Linking Vegetation Dynamics with Physical Processes to Develop Arundo Control and Riparian Restoration Strategies for a Semi-arid River and its Floodplain

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Stillwater Sciences

Coastal Conservancy

BACKGROUND

The lower Santa Clara River and its floodplain have been significantly altered by flood control, land use practices, and invasion by Arundo donax that have disrupted natural processes and resulted in riparian habitat loss. Despite these alterations, the lower river presents a unique opportunity to conserve and restore remaining riparian functions and ecosystems. To this end, the California State Coastal Conservancy is establishing the Santa Clara River Parkway by acquiring and enhancing floodplain habitat and flood-prone property.

This poster presents a subset of the analytical tools, understanding of vegetation dynamics and physical process linkages, and *Arundo donax* (giant reed) treatment and other strategies developed and used to assist with acquiring, managing, and restoring Parkway lands.

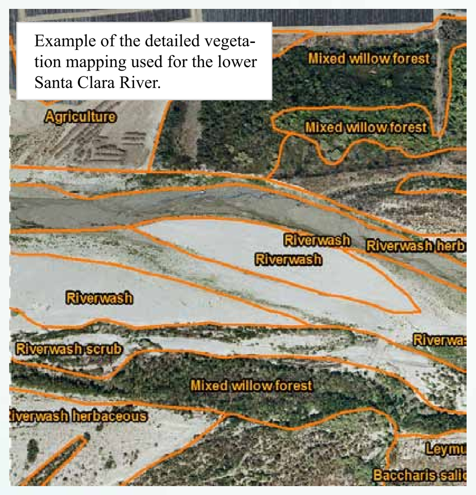
The Santa Clara River watershed.

For more information, please visit: www.santaclarariverparkway.org

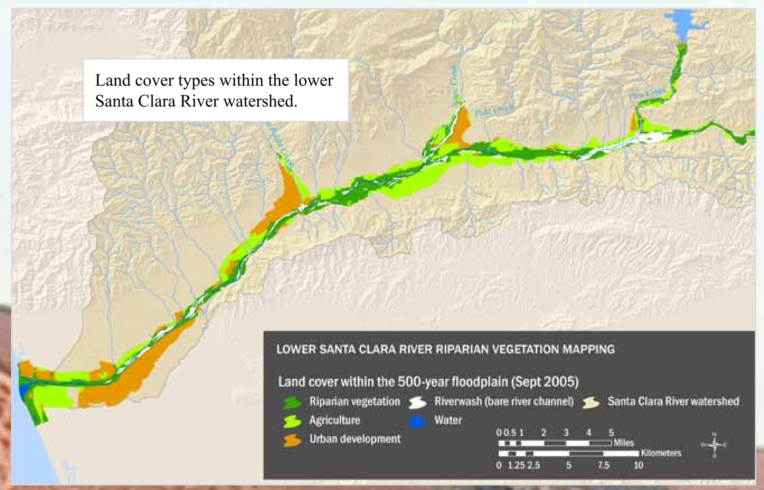
ANALYTICAL TOOLS

Vegetation Mapping

Accurate and current mapping of riparian vegetation, including invasive species, was a crucial first step in river corridor management and restoration planning. This project followed the State of California standard vegetation classification system, mapping to the vegetation alliance level, and included focused percent-cover mapping for invasive arundo and tamarisk.



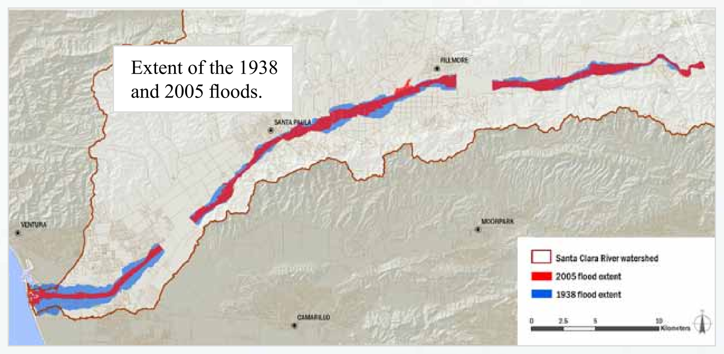
Example of the detailed vegetation mapping used for the lower Santa Clara River.



