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The Coastal Wetlands of San Diego County

SAN DIEGO HISTORICAL SOCIETY—TICOR COLLECTION

San Diego Bay

CALIFORNIA STATE COASTAL CONSERVANCY

This book was produced by the State Coastal Conservancy in conjunction with the Batiquitos Lagoon Foundation. Grant funds were provided by the Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration.

The Coastal Wetlands of San Diego County

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Introduction

We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

– Aldo Leopold

KENNETH W. GARDNER

The return of the California Gray Whale from near extinction to a coastal tourist attraction is one of the few environmental success stories of the past 20 years. The Light-footed Clapper Rail, a secretive bird of tidal marshes, has not been so lucky and remains close to extinction. The ducks and geese that once crowded the winter sky return each year in ever smaller numbers to their coastal wintering grounds. The fish of local bays and lagoons are no longer so numerous and easy to catch. All these animals and many more are wetland dwellers for all or part of their lives. In California the wetlands—the marshes, mudflats, swamps, estuaries, and lagoons—they need to survive are nearly gone.

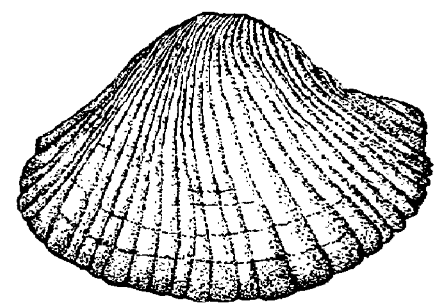
Why should we care about some boggy land and a few ducks? Perhaps because wetlands are the most productive ecosystem in the world. The coastal wetlands support not only a cast of resident fish, crabs, worms, birds, and mammals, but also a large contingent of visiting wildlife. The bird visitors—shorebirds, terns, gulls, ducks, geese, and other water lovers—stop at wetlands along their migrations from nesting sites in Alaska and central Canada. They need to rest and, most importantly, to feed. Each coastal wetland is a refueling station and an essential link in the migratory route. Marine fishes annually move into bays and tidal wetlands to spawn; their offspring may spend a year maturing in the productive, calm waters. Marshes and mudflats provide delicacies to humans as well; clams, crabs, fish, ducks, and geese are all wetland creatures. Besides being marvelous wildlife habitat, wetlands are good filters. They can absorb moderate amounts of nutrients and cleanse stormwater. To many, wetlands are aesthetically pleasing—the solo flight of a heron at dusk or the magical interplay of dawn light on water and marshes bring solace and psychological well-being. But maybe the most important reason we care for wetlands and their wildlife is the same reason we want to save the gray whale—they deserve to share this earth and need our protection to survive.

Coastal wetlands are among the most endangered habitat types in the world, second only to tropical rain forests. The United States loses more than 18,000 acres of coastal wetlands every year. On the California coast, 75 percent of the wetlands have been destroyed in less than 140 years, bringing the term "endangered" to many wetland-dependent species.

San Diego County's wetlands may prove to be the most threatened natural resource on the California coast. By 1900, human activities had modified all 16 wetlands. Since the 1970s, the purchase of many of these areas with public funds for wildlife preserves, as well as regulation of coastal development, has largely stopped direct wetland losses. But the county's population grew at a rate of 35-40 percent this decade, and the associated building boom has caused large increases in erosion of coastal watersheds. Wetlands are the endpoints of these watersheds, and they are rapidly filling in. Unless further development is guided to protect wetlands and watersheds together as a system, San Diego's coastal wetlands and their wildlife will soon disappear entirely.

The California State Coastal Conservancy works to protect what wetlands remain. Created in 1978 to preserve, enhance, and restore the resources of the coast, this non-regulatory agency provides technical assistance and funding to local governments and nonprofit organizations. The Conservancy has produced this booklet with a grant from the Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration. The aim is to provide an easily read discussion of coastal wetlands and watersheds for the public and local decision makers. We have also included sections on the ocean's influence on wetlands, endangered species, wildlife, wetland regulation and restoration, and an inventory of 16 wetlands.

In a rapidly growing region such as San Diego, wetlands and their watersheds can easily be destroyed in the rush for short-term profit. Losing our coastal wetlands means losing some of the richness of our world. The more uniform and built-over the landscape becomes, the more lifeless and boring it seems. Situated in the midst of a crowded city, a wetland is a pleasing slice of openness. It adds variety, beauty, and interest to our daily lives and teaches us and our children about the intricacies of nature. The loss of wetlands diminishes the quality of our lives and denies a part of our natural heritage to future generations. We hope this booklet will assist the people of San Diego in understanding and preserving their wetlands.



basket cockle (Clinocardium nuttallii)

Coastal Wetlands:
The Dynamic Edge of a Continent

Such is the force of water that it will with gentle pressure shape itself to every vessel and yet pierce the very rock.

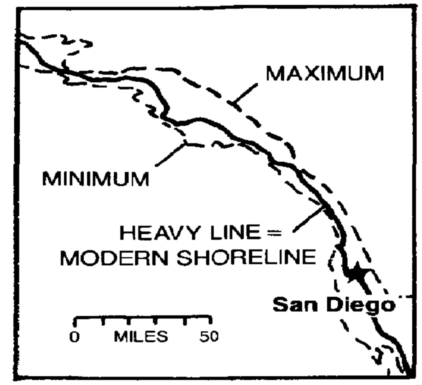
– Emperor Meiji

AERIAL FOTOBANK INC.

Los Peñasquitos Lagoon

Wetlands form a thin edge along the steep and ragged California coast. Wedged into the few protected sites available along this geologically active rim of the continent, wetlands fill river mouths and lagoons, and also line bays. Their appearance along the Pacific coastline coincided with sea level rise following the last ice age. About 18,000 years ago, sea level was some 400 feet lower than it is now, and the shoreline lay miles to the west. The sites of today's coastal cities were far inland. Over thousands of years, rivers and creeks cut canyons and hollowed wide valleys. As the glaciers melted, sea level rose and flooded the river and creek valleys. These "drowned" valleys became the bays and lagoons of today. Eventually, sea level rise slowed enough to equal the geologic uplift of the continent. The shoreline took on a contour very close to its present location. Sand buildup along the new shoreline formed beaches and enclosed lagoons and bays. Landward, sediment flowing down creeks slowly created mudflats and marshes.

For many thousands of years before the Spanish arrived, the wetlands remained in an equilibrium between land and sea. Large numbers of Native Americans lived near the lagoons and bays of the San Diego coast. Excavations of the middens, or garbage heaps, of these early residents turned up numerous shells of estuarine mussels and clams. These animals only occur in tidal embayments and indicate that several of the lagoons (Los Peñasquitos, San Elijo, and Batiquitos) were fully tidal systems prior to European settlement. These same lagoons have changed dramatically in the last 200 years and now are rarely open to the tide. A closer look at the physical processes that shape coastal wetlands may explain why.



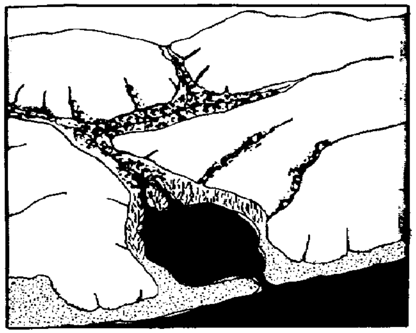
During the past twenty thousand years, sea level has risen much higher and has receded much lower than its present day level.

Between Land and Sea

Poised on the edge of both land and sea, the wetland is a true middle ground, reflecting conditions and changes in both these elements. Streams bring in fresh water, eroded soil, and sometimes pollutants from the land. The sea brings in tidal water with its salts, minerals, and sands twice daily. The result of this intermingling of land, water, and sea is a dynamic environment that is both unique and fragile. The processes that shape, change, and nourish wetlands are complex and are primarily controlled by the wetland's watershed and the sea.

