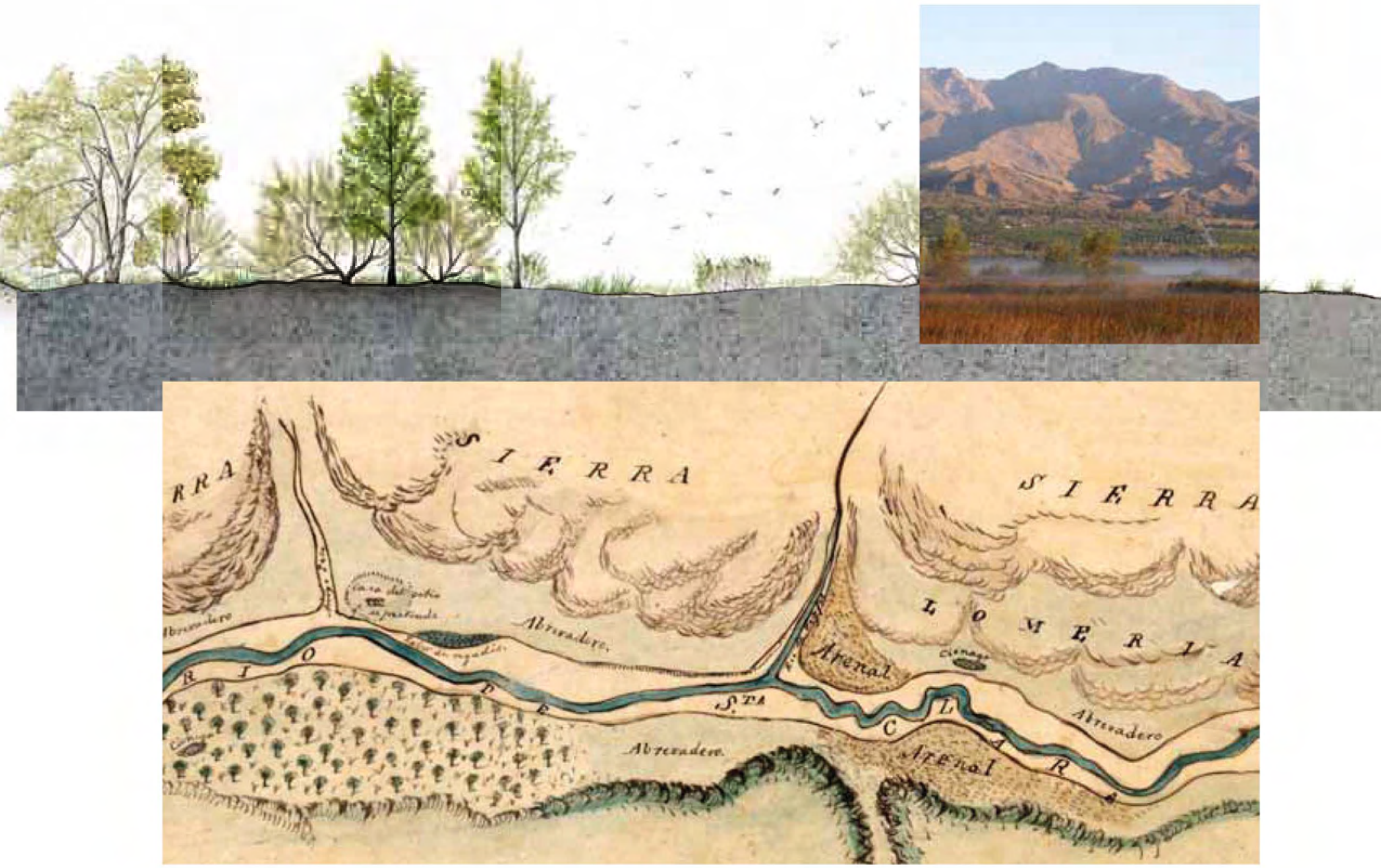
SCCWRP Technical Report 0662

HISTORICAL ECOLOGY
of the lower Santa Clara River, Ventura River, and Oxnard Plain:
an analysis of terrestrial, riverine, and coastal habitats



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HISTORICAL ECOLOGY PROGRAM
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Report and GIS layers are available on SFEI's website, at www.sfei.org/projects/VenturaHE.

Front cover, from left to right: Detail of cross section (by Jen Natali); 19th century Ventura River (Unknown ca. 1890, courtesy of the Museum of Ventura County); modern Santa Clara River (courtesy of Gretchen Coffman); diseño map (U.S. District Court ca. 1840c, courtesy of The Bancroft Library, UC Berkeley)

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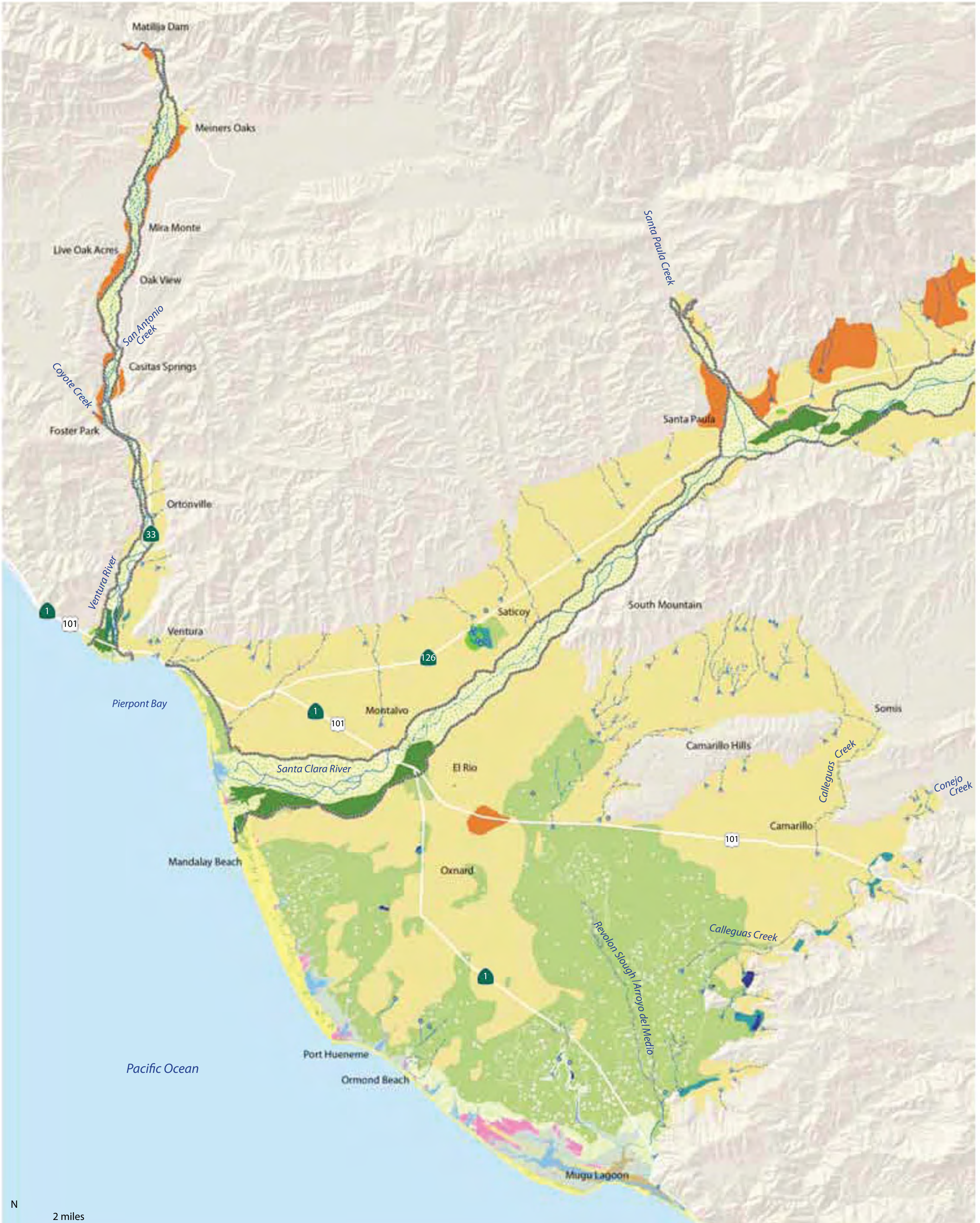

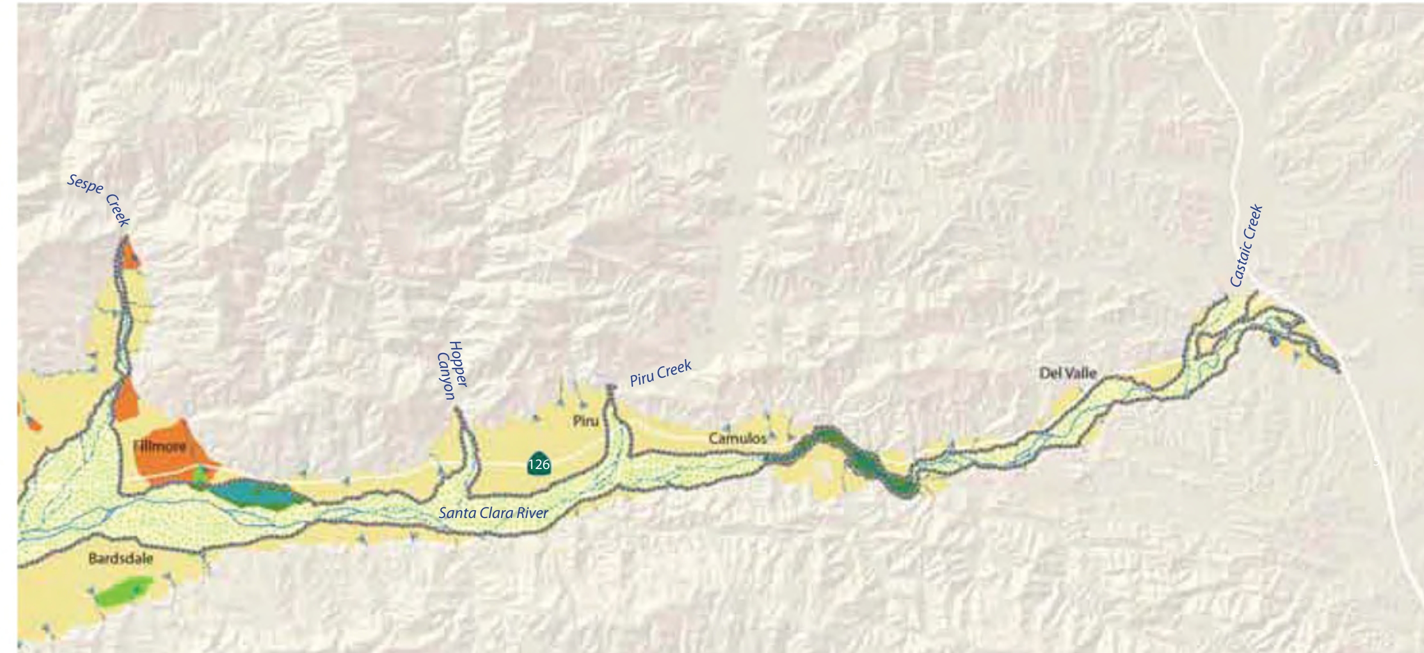

HISTORICAL CONDITIONS, EARLY 1800s

Coastal and Estuarine Habitats

- Ocean
- Beach/Dune
- Lagoon
- Tidal Flat
- Salt/Brackish Marsh and Tidal Marsh
- Salt Flat/Seasonal Pond/ Marsh Panne
- High Marsh Transition Zone

Palustrine and Terrestrial Habitat

- Perennial Freshwater Pond
- Valley Freshwater Marsh
- Willow Thicket
- Wet Meadow
- Alkali Meadow
- Alkali Meadow/Flat
- Oaks and Sycamores
- Grassland/Coastal Sage Scrub

Characteristic Riparian Habitat

- Willow-Cottonwood Forested Wetland
- Other In-Channel Riparian

Hydrology

- Intermittent or Ephemeral
- Perennial
- Distributary
- Outer River Bank
- Spring

This map reconstructs the habitat characteristics of lowland Ventura County prior to significant Euro-American modification (early 1800s). More detailed views are provided in the map sections shown to the right. Some habitat classifications combined here (e.g., beach/dune) are separated in finer-scale maps (see pages at right).

Coastal Conservancy

The State Coastal Conservancy is proud to have funded this study of historical coastal wetlands, rivers, and other habitats of Ventura County. The project was led by the San Francisco Estuary Institute, the leading authority in the analysis of California coastal historical ecology. In this study, they have teamed with a number of experts on Southern California rivers and coastal wetlands, including Stillwater Sciences, Southern California Coastal Water Research Project, California State University Northridge, and other institutions.

This study uses history – namely, the interpretation and integration of historical documents with environmental sciences – to provide a new perspective on how the Ventura County landscape has changed since the early 19th century. Synthesizing over two centuries of local documents, this report and accompanying GIS layers significantly improve our understanding of the natural forces that have shaped the local landscape. The study provides guidelines and inspiration for improvement of the environmental health of this region, which is the goal of the Coastal Conservancy and the governmental agencies and conservation organizations who are our valued partners in Ventura County.

The work of the Coastal Conservancy is to protect, restore, and make accessible the lands and waters of the California coast. SFEI's study will assist us and our partners in several ways. First, it shows us what elements of Ventura County's natural heritage have been lost, and suggests where those might be recovered. Secondly, the study helps us understand the physical and ecological processes still influencing systems today, enabling us design more effective, cost-efficient projects. In fact, the study identifies a number of opportunities to take advantage of intact natural processes to make more self-sustaining projects. Finally, and perhaps most importantly, we hope this new information will involve the Ventura community in considering the natural history of their region and its potential for the future. What underlies the built environment of this area? Through this research, we can now discover and uncover what came before European settlement of Ventura County. Though it will never be the same again, much of this until-now forgotten landscape can be restored, along with the sights and sounds of the species that have long depended on it. These lessons from history can help us make our landscape healthier and more resilient in the coming decades.

This study is dedicated to the people of Ventura County, supporters and sustainers of our work together, so that they can better love and understand the place where they live.

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C a l i f o r n i a   S t a t e   C o a s t a l   C o n s e r v a n c y

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REGIONAL SUMMARY

Great changes have swept through Ventura County over the past 250 years. Willows and live oaks have been cut down, and eucalyptus and other non-native street trees have been planted. Wetlands have been drained and cultivated. Creeks have been straightened and connected to larger streams. Rivers have been hydrologically and ecologically altered by levees, flow diversions, and timber cutting, and have lost floodplain area to farms and cities.

Despite these changes, lowland Ventura County retains substantial high quality ecological resources, particularly in comparison to other, more urbanized, areas of coastal southern California. The two major rivers in the region—the Ventura and the Santa Clara—possess significant restoration potential. The Santa Clara River has remained unchannelized and relatively unregulated by dams, and as a result has retained much of its former reach-scale flow variability, geomorphic process, and riparian heterogeneity. The Ventura River, due in part to relatively limited urban development and floodplain encroachment, has also retained substantial portions of its former hydrologic and ecological patterns, despite the presence of Matilija and Casitas dams. Current management activities, such as the proposed removal of the dam and the Parkway projects ongoing on both rivers, recognize and take advantage of this potential.

This report documents the historical ecological and hydrological patterns and dynamics of the Ventura River valley, the lower Santa Clara River valley, the Oxnard Plain, and the Ventura County shoreline. To do so, we integrated hundreds of historical cartographic, textual, and visual accounts to create a heterogeneous but substantial dataset describing hydrologic, geomorphic, and riparian characteristics back to 1769—the date of the first non-native, land-based exploration of the region. These data were synthesized to provide detailed analysis of landscape-level pattern and process in the region prior to substantial Euro-American modifications, and to better understand the impacts of modifications over the past two and a half centuries. The goal of this process is to provide scientists and managers in Ventura County with detailed, readily accessible information about the region's historical ecological landscape, with particular focus on historical habitat patterns and riverine processes. (The report does not address the historical fauna of Ventura County in detail.)

Our findings reveal an ecologically diverse landscape, with vegetation and drainage patterns reflective of both underlying, long-term physical drivers and temporally and spatially dynamic processes. Valley floor habitats were relatively dry overall, with extensive open grasslands and scrublands predominating in the Santa Clara River valley, lower Ventura River valley, and large portions of the Oxnard Plain. Live oaks and sycamores colonized terraces in the Ventura River valley, in addition to many alluvial fan surfaces north of the Santa Clara River. With few exceptions (notably, Saticoy Springs), non-riparian wetlands were concentrated on the Oxnard Plain. This included coastal brackish and saline wetlands, freshwater ponds and marshes along the eastern foothills in the Calleguas Creek watershed, and (comprising the great majority of the total) the seasonal alkaline wetlands of the Oxnard Plain.

Wetland distribution on the plain has been largely shaped by the migration of the Santa Clara River over geologic time: the river deposited sediments that formed higher and drier zones above the alkaline lowland, which were colonized by grassland and scrub. This migration also created a pattern of coastal lagoon systems along the shoreline, leaving a legacy of perched and closed lagoons marking former river mouths (and separated from the ocean by dunes whose sediment was largely supplied by the river). At least three types of coastal estuarine systems are represented on the Ventura shoreline: seasonally or intermittently closing freshwater-brackish estuaries associated with the Santa Clara and Ventura river mouths, dune-dammed non-tidal lagoons associated with now-abandoned Santa Clara River mouths, and the large, more open wetland system at Mugu. These features formed a near-continuous sequence of coastal wetlands from Mugu Lagoon all the way to the Ventura River mouth: the eastern edge of the Ventura River floodplain was separated from the northwestern edge of the Santa Clara River floodplain (today's Ventura Marina area) by less than one mile.

Then as now, the Santa Clara River dominated the region; even its delta (the Oxnard Plain) was referred to as the lower Santa Clara River valley in the 19th century. Geologic and climatic parameters influenced the river's form and flow, creating a stream with reach-scale variability in channel morphology and the presence of summer surface water. In turn, these elements were linked to heterogeneous riparian patterns along the river, with nodes of broad willow-cottonwood riparian forest and in-channel wetlands separated by reaches characterized by scrub and patchy forest. As a result, riparian forest did not form a continuous corridor along the river, instead occurring in discrete patches corresponding to variations in groundwater-surface water interactions.

Like the Santa Clara, the Ventura River occupied a broad river corridor, with reach-scale variability in hydrology, morphology, and riparian patterns. The Ventura River also maintained large willow-cottonwood forests at its mouth, in addition to a dense riparian corridor along much of the perennial reaches. The intermittent reach of the river was characterized by in-channel live oaks, sycamores, and scrub on established bars and islands, a vegetation community not documented anywhere along the Santa Clara River mainstem.

The research described in this report is designed to provide insight into the Ventura County that once was. We have tried to bring our research alive such that current residents, scientists, and planners may inhabit—if briefly, and imaginatively—the landscape that early Chumash inhabited and later residents inherited. We document historical patterns, as well as the layers of use and modification accumulated over the past centuries, some of which is still evident today to the keen eye. We do not suggest that future restoration efforts should necessarily aim to recreate the former features discussed here, or that these patterns should directly dictate what should or should not be done. Instead, this report seeks to provide insight into the dynamics and processes that shaped—and in many cases, continue to shape—the Ventura landscape, and to be a tool for understanding the past and imagining the future. It is a starting point for conversations about the goals and values of restoration, providing guidelines and framework for what may be desirable or possible.

The primary findings of this study are summarized below, as well as at the end of each relevant chapter. Management implications may be found at the end of each chapter. Taken together with an understanding of modern conditions, these findings can support scientists and managers working to identify restoration opportunities in the Ventura region.

Santa Clara River and Valley

1. **The historical (early 1800s) Santa Clara River valley supported a diverse array of natural habitats,** from the willow groves and wetlands of Saticoy Springs to the sycamores and oaks found on alluvial fans near Santa Paula and Fillmore (page 51). However, the valley floor was dominated by grassland and coastal sage scrub, with trees occurring singly or in stands and along creeks and rivers. Valley oaks were not documented in the Ventura County portion of the valley.

2. **Most substantial freshwater wetland complexes occurred within the river corridor of the Santa Clara River, not on the valley floor (page 87).** A rich array of aquatic habitats were found within the river corridor, including ponds, sloughs, and freshwater marshes in perennial reaches, and a suite of saline and brackish aquatic habitats associated with the estuary at the river mouth.

3. **Prior to modification, most small tributaries did not connect to the Santa Clara River (page 76).** With few exceptions, intermittent small creeks commonly sank into their alluvial fans before reaching the Santa Clara River, a characteristic common to many intermittent tributaries across California. Rather than maintaining defined channels all the way to the river, these creeks were connected hydrologically to the river through subsurface flow and poorly defined, transitory surface channels. Most of these creeks have now been connected to the Santa Clara River though constructed channels, increasing valley drainage density (that is, stream length per unit area).

4. **From the late 19th to the early 20th century, the position of the Santa Clara River corridor remained relatively laterally stable (page 66).** Inter-annual variability in the relative vegetation cover of the active channel and bottomlands is evident in the historical record, with

widespread changes occurring after each major flood. However, our findings support the overall lateral stability of the river even through the St. Francis Dam break in 1928.

5. **In the relatively recent geologic past, the lower Santa Clara River shifted its outlet from near Point Hueneme to its present location (page 71).** While the date of this shift is not clear, it may have occurred in the past 200-500 years based on edaphic, ecological, and ethnographic evidence. This shift is reflected in historical alkalinity patterns on the Oxnard Plain (see page 177).
6. **The Santa Clara River was an interrupted perennial stream,** with alternating perennial and intermittent (summer dry) reaches (page 77). Only two intermittent reaches were clearly documented on the river, near Saticoy and Piru (though additional intermittent reaches may have been present). The location of perennial reaches was informed by a variety of factors, including artesian influence, tributary inputs, valley narrowing, and geologic constraints. Many of these factors continue to affect surface flow patterns today.
7. **The Santa Clara River supported a diverse mix of riparian species,** including trees such as sycamore, live oak, willow, cottonwood, box elder, and alder; scrub species such as scalebroom, buckwheat, mulefat, golden-aster, sagebrush, black sage, and cactus; and understory species such as wild grape and wild blackberry (page 83).
8. **Dense, persistent riparian forest and in-channel wetlands occurred in discrete patches along the Santa Clara River (page 85).** Rather than a continuous corridor, willow-cottonwood riparian forest was found at a few notable locations along the river, corresponding with areas of rising or perched groundwater. Other reaches supported a different matrix of non-vegetated riverwash, willow scrub, mulefat, and alluvial scrub. This longitudinal heterogeneity tied to patterns in groundwater-surface water interactions suggests that different restoration targets are appropriate for different reaches. It suggests nodes for riparian forest restoration centered around former persistent wetland riparian areas, as well as a focus on maintaining the water resources (rising groundwater) that would support these habitats.
9. **Alluvial scrub was a likely component of the driest portions of the Santa Clara River (page 92).** While more research is needed, compiled data suggest that alluvial scrub is a more suitable riparian restoration target for drier reaches (notably the Piru reach) than riparian forest.
10. **Live oaks and sycamores occurred frequently on the Santa Clara River river outer banks (page 85).** Numerous live oaks and sycamores were documented on high banks on the edge of the river corridor. Live oaks and sycamores documented within the river corridor occurred largely in Santa Paula and Sespe creeks (likely on higher bars or islands) and as individuals within large areas of willow-cottonwood forest on the mainstem Santa Clara River.

Ventura River and Valley

1. **The historical Ventura River valley supported a diverse array of natural habitats,** including valley freshwater marsh, grassland, coastal sage scrub, oaks, and sycamores (page 124). While we were unable to map the valley floor in detail, our data indicate a broad transition from grassland in the lower valley (Avenue area) to predominantly oaks, sycamores, and scrub above Foster Park to Matilija Dam. As in the Santa Clara River valley, valley oaks were not documented anywhere in the valley. Only one wetland feature was documented on the valley floor within the study area (not including Mirror Lake).
2. **Most substantial freshwater wetland complexes occurred within the Ventura River corridor.** Aquatic habitats such as ponds, sloughs, and freshwater marshes were likely found in many perennial reaches (page 138), and a suite of saline and brackish aquatic habitats was associated with the estuary at the river mouth.
3. **The Ventura River supported a broad range of riparian species,** including trees such as sycamore, live oak, willow, cottonwood, box elder, alder, and walnut; understory species such as wild grape, wild rose, and wild blackberry; and mulefat and alluvial scrub species (page 138).
4. **Unlike on the Santa Clara River, live oaks and sycamores were common within the river corridor of the Ventura River (page 138).** While on the Santa Clara River live oaks and sycamores were almost exclusively found bordering the river's high (outer) bank, both trees were common on benches, bars, and islands in the Ventura River channel, particularly in the intermittent Oak View reach.
5. **The Ventura River mouth has shifted location numerous times over the past several hundred years,** from the hills west of the river mouth to Figueroa Street in Ventura. Many of these former river mouth areas are still susceptible to flooding (page 130). A brackish lagoon, formerly at the site of what is now the Derby Club across from Seaside Park, marked the route of one of these former river mouths.
6. **The Ventura River was generally perennial for much of its length (page 135).** The uppermost reach (below the present-day location of Matilija Dam) consistently supported year-round surface water, as did the lower half of the river (below the San Antonio Creek confluence). In contrast, the middle reach, through the western Ojai Valley and downstream of Oak View, was typically dry during the summer. The precise extent and location of summer water fluctuated in response to annual variations in rainfall and runoff.

Oxnard Plain

1. **The Oxnard Plain supported a diverse array of habitats,** from the freshwater wetlands and lakes of the lower Calleguas watershed to the alkali meadows and flats, grassland, coastal sage scrub, and chaparral of the broader plain (page 174). Just under half of the plain supported alkali meadows and alkali flats, with the remainder mostly covered by grassland and coastal sage scrub.

2. **The distribution of these habitats reflected underlying physical processes and characteristics (page 163).** Topography, soils, geology, and groundwater availability were primary factors in determining historical habitat distribution.

3. **Few trees were found on the Oxnard Plain (page 174).** Only a small number of trees were documented on the plain by 19th century observers, mostly sycamores (and one live oak) on the sand and sandy loam soils marking the former route of the Santa Clara River to Point Hueneme.

4. **Few streams traversed the Oxnard Plain, particularly in its western portion (page 167).** The plain was notable for its extremely low drainage density (only 1.7 miles of creek per square mile). The few creeks and barrancas that did cross the plain were almost exclusively discontinuous, sinking into coarse alluvium or spreading into and across seasonally wet alkaline areas. Large sloughs such as Revolon Slough (a former channel of the Santa Clara River) formed the backbone of drainage for the central plain.

5. **Calleguas Creek did not maintain a defined channel across the Oxnard Plain,** instead spreading into a broad wash around present-day Highway 101 before re-emerging downslope near Conejo Creek (page 168). The creek terminated in a lake and distributary system near the current location of CSU Channel Islands. Calleguas Creek was hydrologically connected to Mugu Lagoon through shallow sloughs and sheet flow during floods.

6. **Calleguas and Conejo creeks were intermittent on the Oxnard Plain (page 168).** Though sources describe readily available water located below the surface in both creek beds, they are consistently described as dry for much of the year.

7. **Sources document a concentration of perennial freshwater wetlands, ponds, and lakes along the eastern margin of the Oxnard Plain,** particularly east of Conejo and Calleguas creeks (page 182). The majority of these wetlands occurred near the base of small alluvial valleys of creeks tributary to Calleguas and Conejo creeks, near contacts between alluvial deposits and the Conejo Volcanics of the western Santa Monica Mountains.

Ventura County Shoreline

1. **A diversity of coastal systems characterized the Ventura shoreline,** each with differing habitat patterns and hydrologic dynamics (page 191). The overall habitat distribution is well documented, though available historical sources only begin to indicate the range of coastal processes that created these patterns, from Mugu Lagoon to the backbarrier lagoons, dunes, salt flats, and tidal marshes of the Oxnard Plain.

2. **Coastal wetland habitats covered about 4,300 acres,** accounting for a large proportion of former Ventura County wetlands (page 191). Differences in freshwater input, extent of vegetative cover, and closure regime led to varying support functions for native fish and wildlife.

3. **Three distinct types of coastal estuarine systems characterized the Ventura County shoreline**: the freshwater-brackish, intermittently or seasonally closed estuaries of the Ventura and Santa Clara rivers; the non-tidal lagoon complexes marking former Santa Clara River mouths; and the large, more tidally-influenced wetland system at Mugu (page 191).

4. **The Ventura and Santa Clara River estuaries were periodically open to the Pacific Ocean (page 194)**. Regular, seasonal cycles of closure were documented for the Santa Clara River mouth. The Ventura River mouth closed only occasionally (less frequently than the Santa Clara River), reflecting its greater historical volume of summer flow in the lowest reach, steeper channel gradient near the mouth, and lesser wave exposure.

5. **The estuaries of both rivers also shared similar habitat mosaics (page 194).** Both rivers had fairly compressed estuaries, with the relatively limited saline and brackish wetland habitat near their mouths bordered by extensive freshwater habitats, most notably the willow-cottonwood forest and wetland documented at both mouths.

6. **McGrath Lake is a regionally significant feature,** unique because of its persistence over the past centuries and its freshwater character (page 203). Though the lake has persisted, its location has shifted substantially since the mid-1850s; only a small portion of its current area overlaps with its historical extent.

7. **An extensive suite of marsh, salt flats/pannes, and lagoons stretched from south of the Santa Clara River to the western edge of Mugu Lagoon (page 205).** Prior to drainage and agricultural expansion, these systems were a significant component of the Ventura County shoreline. They exhibited a range of habitat patterns based on variable salinity gradients and hydrologic inputs, from the spring-fed brackish Laguna Hueneme to the hypersaline Salinas near Point Hueneme.

8. **Mugu Lagoon was the largest wetland complex in Ventura County, and the site of a broad range of coastal wetland habitats,** including salt and brackish marshes, large salt flats, and extensive tidal channel networks (page 225). Dominant habitat cover was tidal marsh. There is some indication that the complex formerly extended substantially further inland than currently recognized. Its acreage has been dramatically reduced.

9. **Salt flats and high marsh transition zone were major components of Mugu Lagoon (page 228).** These transitional, high elevation habitats were particularly characteristic of the semi-arid climatic setting (Ferren et al. 2007), and have been disproportionately lost from this system. These features likely provided breeding habitat for shorebirds such as least tern and snowy plover (as small present-day remnants still do), as well as an inland migration zone for tidal marsh transgression in response to naturally rising sea level in the past.

ACKNOWLEDGEMENTS

We would like to express our appreciation to the volunteers and staff at the historical societies, libraries, archives, and agencies where we gathered the data that form the backbone of this report. Particular thanks to Charles Johnson at the Museum of Ventura County, Jan Timbrook at the Santa Barbara Museum of Natural History, and Alex Williams at the Ventura County Surveyor's Office. We are also indebted to the volunteers and staff at the local historical societies and public libraries where we collected data, including the Ventura County Public Library, Camarillo Historical Society, Fillmore Historical Society, Ojai Valley Historical Society, Santa Paula Historical Society, Ventura County Surveyor's Office, and Ventura County Recorder's Office. Staff at The Bancroft Library, Water Resources Collections and Archives, Bureau of Land Management, California Historical Society, California State Library, Santa Barbara Museum of Natural History, Santa Barbara Mission Archive-Library, UC Santa Barbara Map and Imagery Library, and Huntington Library were also instrumental in the data collection effort.

Over the course of the project, a number of researchers contributed time and input to data collection and interpretation. Veronica Rojas and Michael Beland of CSU-Northridge collected data at many institutions in Southern California. Murray McEachron at United Water Conservation District, Mark Capelli at the National Marine Fisheries Service, and Mark Bandurraga at the Ventura County Watershed Protection District provided relevant contemporary literature and data layers. Assistance was also provided by a number of SFEI staff, including Chuck Striplen, Josh Collins, and Sarah Pearce.

We would like to thank our Technical Review Team for contributing their expertise to the interpretation and discussion of historical conditions and providing comments on the report. The group included Mark Capelli, Frank Davis, Tom Dudley, Dave Jacobs, Paula Schiffman, and Camm Swift. We also received support and advice from Bill Sears.

This project was funded by the California Coastal Conservancy. We would especially like to thank Peter Brand, our project manager at the Coastal Conservancy, who was critical to the success of the project.

I • STUDY OVERVIEW AND METHODS

Every day makes a little history or a few changes on the map.

—VENTURA FREE PRESS 1914

Introduction

This report synthesizes an array of historical records to document historical landscape patterns, ecological and hydrologic dynamics and trends, and environmental management opportunities in Ventura County lowland watersheds. This report and associated geo-database provide a spatially comprehensive dataset describing the historical distribution, abundance, and (where possible) functions of habitats of the Ventura River, lower Santa Clara River, and Oxnard Plain prior to significant Euro-American modification.

While substantial ecological resources still remain, the region has been subject to extensive modification over the past 250 years. Understanding the scope of these modifications, and the nature of the historical landscape patterns formerly present in the region, is not a trivial task. Regular hydrogeomorphic and ecological monitoring was not present in the county until the 20th century, and the data that do exist are idiosyncratic, challenging to interpret, and scattered in archives across the state. Despite these impediments, historical ecology is an essential component of crafting sound, site-specific environmental restoration objectives, which demand detailed data as the basis for management strategies. Without a detailed understanding of the former characteristics of the region—and how these characteristics changed in response to human alterations of the landscape—appropriate ecological and hydrological restoration targets can be difficult to determine.

This study was designed to support acquisition and restoration efforts by the California State Coastal Conservancy, in particular through the Santa Clara River Parkway project, Ormond Beach Wetlands Restoration project, and on the Ventura River through the nascent lower Ventura River Parkway plan. The characterization of historical ecological conditions developed here aims to inform these and other restoration and conservation opportunities throughout the region, helping managers develop strategies for choosing and designing restoration projects.

A previous report prepared for the Coastal Conservancy (Stillwater Sciences 2007b) analyzes the historical geomorphology of the Santa Clara River from 1938-2005. This current study extends this documentation of

Fig. 1.1. Santa Clara River east of Santa Paula, looking north (November 2008; opposite page).

former river characteristics to include 1769-1938 by integrating historical cartographic, textual, and visual accounts to create a heterogeneous but substantial dataset describing hydrologic, geomorphic, and riparian characteristics back to 1769—the date of the first land-based European exploration of the region.

Regional Setting

This study focuses on the habitat and drainage patterns of the region's lowlands, where change has been most pronounced. The study area encompasses three major contiguous areas: the Ventura River, the lower Santa Clara River, and the Oxnard Plain (fig. 1.2). Specifically, the geographic scope is the Ventura River and valley from its mouth to the Matilija Dam (exclusive of the Ojai Valley), and the Santa Clara River and adjacent valley floor from its mouth to its intersection with Interstate 5 in Los Angeles County (including only the lowest reaches of major tributaries, and focused on the Ventura County portion of the valley). It also includes the lowlands and coastal margins south of the lower Santa Clara River, including the Oxnard Plain and lower Calleguas Creek watershed west of Somis and the edge of the Santa Monica Mountains and south of South Mountain.