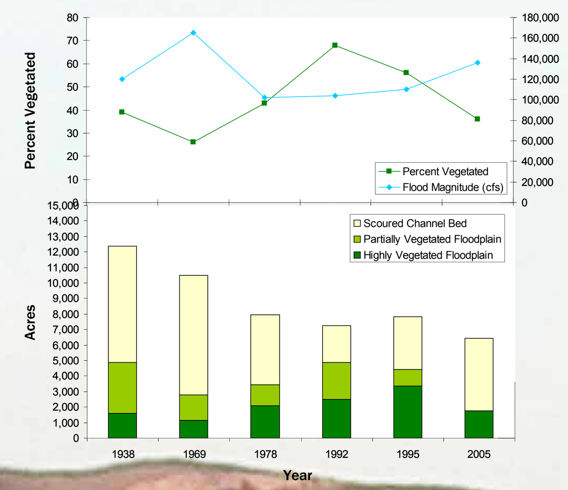
Land cover types within the lower Santa Clara River watershed.

Historical Changes in Riparian Vegetation Extent

Changes in the extent of riparian vegetation along the lower Santa Clara River were quantified by mapping highly vegetated, partially vegetated and scoured areas on overlays of aerial photographs taken soon after six major floods.



Extent of the 1938 and 2005 floods.



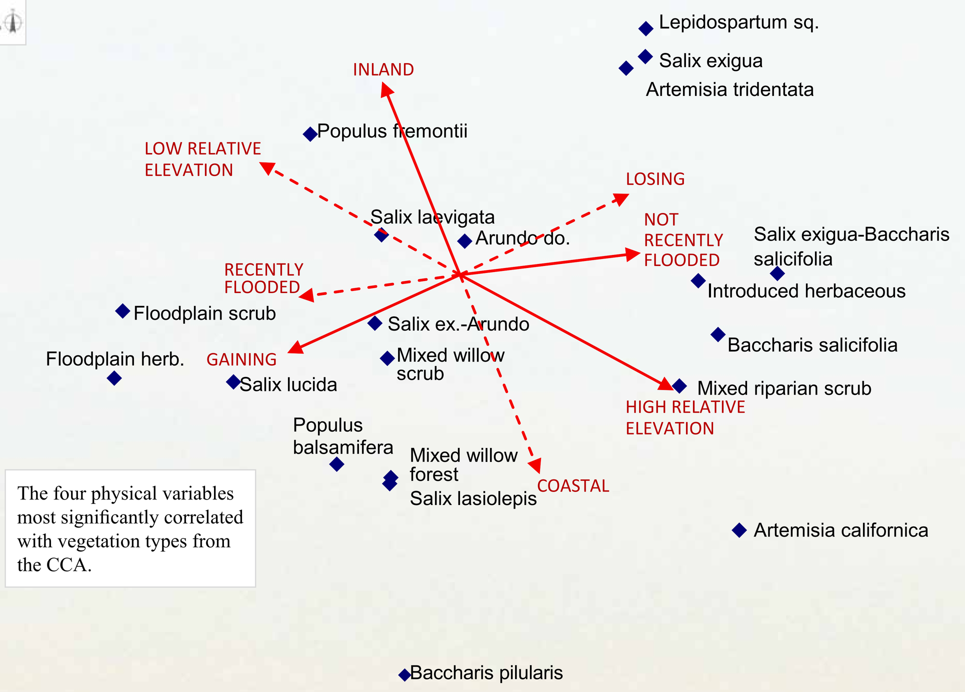
(BELOW) Area of vegetated and unvegetated floodplain affected by selected floods.

(BELOW) Flood events with corresponding aerial photographs used to examine changes in the extent of riparian vegetation in the lower Santa Clara River.

Year	Flow (cfs)	Flood Recurrence Interval
1938	120,000	14 year
1969	165,000	24 year
1978	102,200	11 year
1992	104,000	12 year
1995	110,000	13 year
2005	136,000	16 year

Vegetation Distribution Correlations

Canonical correspondence analysis (CCA) was used to identify the environmental variables most affecting the distribution of vegetation alliances (listed below). Univariate analysis was then used to examine differences in relationships based on the most important environmental variables identified through CCA. This analysis identified linkages between physical processes and the establishment and maintenance of riparian vegetation and assisted in predicting how riparian vegetation may establish and persist on restored floodplains within the study area.