The Watershed

A watershed or drainage basin is the land area drained by a stream system. Each coastal wetland is the endpoint of a watershed where the stream system reaches the sea. The size and shape of each watershed is determined by the particular geology and steepness of the land. Several of San Diego's coastal wetlands (the San Diego, San Luis Rey, and Santa Margarita rivers) have very large watersheds, while some are quite small (Buena Vista and Las Flores creeks). But no matter the size, the physical processes are similar.



Undisturbed wetland and watershed

Erosion and sedimentation shape the watershed. Soil erosion is a natural process and, except during large floods and after fires, occurs very slowly. The steepness of the land, the type of soil, and the thickness of the vegetation determine the susceptibility of a watershed to erosion. Steeper hillsides are more erodible than flat areas because water runs off the ground faster, more easily eroding soil particles. Hard, rocky soils erode less than sandy, loose soils. Soil types in San Diego's coastal watersheds vary greatly. Sandy soils, which cover many of the bluffs surrounding wetlands, are often the most erosion-prone soils. In its natural state, vegetation blankets the soil and protects it from erosion. The thicker and more substantial the vegetative cover, the more the soil is protected. For example, chaparral shrubs have dense foliage, which deflects raindrops, and thick root systems, which bind the soil. Annual grasses, with shallow roots and minimal foliage, provide much less protection. Where vegetation is removed, the soil is left exposed and is easily carried away by rain, dramatically increasing the rate of soil erosion.

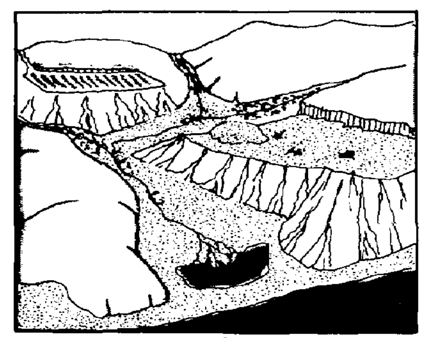
Most erosion occurs during intense downpours. San Diego's climate is relatively mild, with an average of 10 inches of rain concentrated in the winter months. Rain may fall in a series of small storms or in a few intense downpours. These downpours have produced over 1.2 inches of rain in one hour, causing water to run off the land rapidly and in large volumes, carrying large amounts of soil with it.

Once soil particles are eroded from the land, they are carried by stormwater into streams. In the steep, upper areas of the drainage basin, stream flow will be rapid, but as the stormwater reaches the flatter lands near the coast, the stormwater slows down. As the water slows, the heavier soil particles, such as sand, drop out. Vegetation in the stream channel, typically composed of willows or cottonwoods, further slows the water and causes sediment to deposit. In this way, deposited sands gradually build up the floodplain of rivers and creeks. Some of the smaller, lighter soil particles may also deposit on the floodplain, or they may travel all the way to the estuary before settling. In large floods, the volume and speed of the water are so great that the stormwater does not slow down until it reaches the ocean, and sediment is deposited on beaches and offshore. During large storms, floodwaters may erode away the stored sediment from the floodplain and move it further downstream into the estuary. A very large storm may flush stored sediment not only from the streams, but also from the estuary.

We all want to believe that the earth beneath our feet is solid and unchanging, a monument of security. But the land is constantly being transformed. The processes of erosion and sedimentation in watersheds turn mountains to hills and, over time, nourish beaches with the sands. River and streams continuously change form, undergoing small and sometimes catastrophic alterations. A creek bank caves in, a small sandbar forms along a stream meander; a flooding river jumps its banks and forms a new channel. The land is dynamic, undergoing minor gully and rill erosion and occasional massive land-slides. Change in one part of the watershed slightly to drastically alters downstream areas.

There is a dynamic balance between soil, stream, and water in each watershed that is established, lost, and reestablished. When human settlement covers the watershed, this balance is upset and the attempt of the system to reestablish an equilibrium can cause problems both for people and coastal wetlands. Agriculture and urbanization have had three primary effects on San Diego's coastal watersheds—land disturbance, construction of dams and reservoirs, and increases in storm flows.

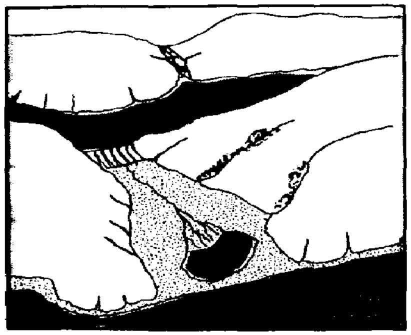
Land Disturbance



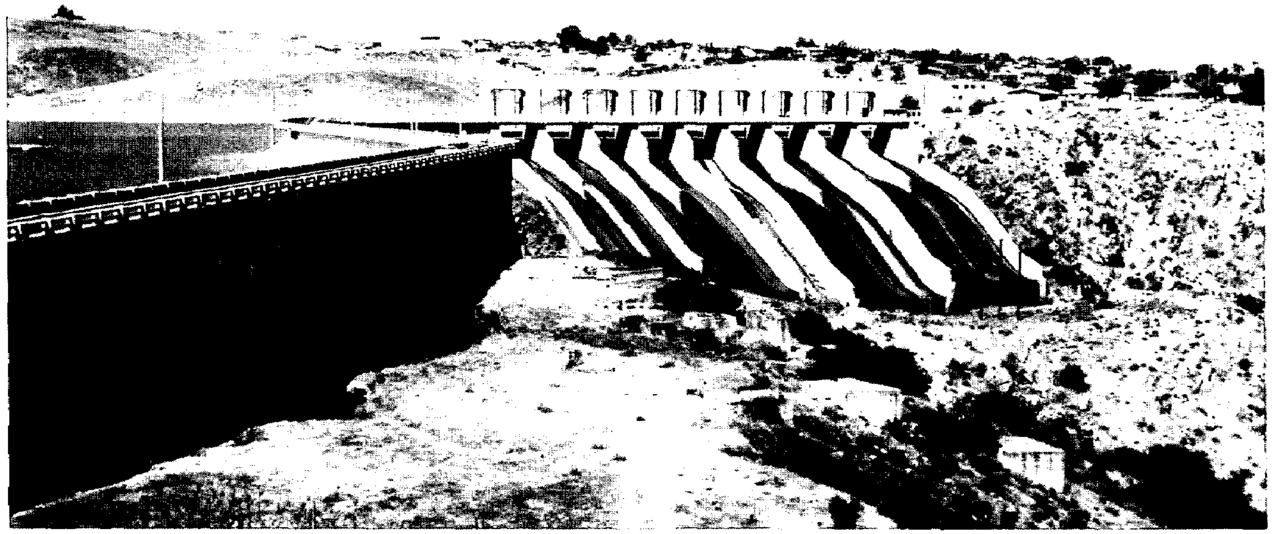
When land is cleared for agriculture or graded and formed to hold roads and buildings, the soil is left unprotected and prone to very high rates of erosion. Row crops or orchards, oriented against the contour of the hill, have furrows and farm roads that easily erode. Land development, even when completed with strict erosion control measures, can still cause sedimentation should a summer thundershower occur or a sediment basin fail. Land grading in the winter with inadequate control measures—a practice widely used in San Diego County developments—can increase erosion up to 10,000 times the rate of a natural drainage. Streets near housing developments are often covered with mud after a storm, indicating erosion of the soil from the building site.

Land disturbance greatly increases the sediment loads in stormwater. Sediment fills in stream channels, causing streams to jump their banks and flood surrounding lands. Extensive development in the upper area of a watershed may produce so much sediment that downstream channels clog, and the older city neighborhoods in the lower watershed will flood. Sediment from land development can have devastating effects on coastal wetlands. Buena Vista, Los Peñasquitos, and Batiquitos lagoons have filled in with great quantities of sediment; where streams enter these lagoons, large deltas can be seen.

