The Urban Mariner

Sea Grant
University of Southern California

Spring 2018

San Elijo Wetlands in San Diego County. Credit: Urban Tides Initiative

Wetlands: Then, Now and for How Long?

Management and restoration of wetlands must occur with both an understanding of the past and a prediction of the future

When you need to contemplate something important, you walk along the beach, or spend a weekend in the mountains, or a week in the desert. You don't tell your family and friends that you are going for a stroll in the marsh or a weekend in the slough. You don't clear your mind in the floodplain. Wetlands clearly do not have the obvious majesty or romanticism of many of Southern California's other natural habitats; however, wetlands are one of the most important habitats in Southern California, affecting everything from water quality to flood control, to the health of fish and the ecosystem as a whole.

USC Sea Grant has a long history of funding research on Southern California's wetlands. Research from the past focused primarily on the historical ecology of wetlands—their composition and distribution before anthropogenic disturbance, as well as how they changed or were lost up to the present day. Current research often focuses on developing restoration plans that are appropriate in the face of a quickly changing climate and a highly urbanized coastline. Let's revisit some of the highlights of USC Sea Grant's wetland research over the last decade as well as new research that is shaping the future of wetlands, and perhaps we can convince you to take your next stroll… in the lowlands.

In this Issue

1
Wetlands: Then, Now and for How Long?

5
Wetlands Research Projects

10
Living Shorelines

11
Wetlands Education

The Vocabulary of Wetlands

According to the US Environmental Protection Agency, "wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season." According to NOAA, there are five general types of wetlands: marine (ocean), estuarine (estuary), riverine (river), lacustrine (lake), and palustrine (marsh).

In Southern California, common names for wetlands include: floodplains, alkali meadows, willow woodlands, alluvial scrub, high marshes, ponds, freshwater sloughs, tidal marshes, salt marshes, estuaries, salt or mud flats, lagoons, and even beach dunes.

Wetlands serve many ecosystem functions, including acting as water filters for sediment, nutrients, and pollutants, providing flood and erosion control by absorbing excess water, and providing food and homes for fish and wildlife.

For more information, here is a one minute NOAA video on wetlands:
https://oceanservice.noaa.gov/facts/wetland.html

An Historic Loss

Almost a decade ago, USC Sea Grant funded Dr. Eric Stein of the Southern California Coastal Water Research Project and Dr. Travis Longcore of the USC Spatial Sciences Institute and USC School of Architecture to use historical ecology as a tool to asses the extent of change of the wetland landscape in Southern California. People knew that wetlands had been filled in as the coastline was urbanized during the 20th century, but no one knew the full extent of the change. In fact, the widely held view of Southern California as a mainly dry, desert-like landscape seems to be inaccurate based on Stein and Longcore's findings.

Stein and Longcore found that up until 1870, one of Los Angeles' main watersheds—the San Gabriel—supported ponds, sloughs, seeps, marshes and a wide and fluctuating floodplain that often intersected the floodplain of the Los Angeles River. Between 1870 and the present day, approximately 86% of historical wetlands were lost in this area (Stein et al., 2010). Stein and Longcore's historical