The four physical variables most significantly correlated with vegetation types from the CCA.

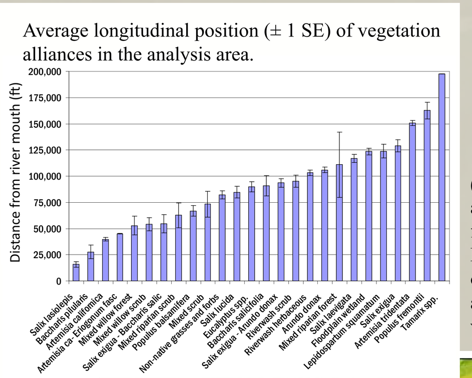
VEGETATION-PROCESS LINKAGES

Species distribution and vegetation reset

Climate

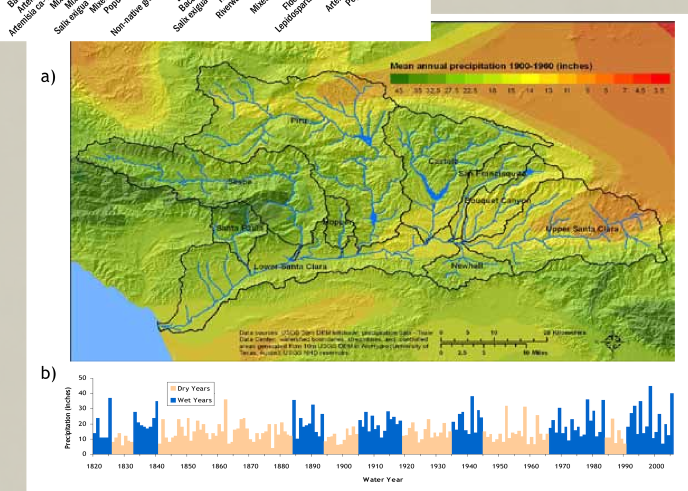
Differences between the coastal fog belt and the arid inland portions of the watershed are at least partly responsible for the correlation between distance from river mouth and plant species distributions, although arundo occurs throughout the watershed.

Riparian vegetation along the lower Santa Clara River is subject to infrequent but dramatic resets during large flood events, particularly during El Niño-Southern Oscillation (ENSO) events, which are characterized by relatively high rainfall and, as a result, high flood magnitudes.



Average longitudinal position (± 1 SE) of vegetation alliances in the analysis area.

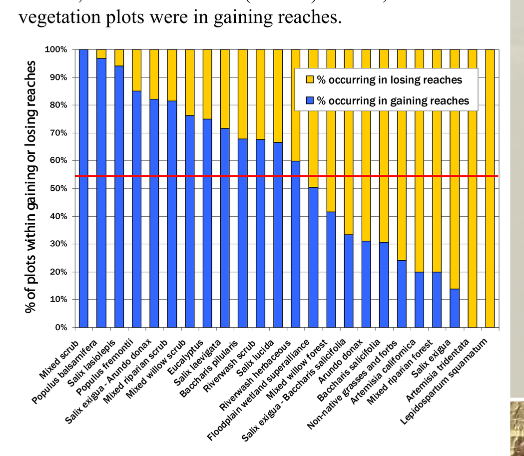
(BELOW) a) Distribution of mean annual precipitation based on data from the period 1900–1960; b) Precipitation records indicate periods of cumulatively wetter (blue) and drier (orange) periods in the watershed.