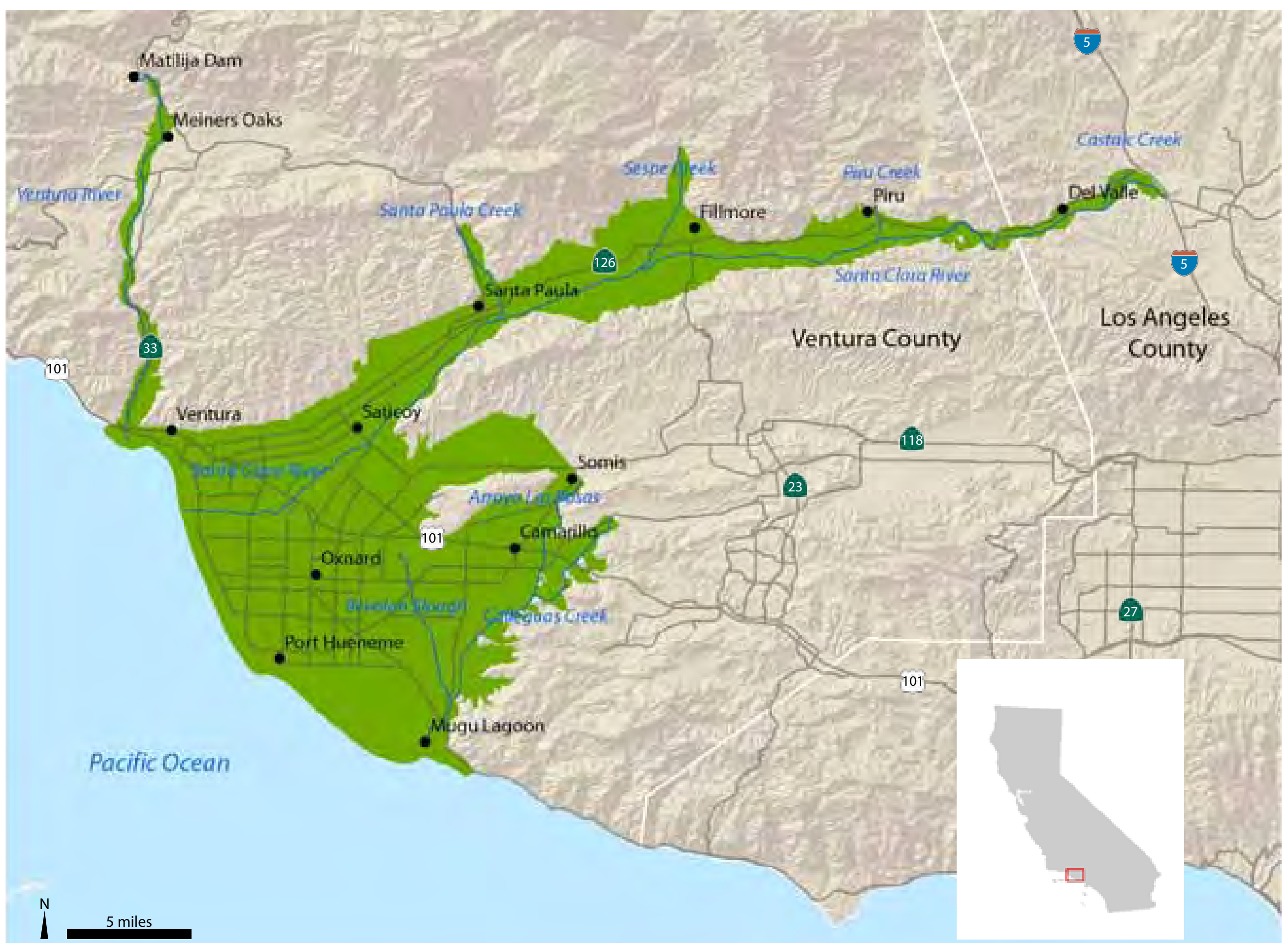


Fig. 1.2. Study area and regional geographic context. The project area included the Ventura River to Matilija Dam, the Santa Clara River to Interstate 5 in Los Angeles County, and the Oxnard Plain.

Ventura County is geologically active, with substantial uplift and lateral displacement occurring related to the San Andreas fault system. The region experiences a Mediterranean climate (cool/mild wet winters and war warm dry summers), characterized by high inter- and intra-annual variability. Most precipitation occurs from November through March. There is significant regional variation in precipitation between drier, low-lying coastal areas and wetter, more mountainous parts of the county.

Land use and population trends have taken a radically different trajectory in Ventura County than in its more urban neighbors to the south, and the region is still relatively unmodified in comparison to the other large coastal watersheds of Southern California. Major population centers in the study area include Oxnard (over 200,000, the county's largest city), Ventura, and Camarillo. The total population of the county is just under 850,000 (Herdt 2010).

DESIGNING RESILIENT LANDSCAPES: HISTORICAL ECOLOGY, RESTORATION, AND CLIMATE CHANGE

Restoration goals should be informed by knowledge of landscape conditions before modern development. Historical ecology research improves our understanding of the habitats we seek to restore, including the physical and cultural processes that governed their former distribution. Studying the landscape under earlier, less impacted conditions facilitates a landscape perspective that addresses questions fundamental to the restoration planning process: What habitats were supported where, and why? Where have certain habitats persisted? How have landscape patterns and process changed over time? Most importantly, how do we choose appropriate restoration and management targets?

Historical ecology has particular relevance to these questions in the context of global climate change. The historical Southern California landscape was well adapted to a highly variable, episodic climatic regime, and buffered the effects of environmental extremes while providing diverse ecological functions. As we anticipate a more variable climate in the future, we can learn from the ways in which dynamic historical ecosystems were able to respond and adapt to extreme conditions in the past. For example, broad floodplain surfaces along the Santa Clara and Ventura rivers would have attenuated flood peaks and recharged groundwater during high flows, while side channels and pools in perennial reaches would have provided refugia critical to the survival of native fish and other wildlife during times of drought and floods. Recovering these attributes will make systems more resilient and adaptable to climate change.

Historical ecology is an essential component of restoration design, but it is not an answer in and of itself. It is a tool for scientists and managers seeking to understand and ameliorate the dramatic landscape changes of the past 250 years. When integrated with contemporary data and future projections, historical information helps identify restoration opportunities and develop realistic management strategies. Often these would not be recognized without a historical perspective. Though controls on habitat distribution such as land use and climate may change, others, such as topography and geology, remain relatively stable. Historical ecology helps us understand which characteristics supported native species of concern and how these can be recovered or enhanced. Understanding the landscape patterns and processes of the recent past can help us establish functional, resilient systems that improve the ecological health of the region.

Fig. 1.3. Detail from a map of Rancho San Miguelito and the lower Ventura River, 1897. A jackrabbit serves as the compass, pointing north. (Barry 1897, courtesy of the Museum of Ventura County)

Lowland Ventura County is dominated by the Santa Clara River and its delta, the Oxnard Plain. The Santa Clara River watershed is one of the largest coastal watersheds in Southern California, draining approximately 1,620 mi². The last 38 miles of the river run through Ventura County, southwest through the Santa Clara River valley and across the Oxnard Plain before reaching the ocean. The Santa Clara River is regionally significant because it is relatively unchannelized and unregulated by dams, and its watershed is not as densely or extensively urbanized as other systems of comparable size in Southern California. As a result, many habitats and processes no longer viable on other comparable systems are still intact to some degree on the Santa Clara River, and there is great potential to restore former ecological and hydrogeomorphic patterns and functions.

Report Structure

The report is divided into six chapters, each of which treats a different topic or geographic region. This introductory chapter describes the project's geographic setting and management context, data collection and mapping methodology, and our habitat and channel classification system. The second chapter includes a discussion of 19th and early 20th century trends in agricultural land use and irrigation practices in the region. The third chapter describes ecological patterns and riverine dynamics for the lower Santa Clara River and valley, and the fourth chapter discusses the same topics for the Ventura River and valley. The fifth chapter describes habitat and drainage network patterns on the Oxnard Plain, and the sixth chapter provides a brief treatment of the habitat patterns along the shoreline from the Ventura River mouth to Mugu Lagoon.

Methods

The discovery, organization, and interpretation of historical data forms the foundation of this project. The complex process through which data spanning disparate places and eras were synthesized for this study is outlined in this section.

Data Collection

A substantial variety and quantity of historical data are needed for accurate assessment of the historical landscape (Grossinger 2005). With this in mind, we assembled a diverse range of historical records spanning about two and a half centuries and compiled these data into a map of historical landscape patterns prior to substantial Euro-American modifications.

Assembled material includes: (1) textual data (e.g., Spanish explorers' accounts, Mexican land grant case court testimonies, General Land Office records, early travelogues, and county histories and reports); (2) maps (e.g., Mexican land grant maps, early city and county maps and surveys, US Department of Agriculture soil surveys, and U.S. Geological Survey maps); and (3) photography (ground-based, aerial, and oblique) and paintings.

To acquire these sources, we visited local historical archives, public libraries, county offices, and regional archives. In total, we visited twenty-seven source institutions across California to collect data (table 1.1). We also reviewed material available online and conducted searches of over twenty electronic sites and databases. We acquired scans, copies, or photographs of a diverse array of primary and secondary sources pertaining to the historical landscape of Ventura County (fig. 1.3; also see "Historical data for Ventura County" spread, pages 6-7).

We acquired full or partial copies of approximately 500 maps, 250 documents, and 500 photographs. These represent a small fraction of the documents reviewed at the archives themselves. While we reviewed

Local Historical Societies and Public Libraries
Camarillo Historical Society
Fillmore Historical Society
Museum of Ventura County
Ojai Valley Historical Society
Santa Paula Historical Society
Seabee Museum
United Water Archives
Ventura County Public Library
County Agencies
Santa Barbara County Recorder's Office
Santa Barbara County Surveyor's Office
Ventura County Recorder's Office
Ventura County Surveyor's Office
Regional Archives
Air Photo Archives, UCLA Department of Geography
The Bancroft Library, UC Berkeley
Bureau of Land Management
California Coastal Conservancy Archives
California Historical Society
California State Library
California State Railroad Archives
CSU Northridge Library
The Huntington Library
Los Angeles County Seaver Center
Mark H. Capelli Southern California Steelhead Watershed Archives, Davidson Library, UCSB
NARA Pacific Region
Santa Barbara Mission Archive-Library
Santa Barbara Museum of Natural History
UC Davis Map Collection
UC Santa Barbara Map and Imagery Library
Water Resources Collections and Archives
Western Foundation of Vertebrate Zoology
Whittier College

Table 1.1. Archives, libraries, and historical societies visited to collect data for the Ventura Historical Ecology study.

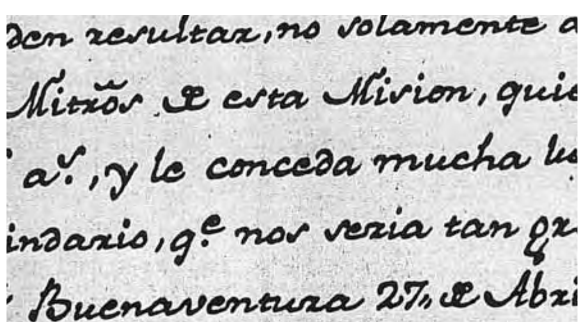
HISTORICAL DATA FOR VENTURA COUNTY

This study involved the collection and compilation of a wide array of historical sources, spanning mutliple centuries, languages, and formats. Historical documents form the backbone of our historical mapping and analysis, from Spanish-language explorer's journals (1769) and correspondence from the San Buenaventura Mission (ca. 1800) to soils mapping and aerial photography of the mid-20th century.

Since each source was produced by individuals in different social contexts and with variable goals, understanding the provenance of the sources we draw on is a fundamental starting point for understanding our findings. Shown below are examples and brief descriptions of some of the primary sources used in this study.

Mexican land grant sketches (1840s-1850s). As the Mission system disintegrated, influential Mexican citizens submitted claims to the government for land grants. A *diseño*, or rough sketch of the solicited property, was included with each claim. *Diseños* often show notable physical landmarks which would have served as boundaries or natural resources, such as creeks, wetlands, springs, and forests. While *diseños* are not as spatially accurate as subsequent surveys, they provide extremely early glimpses of former landscape features and patterns. (U.S. District Court ca. 1840d, courtesy of The Bancroft Library, UC Berkeley)

General Land Office Public Land Surveys (1853-1900). In areas not claimed through the land grant system, the U.S. Public Land Survey imposed a grid of straight lines on the landscape, dividing property into six-mile square townships. Each township was further subdivided into 36 one-mile sections, each section containing 640 acres. Surveyors methodically surveyed section lines along these transects, noting cultural and natural features they encountered along the way. Survey notes and plat maps from these surveys are useful for their ecological information. (Hoffman 1868d, courtesy of the Bureau of Land Management)

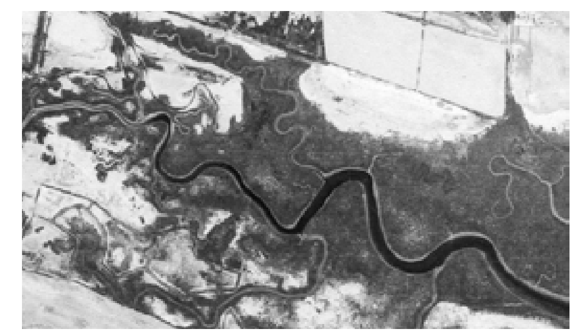


Textual accounts (1769-2011). Written accounts can provide a wealth of detailed information with nuance about landscape dynamics not available on maps. Spanish expeditions provide the earliest accounts; later sources such as land grant case testimonies, newspaper articles, ornithological records, county histories, and travelogues give rich perspectives from early visitors and residents. (text courtesy of the Santa Barbara Mission Archive-Library)

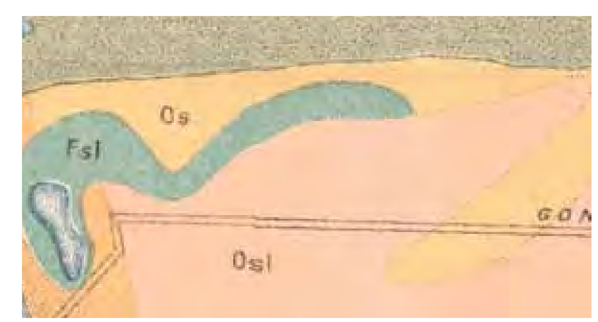
U.S. Coast and Geodetic Survey maps (1855-1934). The U.S. Coast and Geodetic Survey was established in 1807 by Thomas Jefferson to create navigation maps. Though the maps only cover the coastline and immediately adjacent areas, they are a highly valuable source because of their impressive detail and accuracy, scientific rigor, and relatively early survey dates. (Johnson 1855c, courtesy of the National Oceanographic and Atmospheric Administration)

City and county surveys (1860-1930). Local surveyors produced abundant maps, including many surveys of individual parcels. These maps, often surveyed at a large scale, contain details not included in other regional mapping efforts such as sloughs and side channels, smaller ponds and wetlands, or clusters of trees. Though coverage is inconsistent, these maps are invaluable in constructing an understanding of local ecosystem dynamics. (Barry 1894, courtesy of the Ventura County Surveyor's Office)

U.S. Geological Survey topographic maps (1903-1943). Shortly after 1900, the USGS (established in 1879) began producing topographic quadrangles at 1:62,500 for the Ventura County region. Though the maps are relatively coarse, they provide some of the earliest consisent, comprehensive coverage for the entire region. (USGS 1904, courtesy of the CSU Northridge Geography Map Library)



Historical aerial photography (1927-1959). A Depression-era program to ensure crop stability and soil conservation practices resulted in extensive aerial photographic coverage for much of the county. The bulk of historical aerial imagery used in this study is from 1927 and 1938. While the photographs were taken after substantial modification, the photos nevertheless reveal relict ecological features, traces of which are often still present in the landscape. (Fairchild Aerial Surveys 1927, courtesy of Whittier College)



U.S. Department of Agriculture soil surveys (1901-1917). Early soil surveys were developed to describe variability in the agricultural viability of regional soils. These maps, and their accompanying reports, are a key source in the inference of historical habitat extent and location. Descriptions of soil properties and agricultural use can provide insight into former habitats, in particular providing spatially accurate detail on the extent of wet meadows and alkaline habitats. (Holmes and Mesmer 1901b)

Landscape photography (1860s-1950s). Historical photographs represent a category of diverse historical data that can provide extremely localized, accurate information. Photographs can capture the conditions of a given place and time in a manner that provides substantial detail about specific species presence and landscape structure. (Isensee 1928b, courtesy of Museum of Ventura County) thousands of documents for this study, historical research is never completely exhaustive, and the local historical record is extensive. Additional sources will undoubtedly surface showing ecological information that enrich the descriptions and information incorporated in this report. In particular, we were unable to focus substantial efforts on data collection for the major Santa Clara River tributaries (e.g., Santa Paula, Sespe, and Piru creeks) and the Los Angeles County portion of the Santa Clara River. As a result, it is likely that much more information exists detailing the historical landscape of these regions. Future research exploring other sources, such as early court cases and oral histories, may also reveal more detail about this area.

Data Compilation

Data compilation is the process of organizing the large volume of collected, heterogeneous data used in this study into more accessible formats for interpretation at the local and landscape scale. As part of this process, we read narrative sources and transcribed relevant quotes into one comprehensive document, georeferenced maps and spatially locatable quotes, and created large-scale maps, or "base maps," displaying compiled data onto which we transferred non-georeferenced data. High-priority maps were chosen for georeferencing based on their spatial resolution, mapping accuracy, and relevance (e.g., types of features shown and date of mapping). They were georeferenced to contemporary orthorectified aerial imagery (USDA 2005), using ESRI's ArcGIS 9.3.1 software. Approximately 150 maps were georeferenced.

One heavily used source was historical aerial photography, which required orthorectification and mosaicking of 238 aerial photographs into a comprehensive, continuous coverage of the entire study area (fig. 1.4). Aerials were acquired from a number of source institutions and spanned a number of different years. The earliest imagery (1927), used where available, makes up about one half of the entire photomosaic. Later imagery (from 1938, 1945, and 1959) was substituted where 1927 imagery was not available. The spatial consistency, accuracy, and high level of detail available made these an invaluable source for the project.

Relevant quotes were extracted from textual material and transcribed into a Microsoft Word document. Quotes were organized by broad geographic area (Santa Clara River valley, Ventura River valley, Oxnard Plain) and by subject (e.g., riparian vegetation, channel geometry, or wetland habitats). In addition, quotes pertaining to land use history, irrigation history, and climate were transcribed. Over 160 pages of quotes were transcribed. Of these quotes, about 240 were spatially specific enough to be locatable on our base maps. These were mapped and included in our project geographic information system (GIS) as an independent data layer.

In addition, we adapted methods developed by the Forest Landscape Ecology Lab at the University of Wisconsin-Madison that use GIS to store, display, and analyze General Land Office (GLO) data obtained from the microfilm archives at the Bureau of Land Management Office in Sacramento, CA (Manies 1997, Radeloff et al. 1998, Sickley et al. 2000). For Ventura County, survey notes ranged from 1853-1900. Just under 1,700 data points collected from the General Land Office notes were included in this layer.

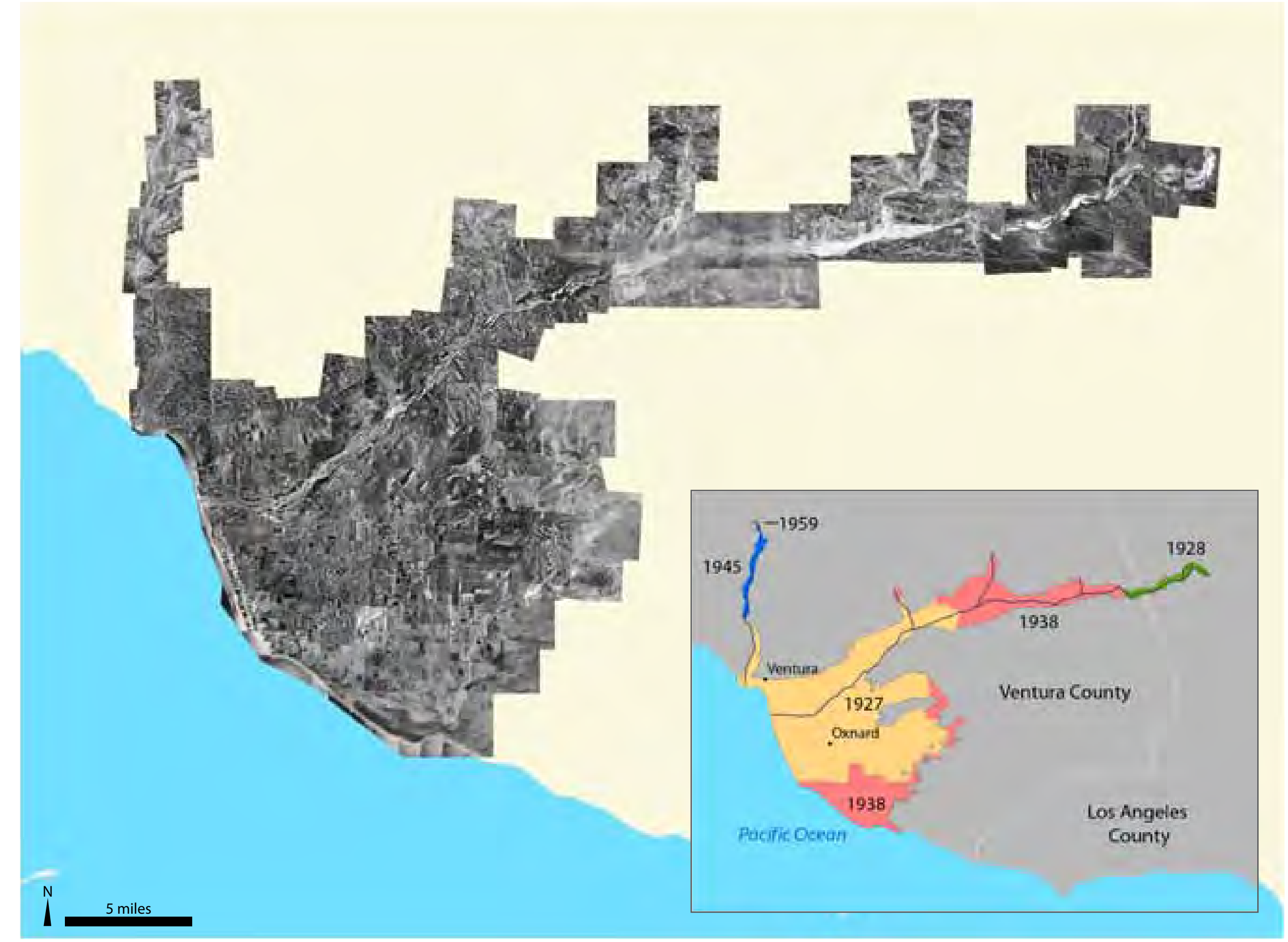


Fig. 1.4. Earliest date of aerial photo coverage. Two hundred and thirty-eight historical aerial photographs were orthorectified and mosaicked to provide continuous coverage of the study area. Aerials spanned from 1927-1959, with the bulk of photos from 1927 and 1938.

Data Interpretation

We examined historical data for evidence of landscape characteristics prior to significant Euro-American modification. Our goal was to map landscape features as they existed, on average, prior to and during the early decades of Euro-American settlement (1770s-1850s). Despite inter-annual and decadal variability, mean climatic characteristics during the period for which historical data were obtained (1769-1940s) were relatively stable (Lynch 1931, Dettinger et al. 1998; see also Haston and Michaelsen 1997). Many later sources (i.e., outside of the target time period) were found to record features that clearly corresponded to features documented by earlier sources, and thus provided more accurate mapping of these features. For example, a feature shown on an early source (e.g., a *diseño*) that confirms the general presence of the feature but not its location, could be confirmed and mapped from a later source (e.g., a historical aerial), despite surrounding land use changes.

Accurate interpretation of documents produced during different eras, using different methods or techniques, for differing purposes, and with different authors, surveyors, or artists can be challenging (Harley 1989, Grossinger and Askevold 2005). To address these issues, we interpreted collected data through an iterative process of source inter-calibration using GIS and other techniques. Our dataset of sources, often overlapping in geography and depiction, allowed us to compare an array of complementary documents, and in doing so assess the accuracy of individual documents and to promote accurate interpretation of landscape characteristics. This approach provided independent verification of the accuracy of original documents and our interpretation of them (Grossinger 2005, Grossinger et al. 2007). In addition, through this process we were able to take a large body of often subjective information (e.g., a traveler's description of the Santa Clara River) and form a reliable, comprehensive, and coherent body of data.

To ensure persistence and accurate interpretation, we documented each feature using multiple sources from varying years and authors where possible. In some cases, a high density of sources documenting a particular feature allowed for high mapping confidence of both presence and extent. However, many features are documented by only one source or simply may not have any specific early source that describes the habitat. In these cases extrapolation based on soil types, topography, hydrology, and general descriptions was necessary.

To document the mapping sources used and the classification and mapping accuracy certainty associated with individual features, we assigned a set of attributes including each feature's derivation and estimated certainty levels (table 1.2). Our confidence in a feature's interpretation (classification), size, and location was assigned as a set of three certainty levels based upon the number and quality of sources, and our experience with the particular aspects of each data source (following standards discussed in Grossinger

Certainty Level	Interpretation	Size	Location
High/ "Definite"	Feature definitely present before Euro-American modification	Mapped feature expected to be 90%-110% of actual feature size	Expected maximum horizontal displacement less than 50 meters (150 ft)
Medium/ "Probable"	Feature probably present before Euro-American modification	Mapped feature expected to be 50%-200% of actual feature size	Expected maximum horizontal displacement less than 150 meters (500 ft)
Low/ "Possible"	Feature possibly present before Euro-American modification	Mapped feature expected to be 25%-400% of actual feature size	Expected maximum horizontal displacement less than 500 meters (1,600 ft)

Table 1.2. Certainty level standards used in the interpretation and mapping of historical features.

et al. 2007). These attributes provide for data transparency and allows subsequent users to assess accuracy and identify original data sources.

Mapping Methodology

We used a geographic information system (ESRI's ArcGIS 9.3.1 software) to interpret and synthesize our information into digitized data layers representing historical landscape characteristics of the lower Santa Clara River, the Oxnard Plain, and the Ventura River. GIS was used to collect, catalog, compile, digitize, analyze, and display our sources. By spatially relating sources from many time periods, we were able to examine habitat location and change through time (fig. 1.5). The relational database component of GIS allows for storage of many attributes about a single feature, which we used to integrate our disparate sources and document the provenance of our interpretation of the historical landscape. Using GIS, we were able to synthesize complex arrays of sources by assembling maps and narrative information from different periods, allowing us to assess each data source, more accurately map each feature, and better understand change over time.

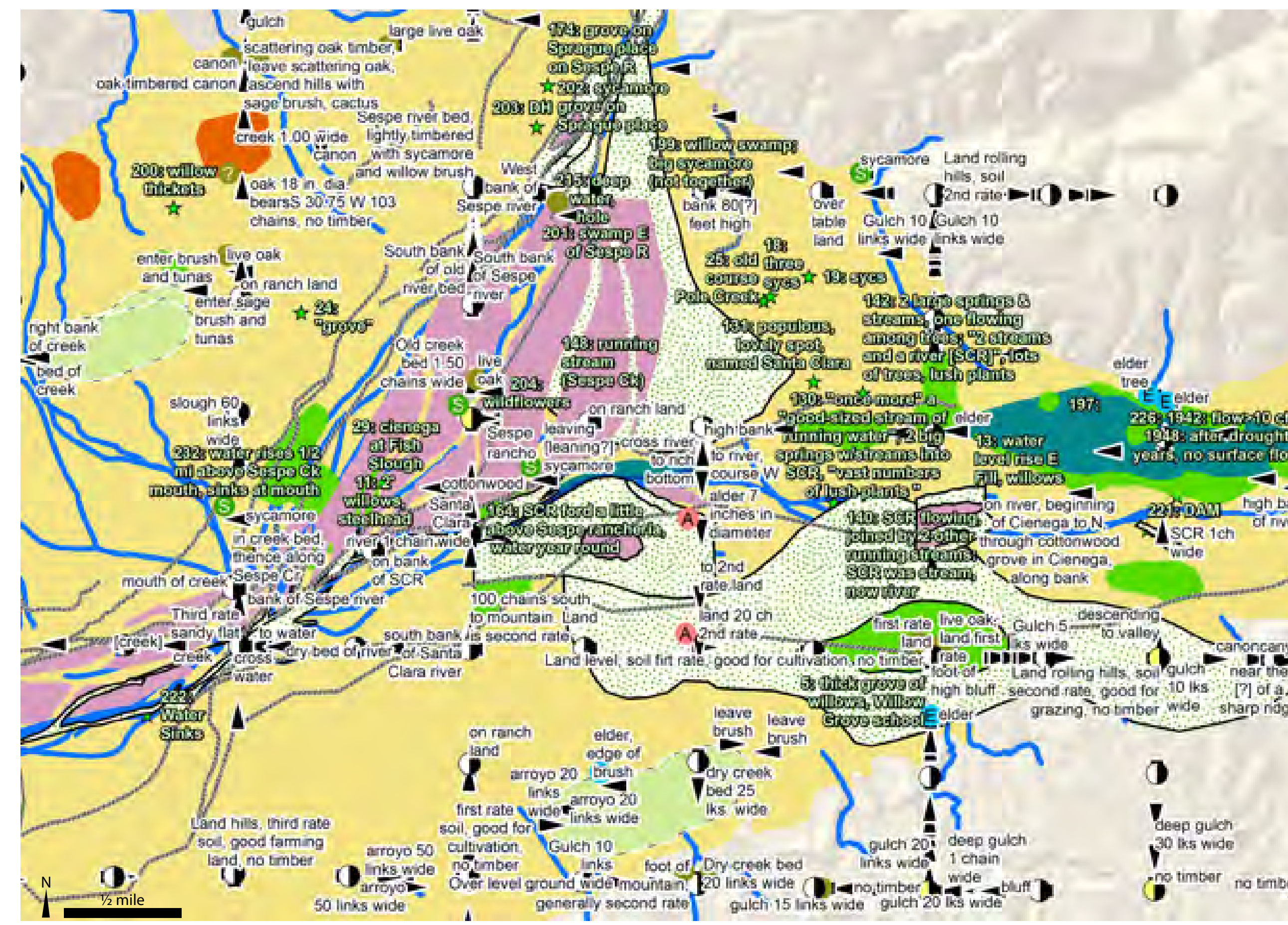


Fig. 1.5. Draft historical habitat and channel mapping at Santa Clara River-Sespe Creek confluence, early 1800s. Features from dozens of historical maps, texts, and photographs were digitized before being synthesized through an intensive process into one integrated map of the region's historical ecology.

The habitat map produced through this process depicts our understanding of landscape features as they existed before major Euro-American modifications (1770s-1850s; referred to as "early 1800s" for simplicity). Individual creek and habitat features were digitized from historical sources, and ultimately synthesized into the study area habitat map (included at the beginning of this report).

The primary purpose of the mapping process and resulting habitat map is to represent habitat diversity and heterogeneity at the watershed scale, leading to a better understanding of regional patterns and processes. While many individual habitat polygons have been mapped with precision (see table 1.2), others have higher error margins for their mapped size. Clearly, our dataset of disparate sources (each representing a different scale, time period, and level of accuracy) prevents mapping each area at the same level of detail. In addition, many former features were undoubtedly not documented by any historical source, and therefore were not mapped. However, these issues do not undermine the map's usefulness as a tool to characterize and understand the region's historical ecological patterns and the underlying processes that shaped them.

The following section outlines the methods used to integrate and synthesize data in GIS to depict broad classes of habitats on the map, both for the purpose of visual representation of historical habitats and channels and for analysis of the historical landscape. For more information on the accuracy of a particular habitat polygon, please refer to the GIS metadata.

RIVER CORRIDORS AND RIPARIAN HABITATS For the river systems (Santa Clara, Ventura) and major tributaries to the Santa Clara River (Santa Paula, Sespe, Hopper, and Piru), the entire river corridor (from outer bank to outer bank) was mapped as a polygon in the habitat layer (fig. 1.6). (Major tributaries to the Ventura River, such as Coyote, San Antonio, and Matilija creeks, were on the edge of the study area boundary and were not mapped as polygons.) This area includes the predominantly sandy active channel (mainstem; high disturbance) in addition to vegetated areas that show evidence of erosion/deposition (medium disturbance) and more densely vegetated areas that may be subject to flow during flood events, but without evidence of major erosion/deposition (low disturbance). Benches or bottomlands with evidence of flow during at least some flood events are also included. This definition of the river corridor was based on research conducted by Stillwater Sciences (2007b) for 1938-2005. More detailed definitions of riverine terms used in this report is can be found on page 61.

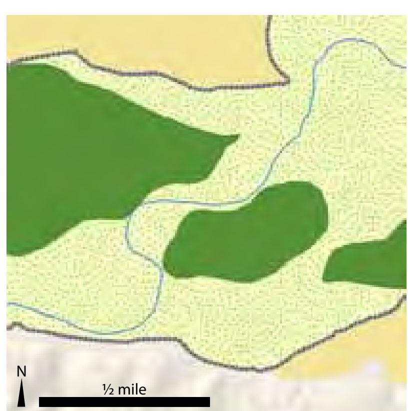


Fig. 1.6. Detail of mapping of outer river banks and river corridor extent. Outer banks were mapped as a broken black line, and river corridor extent with a green and yellow stippled pattern. (The dark green polygons are willow-cottonwood forested wetlands.)

We used Stillwater Sciences' mapping as a starting point for defining the river corridor for the Santa Clara River (Stillwater Sciences 2007b). For other major channels, including the Ventura River, mapping from the earliest available historical aerial served as a base layer. These base layers were then modified where earlier historical sources showed clear evidence of a change in outer bank position. For more details on mapping methodology for the river corridors of major streams, see the Santa Clara River morphology section (page 63).

For these main river corridors, the mainstem channel lines were mapped from the historical aerial photomosaic. Since the location of the low-flow channel would have changed regularly, these lines are only used to represent the presence of mainstem channels in the broadest sense, and do not indicate a persistent feature. They were mainly used as a tool to map seasonality for the Santa Clara and Ventura rivers and main tributaries. Stream seasonality (presence of summer flow) was mapped based on historical USGS mapping, and amended where earlier additional evidence was available.

In general, we did not develop detailed maps of riparian habitats (in-channel and on the outer bank), given their inconsistent documentation and their dynamic nature on a yearly or decadal scale. Riparian vegetation features represented on historical maps within the active channel and on the floodplain were difficult to interpret and impossible to map meaningfully, given inter-annual variability in distribution and characteristics. As a result, riparian vegetation such as live oaks along canyons at the edge of the valley were mapped as the surrounding habitat. In addition, riparian habitat in the active channel was subsumed under "other in-channel riparian" habitat. Historical riparian habitat patterns are described qualitatively in the text.

While many areas of riparian forest inside the active channel were ephemeral, shifting with major flood events, there were a few reaches of the river with large wetland riparian features whose presence was consistently documented through major flood events. These areas are notable in their extent (over 200 acres), their persistence over time (as documented by multiple historical sources), and their relative importance to early residents (as indicated by their prevalence in the historical record). These features are included in our habitat mapping as willow-cottonwood forested wetland.

CHANNELS All other watercourses (including Calleguas Creek and tributaries to the rivers and creeks mapped as polygons, as described above) were mapped as line features in ArcGIS (fig. 1.7). The contemporary National Hydrography Dataset (USGS 2004) was used as a basis for mapping the historical channel network. The NHD GIS layer was modified where historical sources (such as historical aerial photos or maps) clearly showed evidence of a historical plan form differing from the contemporary alignment. This process produced a depiction of our best understanding of the historical channel network based on earliest available source.

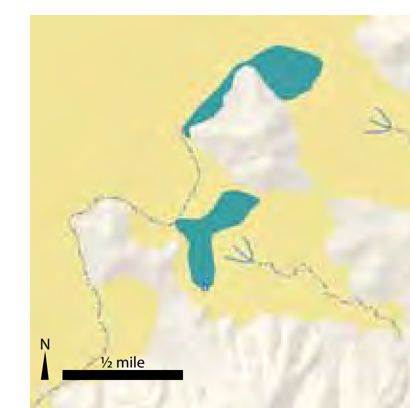


Fig. 1.7. Detail of channel mapping. Small creeks were mapped with a single line, dashed to indicate intermittent/ephemeral conditions. A forked symbol was used to indicate a distributary (that is, the point at which a creek spreads or sinks).

Contemporary stream lines were altered only where historical sources clearly indicated a different channel position or shape than that mapped by NHD (greater than 50 feet difference). This approach accounts for differences in mapping scale between historical and modern mapping, differences in georeferencing, and the accuracy of historical sources.

Although this method will not capture all changes in plan form, it allows us to more accurately analyze major changes in drainage density (stream length per unit area), connectivity, and total stream length while preventing us from over-mapping change. All editing was performed at a scale of 1:4,000.

To map the historical drainage network, we first compared NHD mapping and modern aerial imagery (USDA 2005) to early aerial imagery (1927-1959) to identify 20th century modifications. Engineered channel reaches, such as ditches and artificial flood control channels, were removed from the data set. To evaluate change predating the historical aerials, NHD mapping was compared with earlier maps depicting channel plan form. We also incorporated information from General Land Office (GLO) survey notes, other textual descriptions, topography, and early soils maps. (Contributing sources and certainty levels associated with each creek segment are recorded in the GIS attributes.)