Between 1870 and the present day, about 86% of historical wetlands were lost

Los Angeles River at 12th Street. Credit: Sea Lab

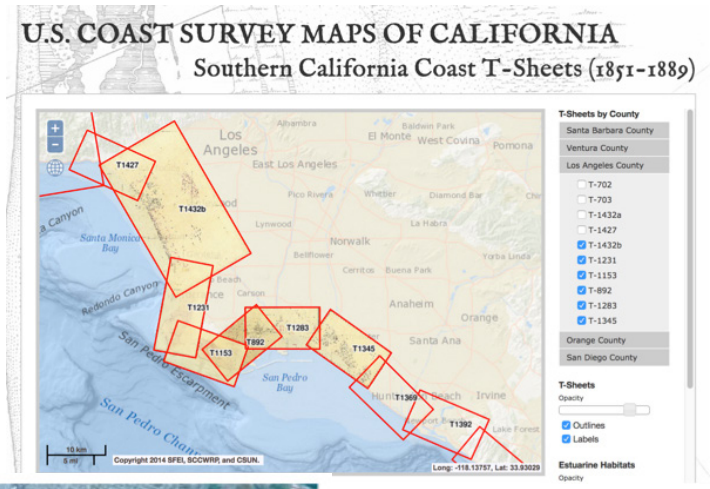
analysis entailed the complex process of weaving together multiple data sources to ensure a high degree of confidence in the geography. Primary data sources covered the time period of 1769-1930 and included: Mexican land grant sketches; General Land Office surveys; irrigation maps and reports from 1886 and 1888 from California's first State Engineer (W.H. Hall); the USDA Reconnaissance Soil Survey and Report of 1917; an 1893 USGS topographic map; aerial photographs taken in 1928; collections of essays and letters prior to and at the time of European contact; a collection of oral histories in 1915 by Los Angeles County flood engineer, James W. Reagan; and herbaria records. All of these data sources were georeferenced and "translated" into ArcGIS layers, allowing for detailed, high-resolution comparisons and analysis via computer.

Unlike the highly-engineered, straightened concrete channel through which the San Gabriel River flows today, the San Gabriel River of the past was a dynamic, snake-like river that changed its alignment four times between 1825 and 1912. It transitioned from being a tributary of the Los Angeles River to forging its own riverine path, complete with its own outlet to San Pedro Bay. During that time of transition, there are records of significant flooding, sometimes uniting the floodplains of the two major rivers, resulting in a diverse wetland mosaic of alkali meadows, wet meadows, alluvial scrub, spring wetlands, secondary channels, perennial freshwater ponds, and riparian habitat.

Below: An example of layers showing the original T-sheet with the overlay of the historical extent of wetlands, and the layer showing the modern landscape and development.

According to the study, wetlands accounted for almost 74 square miles of the San Gabriel watershed in 1870. Now, wetlands account for only about 10 square miles of this landscape, replaced with the highly urbanized, densely-populated cities such as Azusa, Arcadia, Baldwin Park, Rosemead, Commerce, Whittier, Norwalk, Downey, Bell Gardens, Lakewood, Bellflower, Cerritos, Paramount, Los Alamitos, and Long Beach. Extensive groundwater extraction in the early 20th century, the concrete channelization of the San Gabriel River between 1914-1935, and general urbanization and industrialization, resulted in the dramatic loss of wetlands in this area over the last 140 years.

Subsequently, Stein and Longcore and their team expanded their historical ecology analysis of wetlands to include the entire Southern California Bight (Point Conception in Santa Barbara to the US-Mexico Border.) The study used similar data analysis with ARC GIS, but this time they also had U.S. Coast and Geodetic Survey topographic sheets (T-sheets) produced between 1851 and 1889. According to the team, these T-sheets are the "most important single source for understanding the physical and ecological characteristics of the US shoreline prior to Euro-American modification" (SCCWRP Technical Report 826).



Above: The T-Sheets used in this study are accessible to the public online, and opacity layers are available to see the historical extent of the wetlands compared to what is there now. (http://www.caltsheets.org/)

The entire Southern California Bight is mapped by 40 T-sheets, depicting 331 estuarine systems, totaling about 76 acres. Since 1850, there has been an overall loss of 48% of these historical estuarine habitats, with numbers higher or lower in different coastal counties. The T-sheets are available publically online (http://www.caltsheets.org/) and different opacity layers are available to be able to see the historical extent and type of wetlands in a given area, as well as the current development and landscape in those wetland areas today. In Los Angeles, major historical coastal estuarine systems included Malibu Lagoon, Ballona Wetlands, and the Los Angeles and Long Beach Harbor areas. As expected, the historical extent and diversity of wetland habitats in these areas are drastically reduced today, replaced by urban and industrial development.