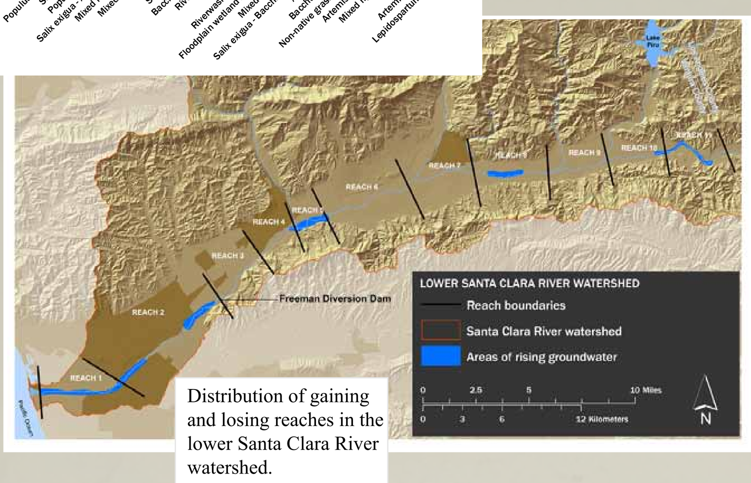
Species distribution

Groundwater Availability

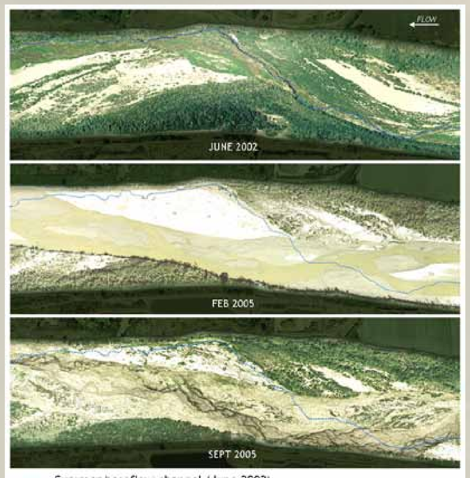
Plant communities differ between gaining and losing groundwater reaches, with species such as *Salix* (willow) and *Populus* (cottonwood) occurring more frequently in gaining reaches, and *Artemisia tridentata* (sagebrush) and *Lepidospartum squamatum* (scalebroom) occurring more frequently in drier, losing reaches. Arundo is established and survives in both gaining and losing reaches.



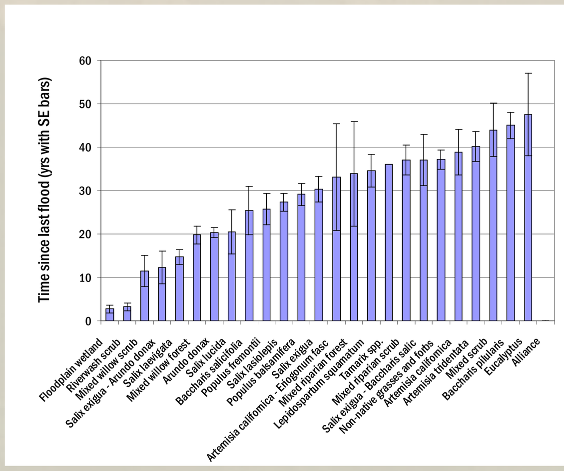
Percentage of plots within each vegetation alliance that occurs in gaining (blue) versus losing (orange) reaches. Overall, 54% of the reaches (red line) in the 1,490 alliance vegetation plots were in gaining reaches.



Distribution of gaining and losing reaches in the lower Santa Clara River watershed.



Summer baseflow channel (June 2002)



(LEFT) Riparian vegetation conditions before (June 2002), immediately after (February 2005), and nine months following the 2005 high-flow event (September 2005). (RIGHT) Average time since last flood (± 1 SE) of vegetation alliances in the analysis area.

Species distribution and vegetation structure

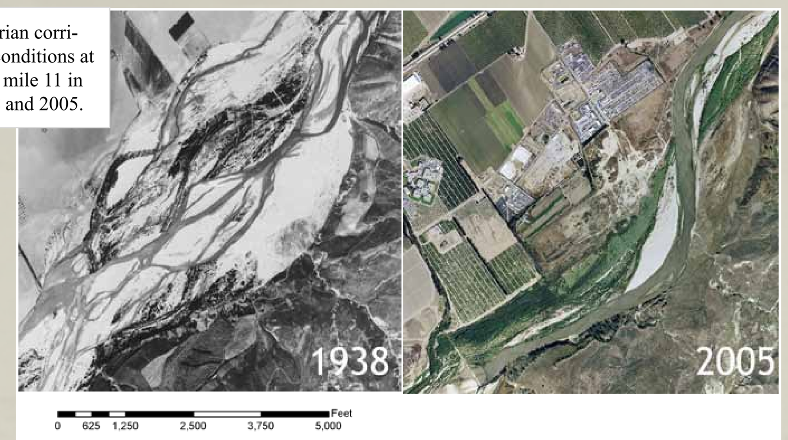
Flood Dynamics

Time since last flood and relative elevation above the channel were two of the strongest correlates with vegetation alliance distribution. This suggests that the extent and distribution of riparian vegetation is closely linked to the dramatic scouring of vegetation during ENSO cycles, and the progression of seral stages thereafter. Arundo is more common on surfaces that have been flooded within the past 40 years.

