaceae	*Rubus ursinus*	California blackberry	3.00		Native
3	E	19	1-3	Understory	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	3.00	0.6	Native
3	E	19-28	1-4	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	18.00	6	Native
3	E	28	1-4	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	10.00	2.5	Native
3	E	41	1-4	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	13.00	3.9	Native
3	E	43	1-4	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	26.00	8.66	Native
3	E	52	1-4	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	32.00	12	Native
3	E	62	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	29.00	9	Native
3	E	70-98	1-5	Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	16.00		No native-Invasive
3	E	104	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	23.00	5.5	Native
3	E	115	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	65.00	10.6	Native
3	E	118	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	59.00	11.4	Native
3	E	114-151	1-5	Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	18.00		No native-Invasive
3	E	144	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	49.20	9	Native
3	E	159	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	68.89	12.9	Native
3	E	114-200	1-6	Ground cover	Herb		*Parietaria pensylvanica*	Pennsylvania Pellitory	1.00		Native
3	E	176	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	62.30	7.5	Native
3	E	184	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	65.60	7.9	Native
3	E	188	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	22.90	2.75	Native
3	E	191	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	42.65	5.11	Native
3	E	199	1-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	65.61	7.87	Native
3	F	0-23	Sand bank								
3	F	1-4	1-1	Ground cover	Herb	Cyperaceae	*Schoenoplectus californicus*	California bulrush	5.00		Native
3	F	1-4	2-2	Ground cover	Herb	Typhaceae	*Typha latifolia*	Broadleaf cattail	6.00		Native
3	F	1-4	2-6	Ground cover	Herb	Cyperaceae	*Cyperus eragrostis*	Tall Flatsedge	3.00		No native
3	F	5	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	17.00	12	Native
3	F	9	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	6.00	1.5	Native

Zone	Cross-Section	Position (feet)	ID	Layer	Type	Family	*Scientific Name*	Common name	Height (feet)	DBH (inches)	Status
3	F	10	2-7	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	3.00		No native
3	F	14	2-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	13.00	1.1	Native
3	F	13-230	2-4	Understory	Herb	Equisetaceae	*Equisetum hyemale*	Scouringrush horsetail	3.00		Native
3	F	17	2-9	Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
3	F	22-56	2-1	Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	4.00	many	Native
3	F	38	2-5	Ground cover	Herb	Chenopodiaceae	*Dysphania ambrosioides*	Mexican tea	1.00		No native
3	F	50	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	19.60	4	Native
3	F	51	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	26.24	4.7	Native
3	F	63	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	36.10	10.6	Native
3	F	74	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	16.40	4.3	Native
3	F	75-86	2-10	Understory	Vine, shrub	Rosaceae	*Rubus ursinus*	California blackberry	3.00		Native
3	F	82	2-7	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	2.00		No native
3	F	80	2-1	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	22.90	7.8	Native
3	F	86-124	2-11	Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	16.00		No native-Invasive
3	F	88	2-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	48.00	22.4	
3	F	130-140	2-3	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	50.00	25.2	
3	F	140-200	Road (end of riparian zone)								
2	D	0	3-1	Ground cover	Herb	Polygonaceae	*Persicaria punctata*	Dotted smartweed	1.60		Native
2	D	0-1		Ground cover	Herb	Cyperaceae	*Schoenoplectus californicus*	California bulrush	5.00		Native
2	D	1-2		Ground cover	Herb	Cyperaceae	*Cyperus eragrostis*	Tall Flatsedge	3.00		No native
2	D	5	3-2	Understory	Herb	Asteraceae	*Helenium puberulum*	Rosilla, Sneezeweed	3.00		Native
2	D	6-12		Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	10.00		No native-Invasive
2	D	14	3-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	20.00	17.71	Native
2	D	24-38		Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	13.00		No native-Invasive
2	D	36	3-4	Canopy	Tree	Sapindaceae	*Acer negundo*	Box Elder	27.00	11.4	Native
2	D	36-85		Understory	Herb	Apiaceae	*Foeniculum vulgare*	Biscuit root, Sweet fennel	5.00		No native
2	D	43	3-4	Canopy	Tree	Sapindaceae	*Acer negundo*	Box Elder	20.00	10.6	Native
2	D	60	3-4	Canopy	Tree	Sapindaceae	*Acer negundo*	Box Elder	39.00	62.99	Native
2	D	85	Solar panels (end of riparian zone)								
2	C	0-2		Ground cover	Herb	Cyperaceae	*Schoenoplectus californicus*	California bulrush	6.00		Native
2	C	2-29	4-1	Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	7.00	many	Native