Channels (over 500 feet long) depicted by a historical source but not present in NHD were included in the historical channel layer. To maintain a consistent depiction of channel density over time, we attempted to map channels roughly to the same level of detail as contemporary NHD mapping. As a result, our mapping excludes some small channels for which there is evidence in historical sources (such as small barrancas, creeks, or sloughs). In particular, a number of small channels visible in the historical aerial photomosaic, but of uncertain size or origin, were not included in our historical channel mapping. This approach allows for more accurate comparison between the historical stream layer and modern mapping.

Many channels historically lost definition on the alluvial plain rather than directly connecting to another channel. We represented the terminus, or distributary, of defined channels with a forked symbol on the habitat map. In cases where channels did connect to a large river (Santa Clara or Ventura river) or a major tributaries (Santa Paula, Sespe, Hopper Canyon, Piru, or Castaic creek), the channels were clipped to the historical outer channel banks layer, signifying probable connectivity to the mainstem.

WETLAND HABITATS We documented the extent and distribution of wetland types prior to significant Euro-American modification based on available historical evidence (fig. 1.8). Wetland types mapped include palustrine habitats (alkali meadow, alkali meadow/flat, wet meadow, valley freshwater marsh, perennial freshwater pond, willow thicket, and willow-cottonwood forested wetland) and also a number of coastal habitat types (see habitat crosswalk, table 1.3).

Salt-affected, seasonally-flooded alkali meadows covered large areas of the Oxnard Plain, and were by far the most extensive wetland habitat type in the region. Extent of alkali-associated habitats was mapped almost exclusively from historical soils maps (Holmes and Mesmer 1901b, Nelson et al. 1917). Alkali meadow was first mapped from the later historical soils map (Nelson et al. 1917), which shows large bodies of land with alkali present (designated with an "A") or alkali present "in spots" (designated with an "S," and covering most of the alkali-affected area). This mapping provided the general extent of alkali influence on the Oxnard Plain. A map of alkali extent accompanying the earlier soils report (Holmes and Mesmer 1901b), which distinguishes between six grades of alkali influence from 0.2% to over 3%, coarsely matches the extent of alkali-affected land as shown on the 1917 map, but provides much more resolution on the extent of highly affected (greater than 1% alkali) land. Highly affected alkaline areas, or alkali flats, were drawn from this map (the alkali meadow/flat category includes areas with 1% or greater alkali concentration in the top six feet of soil).

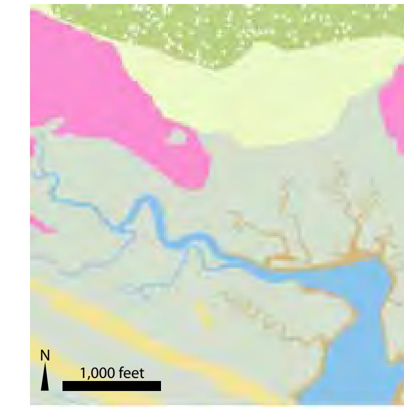


Fig. 1.8. Detail of wetland mapping, northwestern edge of Mugu Lagoon wetland complex. We mapped seasonal wetlands (such as alkali meadows, shown here in green with white stipple) in addition to perennial wetlands (such as the tidal marsh shown in grey-blue).

To map coastal features, we digitized and interpreted features from the earliest available U.S. Coast and Geodetic Survey (USCS) topographic sheets (T-sheets), from 1855 and 1857 (Johnson 1855b,c; Johnson 1857). High-resolution, full-color digital imagery of original T-sheets were obtained from the National Archives and Records Administration in College Park, Maryland (thanks to Dr. John Cloud of NOAA) and georeferenced. This work was completed as part of the Historical Wetlands of the Southern California Coast project, which contains further detail on the digitization and interpretation process for the T-sheets (see Grossinger et al. 2011). This mapping was then compared to additional sources (e.g., later T-sheet resurveys, independent historical maps, GLO survey notes, and other textual descriptions) and modified where appropriate.

Other wetland habitats were mapped from reliable, spatially explicit historical sources documenting the presence and extent of wet meadows, depressional marshes, ponds, and willow groves on the alluvial plains. Where multiple sources showed the same feature, evidence was synthesized to produce the most likely representation of historical feature. Topography, historical soils maps, and early aerial imagery were used to refine the shape and extent of wetland features in the absence of other available documentation.

This process undoubtedly under-represents the historical extent and distribution of wetland features. Some known wetland features are documented in the textual record or on coarse maps, but are ultimately not recorded with enough accuracy to render them mappable. Other wetlands were undoubtedly present, but were left undocumented by the available historical record. Subsequent research may reveal more information about the presence or location of additional wetland features.

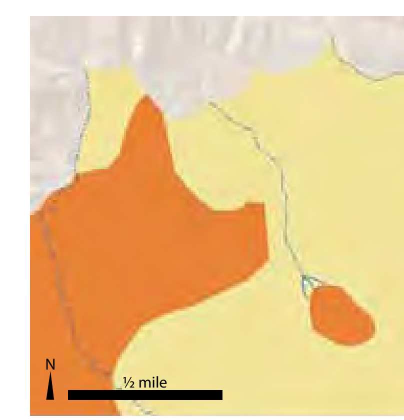


Fig. 1.9. Detail of dryland mapping. We mapped dryland habitats in a generalized fashion, including grassland/coastal scrub (in yellow) and oaks and sycamores (in orange).

DRYLAND HABITATS We documented the extent and distribution of dryland habitat types prior to significant Euro-American modification based on available historical evidence (fig. 1.9). Here we define "dryland" habitats to be well drained terrestrial habitats without regular cycles of flooding. Mapped terrestrial habitat classes include grassland/coastal sage scrub and oaks/sycamores (see habitat crosswalk, table 1.3). This layer provides the background into which we incorporated wetland and river corridor mapping.

Historical sources generally contained much less spatially explicit documentation of dryland habitat features (unlike for many wetland types, where multiple historical sources often document a single feature's location and characteristics). As a result, the goal of dryland habitat mapping was to produce a meaningful representation of patterns of dryland vegetation cover at the landscape scale. Given the lack of spatially specific information in most early sources, we relied predominantly on the few sources that did address dryland habitats, including GLO surveys, historical soil surveys, and historical aerial photography. Where available, textual descriptions, cartographic sources, and landscape photography provided additional support.

In particular, the GLO survey data provided early, detailed information about habitat boundaries and characteristics along survey lines. Later sources (such as historical soil surveys and aerial photography), in addition to edaphic or topographic information, were used to shape polygons in areas where a GLO transect was the only other source of evidence. In some cases, habitat boundaries were defined by the descriptive text associated with the soil surveys. These survyes often describe the native vegetation of the soil type, such as "brush and grass" on Yolo fine sandy loam or "scattered oak and brush" on Vina fine sandy loam (Nelson et al. 1920). Aerial photography was used to confirm the presence of trees identified by earlier sources and to map the extent of that area based on the vegetation pattern.

The "grassland/coastal sage scrub" class covers the majority of the study area (53%). It encompasses a wide range of subtypes of different moisture regimes and vegetation types. Our data suggest that the grassland/coastal sage scrub areas ranged from rich, relatively moist coastal prairie, to barren land, to dense scrub and cactus with little or no grass. This habitat type may also include areas of sparse tree cover or regions with small groves (below the minimum mapping unit, not locatable, or not documented by historical sources). We use the term "coastal sage scrub" because California sagebrush (*Artemisia californica*) was likely the predominating species. However, other chaparral or cactus species also occurred in many areas. In this report, we use grassland to mean a predominantly upland herbaceous cover, encompassing both forbland and coastal prairie types.

We were unable to map grassland and scrub separately at a consistent scale across the region, given the indistinct boundaries between types and the absence of early historical evidence for many parts of the study area. In addition, due to early invasions and the effects of grazing, dramatic changes in extent of grassland and scrub may have occurred shortly after European contact in the late 1700s, which complicates interpretation of mid-1800s sources (see box on page 18). Generalized accounts of the Ventura County lowland describe it as largely dominated by herbaceous cover, and documentation of non-riparian trees was confined to a few select areas (see specific chapters for more details). To address this data gap, we used the grassland/coastal sage scrub habitat class as a default type when no historical evidence existed. As a result, this habitat classification often carries greater interpretation uncertainty than other mapped classes. This is captured in the GIS historical habitat layers.

The "oaks and sycamores" habitat type includes woodland or savanna areas supporting coast live oak (*Quercus agrifolia*) and/or California sycamore *(Platanus racemosa*). It was mapped in areas where tree cover was documented by historical sources (e.g., a GLO survey recording "timbered tableland" or "scattering oaks"; Thompson 1868, Craven 1874g). Polygon boundaries were drawn from a synthesis of historical aerial photography, soils and other historical maps, and textual data. In many of these instances, sycamores were explicitly mentioned (e.g., a map depicting "scattering oak and sycamore" or a GLO surveyor noting "scattering live oak and sycamore with undergrowth sage brush"; Hare 1876, Orcutt 1900); this information is included in the GIS metadata. The "oaks and sycamores" class would have included understory cover ranging from predominantly grassland to predominantly scrub, though this distinction is not represented in our mapping.

As for wetland habitat types, it is likely that mapping of these wooded areas is a conservative representation of extent, since trees were mapped only where there was supporting historical evidence. Some areas of this type are undoubtedly assigned grassland/coastal sage scrub as a default due to lack of documentation.

Inevitably, historical documents reveal more details about the historical landscape than is represented in the habitat map. For example, not all features noted by the GLO surveyors were subsequently mapped in the habitat layer, as some information was more detailed than our mapping standards allowed (e.g., an area with a small patch of cactus noted within grassland was all mapped as part of the grassland/coastal sage scrub class). As is the case with most ecosystems, transitions between woodland, scrub and low herbaceous cover were often gradual and diffuse, extending over broad areas. The habitat mapping represents regional-scale transitions as opposed to local-level detail (such as small groves, patches of scrub, or narrow zones of riparian oaks along ravines). Many of these local characteristics, though not mapped, are explored further in this report. Though the broad habitat classifications we use obscure some of the detail present in the historical record, they provide meaningful classification units that are comparable across the study area, allowing us to map at a consistent scale even in areas with relatively sparse documentation.

GRASSLAND, FORBLAND, OR COASTAL SAGE SCRUB?

The original composition of pre-contact herbaceous cover on Ventura County valley floor—indeed, across all of California—is far from clear. The historical dominance of perennial bunchgrasses in California grasslands has been hypothesized by many ecologists, and was the dominant theory for most of the 20th century (e.g., Clements 1934, Burcham 1956; see Bartolome et al. 2007 and Martinez 2010 for more detail). More recently, however, a number of researchers have proposed the historical prevalence of annual grasses and forbs in Southern California (the Los Angeles coastal prairie; see Mattoni and Longcore 1997, Schiffman 2005) and California as a whole (see Schiffman 2007, Minnich 2008). In the absence of precise, explicit historical evidence, we broadly refer in this report to the low herbaceous cover that dominated much of the Ventura County lowlands as "grasslands." These areas may have included perennial bunchgrasses and annual grasses, in addition to annual forbs and wildflowers and even some shrubs.

In our historical habitat mapping, we lumped these "grassland" habitats with the shrubbier coastal sage scrub. One reason for doing so is the ambiguity of the historical record. While habitat type is clearly indicated in a few areas by the historical record (for example, references to "cactus and sage brush" (Craven 1874f) or a "spacious plain, covered with grass" (Costansó and Browning 1992)), in most areas no such historical resolution exists.

A second reason for combining the herbaceous and shrub classes is the uncertainty surrounding impacts of Chumash land management practices, in particular the burning of grasslands. Widespread Chumash burning of grassland areas in the Santa Barbara Channel region has been exhaustively documented by Timbrook et al. (1982). Frequent (every 1-3 years) burning of valley grasslands, a technique used to increase yields of seeds and other foods during the late summer, would have maintained these areas at the expense of coastal sage scrub. Conversely, the suppression of burning practices in the late 1700s by Mission officials would have led to the encroachment of coastal sage scrub into former grassland areas.

The effects of Chumash burning practices on the extent and distribution of Ventura grasslands and shrublands further compounds the ambiguity surrounding each habitat's historical distribution in the county, and even calls into question the relevance of 19th century ecological observations for these habitat types. Heavy grazing pressures from Mission cattle in the late 1700s and early 1800s may have also distorted these observations. Since distinctions between grasslands and shrublands could not be consistently made across the entire study area, we chose to display the two communities together rather than risk making uninformed decisions.

The cessation of Chumash fire management, grazing impacts, and the introduction and invasion of exotic species all contributed to a rapid change in the character of Ventura grasslands by the early 19th century. Descriptions of widespread non-native cover, particularly wild oats (*Avena fatua*) and wild mustard (*Hirschfeldia incana/Brassica nigra*), were abundant during this time on lowlands across the study area: GLO surveyor Hancock (1854) repeatedly noted "dense mustard" and "belts of grass and mustard" on the Oxnard Plain; a description corroborated by other observers who saw "thickets of wild-mustard" (Roberts 1886), "thousands of acres actually overrun with wild mustard" (Rothrock 1876), a "vast forest of bee-haunted mustard-blooms" (Eames 1889), "meadow grass and wild oat" (*Daily Alta California* 1865), and "wild oats, wild burr-clover [*Medicago polymorpha*], and alfilaria [filaree; *Erodium cicutarium*]" (Storke 1891).

Timbrook et al. (1982) provides a list of grasses that were likely abundant in the Santa Barbara Channel region during active Chumash management. They include California brome (*Bromus carinatus*), ryegrasses (*Leymus [Elymus] condensatus, L. glaucus,* and *L. triticoides*), meadow barley (*Hordeum brachyantherum*), coast range melic (*Melica imperfecta*), bluegrass (*Poa secunda*), needlegrass (*Nassella pulchra, N. lepida,* and *N. cernua*), chia (*Salvia columbariae*), and red maids (*Calandrinia* spp.), among other grass and herb species.

Habitat and Channel Classification

We developed twenty different habitat types based on historical evidence and modern classification systems (table 1.3). These classes balance a desire to preserve the detail often available in the historical record, while creating meaningful classes that are comparable to contemporary classification systems and applicable across the entire study area. In some cases, the character of historical data creates difficulty in direct translation to a single contemporary vegetation class. We divided the 20 habitats or vegetation types into wetland, dryland, riparian, and coastal habitat types reflective of the historical ecology of the region (see table 1.3 for complete list). (In this report, we use the term "riparian" to refer exclusively to streamside vegetation.)

The following definitions provide brief explanation of the habitat types outlined in table 1.3. They are in large part derived from contemporary descriptions and classification systems outlined elsewhere (e.g., Ferren et al. 1990, 1995; Mertes et al. 1996; Holstein 2000; Ornduff et al. 2003; Barbour et al. 2007; Ferren et al. 2007; Grossinger et al. 2007; Stillwater Sciences 2007a,c; Coffman 2008; Orr et al. 2011). For more detailed descriptions of each type, please refer these documents.

Palustrine and Terrestrial Habitats

PERENNIAL FRESHWATER POND Freshwater ponds are permanently inundated, non-vegetated depressional areas containing year-round standing water. They often occur within larger complexes of marshland, willows, and seasonal wetlands.

VALLEY FRESHWATER MARSH Valley freshwater marshes can be associated with low-lying depressions and ponds, in-channel sloughs and areas of high groundwater, or groundwater-fed springs. They are flooded for most or all of the year, and are permanently saturated. Dominant plant species include bulrushes (*Scirpus [Schoenoplectus]* spp.), cattails (*Typha* spp.), sedges (*Carex* spp.), spikerushes (*Eleocharis* spp.), and rushes (*Juncus* spp.).

WILLOW THICKET This category includes stands of willow (*Salix* spp.) not found along rivers or creeks. It includes dense thickets dominated by shrub-sized willows with occasional larger trees (e.g., historically documented box elder; *Acer negundo*), in addition to willow "groves," which tended to include stands of more mature, established trees. Since willows are dependent on a relatively high groundwater table, these areas are often temporarily flooded.

WET MEADOW Wet meadows are temporarily or seasonally flooded grasslands characterized by poorly-drained, clay-rich soils. They can be flooded for days or weeks depending on precipitation and topography, and stay moist longer than adjacent, better-drained areas. The dominant plant species were probably rhizomatous ryegrasses (*Leymus* spp.), with a significant component of obligate and facultative wetland species such as wire rush

Table 1.3. Crosswalk between historical habitat type and modern classification systems.

Historical Habitat Type	California Terrestrial Natural Communities (CNDDB 2003)	Wetland Classification and Water Regime (Cowardin et al. 1979)/ USFWS Riparian Mapping System (2009)
Palustrine and Terrestrial Habitats		
Perennial Freshwater Pond	N/A	Palustrine permanently flooded wetland.
Valley Freshwater Marsh	Valley Freshwater Marsh (52.100.01)	Palustrine persistent emergent freshwater/saline wetland. Temporarily to permanently flooded, permanently saturated.
Willow Thicket	Scrub Willow (63.100.00), Willow Riparian Forests and Woodlands (61.200.00)	Palustrine forested wetland. Temporarily flooded, permanently saturated
Wet Meadow	Native Grassland (41.000.00); Meadows and Seeps not dominated by grasses (45.000.00)	Palustrine emergent wetland. Temporarily flooded, seasonally saturated.
Alkali Meadow	Alkali Meadow (45.500.00), Salt - Alkali Marsh (52.200.00), Saltgrass (41.200.00)	Palustrine emergent saline wetland. Temporarily to seasonally flooded, seasonally to permanently saturated.
Alkali Meadow/ Alkali Flat	Alkali Meadow (45.500.00), Alkali Playa Community (46.000.00), Saltgrass (41.200.00)	Temporarily to seasonally flooded, seasonally to permanently saturated.
Oaks and Sycamores	California Sycamore-Coast Live Oak (61.312.01), California Sycamore (61.310.00)	N/A
Grassland and Coastal Sage Scrub	Native Grassland (41.000.00); Venturan Coastal Scrub (32.190.00), Wildflower Field (41.290.00)	N/A
Characteristic Riparian Habitat Types		
Willow-Cottonwood Forested Wetland	Willow Riparian Forests and Woodlands (61.200.00), Black Cottonwood Riparian Forests and Woodlands (61.120.00), Southern Cottonwood-Willow Riparian (61.130.02), Marsh (52.100.00)	Riparian Forested Deciduous
Other In-Channel Riparian	Scrub Willow (63.100.00), California Buckwheat-Scalebroom (32.070.01), Mulefat Scrub (63.510.00), California Sycamore-Coast Live Oak (61.312.01), Willow Riparian Forests and Woodlands (61.200.00)	Riparian Scrub-Shrub Deciduous, Riparian Forested Deciduous/Evergreen
Coastal and Estuarine Habitats		
Beach/Dune	Coastal Dunes (21.000.00), Native Dunegrass (41.260.00)	N/A
Tidal Lagoon (mostly open?)	N/A	Estuarine subtidal, unconsolidated bottom
Tidal Lagoon (seasonally open)	N/A	Estuarine subtidal/Palustrine intermittently flooded. Unconsolidated bottom.
Non-tidal Lagoon	N/A	Estuarine subtidal/Palustrine intermittently flooded. Unconsolidated bottom.
Tidal Flat	N/A	Estuarine intertidal. Intermittently flooded, unconsolidated bottom.
Tidal Marsh	Coastal Brackish Marsh (51.100.02), Pickleweed Wetland (52.201.00)	Estuarine intertidal persistent emergent wetland. Temporarily to seasonally flooded, permanently saturated.
Seasonally Tidal Marsh	Coastal Brackish Marsh (51.100.02), Pickleweed Wetland (52.201.00)	Estuarine intertidal persistent emergent wetland. Seasonally flooded, permanently saturated.
Salt/Brackish Marsh	Coastal Brackish Marsh (51.100.02)	Estuarine intertidal persistent emergent wetland. Temporarily to seasonally flooded, permanently saturated.
Salt Flat/ Seasonal Pond	N/A	Estuarine intertidal. Intermittently flooded, unconsolidated bottom.
High Marsh Transition Zone	Saltgrass (41.200.00), Alkali Meadow (45.500.00)	Palustrine emergent or unconsolidated bed, possibly hypersaline at times

(*Juncus balticus*), irisleaf rush (*Juncus xiphiodes*), buttercup (*Ranunculus californicus*), and blue eyed grass (*Sisyrinchium bellum*).

ALKALI MEADOW Similar to wet meadows, alkali meadows are temporarily or seasonally flooded grasslands on poorly-drained, clay-rich soils. Unlike wet meadows, however, alkali meadows are characterized by salt-affected soils. The dominant vegetation is salt grass *(Distichlis spicata*), though other salt-tolerant species such as alkalki goldfields (*Lasthenia ferrisiae*), salt marsh birds beak (*Cordylanthus maritimus* ssp. *maritimus*), spreading alkali weed (*Cressa truxillensis*), shaggyfruit pepperweed (*Lepidium lasiocarpum*), and hairy gumweed (*Grindelia hirsutula*) may have also been present.

ALKALI MEADOW/FLAT Some alkali meadows were characterized by a particularly high degree of soil salinity (over 1% in the first 6 feet; Holmes and Mesmer 1901c). These areas are composed of a mosaic of alkali meadows and more sparsely vegetated alkali playas or flats (e.g., "scalds"). Saltgrass (*Distichlis spicata*) is still a significant component, but this category also includes large expanses of open, non-vegetated seasonally flooded areas (<10% plant cover) with local alkaline concentrations too high to support substantial vegetation.

OAKS AND SYCAMORES This classification includes areas not along active stream courses but with documented coast live oak (*Quercus agrifolia*) and/or California sycamore *(Platanus racemosa*). With few exceptions, the dominant tree is coast live oak. Shrubs and herbaceous cover were both documented below the canopy. Since it is unevenly specified by historical documents in this region, we were unable to specify tree density. These areas likely ranged from savanna to woodland densities. They occurred predominantly on well drained terraces and alluvial fans in the Ventura and Santa Clara river watersheds.

GRASSLAND/COASTAL SAGE SCRUB This is a general category encompassing herbaceous and shrub cover, mostly occupying well drained portions of the Ventura County alluvial valleys. Vegetation communities included in this category range from treeless herbaceous cover and coastal prairie (which may have included native perennial bunchgrasses and annual grasses, in addition to annual forbs, wildflowers and shrubs) to Venturan coastal sage scrub (including coyote brush (*Baccharis pilularis)* and California sagebrush (*Artemisia californica*)).

Riparian Habitats

WILLOW-COTTONWOOD FORESTED WETLAND This category includes large areas (over 200 acres) of wetland riparian habitat whose presence has transcended significant flood events of the late 19th and early 20th centuries. Each of these areas is well documented in the historical record as broad forested groves or marshes; many were even named (e.g., West Grove, East Grove, the Cienega). They are distinguished from other in-channel riparian areas by their size, their breadth (in some places over 3,300 ft wide), their persistence, and their notoriety. They are also described in the report as "persistent wetland riparian areas."

These areas included valley freshwater marsh and winter-deciduous riparian forest, with species extent and distribution varying by location. Some areas would have been predominantly forest stands on higher benches, while in other areas forest would have been interspersed with open wetland patches. Mixed willow forest (*Salix* spp., including arroyo willow, red willow, narrowleaf willow, sandbar willow, and shining willow), mulefat (*Baccharis salicifolia)*, black and Fremont cottonwoods (*Populus balsamifera* ssp. *trichocarpa* and *P. fremontii*), and occasional sycamores (*Platanus racemosa*) would have been present in varying proportions in these areas, in addition to wild grape (*Vitis Californica*), wild rose (*Rosa californica*), and California blackberry (*Rubus ursinus*). Freshwater marsh-associated species such as tule (*Scirpus* [*Schoenoplectus*] spp.), cattails (*Typha* spp.), sedges (*Carex* spp.), spikerushes (*Eleocharis* spp.), and rushes (*Juncus* spp.) were also present.

OTHER IN-CHANNEL RIPARIAN Since the variability of historical data precluded detailed riparian mapping for this study, most riparian habitats are included in this category. The character and distribution of these habitats varied with water availability and flood disturbance regime. At one extreme, areas of frequently flooded sandy riverwash occupied the lowest portions of the active channel, and were either unvegetated or sparsely vegetated with willow, mulefat, or alluvial scrub. At the other, established, infrequently flooded bars and islands along portions of lower Santa Paula Creek and the Ventura River supported stands of California sycamore and Coast live oak. Intermediate riparian habitats included willow forest, sycamore-alder-California bay forest (on the Ventura River; Mertes et al. 1996), mixed riparian forest, thickets of willow scrub and mulefat, and alluvial scrub (including mulefat, California buckwheat (*Eriogonum fasciculatum*), and scalebroom (*Lepidospartum squamatum*)). These patterns, while lumped in the GIS, are discussed extensively in the report.

Coastal Habitats

BEACH/DUNE Beaches and dunes are coastal habitats located immediately along the shoreline. Beaches and foredunes are sandy and sparsely vegetated, while backdunes are located inland from foredunes and are generally more stable and more densely vegetated. While foredune vegetation is mostly composed of forbs, backdunes also support some shrubs in addition to herbaceous cover.

Beach and foredune vegetation would have likely included sand verbena (*Abronia maritima*) and pink sand verbena (*Abronia umbellata*), beach bur (*Ambrosia chamissonis*), beach saltbush (*Atriplex leucophylla*), beach primrose (*Camissonia cheiranthifolia*), beach morning glory (*Calystegia soldanella*), dune lupine (*Lupinus chamissonis*), mock heather (*Ericameria*

ericoides), dune buckwheat (*Eriogonum parvifolium*), and salt grass (*Distichlis spicata*). Backdunes would have likely supported coastal sagebrush (*Artemisia pycnocephala*), Heather goldbush (*Ericameria ericoides*), dune lupine (*Lupinus chamissonis*), and buckwheat (*Eriogonum* spp.), in addition to species also present in the foredune community. Scattered willows (probably *Salix lasiolepis*) were documented in dune swales south of McGrath lake.

TIDAL LAGOON (MOSTLY OPEN?) These are coastal bodies of water with a more frequent connection to the ocean, although precise historical closure dynamics are generally unknown. Subtidal communities of eelgrass (*Zostera marina*), Pacific eelgrass (*Zostera pacifica*), and surf-grass (*Phyllospadix torreyi*) occur in subtidal portions of estuarine lagoons.

TIDAL LAGOON (SEASONALLY OPEN) These are coastal bodies of water with a seasonal connection to the ocean. They are typically non-tidal during the summer, when the mouth is closed, and open during the winter, when greater freshwater flows breach the barrier.

NON-TIDAL LAGOON Mostly-closed tidal lagoons are coastal bodies of water with infrequent tidal connection. These lagoons may have salinity gradients ranging from fresh to brackish to saline, with freshwater inputs from springs and streams upslope and occasional tidal inputs. Through stratification, these lagoons may support distinct saline and fresh zones. Some lagoons may have occasionally dried out during the dry season.

TIDAL FLAT Tidal flats are unvegetated intertidal habitat, found on gradually sloping shorelines between estuarine open water and the lowest salt marshes. They are exposed between low and high tides.

TIDAL MARSH Tidal marshes occur along the perimeter of tidal lagoons, and are regularly inundated by the tides. Plant species distribution within the tidal marsh is determined largely by salinity and elevation (and thus inundation frequency); dominant plant species include Pacific cordgrass (*Spartina foliosa*), pickleweed (*Salicornia virginica*), and high marsh species such as saltgrass (*Distichlis spicata*), Parish's pickleweed (*Arthrocnemum subterminale*), and shoregrass (*Monanthochloe littoralis*).

SEASONALLY TIDAL MARSH Found adjacent to seasonally open tidal lagoons, seasonally tidal marsh shares similar vegetative characteristics to tidal marsh but with the addition of brackish emergent vegetation such as prairie bulrush (*Scirpus [Bolboschoenus] maritimus*), tule (*Scirpus [Schoenoplectus] californicus*), and cattail (*Typha domingensis*). Seasonally tidal marshes have brackish to saline hydrology, depending on season, elevation, and precipitation.

SALT/BRACKISH MARSH Found adjacent to non-tidal (mostly closed) lagoons, non-tidal brackish marsh hydrology originates largely from runoff and precipitation, with occasional dune overwash during large storm events contributing saline water. As a result, non-tidal brackish marshes can be fresher than the more marine-influenced tidal marshes, with corresponding shifts in vegetation distribution and frequency. The infrequent presence of an outlet can also make some non-tidal brackish marshes hypersaline. Dominant plant species probably overlap with high marsh plants (e.g., saltgrass), with additional presence of brackish-tolerant species such as bulrush (*Scirpus [Bolboschoenus]* spp.), tule (*Scirpus [Schoenoplectus] californicus*), and cattail (*Typha domingensis*). Little is known, however, about the pre-modification plant community of these marshes.

SALT FLAT/SEASONAL POND/MARSH PANNE Tidal marsh pannes or salt flats are unvegetated, open depressions within tidal marshes. They are irregularly or seasonally flooded. Their hydrology (alternately flooded and dry) and evaporate concentration precludes most plants from establishing. Some seasonal ponds may have occasionally retained open water year-round.

HIGH MARSH TRANSITION ZONE The high marsh transition zone is the ecotone between estuarine and terrestrial communities, with habitats intergrading between upland habitats and the tidally-influenced saline habitats of the coast. High tidal marsh species (e.g., saltgrass) overlap with alkali meadow species and freshwater (non-tidal) species. This area generally receives overflow by extreme high tides.

2 • HISTORICAL BACKGROUND AND CONTEXT

It was late in the afternoon of the next day ere we started for our seven miles ride to Saticoy. Our way led through the upper portion of one of the finest avenues in California…Clinging to the road on both sides are extensive orchards of apricot and walnut trees, while countless acres of beans stretch away to the mountains on one hand, and to the river on the other.

And to think! When I was a little girl this was all a vast forest of bee-haunted mustard-blooms, in which the traveler would get lost as easily as in an Indian jungle.

—NINETTA EAMES 1889,
TRAVELING FROM SANTA PAULA TO SATICOY;
AUTUMN DAYS IN VENTURA

Ventura County has a complex history of occupation, cultivation, and water use. Land and water use both reflect physical characteristics of the landscape (e.g., sugar beet cultivation indicates presence of alkaline soils) and affects landscape character (e.g., groundwater pumping decreases riverine flow). Because of this, understanding the cultural trends in the county is essential to interpretation of changes in landscape patterns and ecological function that have occurred over the past 250 years.

Since other reports have provided detailed histories of land and water use trends in the mid- to late 20th century (e.g., Schwartzberg and Moore 1995, AMEC 2004, Stillwater Sciences 2007b), we do not cover it again here (fig. 2.2). Instead, we focus on 19th- and early 20th-century trends in population, agriculture, irrigation, and resource use that provide context for the broad ecological and hydrologic changes occurring in the county concurrent with the changes detailed below.

Early Settlement History: Ventureño Chumash

The Chumash have been present in the Santa Barbara Channel region for about 9,000 years (Timbrook 2007). Ventureño Chumash occupied most of the study area, including the Ventura River valley, the Oxnard Plain, and the Santa Clara River valley to around Castaic (Van Valkenburgh 1935). The Uto-Aztecan Tataviam lived in the upper portion of the Santa Clara River watershed.

An estimated 15,000 Chumash lived in the Santa Barbara Channel area (including the Channel Islands) in 1769, at the time of Crespí's expedition

Fig. 2.1. Planting lima beans on the Dixie Thompson Ranch, near Ventura. This photo (opposite page), taken around the turn of the 20th century, shows a team in the process of planting lima beans, and is part of a series of such photos. Other photos in the sequence state that the rows were 1.75 miles long, and that teams could plant 150 acres a day. (Unknown ca. 1900c, courtesy of the Society of California Pioneers)

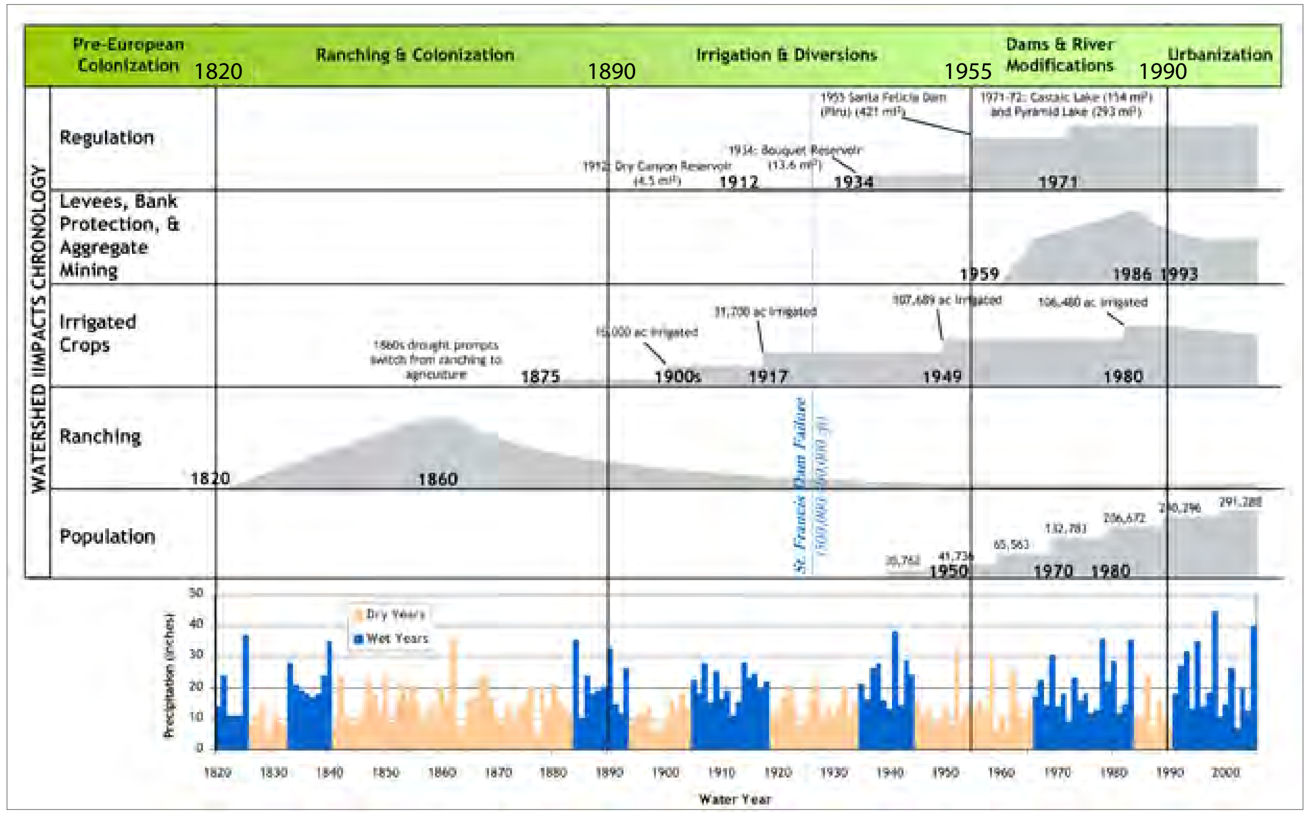


Fig. 2.2. Chronology of land and water use modifications, population, and precipitation on the lower Santa Clara River, 1820-2005. This graphic, produced by Stillwater Sciences (2007b), provides hydrologic and land use modification context useful in the interpretation of historical sources. (Precipitation data extended and adapted from Freeman (1968) by Stillwater Sciences (2007b); graphic courtesy of Stillwater Sciences)

(Timbrook et al. 1982). On a sea voyage in 1542, Juan Rodríguez Cabrillo noted a seaside town which he called Pueblo de las Canoas, a large village with many canoes (in Kelsey 1986). This site has been variably identified by researchers as near Mugu Lagoon (Wagner 1941, Kelsey 1986, King 2005) or near Ventura (Bancroft 1884, Davidson 1887, Bolton 1959; see Moriarty and Keistman 1963 and Kelsey 1986). When Crespí's party traveled through the Ventura region in 1769, they noted a number of large Chumash settlements: a village of about 200 near the confluence of Sespe Creek and the Santa Clara River (Costansó mentions that including this village, he saw 500 Chumash between Piru and Sespe); a village near the Santa Clara River at its confluence with Santa Paula Creek; a large village near Saticoy Springs; and a large village near Ventura (Costansó and Browning 1992, Crespí and Brown 2001).