Dams and Reservoirs

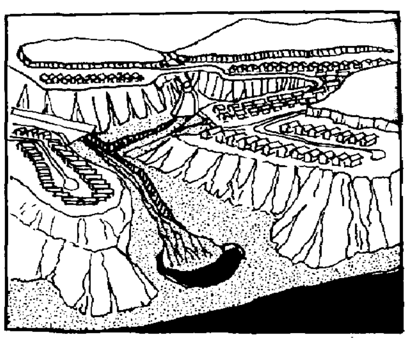


The development of agriculture and cities in the arid climate of San Diego has depended on the creation of a water supply. Most major coastal streams have at least one dam and reservoir. Much of the fresh water that naturally flowed to coastal wetlands is diverted to farms and cities. These dams reduce the size of flood flows and thus also reduce the flushing of sediment from estuaries. They also trap sand that would otherwise nourish coastal beaches.



PAUL JORGENSEN

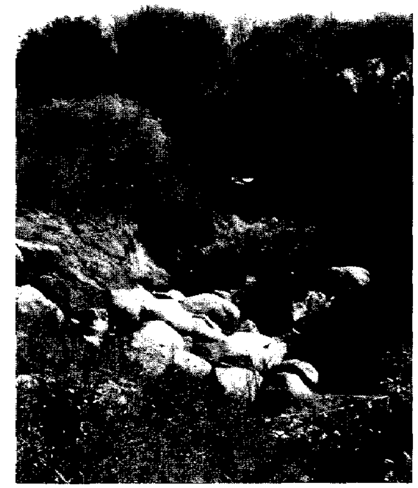
Urban Storm Flows



When a drainage basin is paved, the balance in the watershed changes greatly, just as it does when land is cleared and plowed. Whether a year is dry or wet, the rate at which rainwater flows off the land into the stream system depends on the groundcover in the watershed. Natural vegetation and open land allow maximum percolation of water into underground basins, or aquifers, with a slow release to streams. This natural filtering system mediates the rise of floodwaters in the stream system, producing lower flows in creeks that may last well into summer. When urban land is paved with concrete and asphalt, little percolation occurs. Rainwater flows directly off these hard surfaces into stream channels. Creeks carry enormous volumes of water for a few days following a storm and then dry up early in the season. The natural stream channel, which formerly carried smaller amounts of runoff, cannot handle this increased volume of water. These larger storm flows erode the natural floodplain, turning the creek into a deep gully. The creek channel may erode both downward and outward, toppling riparian trees and creating a wide, steep-banked arroyo. This erosion will continue until the creek is wide enough to carry the new water volume and an equilibrium is reestablished. In a single storm, this process can remove tons of sediment from floodplains, deposit it in coastal wetlands, and destroy streamside forest and property. To prevent flood damage, creek channels are often lined with concrete. Although they may provide temporary protection for one part of the stream, concrete channels accelerate storm flows and increase erosion of natural channels downstream.

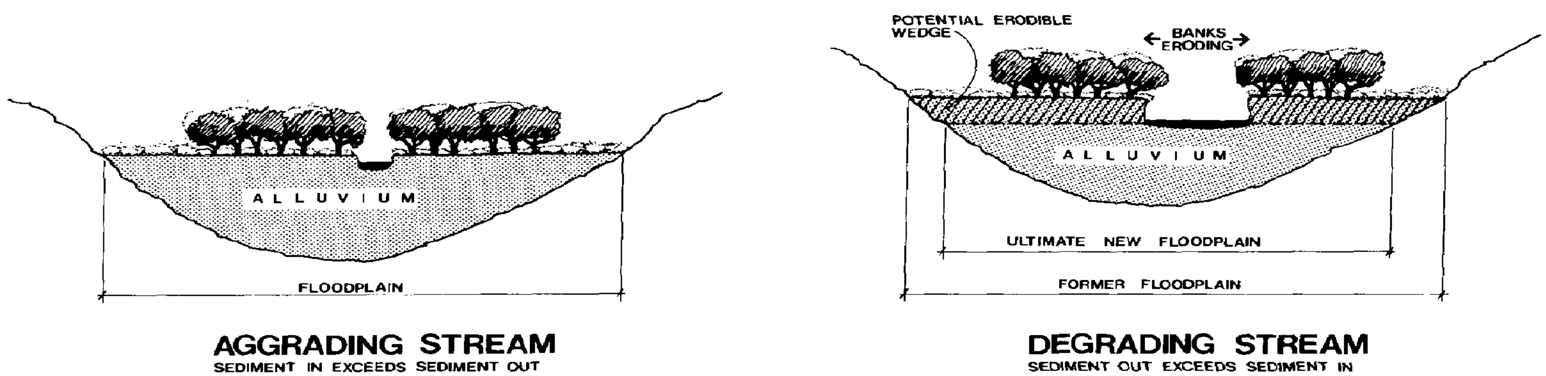
The effect of urbanization in a watershed on its coastal wetland may not be immediate. The case of Buena Vista Lagoon affords a good example. During the dry period from 1965 to 1977, extensive urban development occurred in the watershed. Approximately half of the creek's length was lined with cement, primarily in the lower watershed. During 1978-80, floods carried so much sediment down this channel that the eastern lagoon basin was filled, smothering wetlands. The State spent over $1 million to remove this mud.

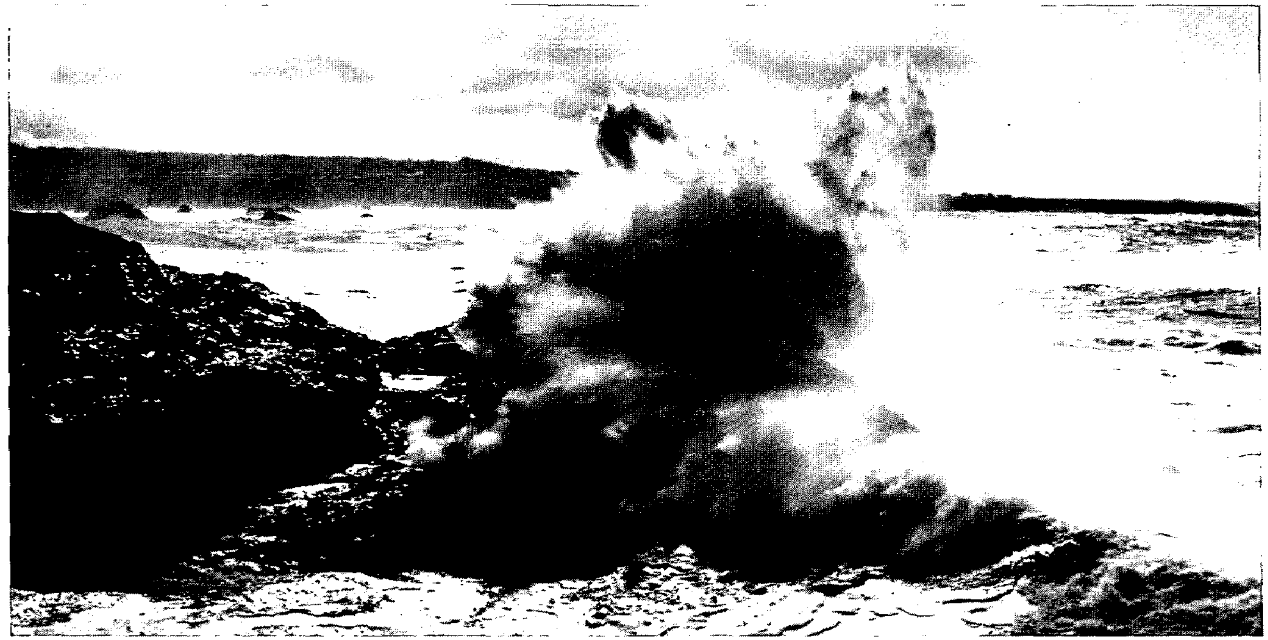
Most of the sediment came from Buena Vista Creek. Urban development had so increased the volume of storm flows that a 20-foot-deep gully formed in the middle reach of the creek. The creation of an arroyo was underway. Concrete channels had replaced much of the natural floodplain below the gully, and the eroded sediment was carried directly into the calm waters of the lagoon, where it settled. The open water and marsh of the lagoon were buried under tons of sediment. Later studies found the lagoon was filling in at a rate of 35,000 tons of sediment a year, a rate that would fill the entire lagoon in 10 to 20 years. Similar problems can be seen in the watersheds of Mission Bay, San Dieguito, and San Elijo lagoons.