The Lessons of the Past

So what do we do now? Historical ecology of wetlands has informed us of the extent of wetlands before watershed modifications and urbanization. Now we realize how geographically sparse and constrained wetlands are today. However, even if the will and funding were there, the complete restoration of all wetlands of the past is impossible. In most cases, the land is now gone. The morphology and hydrodynamics of the region has drastically and permanently changed.

But the lessons of the past are still valuable. The past can teach us about how wetlands naturally function, how many of them form larger interconnected systems, and what ecosystem services have now been lost in certain areas of Southern California. These facts, in turn, can help influence what types of wetlands are necessary in certain areas, what restored systems should look like, and even give us a healthy perspective on the value of the wetlands we have restored. In many cases, these restorations are costly, but perhaps with the historical perspective of the extensive wetland loss, communities will feel better about the funding they have put into small-scale restorations.

Furthermore, in a world where the climate is changing quickly, wetlands now face new threats, including drought, extreme storm events, and sea level rise. Management and restoration of wetlands must occur with both an understanding of the past and a prediction of the future, and USC Sea Grant has recently funded a number of studies that address the future of wetlands in Southern California.

Elevated water levels at Malibu Lagoon during a 2016 king tide flood a walking path.
Credit: Urban Tides Initiative/ Kurt Holland

Wetlands Research: Projects Funded by USC Sea Grant

1 Sea level rise vulnerability assessment helps improve climate-smart wetland restoration

PIs: Cheryl Doughty, UCLA; Kyle Cavanaugh, UCLA; Richard Ambrose, UCLA; Eric Stein, SCCWRP

USC Sea Grant recently funded a project that evaluated and modeled 104 wetland systems throughout the Southern California Bight, which range in size, structure, and initial habitat composition. The project analyzed sea level rise, vertical land motion, marsh accretion, and estuarine mouth dynamics; and created a model that allows predictions in future wetland changes in elevation and inundation and predictions of impacts to habitat composition.

The model results show that for a 2050 sea level rise (SLR) scenario, 35% of the systems are vulnerable; and for a 2100 SLR scenario, 68% of the systems are vulnerable. The most vulnerable systems for 2050 are the large perennially open lagoons, indicating that there is a great risk for drastic conversion of marsh habitats to subtidal and mudflat habitats. By 2100, the small creeks and small lagoons also will be among the most vulnerable systems. The highest concentration of vulnerable sites is in Santa Barbara County.

This regional vulnerability model provides a platform to prioritize future work based on greatest vulnerabilities. There are a number of management strategies that can be incorporated into the model, and 18 agencies across California already are using the model results.

For more information: http://dornsife.usc.edu/uscseagrant/stein-ambrose-2015/

Bolsa Chica Wetlands in Orange County. Credit: Gwen Noda

2 Movement patterns of fish through culvert inform restoration plans for 18-acre urban lagoon

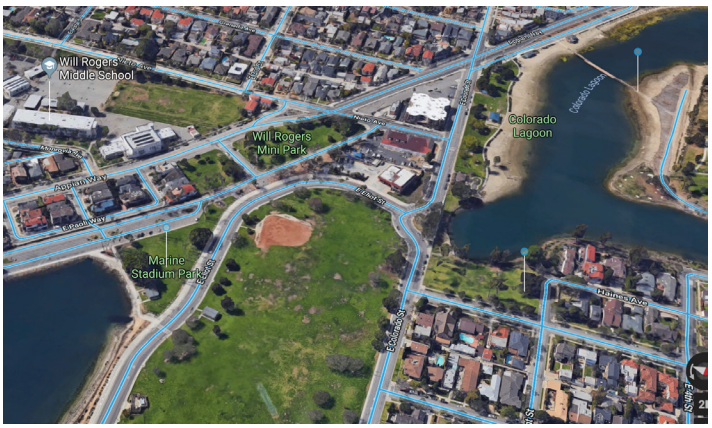
PIs: Christine Whitcraft, CSU Long Beach; Christopher Lowe, CSU Long Beach