A large number of other important settlement and use sites have been identified by archaeologists and ethnographers. In particular, ethnographer and linguist John Peabody Harrington worked closely with the Ventureño Chumash during the early 1910s, recording information about places and place names. Harrington's research documents a rich landscape of place names for springs, lagoons, and other natural features, as well as settlement sites. Sites of particular note recorded by Harrington and other researchers

were located all over the county, including near Ventura, Matilija, Saticoy Springs, Montalvo, El Rio, Somis, Springville, Hueneme, Mugu, Santa Paula and Sespe creeks, Camulos, and Castaic (Harrington 1913e, Van Valkenburgh 1935).

The Chumash made extensive use of a wide variety of plant species in the county, as documented in detail by Timbrook (2007). Mission friar José Señán noted in a report that the Chumash at the Mission still ate the "wild seeds and fruits which they love dearly and cannot forget" (Señán 1822). In addition to supplying food sources, plants were also used for producing material items. Riparian plants along the Santa Clara River, such as carrizo grass (*Phragmites communis*), giant reed (*Arundo donax*), tule, and cattail were used by the Chumash to create housing, boats, and other objects (Schwartzberg and Moore 1995, Timbrook 2007). Tule from the mouths of the Santa Clara and Ventura rivers was used to thatch houses (Harrington 1986b), and canoes were stored in the tule marsh at the mouth of the Ventura River (Harrington 1986b, Timbrook 2007). (One of Harrington's informants recalled that canoe builders "bent tule that was growing there on both sides over the canoe" to shade the boat.)

Along the margin of the river Buenaventura are many small gardens belonging to the Indians, where they raise fruits and vegetables…

—ROBINSON 1846

Deliberate, systematic burning of coastal grassland was also used as a method to create food sources, as documented in the Santa Barbara Channel region by a number of historical accounts (cf. Timbrook et al. 1982). Santa Barbara Mission records from 1793 indicate that Chumash to the north of Ventura County frequently burned the region's grassland, complaining that the Chumash "set [fire] to the grazing lands every year" (Arrillaga 1793, in Stewart et al. 2002). The extent of these practices in the Ventura valley areas, and their effects on vegetation cover, are unknown. It is possible that cessation of native burning may have increased shrub cover in areas where burning may have favored bunchgrass species (e.g., on the alluvial portions of the Oxnard Plain). However, this is impossible to determine from our data set, and is complicated by the impacts of grazing in many areas during the first half of the 19th century, which likely served to inhibit shrub/scrub growth.

San Buenaventura Mission and the Ranching Era (1782-1877)

The San Buenaventura Mission was founded in 1782, introducing stock-raising and small-scale agriculture to what was to become Ventura County (fig. 2.3). Fruit trees and small gardens of vegetables such as melons, corn, and potatoes (Vancouver [1798]1984, Señán 1822) were planted near the Mission, along the lower Ventura River, and in the Santa Paula area (Bowman 1947). By the 1820s, the Mission also tended cultivated fields on the eastern portion of the Oxnard Plain, likely the Las Posas/Calleguas region (Uría 1828). ("Las Posas" means a "pool" or "water hole," features often associated with springs; Gudde and Bright 1998.)

Stock (notably cattle and sheep) ranged over large portions of the Mission property, including the Ventura and Santa Clara River valleys and large

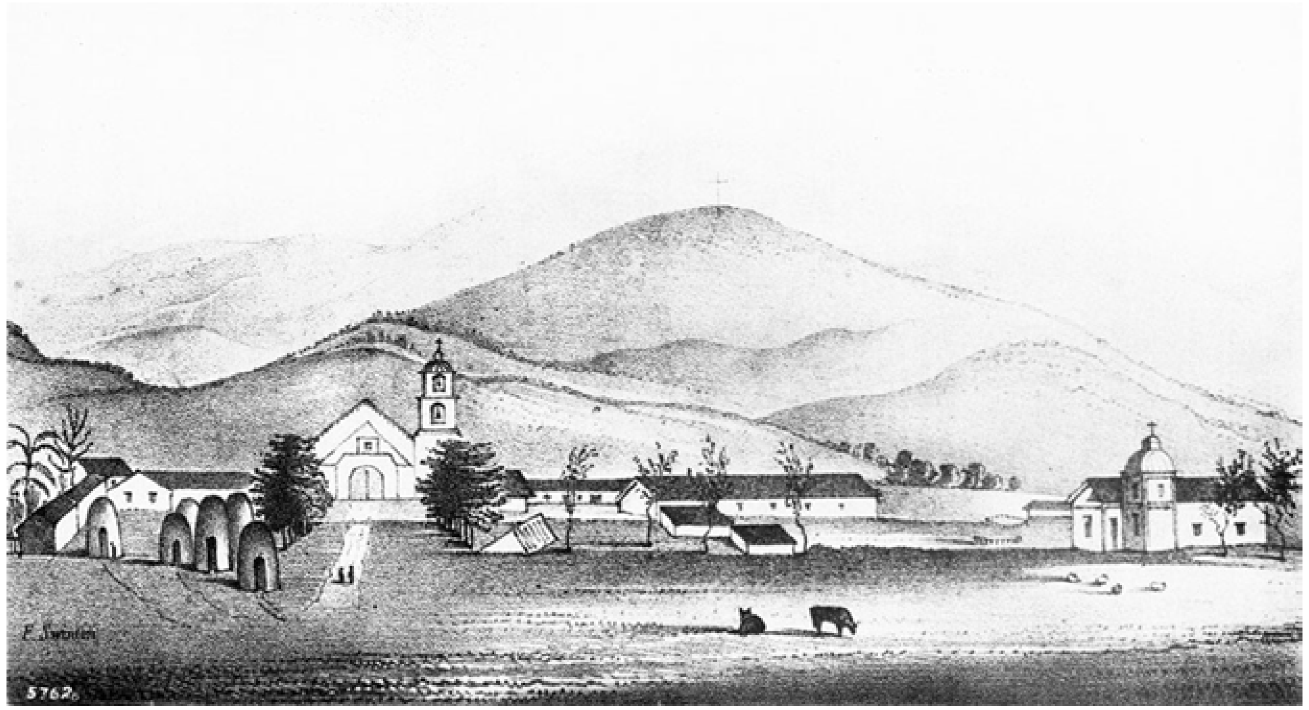


Fig. 2.3. Mission San Buenaventura, ca. 1829. This remarkably early sketch, from Alfred Robinson's book *Life in California*, shows the mission complex as it existed before secularization. Cows graze in the foreground, with what appear to be sheep further back. Two people are on the path to the church complex. In the book Robinson describes his visit to the mission: "At dinner the fare was sumptuous, and I was much amused at the eccentricity of the old Padre…After concluding our meal, we walked with him to the garden, where we found a fine fountain of excellent water, and an abundance of fruits and vegetables." (Text: Robinson [1846]1947; Image: Robinson ca. 1829, courtesy of the USC Digital Archive and the California Historical Society)

portions of the Oxnard Plain (Bowman 1947). The Mission's main site for grazing and breeding cattle was in the Sespe-Pole Creek region (modern day Fillmore; Señán 1822, Van Valkenburgh 1935), though significant numbers of cattle also grazed near Piru (which Señán called "the consolation of this Mission" for its benefit to cattle). Sheep were kept in four flocks in the Ventura River valley north of the Mission (Señán 1822) and also near the current location of the Olivas adobe near the Santa Clara River (Harrington 1913e). Fray José Señán described the extensive ranging of the Mission's cattle:

> The considerable numbers of animals belonging to this Mission do their grazing, in large part, just above the beach. When the pasture there is exhausted or dried up, the cattle go in search of more plentiful or better grazing elsewhere, following the beach inland and spreading out toward Mugú [Santa Paula]. The animals farthest from the beach make their way to a place called Saticoy, and when the grazing there is exhausted (that locality not being very productive and most of the growth being sword grass), they roam farther up to the meadows along the river and through a rather wide canyon into Sécpey, some bands of mares penetrating as far as Camulus. (Señán and Santa María 1804)

At the Mission's peak inventory in 1816, holdings included over 41,000 head of stock, including about 23,000 cattle and 12,000 sheep (Bowman 1947, California Missions Resource Center 2010). Around this time (1815), from 45 to 120 cows were slaughtered per week (Señán 1815). This provided an overabundance of meat, and since cows were kept predominantly for their tallow and hides this extra meat was simply discarded: "the large parts of the meat are taken in carts to the fields and burnt, since there is no one to collect them and there is plenty of fresh meat in the houses" (Señán 1815).

A drought around 1828-9 diminished the Mission's cattle and sheep herds (Lynch 1931, Smith 1972). After the secularization of the California Missions in 1834 holdings were further reduced, until by 1842 a traveler noted "at most, one thousand head of cattle, large and small"(de Mofras [1844]1937). (Interestingly, de Mofras also noted that at this time Mission fields were irrigated with water from the Santa Clara River.) The Mission was illegally sold in 1846 to José Arnaz.

By this time, though, former Mission territory had been largely divided into large ranchos amongst Spanish and Mexican families. By the time the Mission was sold in 1846, what was to become Ventura County had been divided into 19 ranchos (Triem 1985), many of which were heavily stocked with cattle. One resident recalled that in 1850 "the whole country was overrun with cattle…The cattle were so thick and plentiful in those days that vaqueros would have to go ahead of parties traveling through the country to clear the way for them" (Sheridan 1912). By 1860, there were more than 90,000 cattle and 65,000 sheep in Santa Barbara County (including Ventura County, which was not formed until 1873; Gregor 1953; fig. 2.4). (While the numbers cited above seem large, they account for modern-day Ventura and Santa Barbara counties, quite an extensive area.)

The drought of 1863-4 killed massive numbers of cattle all over California. Lack of pasture and water caused thousands of cattle to die of starvation, or be slaughtered in anticipation of the lack of food and water. In Santa Barbara County, a newspaper article noted that 18,000 cattle "have been slaughtered for their hides and tallow, and from one-third to one-half of the remainder have died by starvation" (*Daily Alta California* 1864). (Others report a much larger figure, stating that 2/3 of the County's cattle died; cf. Thompson and West [1883]1961.) This effectively marked the end of extensive cattle raising in the area. By the 1870 U.S. Census, only 10,000 cattle remained in Santa Barbara County (Gregor 1953).

As a result of this sharp decline in cattle numbers, after 1864 sheep ranching became the dominant land use in the region, in part because of their greater tolerance to drought. In 1870, about 190,000 sheep grazed in Santa Barbara County, nearly three times the number in the county a decade earlier. This was consistent with a wider statewide trend: while the 1850 census recorded under 20,000 sheep, by 1876 (the peak of the industry) there were over 6,400,000 sheep in the state being raised for meat and wool (Johnston and McCalla 2004).

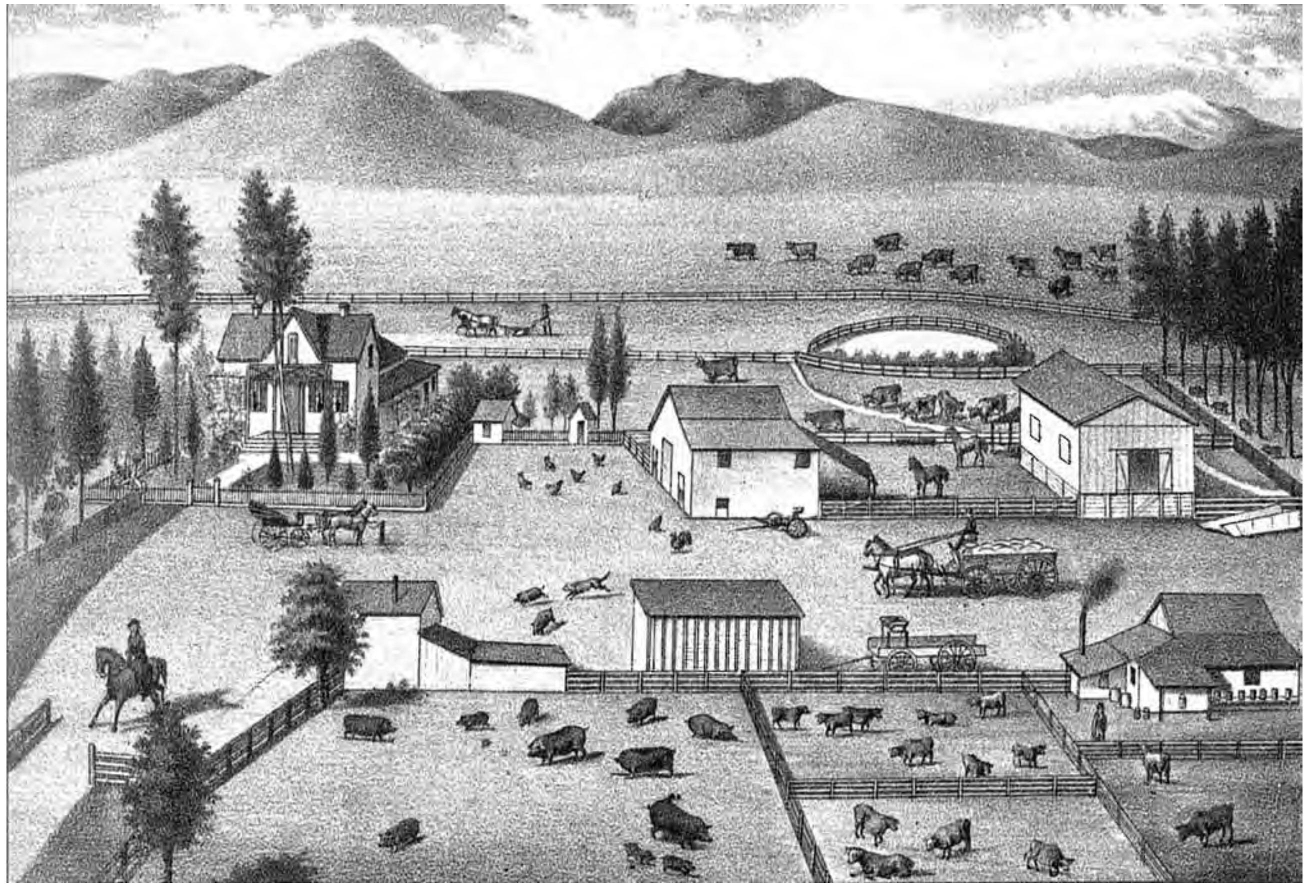


Fig. 2.4. Cattle, horses, pigs, and chickens on the George G. Sewell ranch near Santa Paula, 1881. Unfenced cattle graze in the background, and a dog chases a pig in the enclosure. The farm had 400 acres under cultivation and an additional 500 acres for grazing, including 1,000 hogs and 20 cattle. While the heyday of large cattle ranches had ended, this farm still had a number of stock. (Thompson and West [1883]1961)

The drought of 1877 marked the end of the large-scale stock raising in the county, and decimated the massive sheep flocks of the previous decade:

> The year 1877 was very dry. In Santa Barbara county, hay was forty dollars a ton. I have heard men say, with a sigh, "It was the dry year of '77 that broke me up. My sheep all died." Many a man grew gray that year, as he saw his living withering away. (Rindge 1898)

After this, Ventura County ranchers transitioned to grain farming. Large-scale sheep and cattle ranches, while still present in the county in reduced numbers, were largely pushed onto less desirable lands, either upland areas or uncultivatable or remote lands. An exception was in the upper (Los Angeles County) portion of the Santa Clara River valley, where cattle and sheep grazed near the river into the 20th century (Tait 1912) and still do today. In some areas, sheep and cattle pastured Ventura uplands most of the year, and in valley floor fields during the winter (Nelson et al. 1920, Gregor 1951).

The impact of early cattle and sheep grazing on historical lowland habitats in Ventura County is unknown. At the peak of Mission stock holdings in 1816, stock ranging densities in the county reached an estimated one head for every four to five acres of grazing land (Bowman 1947). This may be considered a relatively low to moderate stocking density: in the late 19th century appropriate stocking densities for cattle in Southern California were considered to be five acres per head for "valley land," and approximately one acre per head for sheep (Bancroft et al. [1890]1970). Furthermore, these standards were based on American cattle, which were only introduced to Southern California by the 1860s (Adams 1946) and were much larger and required more forage than their Mexican counterparts (Cleland [1941]1990, Burcham 1956). The Mexican cattle ubiquitously raised by the Mission and early ranchos would have required less land than the above densities. Impacts of Mission-era cattle grazing were likely limited by the relatively small size and moderate grazing intensity of Mission-era cattle.

And '77, that ghastly year, child as I was, is still with me, when the relentless sun looked down from cloudless blue skies and set red in the west day after day, when the hills were dry and brown from year's end to year's end, and the lowing of cattle being driven out to the country and the bleating of the dying sheep filled my heart with sorrow…

—FRANCIS 1912

However, by the 1850s and 1860s it is possible that cattle and sheep grazing may have had significant effects on ecological and morphological processes in the county. Potential effects of early livestock grazing include alteration of the distribution and type of valley floor habitats (e.g., relative proportion of herbaceous cover and scrub and increased spread of invasive plant species), changes in rainfall runoff and erosion (and a resultant increased sediment supply to Ventura County waterways), and an increase in the depth and density of barrancas (Stillwater Sciences 2007b). These effects are treated only peripherally here (see pages 18 and 172).

A few sources do describe the effects of livestock on portions of the county's pasturelands. Hassard (1887) described some of the effects of the upland shepherding in Ventura County common subsequent to the drought of 1877: "herders… drive thousands of sheep over the government wild lands, and, when they have stripped a region, put the torch to the brush, to improve the pasturage for the next season." Rothrock (1876) described the immense changes wrought by sheep on the Conejo Ranch during the 1876 dry period, noting that

> Hitherto sheep-raising has been the principal interest of the ranch, and of this we had the most indubitable evidence in the appearance of the land, everywhere pastured off the very surface. How long it will take California to regain the rank pasturage the State once had is a question.

Up Sespe Canyon, Rothrock described "a country where in the most accessible spots the soil had been stripped of the meager supply of herbage it perhaps once possessed." While this was an exceptionally dry year, this type of heavy grazing would have likely altered the hydrodynamics of Ventura County streams.

Early Commercial Agricultural Development (1878-1920)

After the collapse of the large sheep ranchos of the 1860s and 1870s, farmers quickly began to switch to other livelihoods. Barley, which thrived in the foggy coastal areas better than other grains, had been cultivated on the Oxnard Plain since the 1860s (Storke 1891, Gregor 1953) and was a major crop of the Ventura lowland areas. Descriptions of the lower Santa

If the stranger ever wondered where Boston got its beans, he found out now, as the land fell away to the Pacific with the soil becoming richer and finer as it expanded into the broad plains of Santa Paula and Hueneme, green for miles with grain and springing corn and beans…

—VAN DYKE 1890

Clara Valley and Oxnard Plain from the mid- to late 1870s describe an agricultural landscape dominated by barley (and, to a lesser extent, corn on the moister portions of the plain):

> [traveling west from Conejo], we crossed the western end of the Santa Clara Valley, and found the farmers engaged in harvesting their barley… Large fields of good corn were seen. It was just in tassel, and gave abundant promise of a heavy crop. It is hardly overreaching to say that on that day we saw thousands of acres actually overrun with wild mustard, which attained a height often of 8 or 10 feet…In some places, indeed, it might well be doubted as to whether it was a mustard or barley field we were passing, both of which were luxuriant enough. (Rothrock 1876)

> [describing "the section east of the Santa Clara River"] As we drove through that region, it seemed as though we were gazing upon a vast sea of grain, and here and there a dark spot looming up like a distant island, and contrasting strongly with the billowy waves of green barley on every hand. The dark spots marked the tracts of corn ground… (Sheridan 1878)

Lima beans were first planted on the Oxnard Plain around 1875 (Storke 1891; fig. 2.5). Like barley, the beans grew well in the fog on non-alkaline lowland soils (Holmes and Mesmer 1901c, Gregor 1953). By the late 1880s, beans had become a major commercial crop for the region; one account describes "one vast field of green and gold—ripening wheat and barley and growing corn and beans" (Oge 1888). A few years later, beans had surpassed even barley in prominence; Ventura County was described in 1891 as "preeminently a bean county" (Storke 1891) and one observer noted "seemingly limitless stretches of beans" (Eames 1890). Oxnard sand and Oxnard sandy loam, the two major soil types mapped on the Oxnard Plain in 1901, were "when free from alkali…the very best for the growing of lima beans. Almost every foot of such land was planted to this crop year after year, with only an occasional crop of barley planted for rotation" (Holmes and Mesmer 1901c). Beans continued to be a major product on the Oxnard Plain well into the 20th century; in 1951 Ventura County produced over 25% of the large lima beans in the United States (Gregor 1953).

However, in 1898 the establishment of the Pacific Beet Sugar Company's sugar factory shifted the agricultural dynamics of the county (fig. 2.6). Sugar beets thrived on the plain's alkali soils, allowing cultivation of land which had previously been only slightly productive or not farmed at all:

> A few years ago only indifferent crops of barley were grown on the greater part of this soil which was considered practically worthless, as quite often the barley hay contained such a great amount of salt that stock would not eat it. Now a great deal of the alkaline portion of this soil is planted to sugar beets with surprising results. (Holmes and Mesmer 1901c)

Only three years after the creation of the factory and the city of Oxnard, sugar beets were considered second in importance in the county only to the bean (Holmes and Mesmer 1901c); in 1913 beets and beans were called "the staples of the county" (Chase 1913). Beets were grown on the low, alkali

Fig. 2.5. "Dixie Thompson's bean threshing," ca. 1899. Workers threshing beans on the Oxnard Plain. (Unknown ca. 1899, courtesy of the California State Library)

Fig. 2.6. Hauling wagon loads of beets on the Oxnard Plain, ca. 1900. (Unknown ca. 1900b, courtesy of Jeff Maulhardt)

land that would not support other crops, while beans were often grown on slightly higher alluvial deposits (Tait 1912). A crop rotation of beans and beets (or beets and barley on land too alkaline for beans) was often practiced in lowland areas, since the beans fixed nitrogen for the beets and the beets removed some alkali from the soil (Gregor 1953). Beans, beets, and barley remained the primary crops for the region until around 1920. By 1917, barley was only grown "on soils less desireable [sic] for other crops and in remote situations" (Nelson et al. 1920), and sugar beet planting peaked in 1919 (Schwartzberg and Moore 1995).

The extensive acreage of the Oxnard Plain meant that the agricutlural statistics for Ventura County essentially reflected the trends of the Oxnard Plain. Through the 1870s, 1880s, and 1890s, beans, beets, and barley were the dominant crops in the county. Barley and beans were also grown at this time in inland valley areas, in addition to wheat in areas not influenced by the coastal fog (such as the Ventura River valley; Hampton 2002).

The lack of fruit culture in the region in the 1870s, and in particular on the Oxnard Plain, was notable to travelers used to seeing orchards in other parts of Southern California. In 1876, botanist J. T. Rothrock (1876) wrote that after traveling along the Oxnard Plain, "What more than anything else surprised me in the day's march was that no attention was paid to fruit-culture. I find recorded in my notes that not a single fruit-tree was seen that day. There was no apparent reason for this." The reason, of course, was the alkaline lowland nature of most of the plain.

While (as Rothrock observed) alkali concentrations and seasonal flooding precluded fruit culture on the plain in the 19th century, by the 1890s orchards began to proliferate in a few areas in the Santa Clara River valley. Early experiments in 1870s, notably around Santa Paula, had proven that walnuts and fruits (such as oranges, nectarines, peaches, and apricots) could succeed in the county (*Ventura Free Press* 1878a, Gregor 1953, Heil 1975, Hampton 2002). One newspaper mused that "some day the whole of the Santa Clara Valley will be a great fruit garden instead of, as now, a barley field" (*Ventura Signal* 1874a); another projected that by about 1880 the county would have fruit available to export (*Ventura Free Press* 1878a). However, fruit culture during this period was largely limited to the Santa Paula (and to some extent, Sespe) region; Rothrock (1876) noted that "With the exception of the Cumules [sic] Ranch…but little cultivation is attempted in the valley above Santa Paula."

The grain was knee-high, the groves were in bloom, the wildflowers carpeted all the fields.

—EDWARDS ROBERTS, 1886, SANTA PAULA

By the mid-1880s, orchards had become more prevalent in the lower Santa Clara River valley (fig. 2.7). One traveler journeying upriver from Ventura described "level fields, some planted with grain and flax, others covered with fruit-groves" (Roberts 1886). Another noted "extensive orchards of apricot and walnut trees…[and] countless acres of beans" between Saticoy and Santa Paula (Eames 1889). ("And to think!" Eames further writes, "When I was a little girl this was all a vast forest of bee-haunted mustard-blooms, in which the traveler would get lost as easily as in an Indian jungle.") Residents of the county who had been present in the 1870s were amazed by the agricultural changes that had taken place in only a decade:

> The individual who viewed the broad, treeless, uncultivated extent of the Santa Clara valley of Ventura county, less than twelve years ago, would now marvel at the transformation that has been wrought during this comparatively short period in that flourishing section. (*Ventura Free Press* 1883a)

> Riding from Santa Paula to San Buenaventura a short time ago, I could not but mark the difference in the style of farming now, in the Santa Clara valley as compared with ten years ago. Then it was nearly all barley, and scarcely a clean field of that, so abundant was the mustard, sometimes taking possession of hundreds of acres. Now it is very different. Cultivated crops are raised to a great extent, and the land is considered too valuable to give over to weeds and everywhere is carefully farmed. Beans, corn, and flax are raised largely, and hundreds of acres have been put to fruit trees. (*Pacific Rural Press* 1886)

The expansion of the Southern Pacific Railroad to Ventura (1887) helped provide a wider market for the burgeoning commercial agriculture of the county and spurred development of both beans and orchards in the Santa Clara River valley (Warner 1891, Gregor 1953). Many towns sprung up along the railroad in the Santa Clara River valley, such as Montalvo, Fillmore, and Piru. While Ventura county was still considered "bean country," it was clear that fruit growing would be the next wave of agriculture in many parts of the valley (Storke 1891). In 1891, a *Ventura Free Press* article opined that "the days of raising barley, corn and potatoes for market, as in days gone by in the Fillmore, Sespe, and Bardsdale sections of Ventura county are numbered. It is essentially a fruit section and the past few years and particularly the past year has seen the convertion [sic] of fields, heretofore given up to the commoner cereals, planted to fruit trees" (*Ventura Free Press* 1891c).

Limoneira Company began growing citrus on a large scale around Santa Paula in 1890; by 1920, citrus had become a dominant crop of the region (Gregor 1953, Schwartzberg and Moore 1995). As artificial drainage (beginning in 1918) and irrigation began to lower the water table and decrease the alkalinity of parts of the Oxnard Plain in the 1930s and 1940s, farms in this area began to convert former beet and bean acreage to citrus and walnuts (Gregor 1953). For detailed information on agricultural trends after 1920, see Gregor (1951, 1952, 1953) and Schwartzberg and Moore (1995).

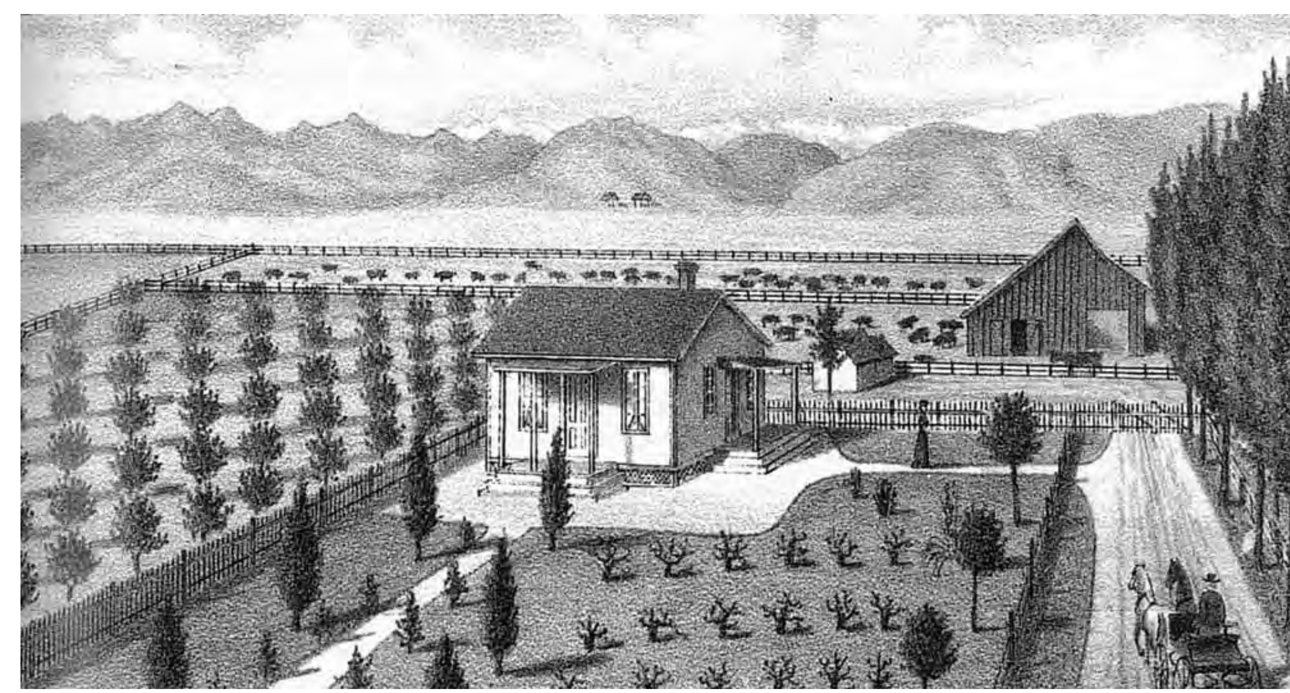


Fig. 2.7. Young orchard on J.H. McCutcheon's farm near Santa Paula, 1883. Young orchard trees—less than a decade old—are shown surrounding the McCutcheon home. Many of these orchards were planted on the site of the barley farms of the previous decade. (Thompson and West [1883]1961)

Hydromodifications: Surface Diversions and Groundwater Extraction

The history of irrigation in Ventura County has been extensively covered by others (Gregor 1953, Freeman 1968, Schwartzberg and Moore 1995). For detailed information on water use in the county, please refer to these texts. What we provide here is a brief overview of surface water use and groundwater extraction as context for the historical data discussed throughout the report.

To address the water needs of Mission residents and their fields, in the early 19th century (ca. 1805-1815) an aqueduct was built bringing water from the Ventura River near the confluence of San Antonio Creek to the Mission and its fields (CERES 2004). The aqueduct, which was destroyed during the floods of 1861-2 and 1866-7 (Greenwood and Browne 1963), was the predominant component of the larger Mission water system. In addition, the Mission used three reservoirs for water storage, two about three miles north of the Mission and one near Santa Paula (Uría 1828). The Mission also diverted water from Santa Paula Creek to irrigate fields in that area (Freeman 1968). Surveyor W. M. Johnson, in a U.S. Coast Survey report, notes that the Ventura River valley is "thoroughly irrigated by water from the river of the same name, which is carried to every part of it by means of ditches" (Johnson 1855a). Saticoy Springs also provided a year-round source of water (*Ventura Signal* 1871b, Freeman 1963).

The mission aqueduct supplied water to the city of Ventura through 1862; after its destruction during that year's floods, water was hauled in barrels from the river (Triem 1985). This was common practice after the secularization of the mission and before the extensive construction of ditches, when many early residents relied on surface water hauled from perennial reaches of Ventura County waterways for domestic use. Anticipating the completion of the Farmers Ditch, one newspaper article celebrated that residents of the area north of the Santa Clara River (around Ventura) "shall not have to buy barrels and haul water from the river or Saticoy twice a week or thrice—the year round" (*Ventura Signal* 1871b). (After its construction, if the Farmers Ditch failed to produce water—such as during the drought of 1876-7—residents would still resort to hauling water; *Ventura Signal* 1876b). Sheridan (1926) recounts that Egbert's Spring (north of downtown Ventura and east of the Ventura River; Barry 1894) used to provide water for domestic use for Ventura city during the early American period: "In the early days of the American occupation, the water of the spring was hauled on a wagon, in barrels, to the back doors of the residences of the settlers, at a cost of 25 cents per barrel. That was the drinking water of San Buenaventura." When artesian water was found on the Ventura side of the Santa Clara River in 1898, a newspaper article noted that "they have been hauling water in that vicinity for thirty years" (*Pacific Rural Press* 1898). Farmers on the Oxnard Plain also hauled water in barrels from the Santa Clara River (Gregor 1952).

From the mid-1860s on, more substantial development of surface water diversions occurred on Ventura County waterways. Flow from perennial reaches of rivers and creeks was transported to fields and for domestic use. An 1864 map of the Camulos area shows a ditch leading to fields and vineyards from the perennial reach of the Santa Clara River about a mile upstream (Sprague 1865). This was likely one of the first diversions from the river (Freeman 1968). By the end of the 1870s, however, an abundance of canals brought water to fields. While many of these ditches had their sources or heads on tributaries (notably Santa Paula, Sespe, and Piru for the Santa Clara River, and San Antonio Creek along the Ventura River), others tapped into the Santa Clara River and Ventura mainstems (Crawford 1896).

These ditches brought water often long distances from perennial reaches near Santa Paula and Sespe creeks down to fields and population centers in need of water (fig. 2.8). The Farmers Ditch (1871) was 16 miles long, and brought water along the north side of the Santa Clara River from a branch of the river above Santa Paula Creek down to Prince Barranca (Hall Canyon), just east of Ventura (*Ventura Signal* 1871b, Freeman 1968). (One old-timer recounted to Vern Freeman (1968) that any extra water from the ditch was "disposed of" in the barranca.) The Santa Clara Irrigating Company's ditch (1871) traveled 12 miles, bringing water to farmers

Fig. 2.8. Diversion ditch from Santa Paula Creek, ca. 1900. Surface diversions, such as this ditch taking water from Santa Paula Creek downvalley, brought water from areas with abundant surface flow to drier portions of the valley. (Unknown ca. 1900a, courtesy of the Santa Paula Historical Society)

At Satacoy [sic] we stopped for supper. From the excitement around the station and the water running down the street I thought an irrigating dam had sprung a leak; but a flowing artesian well had been struck instead, and its bursting forth had caused the commotion. These wells are the life of the country. There is much jealousy among rival settlements, and when one develops a copious flowing well it means beans, and walnuts; grain, vegetables and fruits, and the people shout with an exceeding joy thereat. They bite their thumbs at their envious neighbors and boast vaingloriously. This feeling is not known in the East, where the rain falls on all alike, and the land is all taken up. Here water rights go with the land, and when water in flowing quantities is found it means wealth to that section and the selling of land at good prices.

—KENDERDINE 1898

south of the river from near the west end of South Mountain (southeast of Saticoy) to near Hueneme (Freeman 1968). The Cienega Ditch (ca. 1874) diverted water from the river near the marsh (or *ciénega*) east of Fillmore. On the Ventura River, the Santa Ana Water Company built a ditch about seven miles long from the perennial reach around the Ventura River/San Antonio Creek confluence along the route of the old Mission aqueduct to supply water to the city of Ventura (Triem 1985).

The development of an artesian water supply on the Oxnard Plain beginning in the early 1870s changed the hydrologic landscape of Ventura's lowland areas. While several springs, wetlands, and ponds were present along the eastern boundary of the Plain (i.e., in the Calleguas Creek drainage), there was very little potable water available in the main section of the plain (Thompson and West [1883]1961; see Chapter 5), and artesian wells transformed the non-alkaline portions of the lowland into a desirable farming region. The first artesian well in the county that we found evidence for was drilled near Saticoy in 1868, and was only 18 feet deep (*Daily Alta California* Sept 16, 1868). On the Oxnard Plain, artesian wells were first drilled the same year the town of Hueneme was founded (1870). By 1871, artesian wells were proliferating on the Plain within the artesian zone, which included much of the plain (very roughly) below Highway 101 (Schuyler 1900, Lippincott ca. 1930; see fig. 5.3). Artesian wells were also drilled in the bed of Calleguas Creek (*Ventura Free Press* 1878c). By 1899, there were at least 200 artesian wells in the artesian belt south of the Santa Clara River (Schuyler 1899). While wells were also drilled in the Santa Clara River valley, these were largely reliant on pumping.