Above: Gully in Buena Vista Creek eroded by urban stormflows is the major source of sediment filling in Buena Vista Lagoon. Opposite Page: Rodriguez dam in the Tijuana River watershed.

ARROYO FORMATION



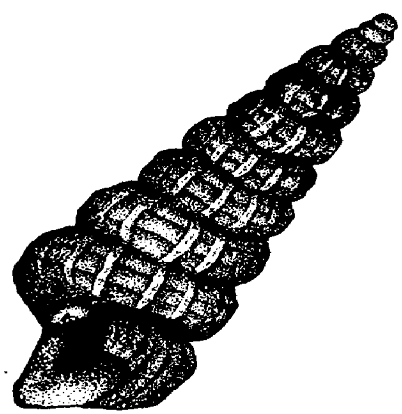


WILLIAM BROWN

The Sea

The daily intrusion of tidal water is an essential and controlling element of coastal wetlands. The San Diego coast has two high and two low tides daily. The average tidal range is about five feet, while the maximum yearly tidal range is ten feet. The maximum high tide helps to define the upper boundary of a coastal estuary by inundating soils often enough to create high salinity levels and eliminate all but the hardy salt marsh plants. This upper tidal boundary—not the crashing surf—is the landward edge of the sea.

Tidal currents shape the wetlands' channels and shoreline. They distribute sediments from watershed creeks throughout the estuary. Most of the finer particles are transported out with the tide. Heavier particles settle, move, resettle, and eventually become part of a mudflat or marsh soil, unless a large storm carries them out to sea. Gusty winds stir up bottom sediments, aiding tidal currents in the redistribution process. In an estuary experiencing large sediment inflows, flushing fine sediment out to sea can take decades. San Francisco Bay, which has strong currents and winds, still retains much of the sediment brought in by streams after hydraulic gold mining in the 1870s flushed soil from the Sierra Nevada foothills.



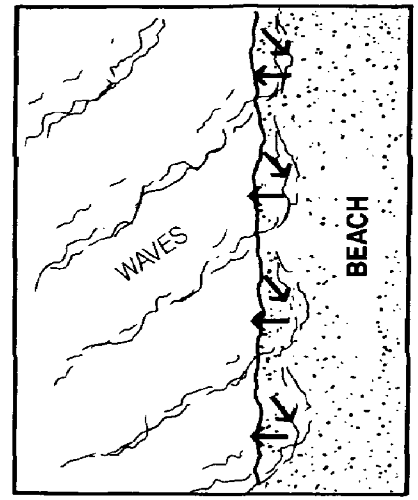
horn snail (Cerithidea californica)

Besides removing and reshaping sediment within the estuary, the ocean moves the sands making up the beach berm at the estuary entrance. Ocean currents and waves, particularly large storm waves, move sand both along the San Diego coast, in a process called littoral drift, and move sand on and off shore. A bucketful of sand dumped on the beach in Carlsbad might be moved out into the shallow water one year and back onto the beach the next, or it might be carried down the coast and become part of a beach in Del Mar. Eventually this sand probably will disappear into the deep submarine canyon off La Jolla and be forever lost to the coastal beaches. Along the southern San Diego coast, sand moves from Mexico north toward Point Loma. Sand eroded from watersheds moves through estuaries into the ocean, constantly resupplying this system.

There is a continuous contest between the power of the ocean waves and the power of the estuary's ebb tide to push the beach sand in and out of the estuary entrance. Large storm waves can move sand into an estuary and partially block the entrance channel. As the tide ebbs, the power of the outflowing water must be great enough to scour the channel and clear the sand or the channel will close off. The volume of water that flows into and out of an estuary during a tidal cycle is termed the tidal prism. Of the two high tides that occur each day, the higher one has a larger tidal prism and a greater ebb flow. The size of the tidal prism varies according to each estuary's size and shape.

During a storm, when ocean waves are largest, an entrance channel may become blocked. At the same time, the estuary receives a large amount of fresh water. The water rises and eventually breaks a new channel through the weakest point in the beach berm. Before highways, roads, and bridges were built on the coast, estuary entrance channels were free to change location. The mouth of a lagoon could be on the north side of its beach berm one year and have migrated to the south by the next summer. To maintain an open channel, the inlet must be able to move in response to sand buildup.

Some estuaries, like Buena Vista Lagoon, never had a tidal prism large enough to scour a new entrance channel. They probably closed off to the tides during summer, when runoff was low, and ocean waves could overpower the small tidal ebb. But large estuaries such as San Diego Bay and Batiquitos and San Elijo lagoons have large enough tidal prisms to remain open year-round.

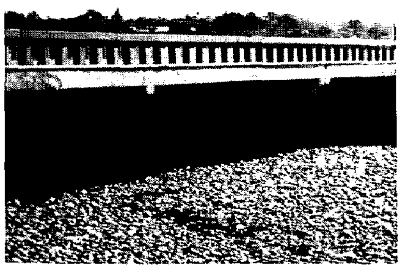


Ocean currents and waves move sand along the coast in a process called littoral drift.

Coastal Development

The development of the San Diego coast has interfered enormously with the function of estuaries. Two or three roads now run through most coastal wetlands, built on landfill with a small bridge across a channel to permit water outflow. Highway 1 constricts the inlet of most of these estuaries and provides only a narrow bridge, thus stopping the migration of the entrance channels. Once the mouth is confined to a fixed location, these estuaries can no longer maintain an open channel. Now when ocean storm waves fill and block the channel with sand, the estuary may remain closed until water levels are high enough to scour the sand in that one location. In addition, many of San Diego's wetlands have been

LAUREL MARCUS



Top: Highway 101 and the railroad dissect San Elijo Lagoon and restrict its entrance channel to a small opening. Bottom: Cobbles fill the mouth of Batiquitos Lagoon. Both lagoons rarely open to tidal flows.

chopped into several separate bodies of water by fill and bridges for Interstate 5, El Camino Real, and the railroad. These constrictions slow water velocities and decrease the power of the ebb flow to scour sand. As a result, many of San Diego's lagoons rarely open to the tide anymore.

When an estuary's entrance channel closes, the movement of sediment out of the wetland stops. Much of the eroded sediment that flows into a closed estuary stays there, filling in tidal areas and decreasing the size of the tidal prism. Direct filling of tidal areas for development, as in San Dieguito Lagoon, further reduces the tidal prism. Agua Hedionda Lagoon is the only lagoon with continuous tidal action because it was dredged in 1954 and its mouth stabilized with jetties.

One long-term effect of development along the San Diego coast is the loss of sandy beaches. Reservoirs now catch much of the sand eroded from watersheds, stopping its movement through streams to the ocean. Closed lagoons now collect the sand that once nourished the beaches. The overall result is an enormous decrease in the supply of sand to the beaches and the movement of what little sand remains down the coast and into the submarine canyon. Cobbles now cover many beaches; ocean waves eat away coastal bluffs.

Riparian Forest

LEE EMKE

Rivers and creeks follow twisted, curvy courses, carving and re-depositing the sediment of the watershed. The riparian forest, a tangle of willow, sycamore, blackberry, nettle, and other plants, creates a dense green lining along these streams. Until recently, the modern urban landscape has had little use for these disorderly water courses. Civil engineers and land developers have straightened and "improved" many of our streams into narrow, deep, and sterile cement channels. The natural creek and river were removed in the name of flood control and in an effort to dry out, fill in, and build on their floodplains.