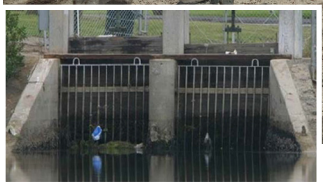
Concrete box culverts that connect ocean water to coastal wetlands and lagoons can be found in many habitats along Southern California's urban coastline. These culverts—tunnel structures that allow water to flow under a road or soil—are, in some cases, the last effort to maintain wetland-system connectivity to the ocean on a highly urbanized and concrete coastline. However, there are few studies that have investigated the effects of culverts on fish movements in the marine environment. Understanding their effects on marine life is vital in maintaining or improving these sensitive wildlife habitats, which have diminished greatly in this region.

USC Sea Grant funded a study on what drives fish movements in a large 268-meter culvert that runs under a park between Alamitos Bay and the 18-acre Colorado Lagoon in Long Beach. The study results show that habitat quality factors such as food availability and water temperature are not driving movements of the fish between the lagoon and the bay by way of the culvert. Rather, a fish's ability to transit the culvert, which may include their size and swimming ability, is driving their movements. Movement patterns showed that many fish were able to move quite freely between both sites and it was noted that the grates, and not the culvert itself, are likely limiting movements of larger fish.

This study was shared with the City of Long Beach and has helped guide decisions about ongoing restoration plans for the Colorado Lagoon. More broadly, study results help us understand the functional recovery of estuaries and improvements for fish from culvert removal.

For more information: http://dornsife.usc.edu/uscseagrant/whitcraft-and-lowe/





Clockwise from top: Google map showing location of culvert between Los Alamitos Bay and Colorado Lagoon in Long Beach; concrete box culvert connecting Colorado Lagoon with Los Alamitos Bay (credit: Urban Tides and Whitcraft Lab); google map street view of Colorado Lagoon.

3 First database of Los Angeles stormwater biofilters and their ecosystem services

PI: Lisa Levin, Scripps Institution of Oceanography, UC San Diego

The last 140 years of urbanization in Southern California has created a hard-surfaced watershed that jet-propels water run-off toward the ocean. This water carries sediments and contaminants derived from residential and commercial activity, which have a significant impact on coastal water quality and marine life. One emerging solution in Southern California is to encourage man-made biofilters—areas of permeable surface, ideally with plants—which can provide many of the same ecosystem services that wetlands used to provide (e.g., water retention, plant uptake of nutrients, breakdown of contaminants by microorganisms in the soil). In a way, they are like mini man-made wetlands. These biofilters can help treat urban runoff before it reaches the ocean and even augment municipal water supply.

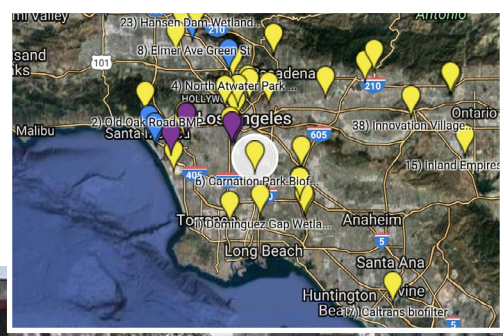
However, there were no comprehensive lists of where biofilters were currently being used, quantifications of their ecological attributes, or monetary valuation of ecosystem services provided by these systems.