The effects of surface water diversions and artesian development on riverine flow and groundwater levels were noted by the early 1880s. Around 1894, all the dry season flow of Piru Creek was being diverted for irrigation (Lippincott ca. 1894). By 1912, it was asserted that all the summer surface flow of the Santa Clara River was diverted for irrigation (Tait 1912).

In addition, groundwater extraction likely contributed to changes in surface water levels, possibly shifting previously perennial stream reaches to intermittent flow (Hanson et al. 2009). An 1883 article from the *Ventura Free Press* described some of the perceived impacts of groundwater extraction on the Oxnard Plain. While it is unclear what role artesian wells on the plain actually played in causing these effects on groundwater levels, the effects are interesting in and of themselves:

> The people living on both sides of the Santa Clara, between where the water of the river at a point below Camulos Ranch down a short distance above the Sespe Creek, have been wondering why, their surface wells are failing year by year since about 1877—the time when the artesian well boring was begin [sic] on a large scale on the Colonia. Since the six large wells lately bored in the Las Posas, for the Hartman ditch, the water has sunk nearly 2 feet in these surface wells, and the Scienega, which was formerly a marsh, that would shake a rod from a man walking over it, is now dry enough to plow. The same volume of water is seen, below the Camulos Ranch, as in former years, and it is thought that the artesian well-boring on Colonia is these [sic] cause of the decrease of these surface wells in and about the Scienega. (Ventura Free Press 1883b)

The Colonia…Its abundant supply of water through its artesian wells give it an immense advantage over any part of the country.

—VENTURA SIGNAL 1876A

Similar effects were felt on the Oxnard Plain. By the turn of the century, coincident with the construction of the Pacific Beet Sugar Company's sugar factory in 1898, many artesian wells on the plain had begun to stop flowing (Freeman 1968). The construction of the factory caused a significant spike in water demand on the Plain, as wells were built to supply water needs for the factory and new town of Oxnard. That year, the *Ventura Free Press* noted the impending problem of declines in groundwater levels:

> The artesian water supply of this valley is soon to become an absorbing problem. Every year scores of new wells are being bored, often close together in the same artesian belt. The result is that wells which a few years ago gave a good flow have now ceased flowing and have to be pumped. The number of these must increase as the as the [sic] new wells increase. (*Ventura Free Press* 1898)

In 1900, the newspaper recorded that "quite a number of the Colonia artesian wells are falling of late on account of the factory wells running steady" (*Ventura Free Press* 1900). It was reported that factory water extractions caused a drop of five to ten feet in wells near Oxnard (Freeman 1968). As artesian water failed, water began to be pumped instead.

Through the 1910s and 1920s, groundwater levels in the Oxnard Plain and greater Santa Clara Valley continued to decrease (Freeman 1968). By the mid-20th century, summer surface flow in the Santa Clara River had sharply decreased; Gregor (1952) noted that the river was "dry most of the year." At this time, almost all (90%) of the Santa Clara Valley and Oxnard Plain's water demand was supplied by deep turbine pumps drawing groundwater (Freeman 1968). Urban development on the Oxnard Plain (and in other areas of the county) further strained groundwater resources.

Water Use and Irrigation

Ventura County was noted for its comparative lack of substantial irrigation development relative to other Southern California regions. On the Oxnard Plain, high groundwater tables and fog reduced the need for substantial irrigation of many crops (Rothrock 1876). In addition, the presence of alkali, coupled with a high groundwater table, impermeable clay subsurface soils, and extremely flat topography actually precluded irrigation over large swaths of the Oxnard Plain, since irrigation water only further saturated surface soils (Gregor 1953). Early farmers on the Plain understood this, and it was observed that they "do not irrigate more than they can avoid, for the reason…it brings the alkali to the surface" (Rothrock 1876).

For this reason, substantial crop irrigation lagged behind the development of large-scale agriculture in the county. The main crops of the 1880s—barley and beans, along with corn—were largely dry-farmed in the foggy, high groundwater table areas near the coast (Thompson and West [1883]1961, Gregor 1952, Swanson 1994).

In 1889, only about 1% of the county's farms were irrigated (Gregor 1952). This was a point of pride for some residents: "In Ventura County… as our farmers do not desire to get rich in a day, corn is planted after the winter rains are over, and but one crop a year is raised and that without irrigation" (Storke 1891). In 1893, citrus orchards near Fillmore were described as one of the "few irrigation enterprises in the county," while in other parts of the county even citrus was grown without irrigation (Brook 1893). By 1900 irrigation was still not widespread, though it was recognized that irrigation would increase the productivity of county cultivation: "the ease with which crops have generally been grown in this district without irrigation, has made the people indifferent to the advantages of skillful irrigation and chary of undertaking it…the prosperity and value of the greater portion of Southern California have been the result of irrigation" (Schuyler 1900).

The general sentiment expressed in historical texts that "irrigation is not used at all in Ventura County" (Storke 1891) was undoubtedly an overstatement, as some farmers irrigated crops during extremely dry years, or during the dry season to increase yields. Other crops were more predictably irrigated, such as alfalfa and (later) citrus. By the turn of the century, staple crops beans, beets, and barley were all irrigated in some sections of the county (Holmes and Mesmer 1901c).

By the 1910s, much of the Santa Clara River valley from Saticoy to Piru that was planted to orchards was under irrigation (Tait 1912). It was widely held that "all orchards are better for irrigation" (Unknown ca. 1909). Citrus was almost universally irrigated, and it was recognized that other fruits, walnuts, and beans would be more productive with irrigation. During this time, all of the citrus in the county, and about half of the walnuts and apricots, were irrigated, while only a quarter of the sugar beets and less than 1/5 of the beans were irrigated (Unknown 1914). For orchards, irrigation was focused mostly in the dry season (around May to September).

Irrigation is not extensively practiced in the area and is confined principally to the Santa Clara River Valley, a small part of the plains north of Oxnard, the lower part of the valley along the Ventura River… and part of the lands along Santa Paula, Sespe, and Piru Creeks.

—NELSON ET AL. 1920

However, even at this time irrigation was not practiced by the majority of Ventura County farmers, particularly on the Oxnard Plain. "The idea has prevailed in Ventura County," wrote Tait (1912), "especially on the coastal plain…that irrigation is not necessary and the success of the lima bean industry without irrigation has done much to divert attention from the development of the water resources of the county. Within the last few years more interest has been taken in irrigation." Irrigation was considered optional for most crops (excluding citrus) through the 1910s, though its role in increasing productivity was recognized (Nelson et al. 1920).

In 1918, extensive artificial drainage projects aimed at flushing out alkali salts began on the Oxnard Plain. Over the next years, these drainage projects leached salts out of alkaline areas on the plain (Gregor 1953). Coupled with the falling water table from groundwater extraction, many of these areas began to be non-alkaline and well drained enough to support tree crops, such as lemons and walnuts. These crops required irrigation, and the tile drains provided a drainage pathway for irrigation waters for these higher value crops.

The transition to irrigation occurred gradually over the 1920s and 1930s as orchards expanded over large sections of the county's cultivatable land. In the decade between 1919 and 1928, irrigated acreage in Ventura nearly tripled, from 31,700 to 86,700 acres. This was largely due to land use shifts on the Oxnard Plain as orchards became more common: by 1947, over 93% of the plain's irrigable area was irrigated (Gregor 1952, fig. 2.9).

The explosion in water demand for irrigation, along with increasing pressure for water rights from outside the watershed, drove many of the major water management developments of the mid-20th century (see fig. 2.2). The most notable examples include the formation of the Santa Clara Water Conservation District (1927) and its successor, United Water Conservation District (1950); the construction of spreading grounds beginning in 1928 to replenish groundwater supplies and water levels in Oxnard Plain wells; and the construction of dams including the short-lived St. Francis dam (1926, failed in 1928) and Bouquet Reservoir (1934) in the upper watershed, and Santa Felicia Dam (1955) on Piru Creek. The Freeman Diversion Dam, also used for groundwater recharge, was completed in 1991.

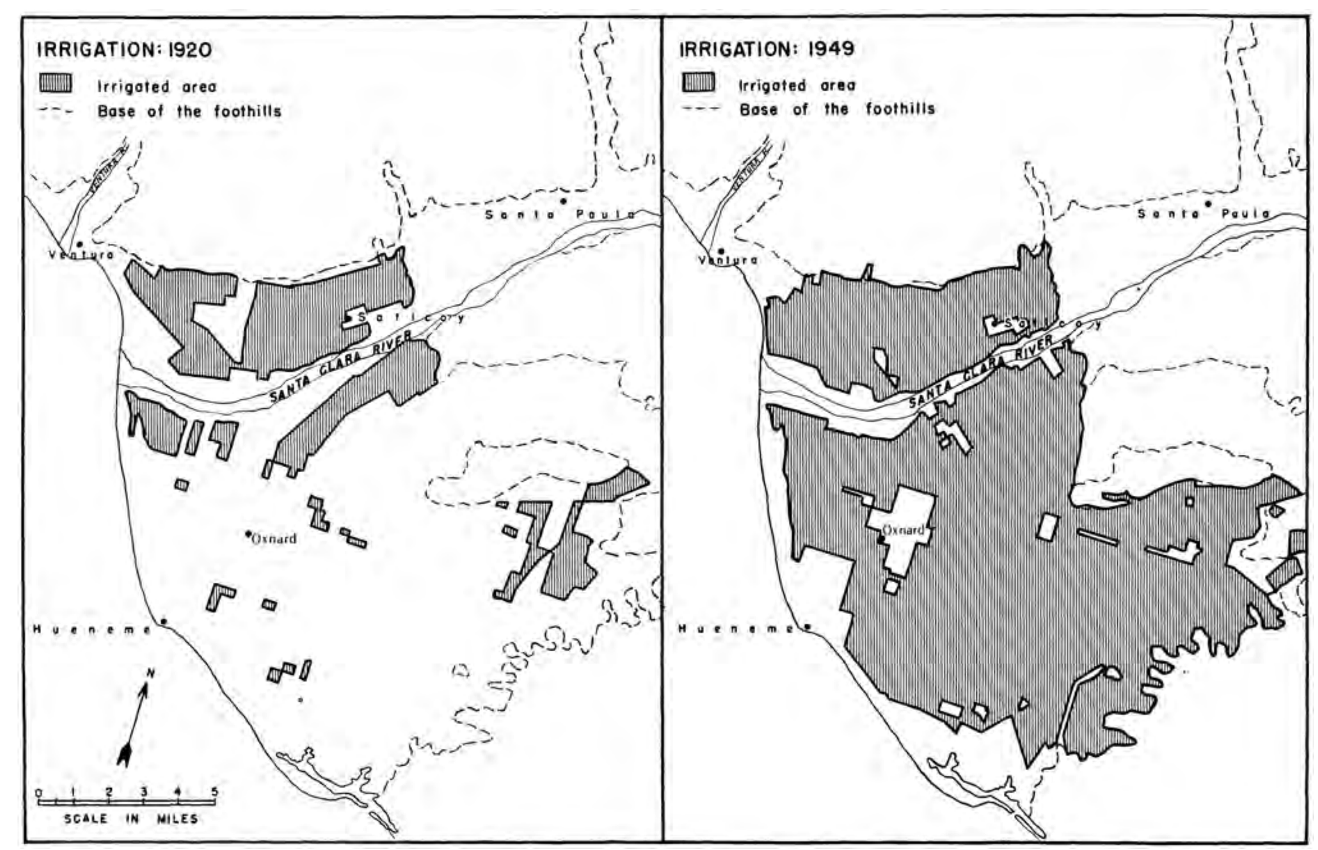
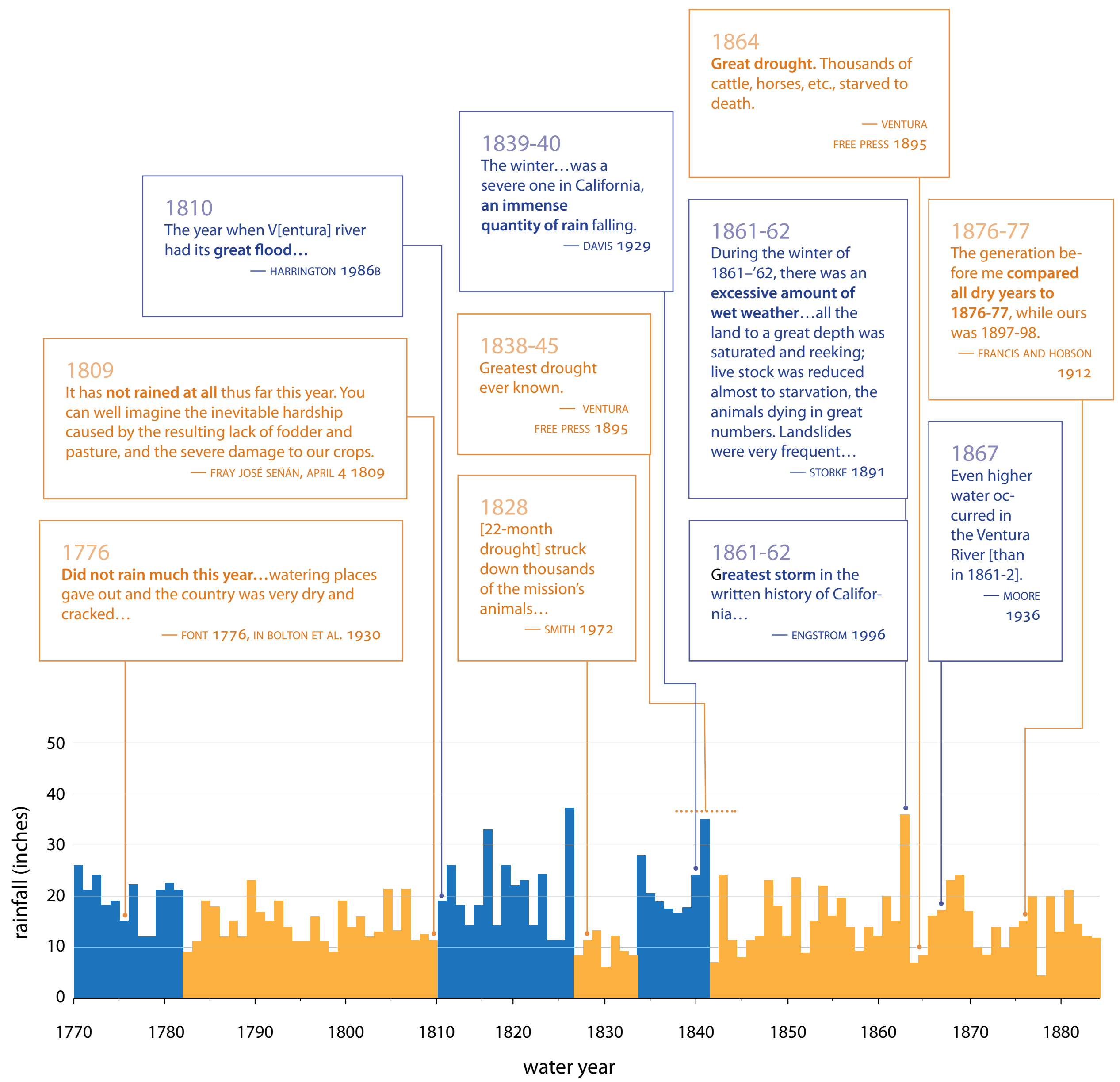


Fig 2.9. Extent of irrigated farms on the Oxnard Plain, 1920 and 1949. Irrigated acreage on the Oxnard Plain expanded rapidly from the 1920s through the 1940s. By 1947, over 93% of the Oxnard Plain's irrigable area was irrigated. (Gregor 1952)

FLOODING AND CLIMATE

An understanding of the timing of major floods and droughts is an important aspect of historical data interpretation, particularly in a semi-arid environment such as Ventura County where channel form and riparian vegetation distribution are controlled by large flood events. In addition, short-term variations in climate can influence native habitat patterns indirectly by affecting land use: droughts can instigate greater reliance on groundwater, new irrigation practices, or the failure or abandonment of a crop, while extreme winter floods can catalyze stream channelization efforts and levee construction. For these reasons, it is essential to consider climatic patterns when interpreting former ecology and land use history.

We used precipitation records compiled by Freeman (1968) and Stillwater Sciences (2007b) to understand patterns of wet and dry years, in addition to qualitative narrative accounts of notable floods and droughts that occurred prior to standardized precipitation and flow monitoring (fig. 2.10). There are also a number of excellent general

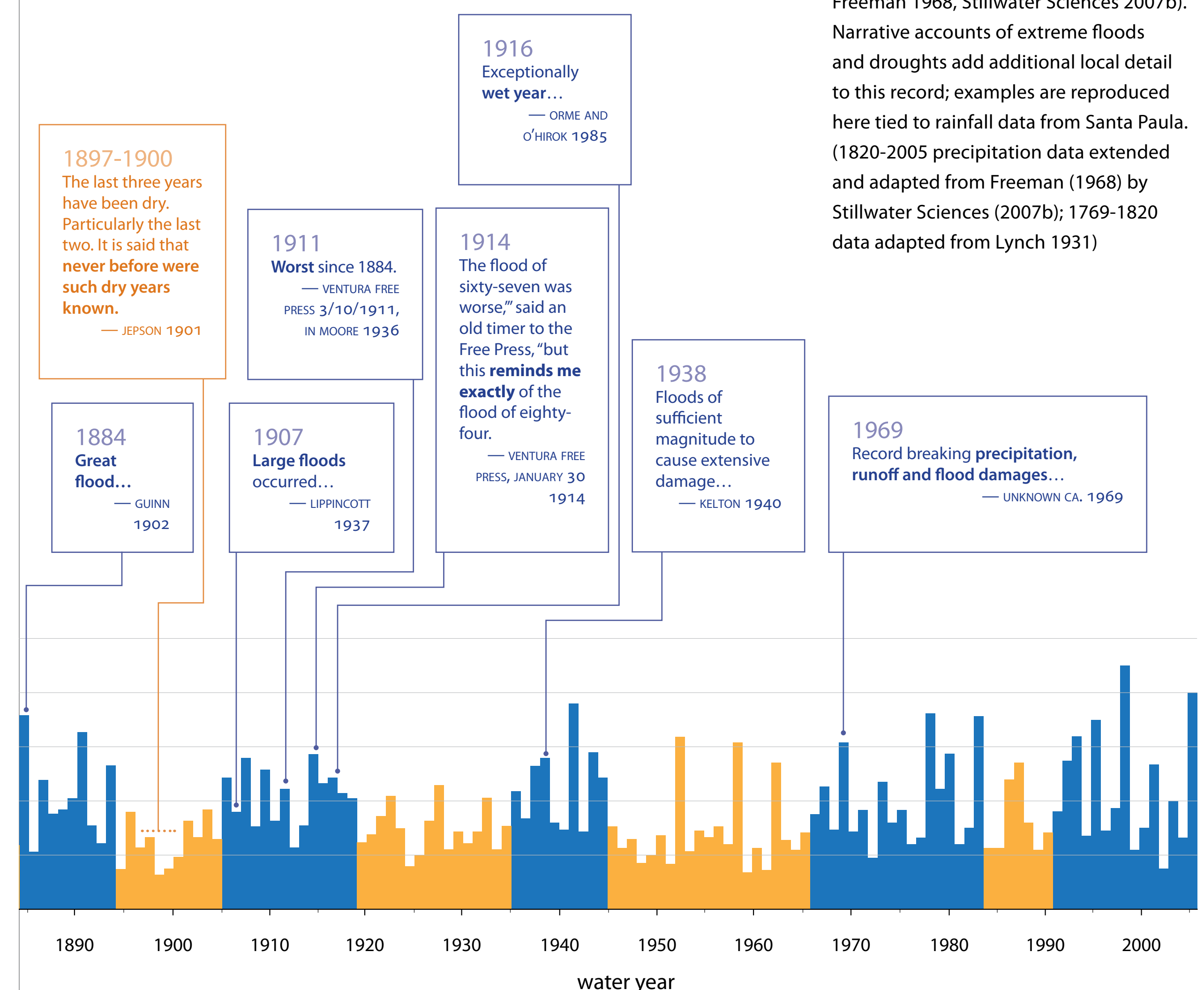


treatments of historical climate in Southern California which were consulted (cf. Lynch 1931, Engstrom 1996, Haston and Michaelsen 1997).

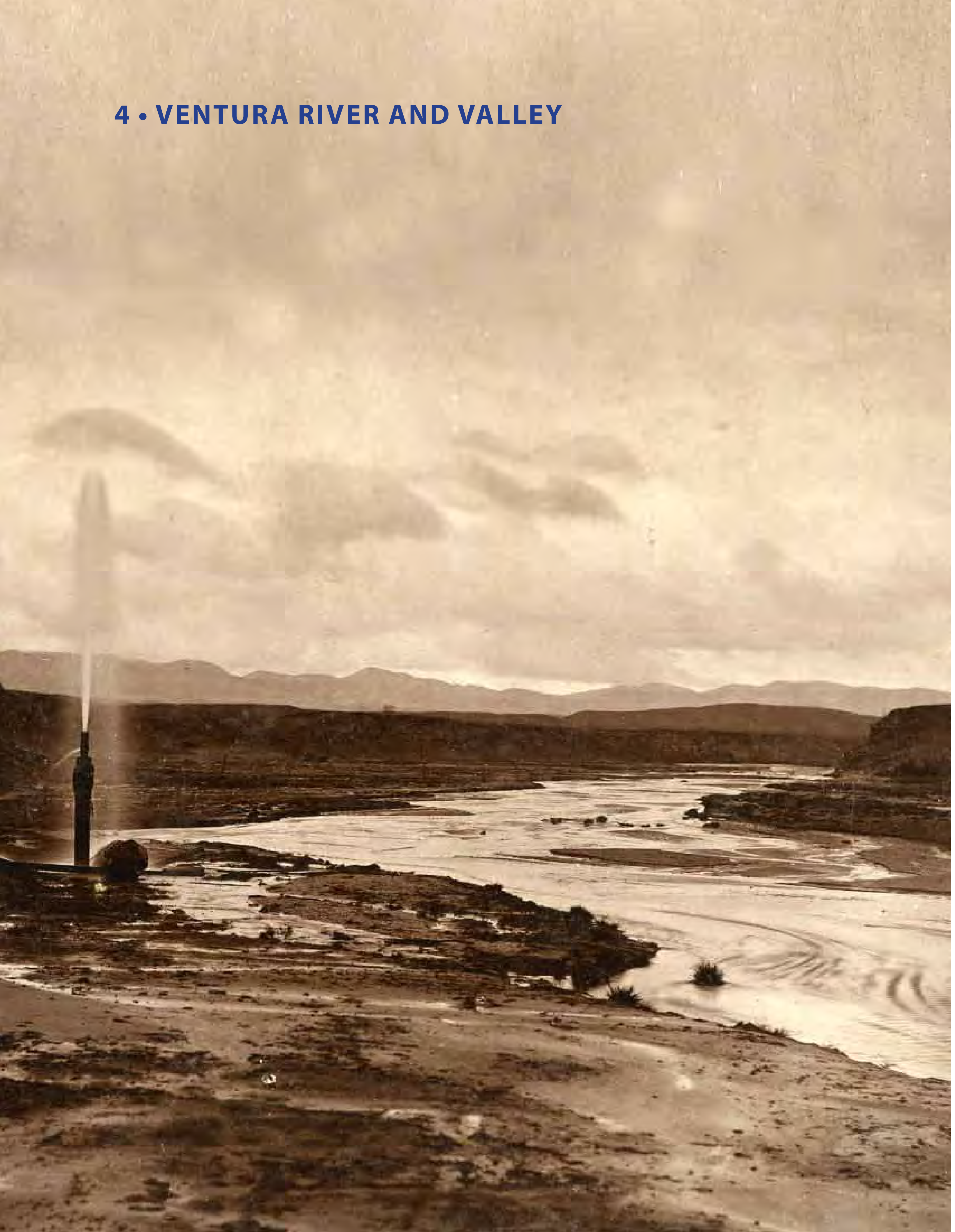
Overall, Lynch (1931) concludes that the average Southern California climate has remained stable since 1769. The following coarse information on notable floods and droughts recorded in the historical record is provided so that the reader can better understand the context in which the historical data presented in this report were interpreted.

Of additional particular note is the flood caused by the St. Francis Dam break on March 12, 1928. The dam, located on San Francisquito Creek, was completed in 1926 at part of the Los Angeles water supply and storage system. After the dam failure, the resulting flood swept down the Santa Clara River valley, causing extensive damage and killing more than 450 people before reaching the ocean.

Fig. 2.10. Patterns of wet and dry years, 1769-2005. Cycles of dry periods (shown in orange) and wet periods (shown in blue) are well documented by the historical record (e.g., Lynch 1931, Freeman 1968, Stillwater Sciences 2007b). Narrative accounts of extreme floods and droughts add additional local detail to this record; examples are reproduced here tied to rainfall data from Santa Paula. (1820-2005 precipitation data extended and adapted from Freeman (1968) by Stillwater Sciences (2007b); 1769-1820 data adapted from Lynch 1931)



4 • VENTURA RIVER AND VALLEY



For the entire distance we closely followed the Ventura River, a clear, dashing mountain stream bordered by hundreds of splendid oaks whose branches frequently met over our heads. We crossed the stream many times, fording it in a few places, and passed many lovely sylvan glades—ideal spots for picnic or camp.

— THOMAS DOWLER MURPHY 1921, TRAVELING FROM VENTURA TO OJAI

Introduction

The Ventura River drains approximately 230 square miles, emptying into the Pacific Ocean just west of the city of Ventura. The headwaters rise in the western Transverse Ranges, some of the youngest and most tectonically active mountains in North America with uplift rates as high as 0.2 to 0.3 inches/year. The resulting steep slopes and the relatively weak exposed sedimentary layers lead to high sediment production, landslide potential, and erosion rates (Scott and Williams 1978, Warrick and Mertes 2009, Cluer 2010).

The Ventura River ranges from steeper slope, step-pool formations with large boulders in the headwaters, to lower slope distributary channels emptying into the Ventura River estuary at the coast. Unlike the Santa Clara River, the Ventura River valley is narrow, and in many places the river occupies much of the valley floor. Upland portions of the watershed are predominantly covered in chaparral scrub, while riparian species occupy the river and its tributary corridors.

The Ventura River watershed experiences a Mediterranean climate, with 90% of the rain falling in the wet season between November and April. However, inter-annual variability is high and cycles of wet years and dry years often span decades. This climatic variability suggests an extremely variable hydrologic regime, similar to the Santa Clara River. Steep slopes in the upper watershed offer shorter lag time for surface water paths to channels, leading to quick flash floods which spread out in the broader portions of the watershed. These floods, common on the Ventura River, provide scour and habitat complexity, as well as flushing sediment through the system. With expanded urbanization and agricultural uses in the lower part of the watershed, levees have been built to confine flooding through urban and agricultural lands, and increased urban runoff and groundwater pollution have impacted water quality.

Together, Matilija Dam (built in 1948) and Casitas Dam/Robles Diversion (1959) block about 37% of the Ventura River watershed. They have broad effects on sediment transport, impeding over half of all sediment delivery

Fig. 4.2. Ventura River reach divisions. We divided the river into three reaches, based on hydrological and ecological characteristics: the uppermost Matilija Reach, the middle Oak View reach, and the lower Avenue/Casitas reach.

(Orme 2005). The Matilija Dam was originally built for flood control purposes; however, the reservoir has filled up with sediment almost completely. The dam is slated for removal, and studies have shown that it has altered flow regimes and geomorphic processes downstream, as well as acting as a barrier for migratory fish species in the watershed.

This chapter explores the historical characteristics of the Ventura River and valley prior to major urban and agricultural modifications. In particular, we focus on the pre-modification hydrology, morphology, and ecology of the river, describing each historical attribute at a reach scale. In contrast to the Santa Clara River, the Ventura River valley was lightly settled and traveled in the 19th century (with the exception of the canyon resorts of the upper Matilija canyon and the Ojai valley, both outside the purview of this report). As a result, there is much less documentation available concerning the historical character of the Ventura River.

Ventura River reach designations

We divided the Ventura River into three broadly defined reaches (fig. 4.2 and table 4.1). These reaches were defined based on the hydrology and ecological characteristics of the system. They are designed to provide meaningful units of analysis to facilitate reach-level understanding of channel dynamics and morphology.

Valley Floor Habitats

We mapped three types of habitats on the Ventura valley floor: grassland/ coastal sage scrub, oaks and sycamores, and valley freshwater marsh (fig. 4.3). Grassland/coastal sage scrub was the most prevalent habitat type. In contrast to the Santa Clara River valley, which was dominated by grassland/coastal sage scrub, our mapping suggests that oaks and sycamores composed a relatively high proportion of the Ventura River valley floor. Only one freshwater marsh (17 acres) was mapped in the project area, occupying a depression to the east of the Ventura River and demarcating a former route of the river.

Broadly, grassland was most prevalent in the lower Ventura River valley, extending about six miles upvalley before transitioning to denser tree cover in the middle (Oak View) reach. Scrubland and oaks were documented north of Meiners Oaks. The following section describes these patterns and transitions in more detail.

Dryland Habitats

Unlike the Santa Clara River valley, the Ventura River valley was dominated by the natural corridor of the river. Early accounts of the river valley are filled with descriptions of its riparian vegetation, while very few sources explicitly document vegetation characteristics of the non-riparian valley floor. As a result, this section provides only coarse descriptions of regional ecological patterns. While not mapped in detail, the Ventura River corridor contained much of the valley's heterogeneity and is depicted in sources as a complex mix of oak, sycamore and scrubland (Norway 1877; Lippincott 1903). Descriptions of bottomland and other riparian characteristics are addressed in the Riparian Habitats section (see page 138).

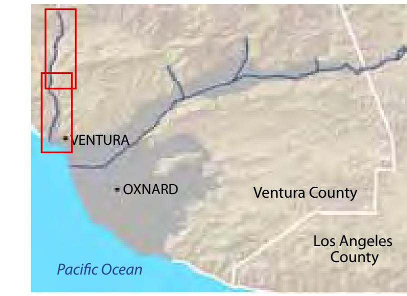
In spite of these impediments, general patterns of valley floor vegetation do emerge. Historical sources, in particular early maps and GLO survey notes, suggest that scrub-dominated cover extended downstream of the narrow, wooded Matilija canyon to the vicinity of Meiners Oaks, where oaks again became more prominent. Below Foster Park, sources indicate that the valley was dominated by herbaceous cover all the way to the river mouth. These areas are described in detail below.

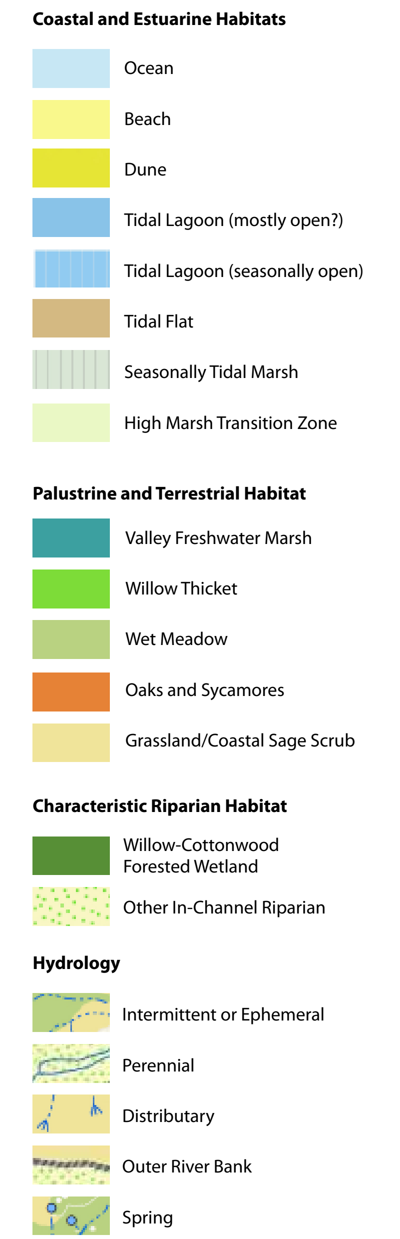
Downstream from the narrow canyon just below the present Matilija dam, the valley floor in the Matilija reach appears to have been dominated by scrub. In contrast to heavy timber described in reaches to the south, GLO surveyor Norway (1878a) noted, "dense brush" on the table land east of the Santa Ynez mountains. On another line a little more than a mile further south, the same surveyor distinguished between the "brushy table land" he just passed through and the "timbered bottom"—the bottomlands of the Ventura River (Norway 1877). As supporting evidence, relatively few trees are present along this reach in the historical aerials compared to timbered areas farther south.

South of Meiners Oaks, and extending to Foster Park, live oaks (and sycamores) became more numerous. For much of this reach (Oak View), the comparatively broad river corridor encompasses almost the entire narrow valley. Observations such as "timbered tableland" (Thompson 1868) and "valley mostly timber" (Norway 1877) are a clear contrast to the descriptions of scrub farther north. Dense tree cover is evident in the historical aerial photography and, in some places where oaks have been cleared for development, earlier GLO surveys note "heavy oak timber" (Norway 1877). Sycamores also appear to have dominated the tree cover in some places (fig. 4.4; Hare 1876). In the Foster Park area, at the southern extent of mapped woodland, a notable area of sycamores and oaks has served as a gathering place since before Mission times (see Riparian Habitats section for more information on Foster Park). As in the Santa Clara River valley, the historical record contains no descriptions of valley

Table 4.1. Upstream boundaries of Ventura River reaches.

	Avenue/Casitas reach	Oak View reach	Matilija reach
Upstream end of reach:	San Antonio Creek confluence	Near Cozy Ojai Road	Matilija dam





Legend for **Fig. 4.3** (map on following page).

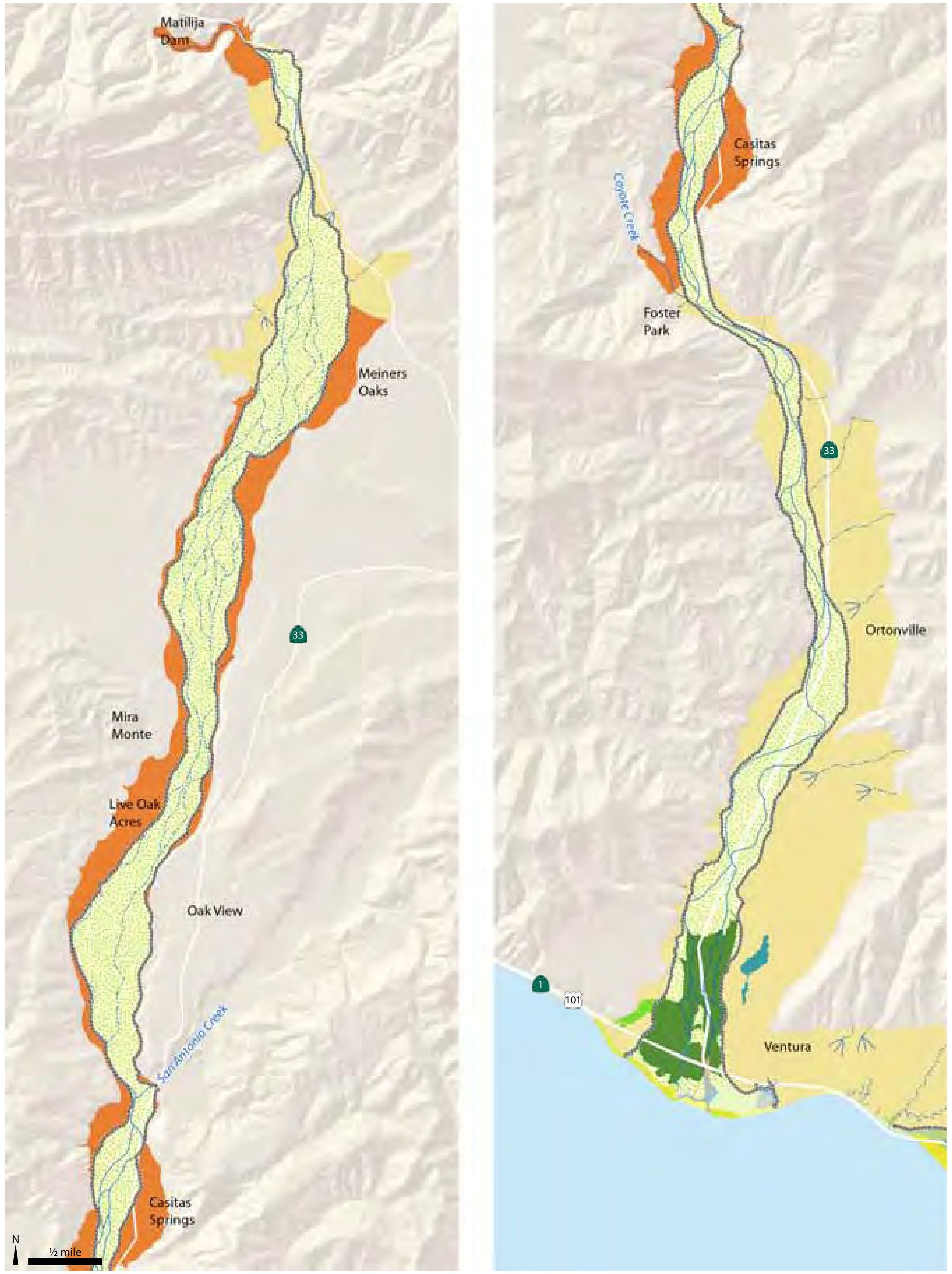


Fig. 4.3 .Historical habitats of the Ventura River valley, early 1800s. The Ventura River corridor was broad, in places occupying a large proportion of the valley floor. Live oaks, sycamores, and scrub were prevalent in the upper valley, while grassland was more common in the lower valley.

oaks in the Ventura River valley by any of the region's travelers, botanists, or residents, despite abundant references to the presence of live oaks by these observers (see page 57). (Ojai Valley, outside our project area, is a notable exception.)