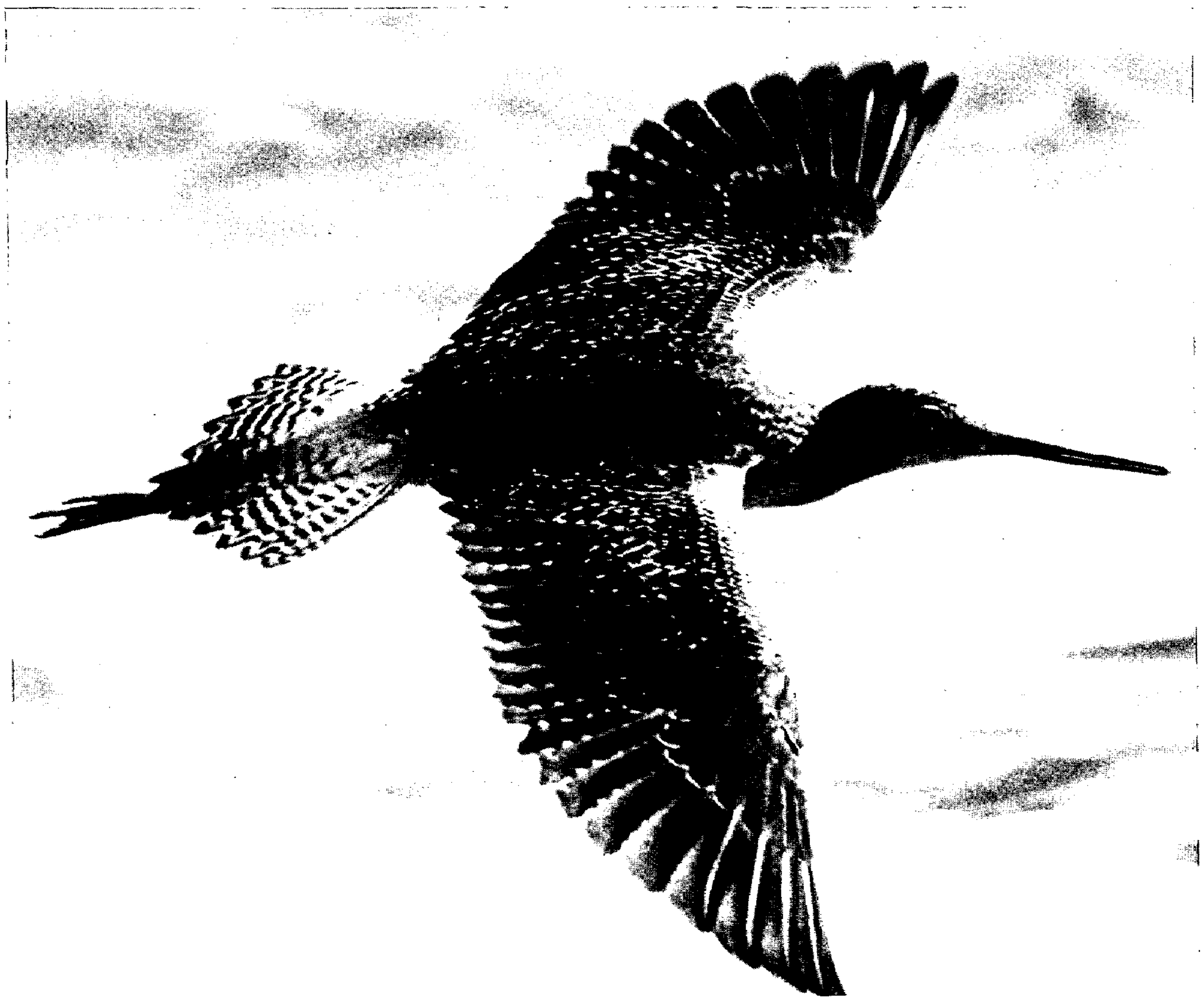
What has our society lost in the effort to control water flows and rearrange stream systems? The most obvious loss is beauty. A concrete channel may be more efficient at moving water, but it certainly lacks the beauty of a natural, green stream. Wildlife habitat is another loss. Ninety percent of the riparian forest in California is gone; the major river systems of Los Angeles and Orange counties are now mostly cement. Remaining riparian forest in San Diego County occurs on the Santa Margarita, San Luis Rey, Sweetwater, Otay, and San Diego rivers as well as many smaller streams. Bird species such as the Least Bell's Vireo are now facing extinction due to riparian habitat loss.

Another often overlooked feature of riparian forest is its function in the movement of sediment in a watershed. Riparian plants have thick, tangled branches and root systems that slow water and collect sediment protecting downstream wetlands from filling in. Take out the trees and straighten the stream, and the sediment is carried directly into the coastal wetland. The tree roots also bind together the soft sediments of the channel banks, lending a degree of protection from erosive urban storm flows. The clearing of riparian forest for agriculture often opens the stream banks to undercutting and failure, sending the few extra acres of added crops downstream. "Improvement" of streams for urban development removes their function as sediment traps and protectors of downstream coastal wetlands.

Wetland Life

There would seem to be no real hope for the future unless we are prepared to accept the concept that man, like all other living things, is a part of one great biological scheme. Today almost every purpose and activity of modern life takes precedence over the one most basic purpose of all, namely that of conserving the living resources of the earth.

– Fairfield Osborn



KENNETH W. GARDNER

Much of wetland life is hidden from human view, played out beneath the high tide or in the rich mud of tidal flats. With each of its movements, the tide transforms the wetland, giving the pulse of the ocean a solid, earthbound expression. For the resident animals and plants, both large and microscopic, these pulses mark the routine of day and night. With each high and low tide, different activities are underway. Bacteria crowd the mud, absorbing and releasing different nutrients and organic compounds at each tidal stage and recycling the basic elements. At low tide, mudflat dwellers lie hidden. High tide brings food to these same creatures—worms, clams, shrimp, and other invertebrates. Under the cover of water, small fish that hide in burrows at low tide, emerge to feed.

During the fall and winter months, flocks of migratory ducks and shorebirds arrive at coastal wetlands. The rapid bobbing and dipping of these noisy flocks animate the shallow water and exposed mudflats, lending a liveliness to the subtle landscape. By late spring the flocks are gone, and the resident birds—herons, gulls, sparrows, and others— are left to offer their own show. Nesting terns, floating pelicans, black cormorants, black-necked stilts, and avocets also remain for the summer.

Most human interaction with wetlands has been by boat or boot for the purpose of harvesting this richness of wildlife. Although we have relished the bounty of ducks, fish, geese, crabs, and other animals the marshes support, most of us have remained ignorant of the wetland's complex workings. The impenetrable mire of the mudflat and sulfurous odor of low tide have deterred most visitors and set the image of "wastelands" into many people's minds. Many coastal wetlands were "reclaimed" through dredge-and-fill projects long before their value was recognized.

Scientists and naturalists only recently began detailed study of the life in San Diego wetlands. Work at the Tijuana National Estuarine Research Reserve and San Diego State University has been particularly important in painting a portrait of the wetland world. Though we do not have a complete picture of this world, there are several aspects we can explore. Among these are the dynamic nature of wetlands, the adaptation of wetland life to environmental change, and the productivity of wetlands and their role in the international migration of birds.

A Dynamic World

Coastal wetlands are a meeting of forces—the ocean pushing its tides and sand against the land and the river or creek draining its fresh water and sediment into the sea. These two forces create everchanging conditions in the wetland. They not only bring fresh water and daily high and low tides, but they also produce floods, storm waves, and large sediment inflows. Such a dynamic environment may seem too hostile to life. But plants and animals not only exist here, they thrive.

Cordgrass (Spartina foliosa)
This plant, like many salt marsh species, has air spaces in its stems and roots that allow it to withstand the lack of oxygen during long periods of tidal submergence.

Visit an estuary and salt marsh on the hottest day of August. The surrounding hills are parched to a cardboard brown, and even the chaparral shrubs must go dormant to survive the summer drought and heat. In stark contrast, the salt marsh, watered by the tide, is lush and green. For the few plant species that have evolved the necessary adaptations, the saltwater wetland provides ample sunshine and water. Other plant species cannot tolerate the physical conditions here, especially the long periods of submergence in water and the high salinity levels. Each wetland plant species tolerates a particular range of these two conditions.