Zone	Cross-Section	Position (feet)	ID	Layer	Type	Family	*Scientific Name*	Common name	Height (feet)	DBH (inches)	Status
2	C	3		Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
2	C	5	4-2	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	3.00		No native
2	C	7	4-2	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	4.00		No native
2	C	9	4-2	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	3.00		No native
2	C	11	4-2	Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	3.00		No native
2	C	29	4-1	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	16.00	6.3	Native
2	C	34	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	19.70	12.6	Native
2	C	37	4-1	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	13.00	6.6	Native
2	C	40-47		Understory	Vine, shrub	Rosaceae	*Rubus ursinus*	California blackberry	3.00		Native
2	C	44	4-1	Canopy	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	10.00	4.3	Native
2	C	49	4-1	Canopy	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	8.00	1.96	Native
2	C	50	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	9.00	6.69	Native
2	C	52	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	8.00	4.3	Native
2	C	53	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	10.00	5.2	Native
2	C	55	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	7.00	6.1	Native
2	C	58	4-3	Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	9.00	6.2	Native
2	C	60	4-4	Canopy	Tree	Salicaceae	*Populus fremontii*	Fremont Cottonwood	9.00	8.26	Native
2	C	63-74	Secondary channel (sand)								
2	C	74-102	4.5	Understory	Herb	Brassicaceae	*Brassica nigra*	Black mustard	4.00	Many individuals	No native-Invasive
2	C	74-102	4.6	Understory	Herb	Apiaceae	*Foeniculum vulgare*	Biscuit root, Sweet fennel	4.00	Many individuals	No native-Naturalized
2	C	74-102	4.7	Understory	Herb	Equisetaceae	*Equisetum hyemale*	Scouringrush horsetail	2.00		Native
2	C	102	4-3	Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	5.00		Native
2	C	104	4-4	Understory	Shrubs	Salicaceae	*Populus fremontii*	Fremont Cottonwood	4.00		Native
2	C	109	4-3	Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	3.00		Native
2	C	111-119	Secondary channel (sand)								
2	C	119-134	4-3	Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	4.00	many	Native
2	C	119-134	4-1	Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	4.00	many	Native
2	C	134-154	4-1	Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	4.00	many	Native
2	C	134-154	4.5	Understory	Herb	Brassicaceae	*Brassica nigra*	Black mustard	4.00	many	No native-Invasive
2	C	134-154		Understory	Vine, shrub	Rosaceae	*Rubus ursinus*	California blackberry	3.00		Native

Zone	Cross-Section	Position (feet)	ID	Layer	Type	Family	*Scientific Name*	Common name	Height (feet)	DBH (inches)	Status
2	C	154-160	Secondary channel (sand)								
2	C	160-190		Understory	Vine, shrub	Rosaceae	*Rubus ursinus*	California blackberry	3.00		Native
2	C	160-190	4-1	Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	4.00	many	Native
2	C	190	4-1	Canopy	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	32.00	18.5	Native
2	C	Riparian zone continues beyond 200 feet									
1	A	0-10		Ground cover	Herb	Cyperaceae	*Schoenoplectus californicus*	California bulrush	6.00		Native
1	A	10		Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
1	A	11		Understory	Herb	Asteraceae	*Erigeron sumatrensis*	Tropical horseweed	3.00		No native
1	A	11-67		Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	5.00	many	Native
1	A	11-67		Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	4.00	many	Native
1	A	67-96		Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	10.00		No native-Invasive
1	A	112		Understory	Shrubs	Asteraceae	*Baccharis pilularis*	Coyote Bush	9.00		Native
1	A	124		Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	49.00	19.6	Native
1	A	117-160		Canopy	Herb	Poaceae	*Arundo donax*	Arundo, giant reed	10.00		No native-Invasive
1	A	130		Canopy	Tree	Salicaceae	*Salix laevigata*	Red Willow	23.00	5.1	Native
1	A	140	5-1	Understory	Herb	Urticaceae	*Urtica dioica*	Stinging nettle	9.00	2	Native
1	A	155	5-1	Understory	Herb	Urticaceae	*Urtica dioica*	Stinging nettle	10.00	2	Native
1	A	160		Canopy	Tree	Sapindaceae	*Acer negundo*	Box Elder	12.00	6.3	Native
1	A	170	Road (end of riparian zone)								
1	B	0-1		Ground cover	Herb	Cyperaceae	*Cyperus eragrostis*	Tall Flatsedge	3.00		No native-Naturalized
1	B	2-67		Understory	Shrubs	Salicaceae	*Salix laevigata*	Red Willow	4.00	many	Native
1	B	2-67	6-1	Understory	Shrubs	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	4.00	many	Native
1	B	7	6-2	Understory	Shrubs	Fabaceae	*Melilotus albus*	White sweetclover	3.00		No native
1	B	12	6-3	Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
1	B	20	6-3	Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
1	B	25	6-1	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	20.00	11.8	Native
1	B	29-79	6-4	Understory	Herb	Equisetaceae	*Equisetum hyemale*	Scouringrush horsetail	4.00		Native
1	B	38	6-1	Canopy	Tree	Salicaceae	*Salix exigua* var. *hindsiana*	Sandbar Willow	23.00	16.14	Native
1	B	70	6-3	Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	4.00		Native

Zone	Cross-Section	Position (feet)	ID	Layer	Type	Family	*Scientific Name*	Common name	Height (feet)	DBH (inches)	Status
1	B	59-77	6-5	Understory	Herb	Asteraceae	*Solidago velutina* ssp. *californica*	California Goldenrod	2.00		Native
1	B	69	6-6	Canopy	Tree	Salicaceae	*Populus fremontii*	Fremont Cottonwood	40.00	10	Native
1	B	78	6-6	Canopy	Tree	Salicaceae	*Populus fremontii*	Fremont Cottonwood	40.00	16.5	Native
1	B	79-107	6-7	Understory	Shrubs	Asteraceae	*Baccharis pilularis*	Coyote Bush	6.00		Native
1	B	113	6-3	Understory	Herb	Asteraceae	*Heterotheca grandiflora*	Telegraph Weed	3.00		Native
1	B	108-119	6-5	Understory	Herb	Asteraceae	*Solidago velutina* ssp. *californica*	California Goldenrod	2.00		Native
1	B	110	6-6	Canopy	Tree	Salicaceae	*Populus fremontii*	Fremont Cottonwood	82.00	35.8	Native
1	B	113	6-6	Canopy	Tree	Salicaceae	*Populus fremontii*	Fremont Cottonwood	19.68	11.1	Native
1	B	121-165	6-7	Understory	Shrubs	Asteraceae	*Baccharis pilularis*	Coyote Bush	6.00		Native
1	B	154-200		Understory	Shrubs	Anacardiaceae	*Toxicodendron diversilobum*	Poison oak	5.00		Native
1	B	Riparian zone continues beyond 200 feet									