Below Foster Park, historical evidence suggests relatively sparse tree cover in comparison to the wooded reach upstream. Vegetation characteristics changed notably in the Avenue area, where the Ventura River valley begins to open to the ocean. While mapped as the same general habitat type (grassland/coastal sage scrub) as the valley floor in the upper Ventura River reaches, the Avenue/Casitas area was likely more predominantly covered by grasses and forbs as opposed to scrub.

Explorer Crespí noted this distinction between the rich grasslands of the lower valley and the woodlands of the upper river valley in 1769:

> At this spot where we stopped in the hollow [Ventura River valley] close to the shore, there is a great deal of very good grass-grown level soil trending north and south, very nearly a league's worth [about 3 miles], it may be, of it, backward from the shore. Its width of smooth level soil must be about a quarter-league, and in some spots, where not so smooth, it may reach half a league, while the country opens out a great deal, further up to northward, with a great many hollows of naturally watered soil and a great amount of live-oak groves. (Crespí and Brown 2001)

The relatively early Leighton (1862) map corroborates Crespí's description of largely herbaceous cover, depicting trees along the canyons while leaving table lands mostly bare of trees. Textual sources also describe a fertile, grassy region north of the river mouth; Brewer noted that the Avenue region was a "pretty valley, green, grassy, and rich" in 1861 (Brewer [1930]1974), and Thompson and West ([1883]1961) called it an area of "unsurpassed richness." In 1856, a traveler to the Mission found the lower river valley "fine green country" with "plenty of grass" (Miller 1856, in Weber 1978). Roughly contemporary with many of these observations, the U.S. Coast Survey mapped the Ventura River mouth, also depicting herbaceous cover outside of the river corridor (Johnson 1855c; see fig. 4.20).

Overall, however, the habitat map may significantly underestimate historical oak woodland extent as a result of methods that default to grassland/coastal sage scrub in the absence of spatially explicit data. The descriptions and maps cited above suggest that, in contrast to the dominance of grass and scrub on the Santa Clara valley floor, oak and scrub may have been the dominant vegetation complex on the Ventura River valley floor above Foster Park.

Wetland Habitats

Only one freshwater wetland complex was documented on the Ventura River valley floor outside of the river corridor. (This does not include the lake at Figueroa Street on the coast, which is treated separately; see page

Fig. 4.4. Ventura River in the vicinity of present day Oak View, 1876. This late-1800s map depicts sycamores and oaks occupying the river corridor, as well as "scattering oak and sycamore" on the valley floor between the high bank and the scrub-covered mountains to the west. (Hare 1876, courtesy of the Ventura County Surveyor's Office)

196. It also does not include Mirror Lake, a wetland feature formerly situated east of the Ventura River between Mira Monte and Oak View, just outside the project area.)

The complex, over 16 acres in extent, occurred in a topographical low spot east of the Ventura River along modern-day Olive Street for ½ mile between West Park Row Avenue to the south and Bell Avenue to the north. It marked a portion of a former route of the Ventura River. It was documented on the 1855 T-sheet, but had disappeared by the 1870 resurvey (Johnson 1855c, Greenwell and Forney 1870; see fig. 4.20). Further research may reveal other freshwater wetlands in the Ventura valley whose presence was unrecorded by the historical documents we uncovered.

Channel Morphology

The Ventura River dominates the majority of the Ventura River valley, with multiple braided channels transporting water and sediment across its broad floodplain. Active uplift, steep slopes, and unconsolidated marine sediments give the Ventura River an extremely high sediment load, one of the highest per unit area in the United States (U.S. Army Corps 2004, Greimann 2006). These same conditions produce coarse substrate and the river's braided form, as channels shift location frequently (Keller and Capelli 1992).

In this section, we review the historical physical characteristics of the Ventura River, including lateral extent and stability, in-channel features, and changes in bed elevation. Since there are relatively few data available (especially in comparison to the Santa Clara River), these topics are only briefly reviewed below.

River Corridor Position and Stability

The overflow area of Ventura River is well-defined and includes nearly all the valley floor between the mesas and low hills on each side.

— KELTON 1940

The Ventura River corridor (including the active channel, in addition to bottomland areas susceptible to flooding) was mapped using similar methods as for the Santa Clara River, with the earliest reliable source available for each section of the river used to map outer bank position in a GIS polygon layer (fig. 4.5). Historical aerials (from 1927 and 1945) were the primary sources used to complete the mapping, though a few earlier maps were also incorporated. This methodology is described in more detail in the Santa Clara River section (see page 63).

Since no contemporary mapping of the river corridor was available, we were unable to quantify changes in extent from this mapping to the present. However, contemporary aerial imagery reveals a few places where levees have limited river corridor extent (such as along the lower river west of Ventura), and where agriculture or development has encroached into the corridor (e.g., at Live Oak Acres and along Meyers Road near Meiners Oaks). In other reaches, such as near southern Oak View, the river corridor appears relatively unchanged.

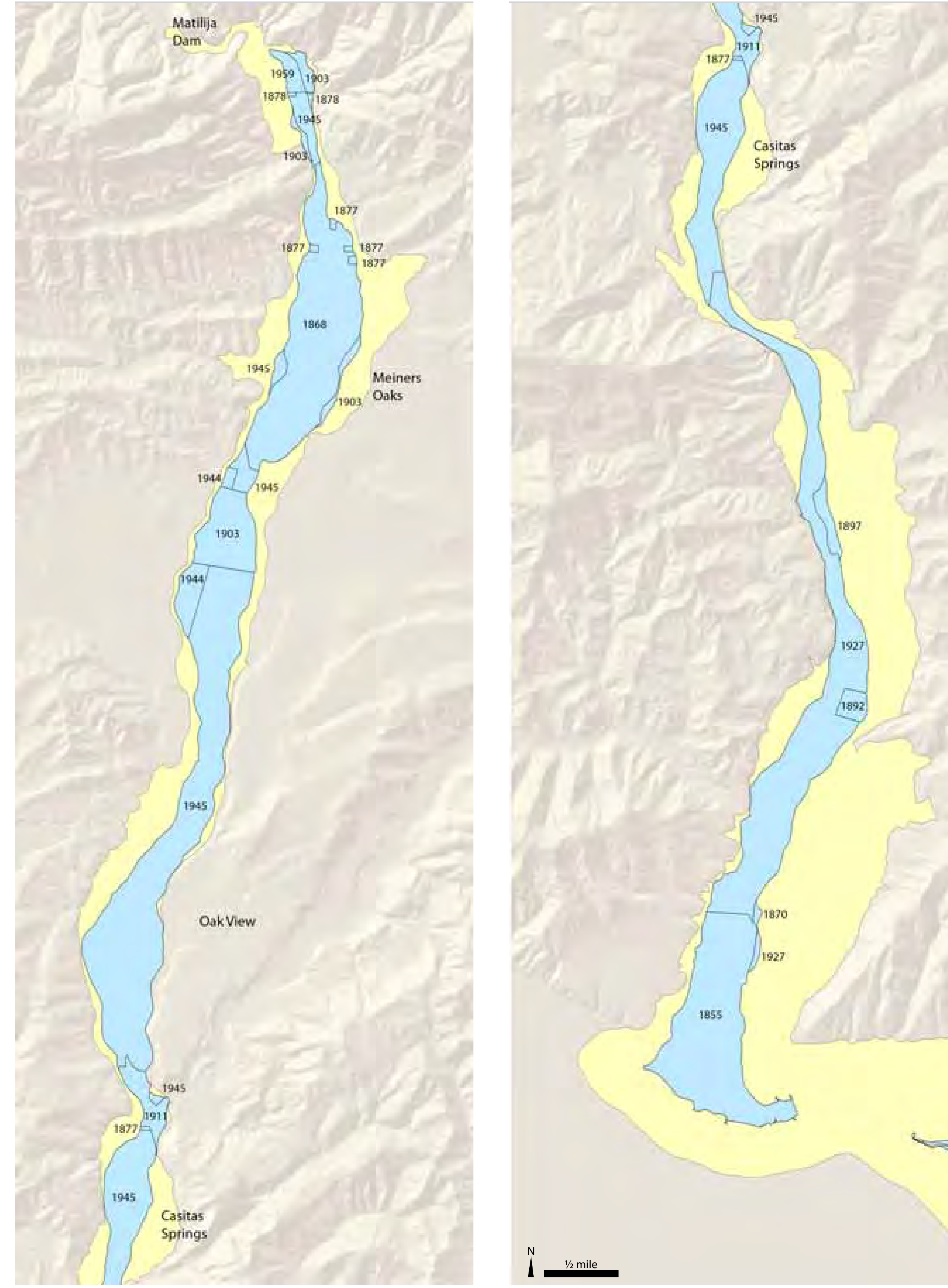


Fig. 4.5. Location of the Ventura River corridor by earliest available source, 1855-1959. We mapped the historical position of the outer bank using the earliest available data for each stretch of the river.

LARGE-SCALE CHANNEL CHANGE Within the river corridor, mainstem and distributary channel location changed frequently with flood events, as the river reoccupied old channels and formed new ones. In addition, historical sources indicate that a few major floods caused large-scale changes in the position of the Ventura River's outlet to the ocean. Interviews with long-time Chumash residents indicate a series of significant changes in the location of the river mouth over about a 1.5 mile stretch of the shoreline, from the hills west of the river mouth to Figueroa Street in Ventura. These accounts describe that the mouth of the river used to be far to the west of its present location: "The V.[entura] river first had its mouth many years ago at the foot of hills west of V. river valley. This was long ago" (Harrington 1986b). (The informant also noted that a "tule patch" at this former river mouth was formerly used to store canoes.)

Accounts state that the river mouth then shifted about 1.5 miles east, to what is now Seaside Park east of the Ventura County Fairgrounds (Sheridan 1912, Harrington 1986a, Harrington 1986b). In the 19th century, a lake here marked the former outlet of the river (see page 196). A number of statements describe the character of this former river mouth:

> The Ventura River used to empty into the ocean where the estero is now situated by the bathhouse west of the Ventura wharf, east of the present mouth of the river. The old Ventura canoe builders used to leave their canoes at that place (ancient mouth of the river)…They bent tule that was growing there on both sides over the canoe…and thus make a shade for the canoe. (Harrington 1986b)

> …in 1825 the Ventura River had its channel where now is Ventura Avenue, and that it emptied to the sea where the slough is, just east of the old racetrack grounds. It followed a course through what are now the courthouse grounds. All the land beyond to the Taylor Hills was good farming land. (Sheridan 1912)

This lake and former river mouth were also the site of a Chumash village, Mitsqanaqan. One of ethnographer John P. Harrington's informants recalled that Mitsqanaqan did not expand west of the lake because "it was said by the old Indians that the vicinity west of the lake was the mouth of the river and that the river was likely to shift its course" (Harrington 1986b).

For the first time in 12 years, Seaside Park was yesterday under water… flood waters forced campers to pack their belongings…The tennis courts, the picnic grounds and the race tracks were all under water.

— VENTURA DAILY POST, 4/8/1926, IN MOORE 1936

In the early 19th century, accounts state that the river mouth shifted from the Seaside Park location westward, closer to its current location. The date at which this shift occurred is not clear: one source states that it occurred in 1810 (Harrington 1986b), while another source inferred that it occurred later, likely during the floods of 1825 (Sheridan 1912). Many smaller changes in the river outlet location have been documented since. One source describes the shift from near Seaside Park first to the west, then slightly back toward the east:

> The mouth of the Ventura river used long ago to be at Mitsqanakan. Then it shifted to a place some distance west of its present mouth, where the little railroad bridge is west of the big railroad bridge. Then it shifted to its present location. (Harrington 1986a)

Early maps of the river mouth, in particular the T-sheets of 1855 and 1870, document the position of the river mouth in the mid-19th century. While locations differ slightly, they are within about 500 feet of each other, in contrast to the earlier large-scale changes. A later map shows the river mouth in the same location as the 1855 T-sheet (Barry 1894).

Later channel changes due to flooding often mirrored the extent or location of these former mouths. During the 1867 floods, the river reoccupied its former outlet near Mitsqanaqan, and "all of what is now Seaside Park became a lake" (Sheridan, in Moore 1936). The river similarly reoccupied this course during the extreme floods of 1884; in addition, the *Ventura Signal* reported that to the west "the river formed a new channel on the Taylor Ranch, over near the mountain by cutting through the great body of land which of recent years has been cleared of its thick growth" (*Ventura Signal* 1884 and Sol Sheridan, in Moore 1936). In 1909, the *Ventura Free Press* reported that the "mouth of the river is at the extreme western point of the lake, a quarter of a mile further to the westward than it has ever been known to be…almost as far west as the big sandhills between the Taylor ranch pasture and the ocean" (*Ventura Free Press* 1909b). A February 1992 flood also reoccupied a former distributary channel (Keller and Capelli 1992, Capelli 1993).

Hydraulic Geometry and Channel Form

PATTERNS IN THE RIVER CORRIDOR A variety of different features were documented in the historical record within the outer banks of the Ventura River. In-channel characteristics such as bottomlands, islands and bars, substrate, mainstem channel patterns, and pool locations were all noted, and are described below.

Within the flood plain of the Ventura River the main stream meanders widely, and the immense amount of debris carried by floods causes rapid and destructive shifts of the current. The stream channels generally are too ill-defined, limited in capacity, and unstable in character to give a definite indication of future flood stages.

— KELTON 1940

Some reaches of the river were relatively narrow (e.g., in Matilija Canyon or below Foster Park); these areas were often characterized by a relatively narrow active channel flanked by dense mixed riparian forest. In other reaches, however, multiple mainstem channels surrounded by riverwash threaded around established vegetated bars and islands. A few early maps capture this complex in-channel pattern, depicting networks of washy, broad channels and islands (Barry 1894, Barry 1897, Waud 1903, Everett n.d.; fig. 4.6). The size and quantity of sediment entering the river helped form the multiple braided channels that would often shift location within the river corridor in a major flood. A 1940 flood control report stated that mainstem channels were "ill-defined" and "unstable" (Kelton 1940).

The most notable aspect of these maps is the presence of large, well defined islands; on these maps coarse depictions of the area of individual islands ranges from less than one to over 35 acres. Other sources also describe islands in the river: a *Ventura Free Press* article refers to "rocky islets" near the mouth, and an early soils map shows gravelly and bouldery islands west of Ojai (fig. 4.7). One long-time resident described camping in the

early 20th century on an island at the confluence of Coyote Creek and the Ventura River:

> The parks became very popular. On what became known as the "Island," between Coyote Creek and the Ventura River, many Ventura people established camps and spent the summer there. The same was allowed east of the river. Each summer we built a temporary dam in the river to make a swimming pool. (Percy 1957)

The likely location of this island is documented in early 20th century maps of the area (Everett 1908, Unknown ca. 1910e).

In addition to islands, the presence of bottomland surfaces similar to those documented on the Santa Clara River is consistently recorded on the Ventura River. GLO surveyors crossing the river note the "river bottom" or "bottom lands" as they enter the floodplain (Thompson 1868, Norway 1877, 1878a). In many places this land, slightly higher than the washy active channel, was used for pasture, or cleared and cultivated for annual crops such as alfalfa (Lippincott 1903).

One notable difference between the Santa Clara River and Ventura River was the size of substrate in the channel, a characteristic shaped by the Ventura River's steeper channel gradient. Gravel, cobbles, and boulders were commonly found in all reaches of the Ventura River; in contrast the Santa Clara River was dominated by sand. (This is still the case today: intertidal cobble substrate, a notable and relatively rare feature along the California coast, is found at the Ventura River delta and supports a variety of marine plants and invertebrates; Ferren et al 1990, Capelli 2010.) At the river mouth in August 1769, Crespí wrote that the river "gave us some trouble on account of the stones and the large amount of water which ran above them" (Crespí and Bolton 1927). An article during the 1884 floods described a new channel at the river mouth "cut through a solid bed of boulders packed in sand" (*Ventura Signal* 1884, in Moore 1936), and a T-sheet resurvey noted "gravel and boulders" (Kelsh 1933a). Further upstream, an 1887 account describes the head of the intermittent reach, where "gravel spreads far over the desolate bottom" (Hassard 1887). Many historical landscape photographs of the

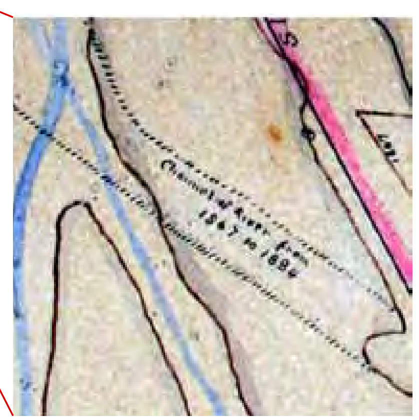


Fig. 4.6. Islands in the Ventura River channel, 1894. This 1894 map shows continuous islands, some over 20 acres in extent, stretching up the first three miles of the river from its mouth. The documented extent of islands extends at least another two miles upstream (Barry 1897). The detail at left shows channel change as a result of the 1884 floods as captured by the surveyor. (Barry 1894, courtesy of the Ventura County Surveyor's Office)

river show coarse substrate on the river bed (fig. 4.8). While some of these photographs were taken after floods and thus may somewhat overemphasize the relative proportion of cobbles and boulders to finer substrate, they still reveal an overall trend toward coarse bed material.

Favorite childhood swimming holes were recalled by long-time residents along the Ventura River mainstem (another feature not well represented on the Santa Clara River, at least by the historical record). J.H. Morrison, who was born in 1887 and grew up on the lower Ventura River, described his favorite swimming holes in the 1890s:

> The shallow mill pond [from the Rose Flour Mill] furnished a fine swimming-hole which we small boys shared with Mrs. Orton's ducks until we graduated to Big Rock, Mays, Dumond's or any one of several deep pools along the river. (Morrison 1959)

Additional swimming holes on the lower Ventura River (below Foster Park) were described by current Ventura residents as part of the Lower Ventura River Parkway vision plan (606 Studio 2008).

INCISION/CHANGES IN BED LEVEL Only fragmentary evidence was uncovered regarding historical trends in bed elevation on the Ventura River. As for the Santa Clara River, there may be additional elevational data (such as cross-sections, surveys for bridge construction, and as-builts) available to study incision rates over time. Obtaining and analyzing these data, though outside the scope of this study, would futher the discussion about historical changes in bed level.

Before the construction of Matilija Dam in 1947, high sediment loads and large, episodic flood events created cyclical changes in bed level, as elevation increased with sediment delivery and deposition only to be scoured out during large floods. This dynamic was captured by descriptions of large floods of the late 19th and early 20th centuries. A 1909 flood was reported to "have washed out the bed of the entire stream to an unparalleled depth below the old bed" near the river mouth (*Ventura Free Press* 1909b). The *Ventura Free Press* (1885) reported that flooding in 1885 did not extend as far as the flooding of 1884, "owing to the deepening and widening of channels by previous floods." A similar process contributed to the minor effects of the 1916 floods following the heavy floods of 1914, since "the flood of 1914 had divested an exceptionally wide channel of all brush and trees and at the same time had deepened the same course so that the waters [of 1916] met with a minimum of diverting resistance" (Moore 1936). Scouring during the flooding of 1914 was so extensive that as late as 1937, it was reported that "the high waters in 1914 cut the channel so deep that since that time it has given you no trouble" (Moore 1937). One witness quantified this incision at Foster Park, testifying that a channel eight to nine feet below the "ordinary stream bed" was created during the 1914 floods (Moore 1937). General trends were also described in the same document:

Fig. 4.7. Islands in the Ventura River, 1917. The 1917 soil map shows islands surrounded by riverwash (Rv) over a three mile stretch west of the Ojai Valley. The islands are composed of coarse Yolo gravelly and bouldery fine sandy loam (Yg), a soil type documented to support live oaks and sycamores on alluvial fans in the Santa Clara River valley. (Nelson 1917)

Fig. 4.8. These images of the Ventura River at Foster Park (top, ca. 1906) and at Main Street in Ventura (bottom, 1916) show the abundant cobbles and boulders characteristic of the river bed even nearly at the estuary. (Unknown ca. 1906, courtesy of Craig Held; Unknown 1916, courtesy of the Museum of Ventura County)

> Chairman Cruse: "Generally speaking is the Ventura River a scouring river or a flooding river, that is to say, do floods scour the river bed, or is the river bed spread out over large areas?"
>
> Mr. Ryan: "I notice the elevation at Casitas Pass has been lowered and I believe in all these California rivers they are, and I know there is a deposit in the center of the Ventura River at the lower end which is filled up, and in the main channel down several miles they are inclined to scour, that is what we found last year." (Moore 1937)

Dry Season Flow

Unlike the Santa Clara River, there is little early (pre-1900), reach-specific evidence for summer flow conditions on the Ventura River. Early explorers only described conditions at the river mouth, while other observers made comments about the river's water supply that provide only a general picture of early conditions. In August 1769, Crespí noted an "abundance of water" and a stony river bed near the ocean (Crespí and Bolton 1927). Mission Father Señán (1817) also described an "abundance of water from the San Buenaventura River." One eager writer described the river as "a clear brawling stream singing down in the summer months by way of a succession of pools and rapids where the trout lie hidden" (Unknown ca. 1909).

Other early generalizations on flow conditions emphasize the aridity of the region and the lack of water in the river. One article asserts that the Santa Clara and Ventura rivers "sink during the summer, before they reach the ocean" (*Daily Alta California* 1864). Holmes and Mesmer (1901c) also describe both rivers as "dry in their lower reaches," retaining only a "small summer supply for irrigation." Though these statements do not reflect average conditions as described by more reliable sources on the lower Ventura (or Santa Clara) River, they do illustrate the general presence of dry reaches on the river.

Both descriptions of the Ventura River—as an abundant source of water, and as an arid stream—have some element of truth. Documentation of flow conditions on the Ventura River consistently depicts three reaches with distinct summer flow regimes within the study area. These reaches are depicted on the historical topographic quad for the river (USGS 1903c; fig. 4.9). The first perennial reach extends from beyond the northern edge of the study area (Matilija Hot Springs) downstream to around the Cozy Dell Canyon (Matilija reach). Below this, the Ventura River valley begins to open up into the head of the Ojai Valley, and the river is intermittent until below

Fig. 4.9. Intermittent and perennial reaches on the Ventura River, 1903. The early USGS topographic quadrangle depicts summer flow conditions on the Ventura River. A solid line indicates perennial flow, while a dashed line signals an intermittent reach. The quad shows the river as about half perennial and half intermittent. (USGS 1903c, courtesy of the Los Angeles Central Library)

Oak View and the river's confluence with San Antonio Creek (Oak View reach). Last, perennial flow is shown from just above the San Antonio Creek confluence downstream to the ocean (Avenue/Casitas reach). However, the precise extent and location of summer water would have fluctuated in response to annual variations in rainfall and runoff. During wet years or series of wet years, reaches with perennial flow would have extended both spatially and temporally, while during dry years intermittent reaches may have been more extensive and would have lost surface flow earlier in the season.

This representation of Ventura River summer flow is supported by numerous additional early sources. Early photographs from the Matilija Hot Springs area show shallow riffles running over a cobble and boulder-strewn river (see fig. 4.10). Ditches brought water downstream from the perennial Matilija reach to irrigate bottomland alfalfa and orange orchards located in the intermittent reach of the river below (Waud 1903, Lippincott 1903). A GLO surveyor noted water in the river in late September 1878, south of the current intersection of Camino Cielo and Rice Road (Norway 1878a).

Shortly after leaving the confined lower reaches of Matilija Canyon, the river spread out into the broad alluvial plains of the Ojai and Santa Ana valleys. This marked a transition between the lush, perennial Matilija Canyon and the scrubby, drier upper Ventura River, as one traveler observed in early June, 1887:

> …we found ourselves at the mouth of…the Matilija Cañon…A rapid brook runs down the canon, shrinking into the deserted bed of what must once have been a broad river, and here and there the gravel spreads far over the desolate bottom. But soon after entering the ravine, the eye is relieved by patches of wood and verdure which at short intervals break in upon the sand. (Hassard 1887)

Storke (1891) also noted that in comparison to the upper Ventura River, the river "flows more tranquilly when it reaches the table-like lands of the Ojai and Santa Ana ranchos" (the intermittent reach) until it "gathers volume from the water of the San Antonio and Coyote creeks" (the beginning of the lower perennial reach).

Below its confluence with perennial San Antonio Creek, the Ventura River flowed year-round once more. About 500 feet below its confluence with San Antonio Creek in August 1877, GLO surveyor Norway (1877) noted that the Ventura River had substantial water present—16 feet wide. (This was one of the driest years on record, so the presence of summer water is particularly meaningful; see fig. 2.10.) The river around the Coyote Creek confluence was a popular area for summer camping and swimming trips (Percy 1957). In "Autumn Days in Ventura," the author described the river below the San Antonio Creek confluence in early fall:

> Before we had reached the wooded cañon of the San Antonio creek, a full moon gave a magical unreality to our surroundings. The stately trees were roofed with wild grapevines from root to crown. They were sentinel towers along the path, and the argent flash of water here and there among them was the blazoned shield of many a silent guard! A dozen times or more we forded the rushing stream. (Eames 1890)

Steady summer flow continued further downstream toward the town of Ventura. (One possible exception is a short reach, less than a mile long, around Casitas Springs, which is mapped on the historical quad as perennial but appears to be scrubby and sparsely vegetated in 1940s aerial imagery.) At Casitas (Foster Park), shallow water flowed over the river's gravel/boulder bottom. One man who grew up on the lower river around the turn of the century described abundant water in swimming holes and other pools along the river when he was young (Morrison 1959). Near the river mouth in mid-August 1769, Crespí described the river as a "very large stream or river where there is a vast amount of fresh water" (Crespí and Brown 2001), though Roberts (1886) noted that the river was often "shallow and easily forded." An alternate version of Crespí's manuscript provides additional detail about summer (August) flow near the ocean:

> They have informed me that this is a river that is split into two branches; that there is not a great deal of water running where we saw it; that the other branch, which is running to the westwards, must have a bed with about eight or ten yards' width of running water that came up to the hocks of the mounts when they went into it to drink. (Crespí and Brown 2001)

The San Buenaventura Mission stone aqueduct brought water from around the San Antonio Creek confluence to Ventura for domestic and irrigation purposes until it was destroyed during the floods of 1861-62 (Triem 1985). This may indicate more abundant or reliable water up near the San Antonio confluence, rather than further down toward the Mission.

God has provided this Mission with an abundance of water from the San Buenaventura River and the streams that flow into it.

— FRAY JOSÉ SEÑÁN 1817

Similar patterns are noted in the mid-20th century, though many accounts indicate an extension in the length of the intermittent reach. A 1937 report described the river as "absolutely dry during at least six months of the year" between Kennedy Canyon and the Coyote Creek confluence (Moore 1937). While this is slightly longer than the intermittent reach as depicted on the 1903 USGS map, it demonstrates that these reaches were largely still preserved into the late 1930s. Cooper (1967) noted more extreme conditions, describing the Ventura River as "dry most of the time," and long-time residents' fond recollections of formerly abundant flow also indicate drier conditions by the late 1950s than were historically present in the river:

> That was in the days when the Ventura River and Coyote Creek flowed water all year. (Percy 1957)

> …it is hoped that any who read this will be convinced that at one time there was water and plenty of it, in the Ventura River. (Morrison 1959)

Residents in the 1970s confirmed the presence of the Oak View summer-dry reach, stating that the reach often had "little or no surface water in the river-bed during the summer" (Ventura County Fish and

[T]he Ventura River…is the southernmost stream of California not muddy and alkaline at its mouth.

— GILL 1881

Game Commission 1973). However, the same report also noted that impoundments, diversions, and wells had contributed to the drying of reaches which had historically maintained surface flow during the summer. Anthropogenic changes in the stream hydrograph, in addition to climatic conditions (see pages 44-45), may have exacerbated the aridity of this intermittent reach beyond earlier conditions. These observations are consistent with the development of major water infrastructure on the river, such as Matilija dam (completed in 1948) and the Los Robles diversion dam and Lake Casitas (completed in 1959). The trend would have been compounded by a mid-century period of low rainfall (see fig. 2.10).

Riparian Habitats and Ecology

In contrast to the Santa Clara River, visitors to the Ventura River commented consistently on the abundance of trees found along the river. In a letter written in 1770, Juan Crespí described that along the Ventura River "there are large groves of willows, cottonwoods, and alders, plenty of oaks for firewood, and plenty of stone for building" (Crespí and Bolton 1927). A 1921 booster article boasted the Ventura River was "bordered by hundreds of splendid oaks whose branches frequently met over our heads" and had "many lovely sylvan glades—ideal spots for picnic or camp" (Murphy 1921).

Portions of the Ventura River were characterized by the presence of large stands of live oaks and sycamores in addition to the ubiquitous scrub—not just on the outer bank (as was largely the case on the Santa Clara River), but also on established islands within the river corridor. This, along with extensive sections of dense willow-cottonwood forest along some portions of the river, formed a riparian corridor that in many ways contrasted with patterns documented along the Santa Clara River.

The outer river banks, bottomlands, and active channel of the Ventura River exhibited distinct vegetation patterns (for definition of terms see page 61). While lone sycamores and live oaks on the outer bank of the Santa Clara River were often notable features in the sparsely forested valley, many of the riparian trees on the Ventura River merged into the surrounding upland live oaks and sycamores. Bottomland areas on the Ventura River were colonized by dense mixed riparian and willow-cottonwood forest in many portions of perennial reaches, while oaks, sycamores and alluvial/willow scrub composed bottomland vegetation in the intermittent reach. The active channel itself formed a largely non-vegetated matrix of scrub, boulders, cobbles, gravel, and sand, similar to the Santa Clara River active channel though with coarser substrate. In many portions of the river, well developed islands above the active channel supported vegetation similar to that found on bottomland surfaces.

As on the Santa Clara River, riparian vegetation varied both laterally and longitudinally, as expected for a semi-arid stream (see page 85). Riparian habitats along the Ventura River were broadly divided into three reaches,

reflecting shifts in hydrology (summer flow, depth to groundwater) and variations in geomorphology (surface elevation, flood frequency). Directly below the present-day Matilija Dam, a short (about two mile) perennial reach was presumably flanked by mixed riparian forest in Matilija canyon, which transitioned to scrubbier cover as the canyon opened up somewhat below the Camino Cielo Road crossing (Matilija reach). As the canyon opened onto the broad flats at the head of the Ojai Valley and the river sank into its bed, riparian vegetation transitioned to a mix of sycamores, live oaks, and scrub (Oak View reach). Beginning at the confluence of San Antonio Creek with the Ventura River, a second perennial reach stretched eight miles to the ocean, and was characterized primarily by mixed riparian forest with patches of scrub and a large, persistent area of willow-cottonwood forest and in-channel wetlands at the mouth of the river (Avenue/Casitas reach). These coarse reach-scale differences in riparian habitat are described in detail below.

Of course, the morphologic complexity created by islands, side channels, and bottomlands would have created many small-scale variations in vegetation distribution, character, and density along the length of the river complicating—and presumably sometimes contradicting—the broad patterns discussed above. In particular, there may have been additional persistent wetland riparian areas historically present on the river but not documented, and at the sub-reach level there were likely short intermittent stretches along the perennial reaches of the river (or vice versa). The descriptions below do not preclude these finer-scale patterns.

In addition, though described patterns appear consistent between 19th century accounts and 20th century photographs, the Ventura River was a dynamic system, and the proportion and distribution of scrub and trees would have shifted from year to year, perhaps changing dramatically during major flood events. This was recalled in relation to the flooding of 1825, when "trees and villages were washed away" around Ortonville (Jones 1938, in Freeman 1968). It was also documented for the 1914 flood:

> If you go up the river now [1937], every tree in that river bed is 23 years of age, just exactly. There wasn't a tree left in the entire river bottom following the flood of 1914 from Foster Park in the main channel clear up to Live Oak Acres. There is a heavy growth of willow, sycamore, cottonwood and alder trees. An alder tree is a very short lived tree so the alder trees suddenly die; when they get 8 or 10 inches in diameter, they all fall and become debris in the channel. (Hollingsworth, in Moore 1937)

Matilija Reach

Extending downstream of the present-day Matilija Dam through the Matilija Canyon and down to the head of the Ojai Valley, the uppermost portion of this reach was confined (in contrast to the more broad, braided pattern at the downstream end of the reach). In the narrow canyon, the riverbed was "a mass of fallen rock and bowlders" (Roberts 1886), without the broad bottomlands found elsewhere along the Ventura River. Another account describes seeing, upon entering Matilija Canyon, "patches of wood and verdure which at short intervals break in upon the sand" (Hassard 1887). A number of sandbar willows (*Salix exigua*) were recorded in Matilija Canyon just upstream of the study area (Bracelin 1932). Early images of the canyon corroborate these descriptions of the confined portion of the river (fig. 4.10).

Less is known about the character of downstream portion of the Matilija reach, after the river exits the most confined portion of the canyon. Historical aerials (Ventura County 1945) show prevalent scrub in the broader channel.

Oak View Reach

For six miles along the Ventura River—from the top of the Ojai Valley near Meiners Oaks, past Oak View and Live Oak Acres, to the confluence of the river with San Antonio Creek above Casitas Springs—the river corridor supported abundant scrub, in addition to substantial areas of live oaks and sycamores colonizing islands and other bottomland surfaces within the river's banks. Riparian patterns in this intermittent reach were notably different from those found on the Santa Clara River mainstem, where substantial in-channel tree cover was not documented (apart from the persistent wetland areas).

The presence of scrub and trees (overwhelmingly live oaks and sycamores) in this reach is described by a number of narrative and textual accounts. The upper portion of the reach, at the transition to a broad, washy river from Matilija Canyon, was especially commented upon (fig. 4.11). Sheridan (1886) described that the "river rushes out across a broad sycamore dotted flat" from the canyon, and Roberts (1886) described the river here as "overgrown with brush, sycamores, and oaks." The early presence of oaks and sycamores is corroborated by GLO survey notes, which describe a "timbered bottom" and "bottom land with heavy oak & sycamore timber" (Norway 1877). The few GLO bearing trees documented in this reach also generally support this description (two live oaks 10 and 48 inches in diameter, and one sycamore 20 inches in diameter; Norway 1877).

Leave riverwash, enter bottom land with heavy oak & sycamore timber…

— NORWAY 1877, BETWEEN OAK VIEW AND CASITAS SPRINGS

Early maps of the reach also show a mixture of scrubland, oaks, and sycamore. An 1876 map marks "oak and sycamore" near Live Oak Acres toward the bottom of the intermittent reach (Hare 1876). Upstream near Meiners Oaks, a map along two miles of the river shows a combination of oaks, scrub, and grasses present in the river corridor between patches of cultivation, labeling bottomlands "oaks and brush," "oaks, brush & grasses," "oaks (12" to 18" diam)," and simply "brush" (Lippincott 1903; fig. 4.12). Aerial images from the 1940s also show oaks and scrub.