With high tides submerging the marsh every twelve hours, soils remain waterlogged—a situation similar to overwatering house plants. Marsh soils are often made up of clay and drain very poorly. During yearly maximum tides, the plants of the lower marsh may be submerged for 10 to 12 hours continuously. Only a few species have adapted to endure this stressful situation. The average high tide will only briefly cover the high-elevation marsh, which lies at about 2 1/2 feet above mean sea level. (Mean sea level is usually equated with the 0.0-foot elevation on most maps). But the low-elevation marsh lying at mean sea level or below is regularly covered by the high tide for hours at a time.

Soil salinity varies over the marsh surface. The lower marsh is continually bathed by the tide; its soil salinity is close to that of seawater and does not vary much over the seasons. In the middle and high marsh, soil salinities can vary greatly. Winter floods leach salts from the higher elevations while summer drought concentrates salts, creating hypersaline soils. The upper edges of the marsh are bathed in salt water only several times a year during extreme high tides, yet their soils are saline enough to exclude most upland plants.

Different species inhabit the high and low marsh zones. Cordgrass grows by itself at the lowest fringes of the marsh. Airspaces in its stems and roots enable it to withstand longer periods of submergence than any of the other salt marsh species. A more diverse array of plant species inhabits the upper marsh zone, with pickleweed often dominant. Other plants, found in pockets of the higher marsh, include saltwort, annual pickleweed, jaumea, saltgrass, alkali heath, and sea lavender. Each of these species can withstand only moderate levels of submergence and has a specific tolerance range for soil salinity.

PAUL JORGENSEN

Among resident wetland animals, the most inconspicuous group is the invertebrates—worms, snails, crabs, and mollusks. These animals inhabit the mudflats, muddy bottoms, and sides of tidal channels, the soils beneath marsh plants, and often the plants themselves. For the most part they are sedentary creatures, staying in a small area throughout their short lives. Each species can endure a certain range of salinities, depth of water, temperature, period of submergence and exposure, and type of substrate (sand versus clay). The sediments beneath the deep, open water of San Diego Bay will support species of invertebrates that will differ from those found in the intertidal mudflats of the same estuary. More brackish areas of the estuary near an inflowing river or creek present different conditions and may support invertebrate species not found in the tidal mudflat.

What's A Wetland?

Most coastal wetlands line estuaries. An estuary is a semi-enclosed body of water that receives both fresh water and seawater and includes the bays, lagoons, and river and creek mouths of the coast. Along the shores of these estuaries are salt and brackish (somewhat salty) marshes, mudflats, and tidal channels. Freshwater marsh may border inflowing creeks. All constitute wetlands. The lagoon or estuary itself may also be referred to as a coastal wetland. Seasonally flooded pools or salt pannes, closed lagoons and salt evaporator ponds are also wetlands. So is the riparian forest—the creek and river floodplains where trees and plants grow. To avoid confusion, these stream-associated forests are referred to as riparian wetlands.


IAN C. TAIT

Unlike the sedentary invertebrates, fish can swim to areas within a wetland where environmental conditions are favorable to them. Some small fish, such as the arrow goby or the long-jawed mudsucker, reside in burrows in mudflats or channel banks. Turbot and halibut are bottom fish whose larvae develop in the calm estuarine waters. Mullet, sandbass, killifish, surfperch, and topsmelt are common in tidal channels and open water areas. The environmental conditions most important to fish species include salinity levels, water temperatures, the variety of habitat types, and abundance of food sources. Some chemical components, such as the amount of oxygen dissolved in the water, are critically important to the survival of fish.

Wetland plants and animals are specialists, adapted to particular places in the wetland. These places are their habitat. Most plants and some animal species can live in only one habitat, others need a variety. Several types of habitat can be identified in estuaries. Vegetation type defines some—high or low marsh, brackish marsh, eelgrass beds; water character defines other habitats—open water, intertidal mudflat and channels, subtidal bottom, and salt panne. The more mobile animals—fish, birds, and mammals—may feed, nest, spawn, or rest in different habitat types, and the variety of these habitats within a given estuary is especially important.

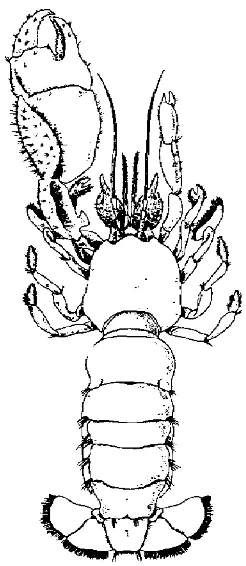
Tidal salt marsh at Tijuana Estuary

JULIE BUBAR

Environmental Change

When the wetland environment changes, plants and animals must be able to withstand the change or they die. Small or short-term variations, such as a winter flow of fresh water into a tidal estuary, temporarily lower salinity levels and leach salts from soils. Most estuarine plants, invertebrates, and fish can tolerate salinity levels lower than those of seawater (34 parts per thousand), but not as low as pure fresh water (less than 1 part per thousand). Cordgrass has adapted to changing salinity levels. Its seeds germinate best when salinity levels are low, allowing the species to spread and grow rapidly following major floods. The return to high salinity levels during summer may kill some of the new plants, but many survive and the species expands its coverage.

Marsh vegetation continuously varies in response to everchanging physical conditions. Researchers have studied the boundary between pickleweed and cordgrass over several years at Tijuana Estuary, a tidal system with a large drainage basin. They found that this boundary varies each year, with each species expanding or declining as conditions change and give one plant species a greater advantage over others. Since pickleweed can withstand very high salinity levels, a long dry season or nontidal period might favor it while causing cordgrass to die back because it is less tolerant of hypersaline conditions. Both plants grow at slightly different elevations in the marsh. A slight change in elevation due to sediment deposition would favor pickleweed while scour would favor cordgrass. The nature of wetlands is dynamic; static boundaries can rarely be applied.



ghost shrimp (Callianassa californicus)

Prolonged Freshwater Flows

Water releases from upstream reservoirs have caused major salinity changes in some coastal wetlands, with consequent damage to salt marsh vegetation and wildlife. Under normal conditions, freshwater inflows occur in winter and are rare between May and October. In the San Diego River flood control channel, for example, a well-developed tidal marsh existed on the seaward end. Prolonged releases from an upstream reservoir in 1983 leached salt from soils and created freshwater conditions well into the summer. Later studies by Dr. Joy Zedler of San Diego State University confirmed that the pickleweed was smothered beneath a dense growth of freshwater tules. The pickleweed could not withstand the prolonged submersion created by the water releases, nor could it compete with the freshwater marsh plants that invaded the area once salinity levels dropped. Even small discharges of fresh water into wetlands during summer can change vegetation. For example, at Los Peñasquitos Lagoon, storm drains carrying small amounts of fresh water from garden irrigation and roads have created a year-round source of fresh water and an invasion of the salt marsh by cattails.

STEVE RENEAU

STEVE RENEAU

Far left: Saltgrass (Distichlis spicata) *This plant species excretes salt through special glands on its stems and leaves. Left: Pickleweed* (Salicornia virginica) *This common salt marsh plant eliminates excess salt by storing it with water in succulent leaf joints. These joints turn red in autumn and fall off, ridding the plant of the salt.*

Lagoon Closure

DOUG STOWE

Open tidal channel at Tijuana Estuary.

When the mouth of an estuary or lagoon closes, environmental conditions change greatly. How wetland animals fare during a closure has been studied in detail at Tijuana Estuary and at Los Peñasquitos Lagoon.

Tijuana Estuary had been open to continuous tidal action for many years, but due to high tides and large ocean waves in January 1984, the entrance channel became clogged with sand. The following April, the mouth closed. Monitoring studies found that water salinity levels soon after closing reached 60 parts per thousand (ppt) and that large areas of the marsh dried out. The majority of the intertidal invertebrates and fish species died. Eight months later, the mouth was dredged open, and the estuary returned to a tidal condition. But studies by biologist Chris Nordby of San Diego State University for two years after the dieback showed that the invertebrates and fish have not recovered. The purple clam, one of the dominant invertebrates before the closing, has become extinct from Tijuana Estuary. Fish have not returned in the variety of species that had occurred previously.