Vegetation extent

Floodplain Development

Our historical flood mapping demonstrates the dramatic effect of levees and development in constraining the floodplain and limiting riparian vegetation. In the lowest reaches of the river where levees are most extensive, the riparian corridor has been reduced by nearly 70% compared with conditions in 1938.

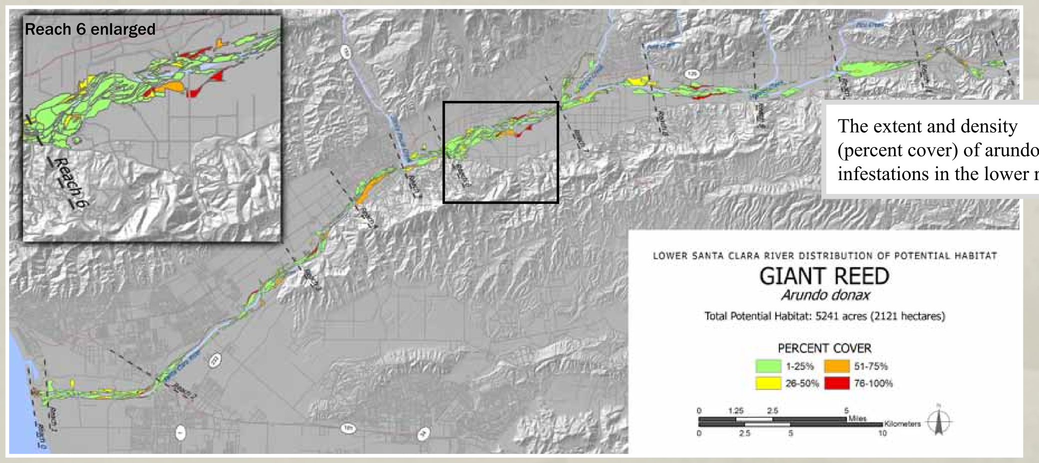


Riparian corridor conditions at river mile 11 in 1938 and 2005.

Native vegetation extent

Invasion by Arundo

Arundo has invaded, and in many areas replaced, native riparian vegetation in the watershed. In addition to reducing riparian habitat quality and quantity, accumulated arundo biomass increases the susceptibility of the lower Santa Clara River riparian corridor to fire, and post-fire conditions further promote arundo growth rates by elevating nutrient levels and eliminating competition from native species (Coffman et al. 2010).



The extent and density (percent cover) of arundo infestations in the lower river.

INFORMED ARUNDO TREATMENT and RESTORATION STRATEGIES

Increase and improve floodplain connectivity

Preventing development in the floodplain and increasing floodplain width and connectivity with the river will ameliorate some of the most significant impacts on the lower Santa Clara River and promote a greater extent of native riparian vegetation.

- Acquire land for conservation through purchase or easements.
- Remove or stop repairing unnecessary berms and levees.
- Replace bank-edge levees with setback levees.

Promote and implement sensible revegetation

The nature of flooding and vegetation reset along the lower river should determine the area where active planting is implemented, to avoid the loss of expensive active revegetation efforts. Where active planting is reasonable, the riparian dynamics analysis results can be used to inform select plan species that are most likely to be successful at a given site.

- Allow natural recruitment in the active floodplain.
- Focus active revegetation in areas not subject to frequent, resetting floods.
- Actively revegetate sites following arundo removal.

Implement strategic actions to control arundo

The vegetation dynamics-physical process linkages described above, as well as recent research by Coffman et al. (2010) on the ecology and impact of arundo on the lower Santa Clara River, provides guidelines for prioritizing arundo treatment projects:

- Treat arundo in the spring/summer following major floods to take advantage of the removed biomass.
- Control arundo in an upstream to downstream direction and from tributaries.
- Control arundo in and adjacent to fire-prone shrub lands.
- In monospecific stands of arundo, or where it occurs with immature native vegetation, use more economical mowing techniques to remove biomass prior to treatment.
- Use hand-removal techniques around mature native trees and patches of native vegetation to enhance ability of native vegetation to recruit naturally after treatment.