Species data provide additional details on scrub composition in the Oak View reach in the mid-20th century. Chaparral whitethorn (*Ceanothus leucodermis*) was collected in a "wash" of the Ventura River below Meiners

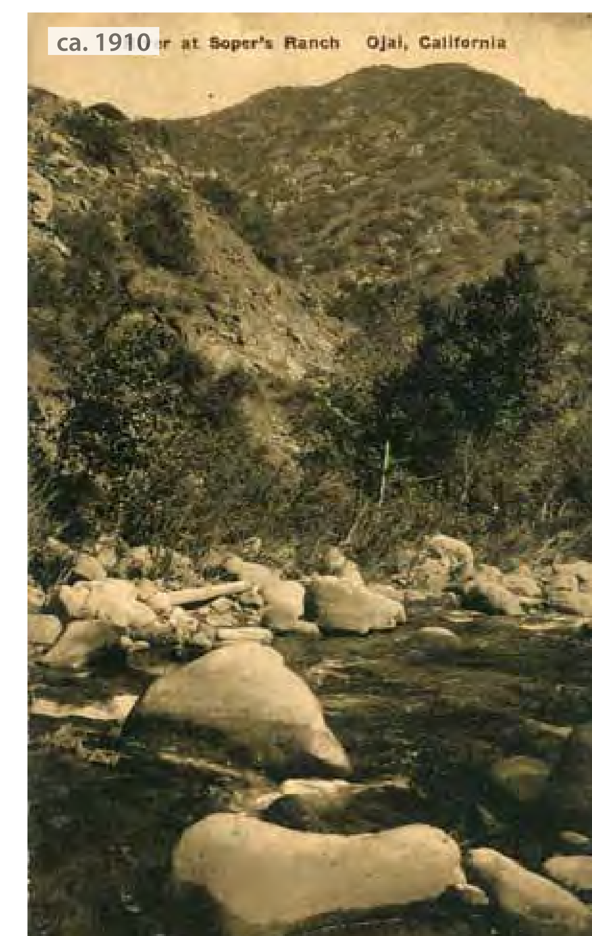


Fig. 4.10. Two views of the upper Ventura River, ca. 1910. These two postcards, both dating from the first years of the 20th century, show the boulder-filled channel of the river in lower Matilija Canyon. The photograph at top was taken at Matilija Hot Springs, just below Matilija dam. The photograph at right was taken less than a half mile downstream. Note the narrow fringe of mulefat, willow scrub, and trees (likely alder, cottonwood, and sycamore). (Unknown ca. 1910b, d)

Oaks (Hoffmann 1932b), and slender woolly buckwheat (*Eriogonum gracile*) and chaparral yucca (*Hesperoyucca whipplei*) were collected in the river near Oak View (Pollard 1963a, 1969). Mulefat was also documented (*Baccharis salicifolia*; Pollard 1944). These records imply the presence of alluvial scrub; it is likely that a mixture of willow and alluvial scrub was present through this reach (fig. 4.13).

Avenue/Casitas Reach

Below Oak View and near its confluence with San Antonio Creek the Ventura River became perennial again, with an accompanying shift in vegetation. This reach was characterized by a matrix of often dense mixed riparian forest, riverwash, and scrub. (One possible exception is a short one mile reach at Casitas Springs, which looks much more like the intermittent reach described above on the 1945 aerial imagery.)

Strongly supporting the concept of dense riparian forest in this reach, an 1840s *diseño* of the Cañada Larga ranch shows a continuous riparian corridor stretching the three miles from near Foster Park to Gosnell Hill/Cañada de San Joaquin (fig. 4.14). The riparian corridor is shown of variable width, including a short reach of oaks south of Cañada Larga and a lot of other trees (interpreted as willow-cottonwood forest). This map is supported by

Fig. 4.11. "Looking west across Ventura River, mouth of Matilija Canyon," February 1930. This photograph, part of the Wieslander Vegetation Type Mapping Project of the late 1920s and early 1930s, shows low scrub flanking riverwash along a shallow, broad channel in the intermittent reach of the river. It was taken approximately one mile below the mouth of Matilija canyon, looking west toward the site of the current Robles Diversion Dam (Capelli pers. comm.). (Clar 1930, courtesy of the Marian Koshland Bioscience and Natural Resources Library, UC Berkeley)

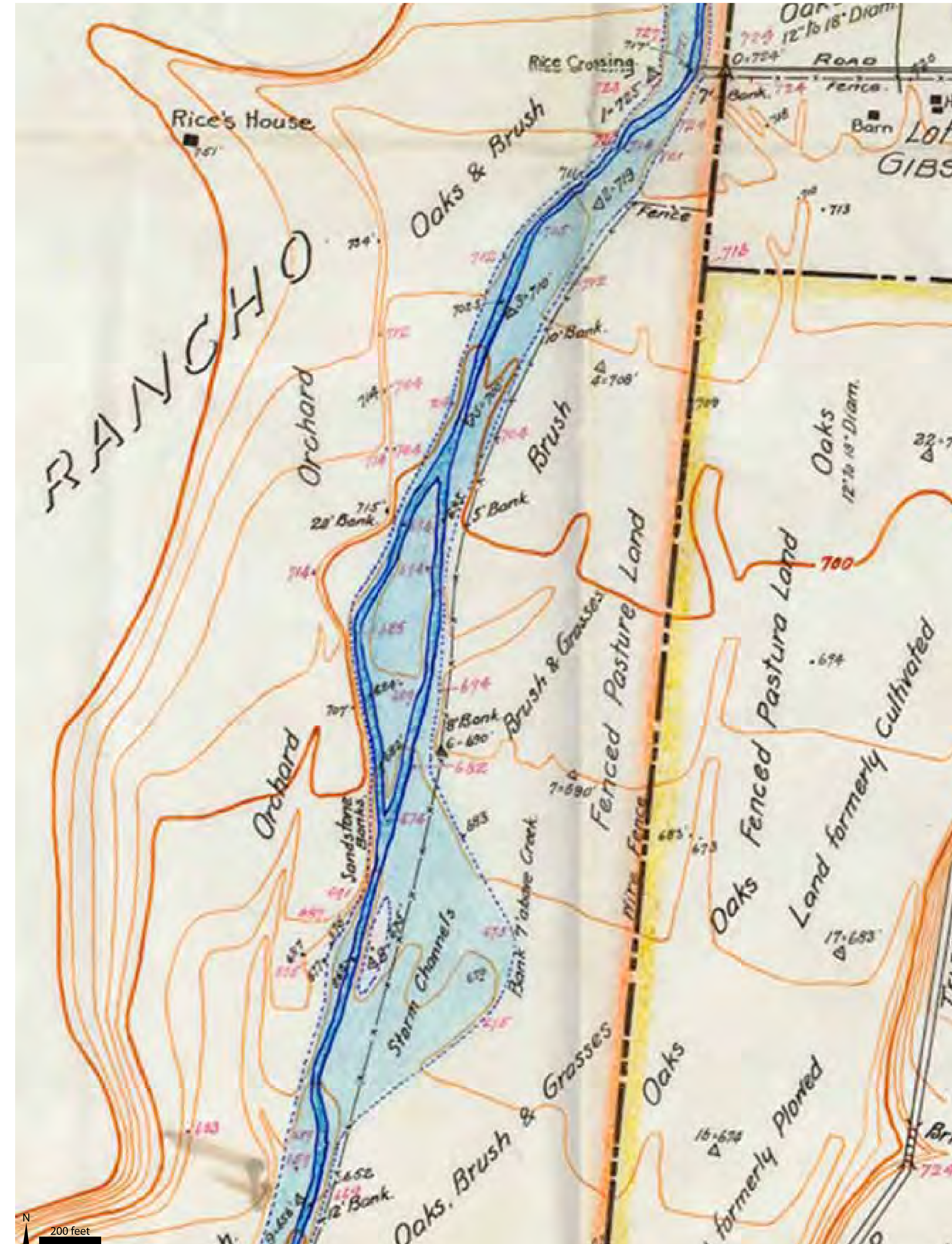


Figure 4.12. Vegetation in the Ventura River, 1903. This map of the river in the intermittent reach near Meiners Oaks shows local-scale variation of riparian vegetation, including oaks, sycamore, and brush, within its outer banks. It is evident from this map that many portions of the bottomland had already been cleared or fenced for pasture. (Lippincott 1903, courtesy of the Museum of Ventura County)

Fig. 4.13. Ventura River at Live Oak Acres. The oblique aerial photograph (top), taken in June 1938, shows characteristic riparian patterns in the Oak View reach. Sparsely vegetated riverwash composes the active channel, flanked by dense scrub on bottomlands. Further away from the active channel, more mature live oaks colonized higher river surfaces. Seven years later, the aerial photograph of the same place in 1945 (left) shows similar patterns of riverwash, scrub, and trees. (Spence Air Photos 1938, courtesy of the Benjamin and Gladys Thomas Air Photo Archives, UCLA Department of Geography; Ventura County 1945, courtesy of UCSB Map and Imagery Library)

Fig. 4.14. Dense riparian corridor along the Ventura River, ca. 1840. An early depiction of the Ventura River for three miles below Foster Park shows continuous riparian forest flanking the river, of variable—and in many places, substantial—width. A small area of oaks is shown along one portion of the river (below the "I"); the small check marks that line the river are interpreted as mixed riparian forest. (U.S. District Court ca. 1840b, courtesy of The Bancroft Library, UC Berkeley)

FOSTER PARK

Within the lower perennial reach of the Ventura River, Foster Park was particularly noted and admired for its riparian trees. The park, created in 1908, is the site of many of the historical data describing the Ventura River, including photographs, specimen records, and textual descriptions. According to one historian, the Foster Park area had been used by both Chumash and Mission fathers (Sheridan 1926). Images of this area show thick stands of trees and scrub growing over cobbles along the river, similar to today (figs. 4.15, 4.16).

Between 1932 and 1972, many plant specimens were collected at Foster Park. While most of these records are too late to be considered unambiguously historically relevant, they do provide a general sense of the wetland character of the reach. Species archived from this location indicate the presence of a diverse willow woodland with three species of willow (*Salix exigua, S. lucida,* and *S. laevigata)*, along with mulefat (Pollard 1946, 1960, 1968, 1972). Obligate wetland species are also recorded, including stream orchid (*Epipactis gigantea*; Canterbury 1939), seep monkey flower (*Mimulus guttatus*, Pollard 1964), least duckweed (*Lemna minuta*, recorded in a "pool in willow thicket"; Pollard 1962, 1965), and water speedwell (*Veronica anagallis-aquatica*, Broughton 1967), indicating presence of surface water through large portions of the year. These plants are described as being in a "willow thicket" or in "shaded pools under willows." Other records document the presence of an alluvial scrub community in portions of the floodplain (e.g., *Eastern Mojave buckwheat/Eriogonum fasciculatum var. foliolosum*; Pollard 1963a).

The diversity of species present in the Foster Park area is further illustrated by a number of ornithological records, which note both the bird collected and the nature of the locality where the bird was found. Records from the early 20th century describe many Allen's hummingbirds (*Selasphorus alleni*) in addition to black-headed grosbeak (*Pheucticus melanocephalus*), yellow-breasted chat (*Icteria virens longicauda*), and warbling vireo (*Vireo gilvus*) (Canfield 1919, 1920; Canfield and King 1919, King and Huey 1919, Huey 1920). Many of these species had nest sites recorded in "thickets" of wild rose, wild grape, or blackberry. One hummingbird was found in a blackberry thicket "completely shaded by grove of tall cottonwoods," while another was found on "an elder bush in dense willow woods" (Canfield 1920, Huey 1920).

Fig. 4.15. Ventura River at Foster Park looking north from the bridge, July 2008. Cottonwoods and willows flank the river, and willows, mulefat, and Arundo colonize coarse bars and islands.

Figure 4.16. Three images of riparian vegetation near Foster Park/Casitas, ca. 1890-1914. Top: "On the Ventura River 6 miles up the Avenue (the ford)," ca. 1890. Middle: "Looking up Ventura River from the Bridge," ca. 1914. Bottom: "Casitas – View of Ventura River Crossing," ca. 1914. These images show three versions of the riparian corridor in the vicinity of Foster Park, including sycamore, live oak, willow, cottonwood, and alder. (Fletcher ca. 1890, courtesy of the California State Library; Unknown ca. 1914a and 1914b, courtesy of The Bancroft Library, UC Berkeley)

…the good Padres gathered their neophytes under the trees of the present Foster Park, and called them to their daily prayers and their daily tasks beneath the whispering leaves of the sturdy sycamores and live oaks.

— SHERIDAN 1926

Fig. 4.17. A section of riparian corridor 1.5 miles south of Foster Park. Broad, dense riparian forest present in 1927 (left) and 1945 (middle) has been converted to agriculture by 2009 (right). (Fairchild Aerial Surveys 1927, courtesy of Whittier College; Ventura County 1945, courtesy of UC Santa Barbara Map and Imagery Library; USDA 2009)

aerial imagery from 100 years later, which still shows many stretches of dense mixed riparian corridor (fig. 4.17). Photographs of this reach show a corridor of dense trees and scrub, particularly in the Foster Park area (see spread, pages 146-147).

A variety of species were documented within the mixed riparian forest. Bottomland trees in this reach included willows, sycamores, alders, box elders, cottonwoods, oaks, and walnuts, in addition to wild grapes and blackberries. A traveler in fall 1890 described "stately trees…roofed with wild grapevines" (Eames 1890), and a newspaper account from 1874 waxed poetic on the beauty of this stretch of the Ventura River:

> Our way for miles was through a shaded canyon, down which coursed a clear stream, bordered by willows and sycamores, whose light-green foliage contrasted well with the dark green of the wild walnut, by which they were thickly interspersed. Wild grape vines trailed in the greatest profusion over every place that offered a support for their clinging tendrils… (*Ventura Signal* 1874b)

This is corroborated by a 20th cenutry specimen of wild grape (*Vitis girdiana*) collected in a "poplar [cottonwood] grove" at the Ventura River-San Antonio Creek confluence (Pollard 1969).

Fig. 4.18. Sycamore on island in the Ventura River, 1894. West of lower Ventura Avenue (and just above the persistent wetland riparian area at the river mouth), this small depiction shows a 24 inch diameter sycamore above the active channel of the river. (Barry 1894, courtesy of the Ventura County Surveyor's Office)

Seven sycamores from eight inches to three feet diameter were used as bearing trees by early surveyors, in addition to a cottonwood tree (30 inches in diameter) and live oaks (20-24 inches in diameter) (Barry 1897, Unknown ca. 1910c). Some sycamores (up to 24 inches in diameter) were found within the channel, suggesting relative stability of islands or other bottomland surfaces (fig. 4.18). In 1937, the channel south of the Casitas bridge was "heavily wooded with cottonwood trees and other growths

STEELHEAD ON THE VENTURA RIVER

The historical habitats of the Ventura River undoubtedly supported a wide variety of aquatic and terrestrial wildlife species, including some that currently have special status designations or are considered locally extirpated. This aspect of the region's historical ecology is not covered in the report (see box on the Santa Clara River, page 101, for more information).

However, given the regional importance of the Ventura River's historical steelhead and trout fishery, it must at least be noted here. Prior to the protracted drought of the late 1940s and the construction of Matilija Dam in 1948, the Ventura River system supported one of the most consistent, abundant runs of the federally endangered Southern California steelhead in the region (Ventura County Fish and Game Commission 1973, Capelli 1974, Capelli 2004, Boughton et al. 2006, Titus et al. 2010). Up to that time, the river supported an important recreational steelhead and trout fishery. In addition to the mainstem river, the estuary would have been important for rearing steelhead and providing habitat for other native fishes.

Numerous early accounts describe large quantities of steelhead and trout in the river. One of the Ventureño Chumash residents interviewed by John P. Harrington recalled in 1913 that formerly "the salmon were very numerous in the Ventura river," while traveler Alfred Robinson wrote that around 1829 "salmon of excellent quality are sometimes taken in the river" (Robinson [1846]1947, Harrington 1986b). Chase (1913) noted that "from May to October the breakfast tables of Ventura need never go troutless."

of that character" (Moore 1937). Additionally, the presence of scrub is documented by much later plant collections, in which two varieties of buckwheat (*Eriogonum fasciculatum* var. *foliolosum* and *E. cinereum*) were documented near Ortonville (Pollard 1961).

River Mouth

We mapped one persistent wetland riparian area on the Ventura River, at the river mouth. This area supported dense willow-cottonwood riparian forest, valley freshwater marsh, and tidal lagoons and marshes. It could be considered a subset of the broader Avenue/Casitas reach designation, highlighting a large area whose persistence is well documented by early sources. Like similar persistent wetland riparian areas on the Santa Clara River, it is large (over 200 acres), broad, and is documented to have persisted over time. Since portions of this grove were adjacent to the city of Ventura and visible to travelers passing through Ventura on their way up- or downcoast, there are multiple descriptions characterizing it. It is mentioned by explorer Crespí, who described in 1769 that "a great many trees are to be seen on this river bed, willows, cottonwoods, and live oaks (sycamores). There are vast numbers of rose bushes at this hollow" and six months later, in 1770: "a vast amount of willow trees, cottonwoods, and a few sycamores and live oaks" (Crespí and Brown 2001). Over 70 years later, GLO surveyor Norris (1853) noted a "willow swamp" in the area. Many other 19th and early 20th century accounts also refer to the willows at the river mouth, describing a river with "willow-fringed banks" (Darmoore 1873) and "willows festooned by wild grape vines and clematis" (Francis and Hobson 1912) that "creeps

Fig. 4.19. Willows on the Ventura River, 1877 (above). A subset of the forest depicted on the T-sheets is shown in this bird's-eye view lithograph. The view is looking northwest across the river and Main Street in the city of Ventura, drawn seven years after the T-sheet re-survey. It further confirms the presence of trees, although the area appears reduced from the initial T-sheet depictions. (Glover 1877, courtesy of the California Historical Society)

Fig. 4.20. Riparian forest at the mouth of the Ventura River, 1855 and 1870. While the initial survey of the Ventura River mouth by the U.S. Coast Survey (top right) provides evidence of the extent of willow-cottonwood forest at the mouth of the river, the re-survey 15 years later (bottom right) shows that, alhtough trees have been scoured near the main channel, the feature transcended the floods of 1861-2. Dense trees near the mouth of the river taper towards the northern edge of the map. (The freshwater wetland marking a former river route can be seen on the earlier map just north of the nascent city of San Buenaventura; it was almost completely gone by 1870.) (Johnson 1855c, Greenwell and Forney 1870; courtesy of NOAA)

lazily out from the grove of alders and willows" (Holder 1906). Early maps also show willows in the area (Leighton 1862, Everett n.d.).

The most persuasive evidence, however, comes from an early T-sheet and resurvey depicting vegetation at the river mouth (Johnson 1855c, Greenwell and Forney 1870; figs. 4.19, 4.20). Since these maps bracket the huge floods of 1861-2, they offer significant evidence of the feature's resilience over time. For a detailed discussion of more recent ecological characteristics of the Ventura River mouth and estuary, see Ferren et al. (1990).

Riverine transformation and synthesis

The Ventura River historically exhibited a diverse suite of ecological, hydrologic, and geomorphic characteristics. This section synthesizes the patterns documented in this chapter to provide a more integrative, visual understanding of riverine properties both longitudinally and through time (fig. 4.22). We also provide a summary of our findings and the implications of our research for management strategies in the watershed today.

We focus here on three sample reaches chosen to illustrate these concepts in cross-section: an upstream reach at Meiners Oaks (fig. 4.23), an intermediate reach at Casitas (fig. 4.24), and a lower reach near the river mouth (fig. 4.25). The transects and accompanying plan form representations illustrate the historical hydrology, morphology, and ecology of the river in these three very different locations in the 19th and early 20th centuries (1853-1903). We also produced cross-sections presenting conditions in these reaches during the mid-20th century (1927-1945) and early 21st century (2005) to depict the impacts of changing land use over this time. Taken together, these reaches represent a broad variability in vegetation and flow characteristics along the river.

We used a variety of historical sources to develop these cross-sections. Our own historical mapping, General Land Office survey notes, a U.S. Coast Survey T-sheet, and a county surveyor's map formed the backbone of our historical transects, and aerial imagery (from 1927, 1945, and 2005) were used to interpret land use changes, vegetation, and channel features on the intermediate and modern cross sections.

In the absence of historical elevational data, we used modern (2005) LiDAR data as the starting point for historical elevations and valley width, making adjustments as needed for the historical renderings (e.g., removing anachronistic road cuts and levees). As a result, the following cross-sections necessarily focus more on changes in floodplain extent and character than on changes in bed elevation.

While these cross sections are only a snapshot of patterns at narrow locations and points in time within the watershed, we believe they offer representative glimpses of temporal and spatial change in three different parts of the Ventura River. Bear in mind that they are purely conceptual in nature, and are not intended to represent exact landscape patterns (e.g., tree density or marsh extent).

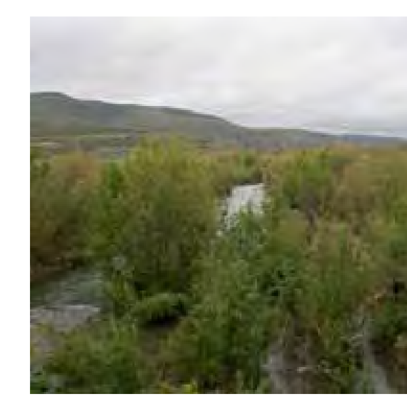


Fig. 4.21. Looking over the Ventura River from the Main Street bridge near its mouth, February 2011.

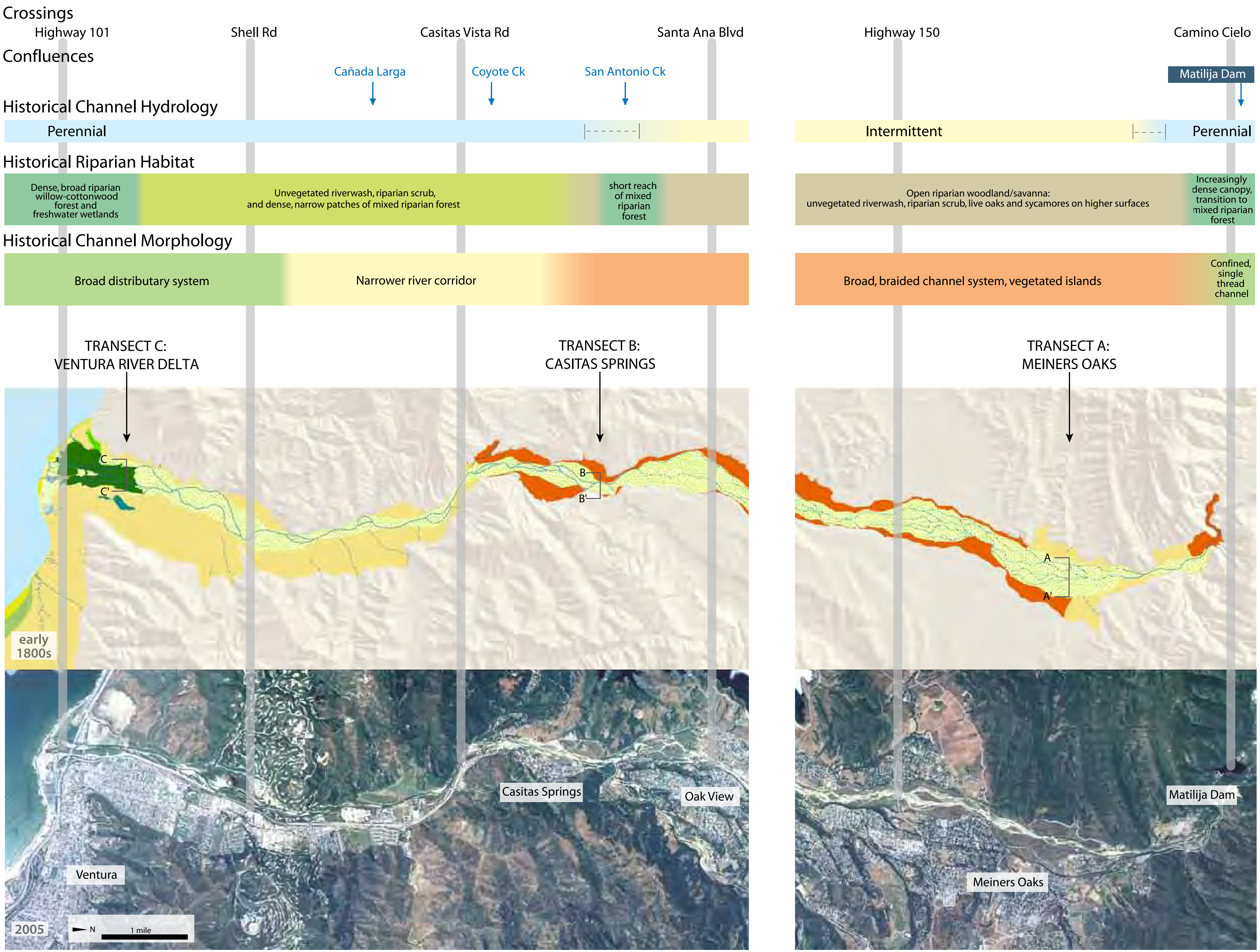


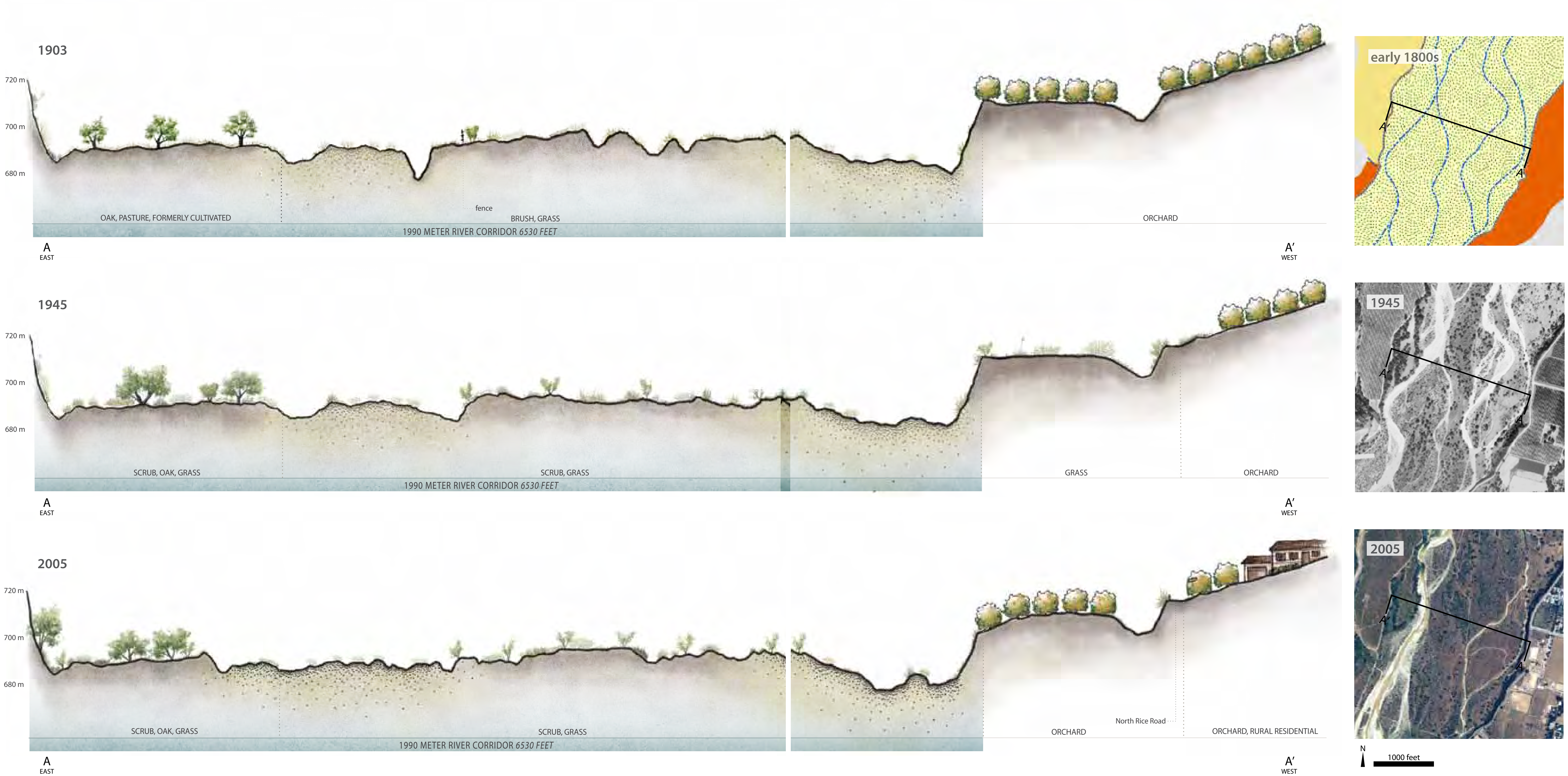
Figure 4.22. Historical characteristics of the Ventura River by reach. This diagram shows how fundamental attributes of the Ventura River varied by reach. The close relationships evident in this diagram between riverine hydrology, ecology, and morphology indicate the interrelated nature of these characteristics. Transitions between reaches were gradual, with variable locations through time. The locations of the three transects (following pages) are also indicated here.

MEINERS OAKS REACH

This reach is located near the town of Meiners Oaks, downstream from where the river exits its canyon and spreads out across the upper Ventura River valley. The area was historically characterized by a broad, braided channel with intermittent flow. Two maps from the turn of the century (1903) record the detailed vegetation (oaks, scrub, and grasses), topography, and braided channel patterns for this reach. At this time there were already multiple early uses of the river; the surveyors recorded orchards and cattle fences crossing the stream and describe in-channel areas as lands formerly used for grazing and cultivation.

By 1945, some of the orchards had been moved away from the river, though the overall character appears largely unchanged in the historical aerial. The same is true in 2005. This area is now part of the Ventura River/Rancho El Nido Preserve.

Fig. 4.23. Historical cross-sections at Meiners Oaks, 1903-2005. This time series shows the Ventura River just west of the town of Meiners Oaks, in a broad, braided section of the river about 2 miles north of the Highway 150 bridge. Broad patterns in river corridor width and ecology have remained remarkably consistent in this reach over time. Cross-sections are drawn with 5x vertical exaggeration. (Waud 1903 and Lippincott 1903, courtesy of the Museum of Ventura County; USDA 1945, courtesy of the UC Santa Barbara Map and Imagery Library; USDA 2005. Cross-sections produced by Jen Natali)

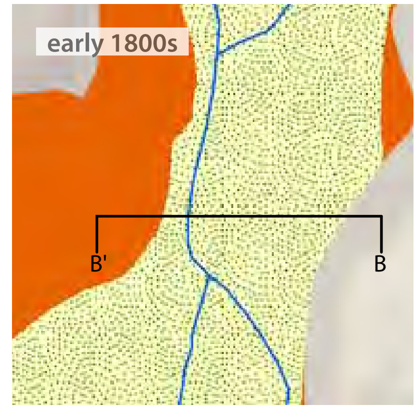


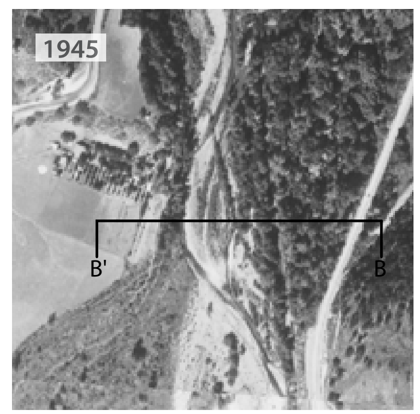
CASITAS REACH

This cross section is located between the present day towns of Oak View and Casitas Springs immediately downstream of the confluence with San Antonio Creek. The toes of two hills narrow the valley here, pinching the river slightly and narrowing the river corridor.

On August 3 and 4, 1877, surveyor W.H. Norway walked this transect; his survey forms the basis of the eariest cross section. Norway described the active channel as "riverwash" 460 feet wide, with a low-flow channel 16 feet wide carrying summer water toward the ocean. (This is especially notable given that 1877 was a severe drought year in the region.) On the eastern side of the river between the active channel and the hills, he noted "heavy oak & sycamore timber" on the "bottomland" surface. He also documented early modifications, including the wagon road connecting Ventura and Ojai and paralleling the river on the western side, and a fence separating agricultural fields from the river on the west bank.

Surprisingly, aerial photos from 1945 show evidently little change in riparian composition and river corridor extent from the snapshot provided by Norway in the late 1870s. The wagon road route remained, replaced by a branch line of the Southern Pacific Railroad. Broad, dense riparian forest still characterized the eastern bank. The most severe modifications occurred in the second half of the 20th century, when a levee on the west bank was constructed and the wagon road remnant transformed into several highways, including Highway 33 and the Ojai Valley Trail Road. Significant riparian forest (willows near the channel, and oaks and sycamores on the eastern floodplain) remains, though it is bisected by the Ojai Valley Trail and Highway 33.