Marsh plants were also affected. The dry, hypersaline conditions favored the growth of pickleweed, but killed many cordgrass plants. Two other high-marsh species, annual pickleweed and sea blite, were almost eliminated from the marsh following the closure.

Los Peñasquitos Lagoon has been closed to regular tidal action for many years. It has lost much of its tidal prism because of sedimentation and because the Highway 1 bridge has restricted its mouth. Since 1986, the mouth has been opened periodically with a bulldozer in an effort to enhance the lagoon. Studies have shown intertidal invertebrates and fish invade on the incoming tide and become established in the marsh channels. However, the lagoon mouth closes again a short time later, since the tidal prism is not great enough to keep it open. Hypersaline conditions develop, but some of the fish and invertebrates are able to survive. A fall or winter rainstorm will occur when the mouth is shut and cause a sudden drop in salinity that kills most of the marine invertebrates and fish. This pattern of colonization, closure, freshwater inflow, and dieoff has been documented for three years.

In both these wetlands, the chemical components of the water begin to change with the closure of the entrance channel and loss of tidal flows. The impounded water evaporates, leaving its salts behind, and creating a highly saline environment intolerable to many wetland animals. Intertidal animals must "breathe" by taking in dissolved oxygen through gills or skin. As the stagnant water heats up and the animals use up the oxygen, they suffocate. A large influx of fresh water drastically changes salinity levels in the lagoon killing many aquatic species. The conditions of the closed lagoon far exceed the tolerance of many plants and resident animals. Before human disturbances along the coast, large ocean waves may have closed San Diego's estuaries occasionally. But as the lagoons and estuaries all had larger tidal prisms and unrestricted channels, it's likely that they readily reopened. These large die-offs probably seldom occurred.

PAUL JORGENSEN

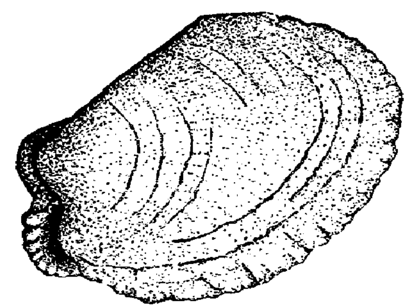
The closure of the mouth of Tijuana Estuary in 1984 dried out tidal sloughs and caused a die-off of cordgrass marsh and its inhabitant, the Light-footed Clapper Rail.

Sedimentation

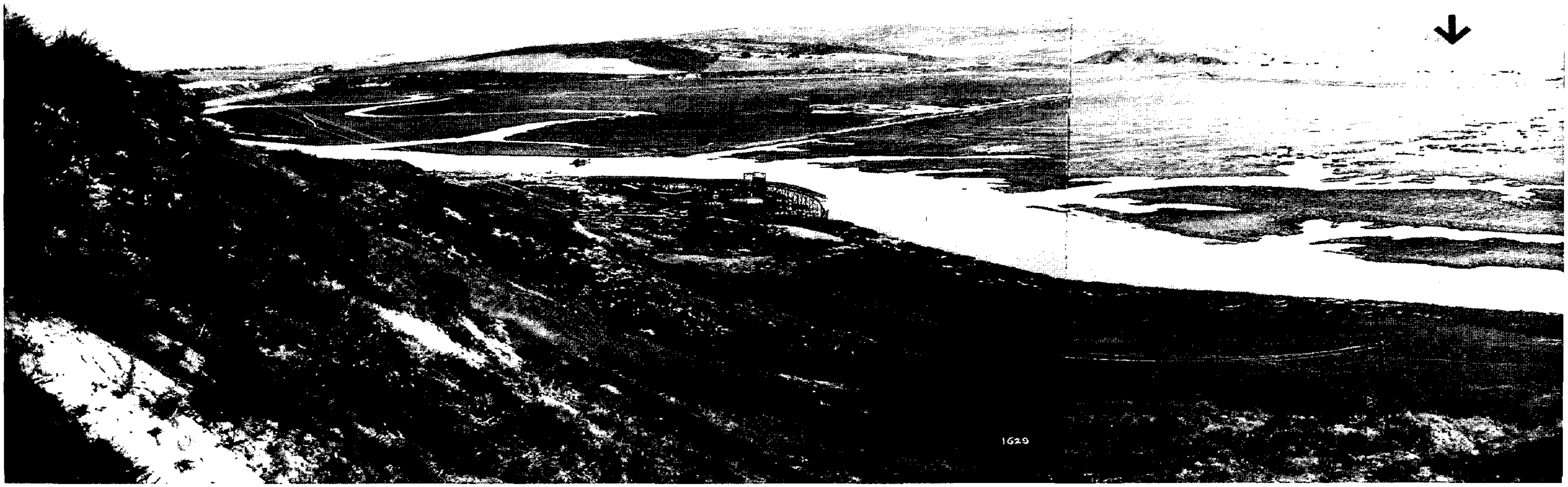
The gradual accumulation of sediment over years of average rainfall may go unnoticed, but have pronounced effects on the wetland. Los Peñasquitos Lagoon clearly shows these effects. During five years of grading for housing developments just upstream, a delta at the mouth of Carmel Valley Creek increased in height by 6 to 7 feet and smothered the pickleweed marsh with sand. This new sediment lies above tide level and is not saline. Riparian forest now grows in the new sediment, where previously salt marsh vegetation had grown. The animal species using the riparian habitat will be completely different from those in the salt marsh.

Following a large storm, large deposits of sediment will not only smother the animals living in the estuary bottom, but also completely change the sediment type. The animals that recolonize the new sediment will greatly differ from the previous inhabitants. For example, the distribution of clam species in intertidal areas is related to the grain size of the sediment. Purple clams prefer coarse sand, while littleneck clams inhabit areas of finer sediment. California jackknife clams are found in medium to fine sand, and the white sand clam mostly in medium-sized sand. If fine sediment from watershed erosion covers an intertidal area, only the littleneck clams will recolonize the site previously inhabited by four clam species. A larger inflow of sediment could change this clam bed into a flat dominated by other invertebrate species, such as worms. If the amount of sediment is extreme, or the inflow occurs during a mouth closure, the entire intertidal flat could be filled in above high-tide level and become a marsh or even an upland.

Wetland plants and animals can survive many changes. They inhabit a waterborne world where physical conditions vary with both the season and the time of day. But once the environment changes beyond their tolerance levels, these species die, and the basic character of the wetland is transformed. For many of San Diego's wetlands, this transformation has already occurred.



littleneck clam (Protothaca staminea)



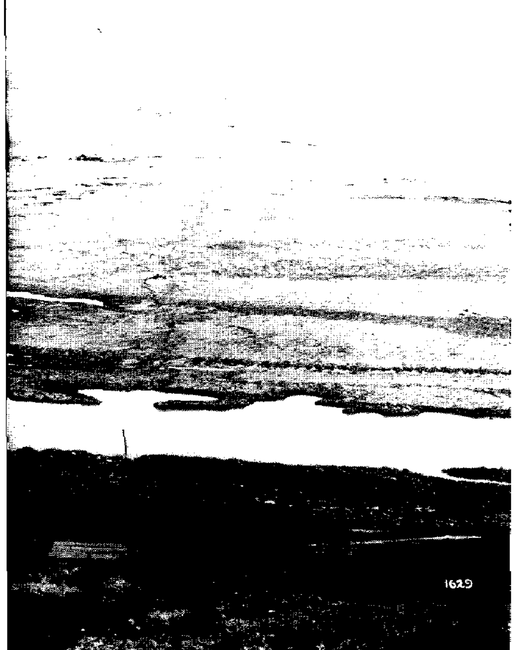
SAN DIEGO HISTORICAL SOCIETY—TICOR COLLECTION

The Edge Gets Thinner

When the Spanish traversed this land, they traveled far to the east of the coastline. Their route was El Camino Real, which traces the upper border of many of San Diego's lagoons and bays. They chose this route because the wetlands were major impediments to travel. Horses and wagons could only cross at the far eastern end.