This project generated a lengthy list and interactive map of Los Angeles region biofilters that can be used as the basis of applied research by regulators, industry, or academia. The map and database include: the locations of existing biofilters in Los Angeles; their linkage to the ocean; the configurations and construction designs (bioretention vs. biofiltration); their effects on surrounding plant and animal ecology; and an analysis of the ecosystem services (e.g. water supply, flood control, contaminant removal, biodiversity, pollination, climate regulation, education, recreation, aesthetics) that are provided by the biofilters. This project provided the first look at biofilters from an ecosystem services perspective, providing the groundwork for monetary valuation of biofilter ecosystem services, information that could be very persuasive for the adoption and implementation of low impact development plans for jurisdictions.

For more information: http://dornsife.usc.edu/uscseagrant/levin-2015/

Left: The project's interactive map of Los Angeles area biofilters: https://goo.gl/76sswN

Below: Carnation Park biofilter in Lynwood is designed to capture and treat urban stormwater before it enters the Los Angeles River. Credit: Google maps



4 How will Southern California lagoons respond to large storms and sea level rise?

PIs: Sarah N. Giddings, UC San Diego, Scripps Institution of Oceanography; Geno Pawlak, UC San Diego, Dept. of Mechanical and Aerospace Engineering

USC Sea Grant is funding a study in San Diego to evaluate the ability of different types of estuaries (marsh vs. embayment) to deal with sediment transport and blockage during large storm events, which have been—and will continue to become—more common with climate change and rising sea levels. Estuary blockage can lead to a lack of water circulation, a lack of oxygen (hypoxia), and even mortality of plants and animals within the lagoon. The project is using a host of techniques including hydrographic transects that study the flow and depth of water, sediment sampling, and aerial surveys to assess the seafloor topography and hydrology of these estuaries.

The goal of this study is to be able to use these observations to make predictions about the response of these types of estuaries to future conditions, including sea level rise. This information can assist managers in planning dredging operations prior to large storms and in adopting coastal resiliency programs. Progess is ongoing and we look forward to reporting project results soon.

For more information: http://dornsife.usc.edu/uscseagrant/giddings-2016/

Above and below: Researchers conduct surveys and deploy sensors during research at Los Peñasquitos Lagoon in San Diego County. Credit: Sarah Giddings Lab

5 Improving oyster reef success in living shoreline restoration projects

PIs: Erika Holland, CSU Long Beach; Christine Whitcraft, CSU Long Beach

In California alone, only 10% of estuarine, or coastal wetland, environments remain and this habitat is particularly degraded near more urbanized areas of the state. Estuaries and vegetated habitats along the shoreline provide a wide range of ecosystem services including reduced shoreline erosion, increased habitat for important species, and recreational areas for human use.

One estuarine habitat that has been degraded is Upper Newport Bay, a 1000-acre section of Newport Bay. Restoration projects are underway including the introduction of living shorelines at four locations. The living shorelines include transplanted eelgrass and oyster shell to promote oyster bed development. Living shorelines that include oyster beds are arising as important restoration models in urban estuaries. This approach is relatively new, especially on the west coast, and questions remain regarding the optimal conditions for oyster bed creation.

This project aims to inform restoration efforts for the native Olympia oyster, which previously supported the west coast oyster fisheries. Research will evaluate whether living shoreline plot parameters, such as construction with or without eelgrass, together with changes in water quality and surrounding contaminant loads affect oyster health. The goal is to establish what factors may contribute to oyster bed success or potential failure.

Researchers will conduct analysis on native Olympia oyster (*Ostrea lurida*) and the non-native Pacific oyster (*Crassostrea gigas*) using a technique called transcriptomics, a type of analysis that identifies how genes respond to different environmental factors. This technique will be used to match oyster stress to environmental parameters thereby identifying potential conditions stressful for the oyster species.

The data will then be mapped to Upper Newport Bay living shoreline sites, bed plot design, contaminants and other environmental variables to evaluate their combined impacts on oyster success and health within the restoration project. Results will inform local agencies involved in Upper Newport Bay restoration efforts.