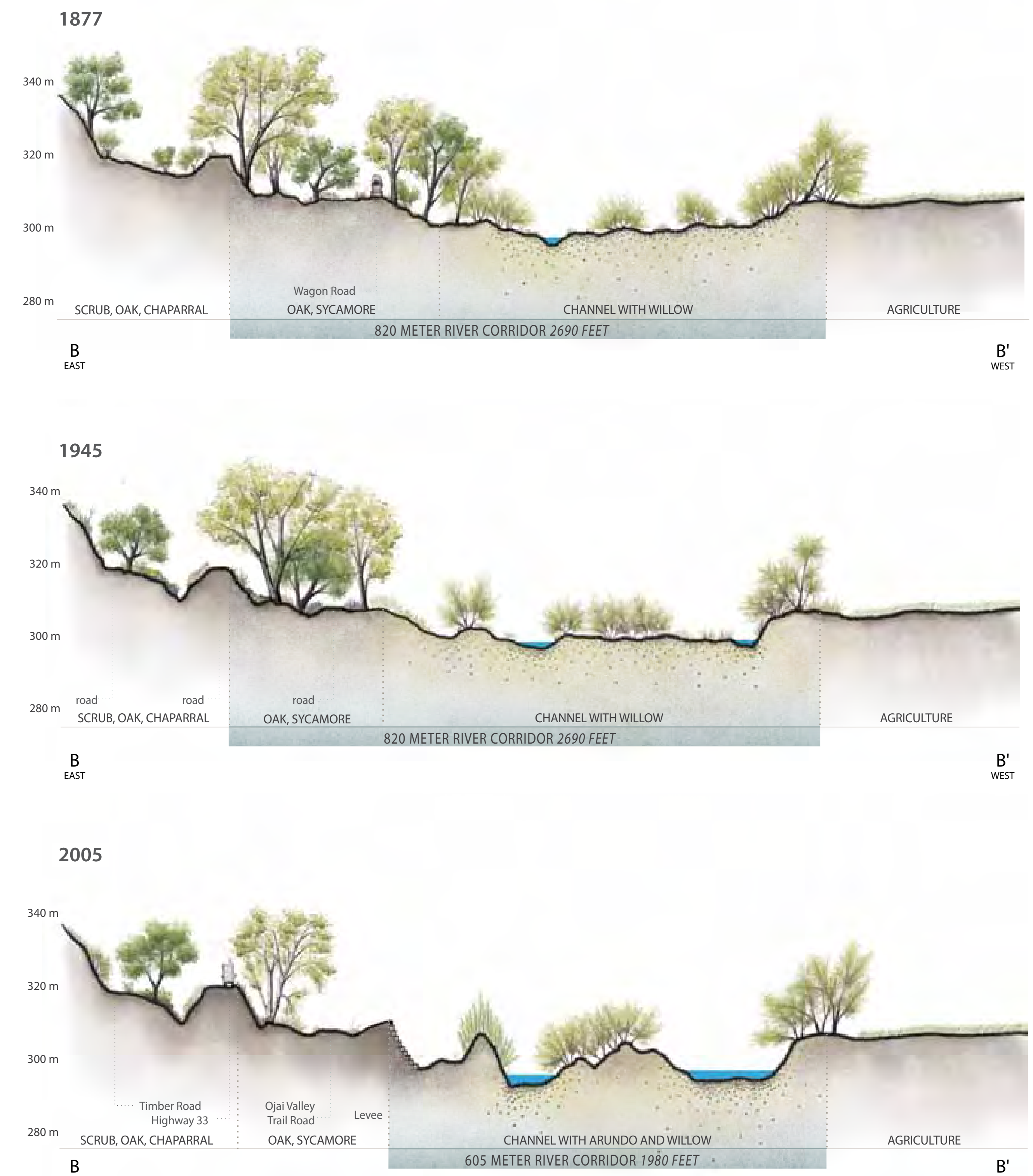


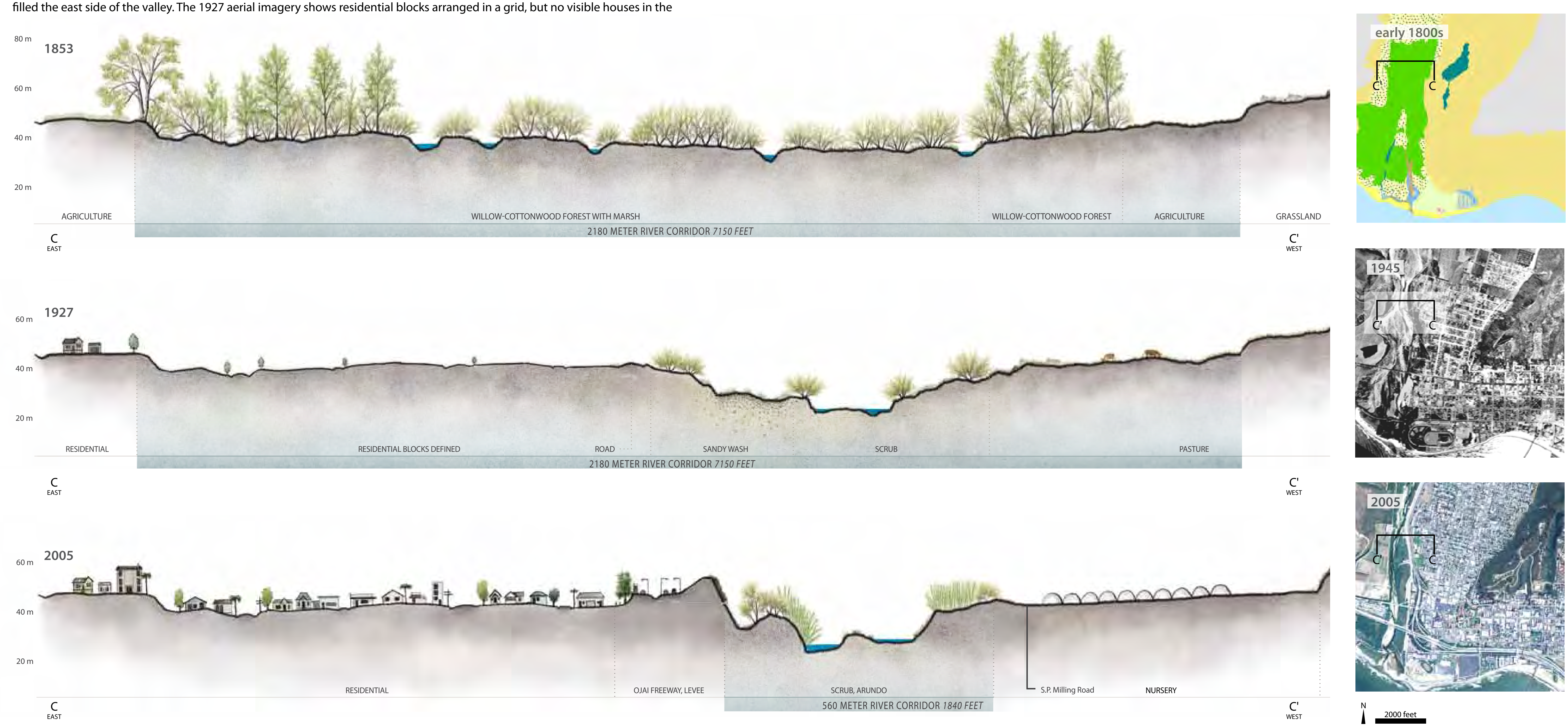
Fig. 4.24. Historical cross-sections at Casitas, 1877-2005. This series of cross-sections shows the Ventura River south of the San Antonio Creek confluence. The transect is in a reach with perennial flow, a relatively narrow river corridor (in comparison to other reaches of the river), and historically abundant live oak and sycamore. Like the Meiners Oaks reach to the north, this reach has retained many of its historical characteristics. Cross-sections are drawn with 5x vertical exaggeration. (Norway 1877; USDA 1945, courtesy of the UC Santa Barbara Map and Imagery Library; USDA 2005. Cross-sections produced by Jen Natali)

VENTURA RIVER DELTA

This cross section captures the dramatic changes over time at the mouth of the Ventura River, about ½ mile upstream of the current Highway 101 crossing. The T-sheet for this area, surveyed in summer 1855, depicts a broad (over 1.2 miles wide) river corridor dominated by interconnecting distributary channels and dense riparian forest. This is corroborated by a GLO survey conducted two years earlier in October 1853, when surveyor Robert Norris noted crossing four channels in the midst of what he termed a "willow swamp." Grassland and some early cultivation bounded the river in the "first rate land in bottom." The 1870 T-sheet resurvey confirms the continued presence of the riparian forest and marsh through the later 19th century (Greenwell and Forney 1870).

Between 1860 and 1930 the population of the city of San Buenaventura increased more than 18-fold, from around 600 residents to over 11,000. (From 1920 to 1930 alone the population of the city almost tripled; California State Department of Finance 2003.) Riparian forest area had severely decreased by 1927, and residential housing blocks encroached into the floodplain and filled the east side of the valley. The 1927 aerial imagery shows residential blocks arranged in a grid, but no visible houses in the river corridor. This may be a snapshot of a post-flood period of rebuilding, or it may be the beginning of a rapid urbanization of the lower watershed. By 2005, the city of Ventura had expanded fully into the floodplain of the river, fortified by a levee and bounded by the Ojai Freeway. *Arundo donax* has established on both sides of the narrowed river corridor; it was described as "well established for many miles along the river" as early as 1945 (Henry Pollard, in Ferren et al. 1990). Industrial agriculture and nurseries have replaced pasture on the west bank of the river.

Fig. 4.25. Historical cross-sections at the Ventura River mouth, 1853-2005. This time series shows the Ventura River at its mouth, about ½ mile upstream from the Highway 101 bridge. The area was dominated by broad willow-cottonwood forest and shallow, multi-thread distributary channels. By the early 20th century, the floodplain had been converted into a much narrower, leveed channel to make way for northward expansion from the town of Ventura. The earliest cross-section is derived from GLO notes and the mid-19th century T-sheet drawn of the river mouth by the U.S. Coast Survey. Cross-sections are drawn with 5x vertical exaggeration. (Norris 1853, Johnson 1855c, courtesy of the National Oceanographic and Atmospheric Administration; Fairchild Aerial Surveys 1927, courtesy of Whittier College; USDA 2005. Cross-sections produced by Jen Natali)



SUMMARY OF FINDINGS

The following findings represent some of the significant conclusions drawn from our research and analysis. Combined with an understanding of modern conditions, these findings can support scientists and managers working to identify restoration opportunities in the Ventura River valley. Further comparison with contemporary Ventura River corridor mapping may help identify and quantify changes over time.

1. **The historical Ventura River valley supported a diverse array of natural habitats,** including valley freshwater marsh, grassland, coastal sage scrub, oaks, and sycamores. While we were unable to map the valley floor in detail, our data indicate a broad transition from grassland in the lower valley (Avenue area) to predominantly oaks, sycamores, and scrub above Foster Park to Matilija Dam. As in the Santa Clara River valley, valley oaks were not documented anywhere in the valley. Only one wetland feature was documented on the valley floor within the study area (not including Mirror Lake).

2. **Most substantial freshwater wetland complexes occurred within the Ventura River corridor.** Aquatic habitats such as ponds, sloughs, and freshwater marshes were likely found in many perennial reaches, and a suite of saline and brackish aquatic habitats was associated with the estuary at the river mouth.

3. **The Ventura River supported a broad range of riparian species,** including trees such as sycamore, live oak, willow, cottonwood, box elder, alder, and walnut; understory species such as wild grape, wild rose, and wild blackberry; and mulefat and alluvial scrub species.

4. **Unlike on the Santa Clara River, live oaks and sycamores were common within the river corridor of the Ventura River.** While on the Santa Clara River live oaks and sycamores were almost exclusively found bordering the river's high (outer) bank, both trees were common on benches, bars, and islands in the Ventura River channel, particularly in the intermittent Oak View reach.

5. **The Ventura River mouth has shifted location numerous times over the past several hundred years,** from the hills west of the river mouth to Figueroa Street in Ventura. Many of these former river mouth areas are still susceptible to flooding. A brackish lagoon, formerly at the site of what is now the Derby Club across from Seaside Park, marked the route of one of these former river mouths.

6. **The Ventura River was generally perennial for much of its length.** The uppermost reach (below the present-day location of Matilija Dam) consistently supported year-round surface water, as did the lower half of the river (below the San Antonio Creek confluence). In contrast, the middle reach, through the western Ojai Valley and downstream of Oak View, was typically dry during the summer. The precise extent and location of summer water fluctuated in response to annual variations in rainfall and runoff.

Management Implications

- **Restoration of historical riparian habitats that have been degraded or eliminated should be considered.** Despite extensive modification, the Ventura River has retained significant habitat features, such as willow-cottonwood riparian forest remnants on the Ventura River delta and alluvial scrub in the intermittent reach near Oak View. Preservation of remnants such as these, which could serve as nodes for river restoration, is an important component of maintaining the ecological diversity of the river.

- **Riparian restoration goals should be reach-specific.** Each of the three reaches of the Ventura River we examined were characterized by different patterns of flow and riparian vegetation, providing valuable information on potential restoration targets that may be realistic for a given reach.

- **Maintaining the hydrologic heterogeneity of the Ventura River is an essential component of conserving ecological diversity.** Groundwater availability (and by extension, summer flow) is clearly a primary driver in the distribution and composition of riparian habitat.

Fig. 4.26. Ventura River at the Rancho El Nido Preserve, February 2011.

6 • VENTURA COUNTY SHORELINE

Where the plain meets the eastern mountain
is the Laguna Mugu, with extensive marshes and a low,
narrow sand beach, with a slight tidal opening
as if the [Santa Clara] river may at one time have
emptied here.

—DAVIDSON 1897

Introduction

Nineteenth century Ventura County exhibited a complex and heterogeneous shoreline, with a variety of habitats and morphologies associated with different estuarine and wetland systems and different formative processes (fig. 6.2). At the Ventura River mouth, willow-cottonwood forest transitioned into a small, intermittently closed lagoon, while a culturally significant beach-dammed freshwater wetland complex occupied a former river mouth to the east. A distinctive seasonal wetland area—the Pierpont lowlands—extended in a broad arc from Ventura to the Santa Clara River mouth, nearly connecting the eastern edge of the Ventura River corridor to the northwestern edge of the Santa Clara River (they were separated by less than one mile). Here sand dunes trapped Santa Clara River floodwaters and valley seepage in a recently prograded portion of the shoreline, creating a large area of seasonally inundated meadow. At the Santa Clara River mouth, willow swamps bordered a small seasonal estuary similar in form and function to the Ventura River delta (and including a freshwater wetland complex, McGrath Lake). To the south, a series of at least nine elongate lagoons—some brackish, some saline—incised the Oxnard Plain shoreline, marking former mouths of the meandering Santa Clara River. Usually blocked from the tides by substantial beaches and dunes, the water source for these lagoons was a varying mix of saline (through dune overwash and seepage) and fresh water (from precipitation, runoff, and springs). As a result, the lagoon complexes supported a gradient of heterogeneous habitats ranging from freshwater to brackish to saline, including vegetated marsh, salt flat, and open water. At the southern edge of the Oxnard Plain, Mugu Lagoon represented by far the largest coastal wetland system in the county, with extensive subtidal, tidal flat, tidal marsh, and salt flat habitat.

Recent research by Grossinger et al. (2011) puts these patterns within a Southern California regional context. The study examined these wetlands in the context of broader Southern California coastal wetlands, drawing conclusions about broad categories of estuarine systems in the region (see Grossinger et al. 2011 for more information). Ventura County historically represented at least three distinct estuarine habitat mosaics or archetypes: the compressed estuaries merging into broad riparian forest associated

Fig. 6.1. Mugu Lagoon from the east, 1923. This oblique aerial image of Mugu Lagoon shows habitats of the eastern arm of Mugu, including tidal flat, salt marsh, and the lagoon itself. The patterns shown bear a striking resemblance to those shown on the T-sheet, surveyed over 50 years earlier. (Harrington 1923a, courtesy of the Smithsonian Institution)

Fig. 6.2. Habitats of the Ventura County shoreline, early 1800s. At least three general types of coastal systems, or coastal archetypes, can be identified along the Ventura shoreline: freshwater-brackish estuaries associated with the Santa Clara and Ventura river mouths, dune-dammed non-tidal lagoon systems (with associated salt/brackish marsh and salt flats) marking former Santa Clara River mouths, and the large coastal wetland system at Point Mugu.

Coastal and Estuarine Habitats

- Ocean
- Beach
- Dune
- Tidal Lagoon (mostly open?)
- Tidal Lagoon (seasonally open)
- Non-Tidal Lagoon
- Tidal Flat
- Tidal Marsh
- Seasonally Tidal Marsh
- Salt/Brackish Marsh
- Salt Flat/Seasonal Pond/Marsh Panne
- High Marsh Transition Zone

Palustrine and Terrestrial Habitat

- Perennial Freshwater Pond
- Valley Freshwater Marsh
- Willow Thicket
- Wet Meadow
- Alkali Meadow
- Alkali Meadow/Flat
- Oaks and Sycamores
- Grassland/Coastal Sage Scrub

Characteristic Riparian Habitat

- Willow-Cottonwood Forested Wetland
- Other In-Channel Riparian

Hydrology

- Intermittent or Ephemeral
- Perennial
- Distributary
- Outer River Bank
- Spring

with the high-energy Ventura and Santa Clara river mouths and substantial freshwater influences; the distinctive Oxnard plain backbarrier lagoons associated with now-abandoned Santa Clara River mouths; and the large tidal wetland system at Mugu. These environments, exhibiting spatial and temporal variation in vegetation type, extent and duration of open water, salinity, and tidal connection, supported distinct mosaics of native species.

The following chapter provides a historical perspective on the patterns and characteristics of Ventura's coastal features, including the Ventura River delta, the Santa Clara River mouth, the county's backbarrier lagoons, and Mugu Lagoon.

Ventura River Delta

The Ventura River and floodplain empty into the ocean west of the city of Ventura. Historically, the estuary consisted of a large willow-cottonwood riparian forest with numerous distributary channels, a tidal lagoon and tidal flat, salt marsh, high marsh transition zone, and a number of small seasonal ponds within the marsh (fig. 6.3). Similar habitat patterns largely persisted on the T-sheet resurvey (Greenwell and Forney 1870). By the 1933 resurvey, however, most of the estuarine features were no longer depicted, including the former lagoons, marsh, and willow-cottonwood forest (Kelsh 1933a). Only limited trees (labeled "camping grounds in grove," south of the 1855 extent of forest) and salt marsh are depicted on this later survey.

The old Ventura canoe builders stored their canoes in the tule marsh at the mouth of the Ventura River. They cut and piled up tule stems so the canoe could rest out of the water, and bent the tule growing on both sides over the canoe as a sunshade. The tips of the tule stalks interlaced like the fingers of clasped hands, and a pole was laid on top to hold them in that position.

—TIMBROOK 2007

Apart from the T-sheets, there are limited data available describing the historical character of the Ventura River estuary. Ethnographer John P. Harrington's informants recalled tule marsh at the mouth of the river, where tule was collected and canoes were stored (Calendaria Valenzuela, in Hudson and Blackburn 1984; Timbrook 2007). These canoes were used on the lagoon at the Ventura River mouth (Simplicio Pico, in Hudson and Blackburn 1984). Wire rush (*Juncus balticus*) and Indian rush (*J. textilis*) were found in the sand dunes at the river mouth as well as "in the *montes*" and "at Sauzal," both designations that probably refer to the willow-cottonwood forest at the mouth (Blackburn 1963, Timbrook 2007).

Herbarium specimen records also describe the presence of this suite of marsh, flat, lagoon, and dune habitat at the Ventura River mouth, although most records are relatively late. The earliest collection, made by William Brewer in March 1861, describes the estuary and marsh as the "swamp by camp" (he collected distant phacelia [*Phacelia distans*]; Brewer [1930]1974).

Specimens collected in the dune community included marsh jaumea (*Jaumea carnosa*), beach saltbush (*Atriplex leucophylla*), California saltbush (*Atriplex californica*), branching phacelia (*Phacelia ramossissima*), Menzies' goldenbush (*Isocoma menziesii*), sawtooth goldenbush (*Hazardia squarrosa*), silver bur ragweed (*Ambrosia chamissonis*), pink sand verbena (*Abronia umbellata*), and red sand verbena (*A. maritima*) (Pollard 1945, Hagerty 1950, Pollard 1962, 1963b, 1964). A more detailed exploration of 20th century botanical specimens can be found in Ferren et al. (1990).

Fig. 6.3. Habitats of the Ventura River mouth, early 1800s. Extensive riparian willow-cottonwood forest and estuarine habitat characterized the Ventura River floodplain at its mouth.

Limited available evidence suggests that the Ventura River mouth did not close as regularly during the summer as did the Santa Clara River mouth, perhaps reflective of greater perennial flow in the lower reach in addition to lesser wave exposure. Based on the classification system of Jacobs et al. (2010), the river was a small to medium watershed in a prograding, low exposure (south facing) setting, with hydraulic estuarine formation, and would therefore be expected to be fully open or have subtidal closure more than half the time, with periodic closure up to and above high-high tide.

This analysis is supported by historical accounts. The earliest T-sheets for the two mouths, produced during the same year and the same (summer) season, show the Santa Clara River mouth separated from the ocean by a narrow barrier, while the lagoon at the Ventura River mouth maintained a narrow outlet. A GLO surveyor, surveying along the beach on July 1, 1869, noted crossing the "outlet of the mouth" of the river (Thompson 1869). The earliest evidence comes from the journal of explorer Juan Crespí in mid-August 1769 and May 1770. Crespí observed that the river "reached to the sea" in August, though at high tide there was no perceptible flow and an inlet was created (Crespí and Brown 2001). In May of the following year, however, his party was able to observe the river at low tide, and Crespí noted that "where we saw it the other time, it was not flowing but instead was ponded up and turning into an inlet; the tide was low this time, it was flowing almost as far as the very shore."

The mouth did close, though closure dynamics are uncertain and not well documented. Timing, duration, and frequency of closure would have likely varied with yearly oscillations in rainfall, as well as with anthropogenic changes in flow in the lower river over time. The only historical evidence found that directly addresses the question is a newspaper article from 1909, describing a season with abnormally high flow:

> The mouth of the Ventura river presents a sight more remarkable than for thirty years past. Indeed, not the oldest inhabitant can remember when it was just exactly as it is at present. There is a great volume of water still coming down from the mountains, and this is of a very beautiful dark green color. It has gathered in a great lagoon below the bridge, the lake presenting a frontage of almost a quarter of a mile to the ocean. Between the sea and the lagoon are piled up great masses of rock, of all sizes, tons and tons of it, and the waves run up on this at high tide, although they do not get over into the lake. The mouth of the river is at the extreme western point of the lake, a quarter of a mile further to the westward than it has ever been known to be…The stream shows small signs of closing up this summer, and very likely will not be closed. But if the lagoon remains as now, there will be plenty of duck shooting and lots of water for boating and for the boys to swim in. The lagoon in fact is deeper than it has been in years. The flood seems to have washed out the bed of the entire stream to an unparalleled depth below the old bed. (*Ventura Free Press* 1909b)

One notable feature in the Ventura River delta was a brackish lake to the west of the end of Figueroa Street. The lake marked a former outlet of the river, and covered about 2.5 acres of open water and 9 acres of marsh. This lake and former river mouth were also the site of a Chumash village, Mitsqanaqan. (See page 130 for more information on channel change at the mouth of the Ventura River.)

…there used to be a lake, but the lake is gone now. This was not an estero, nor did the water come from the river, but seeped in from sea through the sand.

—HARRINGTON 1913E

On the earliest (1855) T-sheet, the lake is shown occupying a low spot behind a narrow beach, not connected with the ocean and with substantial surrounding marsh (Johnson 1855c; fig. 6.4). It is documented similarly on the 1870 resurvey, though with a larger amount of open water adjacent to the beach. An unrelated survey from May 1868, however, shows a small lake with marsh in this vicinity with a clear connection to the ocean (Bard 1868). If this is indeed the same body of water, then the lake may have had at least an intermittent connection to the ocean.

The lake is vividly described by Chumash residents interviewed by John P. Harrington in the early 20th century. Though at the time they were interviewed the lake no longer existed, his informants recalled what it had been like decades earlier (fig. 6.5). The lake was called Tsikatskats (with variable spellings in Harrington's notes), which was translated by his informants as "sweet water running below," presumably referring to

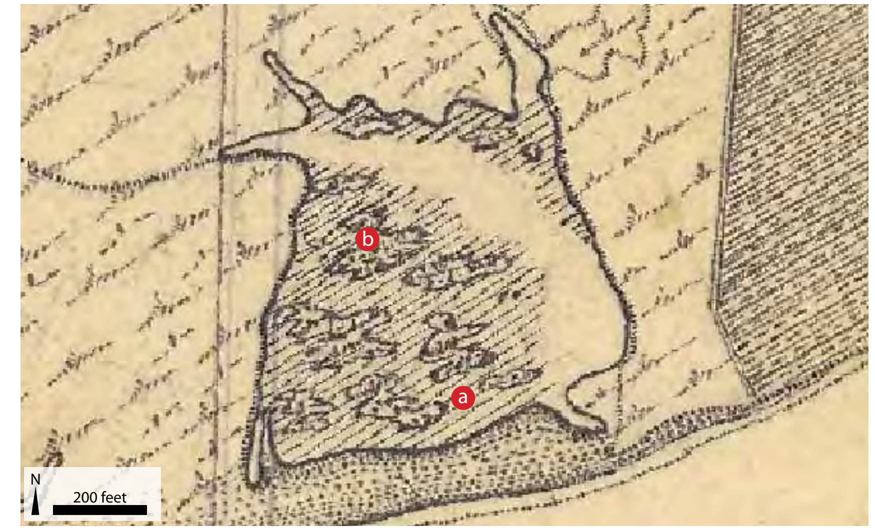


Fig. 6.4. Lake east of the Ventura River, 1855. This small brackish lake marked the easternmost extent of the historical Ventura River floodplain, and was surrounded by extensive tule marsh (shown by the closely spaced lines in the marsh on this map a). Though the symbol within the marsh is non-standard b, we interpret it to be patches of grassy cover, such as saltgrass or seasonally inundated meadow. (Johnson 1855c, courtesy of the National Oceanographic and Atmospheric Administration)

Fig. 6.5. Tsikatskats, the lake at the end of Figueroa Street. This photograph, taken in the fall of 1923, shows the remnant of what was once a well known brackish lake in the Ventura River floodplain. What are likely cattails (*Typha latifolia*) are visible in the foreground, along with stands of alkali bulrush (*Scirpus [Bolboschoenus] maritimus*) and bulrush/tule (*Scirpus [Schoenoplectus] californicus*; see particularly the matted vegetation to the right of the open water). Pickleweed (*Salicornia virginica*) dominates the foreground. (Harrington 1923b, courtesy of the Smithsonian Institution; plant interpretation, Baye pers. comm.)

Fig. 6.6. Two views looking across the city of Ventura to the shoreline. A circa 1875 image (top), taken from the hill behind Mission San Buenaventura facing southwest, shows the low floodplain area east of the Ventura River. A portion of what is likely Tsikatskats lake can be seen in the distance, at a. A nearly identical view (below), taken about eight years later, shows the same area in flood. What appears to be a small seasonal pond or panne, corresponding in shape to one depicted on the T-sheet 28 years earlier, can be seen at b. (This feature is visible on fig. 6.3 as the leftmost salt flat/seasonal pond/marsh panne, shown in pink.) (Unknown ca. 1875, Pierce ca. 1883; courtesy of the California Historical Society)

groundwater from the Ventura River found beneath an otherwise brackish lake (Harrington 1986a,b). It was described as a "pool of brackish water," surrounded by abundant tule (Harrington 1986b):

> The former lake situated where the pool of water is now situated, west of the lower end of Figueroa St. was called in V. tciqatcqatc, meaning "sweet water running below". There used to be much tule there where the tule is now. The lake was where the water is now. (Harrington 1986b)

The lake, only present as a small pond/slough complex in 1913 as described by Harrington's informants, was barely visible on the 1927 aerial imagery, and left unmapped on the 1933 T-sheet resurvey. The area, historically part of the Ventura River delta, continued to flood well into the 20th century (fig. 6.6). It has remained in relatively unintensive use even today (it is now the parking lot across from Seaside Park at the Derby Club).

Santa Clara River Mouth

The mouth of the Santa Clara River encompassed a diverse array of freshwater, brackish, and saline habitats. A seasonally open tidal lagoon, bordered by tidal marsh, formed the outlet of the river. To the north and south, alkaline/saline habitats (e.g., alkali meadows and salt flats) as well as abundant freshwater habitats (wet meadows, willow-cottonwood forests, and a freshwater lake and surrounding marsh) were also present (fig. 6.7 and 6.8). Under Jacobs et al.'s (2010) definitions, the Santa Clara River mouth regularly closed above high-high tide or perched, with seasonal breaching and opening to the subtidal level. This closure pattern reflects the river mouth's exposure to wave action in addition to freshwater inputs from the watershed.

> *I would state here that there is one peculiarity in the creeks and many of the rivers and small esteros on the southern coast of California, and that is that in the dry seasons the creeks and rivers sink before they get to the ocean, and their mouths are closed or filled up with drifting sand…*
>
> — UNKNOWN CA. 1869

The seasonality of the estuary is well documented by historical accounts. The earliest detailed depiction of the lagoon at the river mouth, surveyed during the 1855 summer field season, shows the lagoon separated from the sea by a narrow beach (Johnson 1855c). In a report associated with this survey, Johnson explains that though at the time of writing (October 1) the lagoon was not connected with the ocean, "after the rains of winter begin, it…has water enough to break through the narrow sand-beach at present separating it from the sea" (Johnson 1855a). A subsequent U.S. Coast Survey report supports this, stating that "in the rainy season a volume of water is brought down having sufficient force to break through the narrow sand beach and flow into the ocean" (*Daily Alta California* 1857; a direct quote from Davidson 1864). These descriptions are corroborated by other (albeit less precise) 19th century sources, which also describe a lagoon with "no visible communication with the sea, save when in winter the floods tear away the intervening wall of sand" (Thompson and West [1883]1961; see also Storke 1891) and a river "blocked up by sandhills in summer" (Cooper 1887).

Maps also support this variability: some cartographers showing the lagoon open to the ocean, while others show no connection. One early sketch shows a narrow "salt laguna" at the mouth of the river, with no connection to the ocean (Unknown ca. 1870). Another much later map also shows a large, disconnected lagoon (Farrell 1935). However, other maps show the lagoon with a clear tidal connection (e.g., Stow 1877, Schuyler 1900, Holmes and Mesmer 1901b, Kelsh 1933b; fig. 6.9). The earliest topographic quad and a historical soil survey contain an intermediate depiction, showing thin blue lines connecting the lagoon to the ocean (USGS 1904,

SUMMARY OF FINDINGS

The following points represent some of the significant findings from our research on the Ventura County shoreline. Along with an understanding of modern conditions, these findings can support scientists and managers working to identify restoration opportunities in these coastal systems.

1. **A diversity of coastal systems characterized the Ventura shoreline,** each with differing habitat patterns and hydrologic dynamics. The overall habitat distribution is well documented, though available historical sources only begin to indicate the range of coastal processes that created these patterns, from Mugu Lagoon to the backbarrier lagoons, dunes, salt flats, and tidal marshes of the Oxnard Plain.

2. **Coastal wetland habitats covered about 4,300 acres,** accounting for a large proportion of former Ventura County wetlands. Differences in freshwater input, extent of vegetative cover, and closure regime led to varying support functions for native fish and wildlife.

3. **Three distinct types of coastal estuarine systems characterized the Ventura County shoreline**: the freshwater-brackish, intermittently or seasonally closed estuaries of the Ventura and Santa Clara rivers; the non-tidal lagoon complexes marking former Santa Clara River mouths; and the large, more tidally-influenced wetland system at Mugu.

4. **The Ventura and Santa Clara River estuaries were periodically open to the Pacific Ocean**. Regular, seasonal cycles of closure were documented for the Santa Clara River mouth. The Ventura River mouth closed only occasionally (less frequently than the Santa Clara River), reflecting its greater historical volume of summer flow in the lowest reach, steeper channel gradient near the mouth, and lesser wave exposure.

5. **The estuaries of both rivers also shared similar habitat mosaics.** Both rivers had fairly compressed estuaries, with the relatively limited saline and brackish wetland habitat near their mouths bordered by extensive freshwater habitats, most notably the willow-cottonwood forest and wetland documented at both mouths.

6. **McGrath Lake is a regionally significant feature,** unique because of its persistence over the past centuries and its freshwater character. Though the lake has persisted, its location has shifted substantially since the mid-1850s; only a small portion of its current area overlaps with its historical extent.

7. **An extensive suite of marsh, salt flats/pannes, and lagoons stretched from south of the Santa Clara River to the western edge of Mugu Lagoon.** Prior to drainage and agricultural expansion, these systems were a significant component of the Ventura County shoreline. They exhibited a range of habitat patterns based on variable salinity gradients and hydrologic inputs, from the spring-fed brackish Laguna Hueneme to the hypersaline Salinas near Point Hueneme.

8. **Mugu Lagoon was the largest wetland complex in Ventura County, and the site of a broad range of coastal wetland habitats,** including salt and brackish marshes, large salt flats, and extensive tidal channel networks. Dominant habitat cover was tidal marsh. There is some indication that the complex formerly extended substantially further inland than currently recognized. Its acreage has been dramatically reduced.

9. **Salt flats and high marsh transition zone were major components of Mugu Lagoon.** These transitional, high elevation habitats were particularly characteristic of the semi-arid climatic setting (Ferren et al. 2007), and have been disproportionately lost from this system. These features likely provided breeding habitat for shorebirds such as least tern and snowy plover (as small present-day remnants still do), as well as an inland migration zone for tidal marsh transgression in response to naturally rising sea level in the past.

Management Implications

- **The preponderance of closed conditions in most lagoons along the Oxnard Plain suggests strategies for habitat rehabilitation in these areas.** Efforts to restore coastal lagoon functions in these areas, for example at Ormond Beach, should consider these historical dynamics in restoration design. Current physical conditions at these sites (e.g., barrier dunes, small watersheds) may not reliably support open marine conditions without regular maintenance, but could potentially provide support functions for a range of native species. Restoration activities could also enhance the ecological functions of existing features. For example, the lagoon at Ormond Beach, though formed at a different location than historical features, currently exhibits similar closure dynamics. Sustaining and augmenting the geomorphic and ecological functions of this feature is an important restoration consideration.

- **Coastal lagoon complexes with high salinity levels and extensive surrounding salt marsh and salt flat were a significant component of the historical Ventura County shoreline.** These complexes, which occurred in areas with extremely small watersheds and limited freshwater input, may be under-represented in Southern California today.

- **Conversely, brackish-freshwater conditions maintained in some coastal complexes may be considered a significant component of coastal habitat restoration strategy.** While most coastal habitats historically exhibited high salinity levels, a few places maintained fresh-brackish conditions. In particular, the Santa Clara and Ventura river mouths and spring-fed lagoons such as Laguna Hueneme were less saline than surrounding systems. Maintenance of contemporary freshwater sources should be considered to restore or maintain such environments, with adequate consideration of water quality concerns.

- **Re-establishing transitional habitats at Mugu Lagoon is an important component of habitat restoration, and may be of regional significance.** Mugu Lagoon is recognized as the biggest coastal wetland complex in Southern California, yet it has lost much of its habitat area, particularly on its landward edge. High marsh ecotone, a transitional habitat between tidal marsh and alkali meadow, was a significant component of Mugu Lagoon and accounted for much of the region's wetland area. Re-establishing portions of this ecotone may be an important component of the lagoon's future persistence and resilience, and could provide room for inland migration in response to sea level rise. This is one of the few places where this is possible in Southern California.

- **Consideration should be given to potential brackish marsh areas within Mugu Lagoon.** Rush stands documented at the northern edge of the complex may have been important historically for light-footed clapper rail, as they are today. Expansion of this habitat may be an important part of species recovery and enhancement plans.

Fig. 6.29. San Jon Road at Highway 101, looking west. Areas of the Pierpont lowland are still susceptible to flooding, as shown in this December 2008 photograph.

RECOMMENDED FUTURE RESEARCH

This study documents historical landscape patterns of the Santa Clara and Ventura river valleys, the Oxnard Plain, and the Ventura County shoreline prior to major Euro-American modification. In particular, it focuses on former habitat distribution, riverine character and processes, and riparian ecology in each of these areas. However, there are a number of additional research directions that would enrich our understanding of the historical landscape and enhance our ability to apply these findings to current local management.

Additional geographic areas of interest

This research focused on the Ventura County portion of the Santa Clara River and valley, with limited investigation on upper (Los Angeles County) river reaches. Additional data on the upper river undoubtedly exists in Los Angeles County archives not visited during the course of this project, such as the Santa Clarita Valley Historical Society, the Los Angeles Public Library, the Braun Research Library, the Los Angeles County Surveyor's Office, and the Los Angeles County Assessor's Office. A more detailed understanding of this portion of the river, in conjunction with other studies (e.g., Stillwater Sciences 2011), would provide insight into the historical hydrogeomorphic processes and riparian patterns across the entire river.

The study area also excluded a few adjacent areas of possible interest. These include the Ojai Valley east of the Ventura River, and the Santa Rosa Valley and Conejo Valley/Thousand Oaks area east of the Oxnard Plain. In addition, while the lowest reaches of major tributaries to the Santa Clara River were included within the study area, they were not the focus of our research. Subsequent data collection and analysis efforts could reveal more details on the historical dynamics of these systems, in particular Santa Paula, Sespe, and Piru creeks.

Future research directions

Though this study covers many aspects of the Ventura County historical landscape, it is not comprehensive. A number of additional topics merit further research, and would contribute to a better understanding of ecological and hydrogeomorphic pattern, process, and function in the region. While we performed limited analysis of historical botanical and ornithological records, the voluminous available data merit more substantial analysis. In addition, we did not explore historical faunal records. A detailed analysis of these wildlife records by regional experts may support interpretation of historical habitats and linkages with species support functions, which is for the most part not covered in this report. This is particularly true for native fisheries use of Ventura County streams.

Future research into processes and dynamics that shaped the historical ecological landscape would further develop our understanding of former conditions. For example, more in-depth investigations of the history of invasive species introduction (such as *Arundo donax*), fire ecology, historical grazing impacts, and Chumash land management would provide important context for interpreting historical conditions.

In addition, future research may further elucidate historical trends and characteristics outlined here. Interviews with long-time county residents would deepen our understanding of local environmental change and persistence. Scientific studies using geoarchaeology, coring, remote sensing, and other techniques could also add additional detail to this picture of early conditions. More extensive field-based assessment of the findings outlined here would also be useful.

Application of report findings

The research presented in this report provides the foundation for supporting local and regional environmental management with detailed historical data. However, the historical record alone is insufficient to apply these findings on the ground. This research must be integrated with contemporary assessments of physical and biological conditions to develop practical, place-specific conservation strategies for use by local organizations. For example, the management implications explored here for floodplain and riparian restoration need to undergo feasibility analysis before application to particular sites. Partnerships between local residents, managers, and scientists is a crucial component of determining how and where to apply these data.

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