For more information: http://dornsife.usc.edu/uscseagrant/oyster-reefs-newport-bay-holland/

View of Upper Newport Bay in Orange County. Credit: Gayle Rindge

Living Shorelines and Resilience in Southern California

Workshop series summary report

How do you design living shoreline projects and monitor for resilience? USC Sea Grant participated in a series of workshops in Summer and Fall 2017 to advance local dialogue around using living shorelines to increase community resilience to coastal hazards. The Living Shorelines and Resilience in Southern California workshops were coordinated by the Greater San Diego Resilient Coastlines Project.

Focusing on the unique benefits, challenges, and opportunities in the southern California region, the workshops engaged a range of community planners, scientists, and stakeholders. It was the first ever opportunity to come together and learn about the connections between local climate adaptation planning, science, policy, and nature-based solutions, such as living shorelines. Living shorelines are a relatively new approach in California. Projects will need both robust monitoring to determine success and support from the public.

Discussions explored key questions such as:

- In our highly urbanized environment, where is there room for living shorelines?
- If a project has both hardened and living components, is it considered a living shoreline?
- What physical, biological, cultural, and community aspects must be considered to plan, implement, and monitor a living shoreline in Southern California?

Key themes from the workshops included:

- Public access and project success;
- Living shorelines and phased sea level rise planning;
- Citizen science and socio-ecological monitoring;
- Exploring commercial opportunities; and
- Permitting pathways to support demonstration projects.

View report, key themes, presentations, and additional resources here: http://www.resilientcoastlines.org/livingshorelines

View of sand dunes in Newport Beach, part of a living shoreline restoration project. Credit: Gayle Rindge

Urban Wetlands Education

Wetlands serve as a link between land and water and they are a perfect outdoor classroom to illustrate the link between humans and the natural environment: from water quality and sea level rise; to invasive species and habitat restoration. Several of USC Sea Grant's education initiatives include wetlands as a core unit of exploration and community engagement. We work to integrate wetlands research into educator workshops, public presentations, and student and family programs.

The Los Angeles Coastal California Naturalist training course, for volunteer naturalists and citizen scientists, explores wetlands, watersheds, and water resources in depth. Through fieldwork and classroom activities, the program brings together traditional and scientific knowledge to foster effective interpretive programs and prepares volunteers to take an active role in natural resource conservation, education, and restoration.

The Los Angeles Coastal California Naturalist class observes harlequin bugs on bladderpods at the Bolsa Chica Wetlands. Credit: Linda Chilton

Learn more here: http://dornsife.usc.edu/uscseagrant/la-coastal-ca-naturalist/

About USC Sea Grant

USC Sea Grant contributes to solving the problems of the Urban Ocean, while recognizing the opportunities for coastal commerce, recreation, and improving the quality of life in coastal regions. USC Sea Grant has served Southern California since 1972, funding research, communicating research results to government agencies and community stakeholders, and providing information about marine resources, recreation, and education to the public. We are one of 33 Sea Grant programs in coastal and Great Lake states administered through the National Oceanic and Atmospheric Administration (NOAA).

This Urban Mariner is written by Charlotte Stevenson with editorial assistance from Holly Rindge and Phyllis Grifman.

USC Sea Grant Contact Information
seagrant@usc.edu | 213.740.1961

http://dornsifecms.usc.edu/uscseagrant

http://dornsife.usc.edu/uscseagrant/urban-mariner/

USC Sea Grant Staff

Linda Duguay, Ph.D., Director
Phyllis Grifman, M.A., Associate Director
James Fawcett, Ph.D., Marine Transportation/ Seaport Specialist, Extension Leader
Linda Chilton, M. A., Education Programs Manager
Alyssa Newton Mann, MPA, Research, Policy and Planning Specialist
Nick Sadrpour, M.S., Science, Research and Policy Specialist
Holly Rindge, MAS, Communications Manager
Charlotte Stevenson, M.S., Science Writer
Ruth Dudas, Contracts and Grants Coordinator