Most of San Diego's coastal wetlands are no longer tidal, and many have lost most of their marshes and mudflats. Over the entire San Diego coastline, 75 percent of the wetlands are gone. This loss has led to such dramatic population declines in several species that they now face extinction. Although no one counted migratory birds in the 1800s, historic accounts give the impression there were thousands more than we see today. Their numbers declined as the mudflats, their favorite feeding area, were filled. Fish populations also have declined with the loss of shallow tidal habitat.

Let us trace the changes in two of San Diego's wetlands—San Dieguito and Batiquitos lagoons. Both have undergone drastic alterations causing declines in wildlife. We have chosen these areas because they have each undergone a different form of loss. Despite changes, thousands of migratory birds still depend on these areas. These wetlands are more valuable



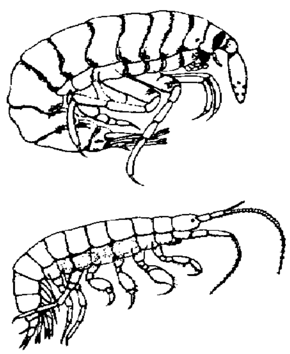
WILLIAM BROWN

Far left: San Dieguito Lagoon as viewed from Crest Canyon in 1915. Arrow indicates current location of I-5. Left: The Del Mar Fairgrounds was built on 200 acres of wetlands in San Dieguito Lagoon.

than ever before because so few wetlands are left.

We know from archaeological and historic evidence that these wetlands were fully tidal systems before European settlement. We do not have records of the amount of marsh, mudflat, open water, or other wetland habitats that existed in the lagoons in the early 1800s. The earliest maps date from 1887. However, since these were tidal estuaries, we can assume that there was some salt marsh as well as other intertidal habitats in each lagoon.

San Dieguito Lagoon was the largest of San Diego's six lagoons. Its wetlands once stretched inland well past the present-day Interstate 5 bridge. Historical maps and records indicate that the lagoon mouth was open most of the time until the 1940s. Oyster beds and cordgrass marsh occurred here—both dependent on regular tidal flushing. Between 1910 and 1975, the marsh was filled to build roads and highways, a race track and fairgrounds, a shopping center, and a military airfield. Upstream of Interstate 5, sedimentation has been extreme. Areas once inundated by the tide are now 12 feet above sea level. Treated waste water was released into the lagoon for over 20 years. Much of the freshwater flow in the San Dieguito River that reached the lagoon was impounded with dams by the 1920s. By the early 1940s, the lagoon mouth was closed most years. Since then, the value of the wetland habitat has steadily declined.



amphipods (Vibilia spp.)

Overall, direct filling and sedimentation have destroyed more than half of this lagoon. The lagoon has tidal habitat—high salt marsh, tidal channels, and mudflats—in its remaining area. Along the east side of I-5, many remnant "pieces" of salt marsh delineate the former extent of tidewater. These pieces are now isolated from the main tidal channel and are quickly changing to upland as adjacent lands are plowed for agriculture. A 1983 project funded by the Conservancy and the City of Del Mar restored tidal flows to a 70-acre area. Overall, San Dieguito Lagoon has been greatly reduced in size, leaving much less habitat for wetland animals.

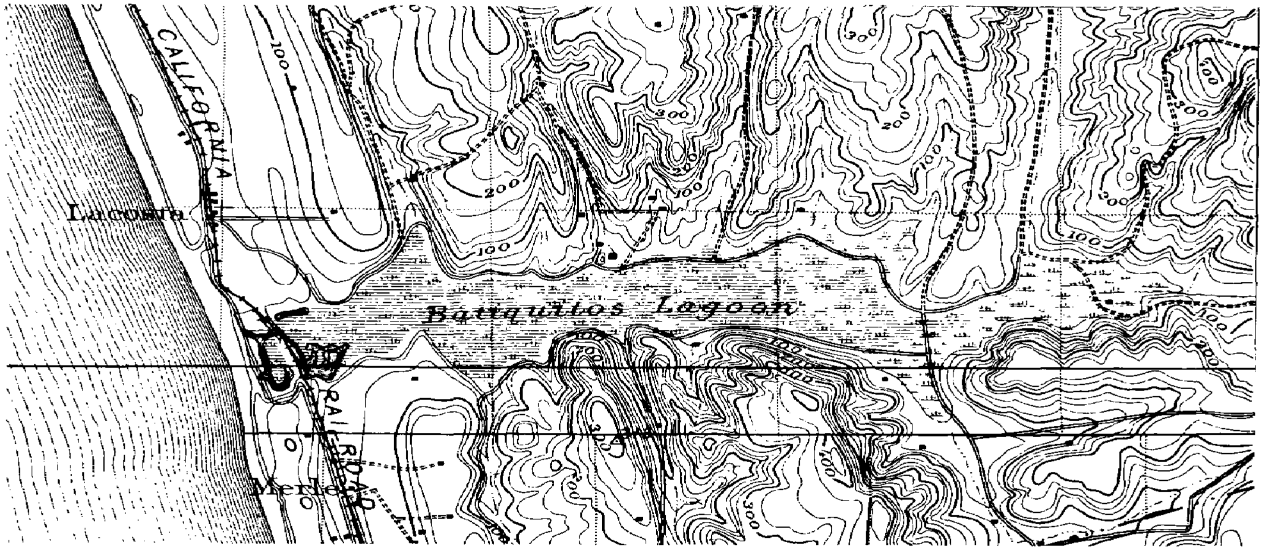
Batiquitos Lagoon, once a fully tidal system, no longer opens to tidal action. Sedimentation has reduced its tidal prism to a fraction of its former size, and three road-fills block water flows. The Highway 1 bridge constricts the lagoon mouth and plays a major role in keeping the lagoon closed to the tides.

Stormwater now fills Batiquitos Lagoon during winter months. In dry years, water depths may only reach several inches. In wet years, the lagoon may hold up to 12 feet of water. Summer heat evaporates this water, concentrating salts remaining from the time the lagoon was tidal. As the salts concentrate, the remaining water becomes hypersaline and sometimes reaches over 60 ppt salt, almost twice the salt concentration in seawater. During dry years, the lagoon waters shrink or disappear completely.

Batiquitos Lagoon now has a highly variable water regime that changes the types of habitats available from year to year. A narrow fringe of salt and brackish marsh covers the edge of the lagoon. Winter submergence with fresh or brackish water favors brackish and freshwater species, while hypersaline and dry summer conditions will favor certain salt marsh plants. The marsh may change dramatically as the annual water regime varies.

WILLIAM BROWN

Batiquitos Lagoon is now closed to tidal flows.

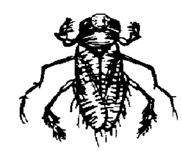


Batiquitos Lagoon in 1898. The constriction of the mouth by the railroad already caused frequent closures. Marsh once extended east of El Camino Real.

Some recent sampling found very few invertebrate species inhabiting the lagoon bottom. Three insect species, one species of ostracod (a microscopic crustacean), and one snail species made up the majority of the organisms found. The most plentiful invertebrate was a small aquatic insect, the water boatman. The lagoon supports huge blooms of these highly mobile insects, which feed on algae and other detrital material, and are able to withstand a very wide range of salinities. For migratory birds, these insect blooms are a major source of food, but they are only available when water levels are shallow. Deep water excludes most shorebirds and dabbling ducks from feeding.

Although it is no longer tidal, Batiquitos Lagoon supports several thousand migratory shorebirds and ducks when water levels are low. The birds have adapted to feeding on the insects and ostracods now present rather than the mudflat invertebrates more common in a tidal lagoon. Most fish and invertebrate species cannot survive in the lagoon and appear to have been lost from this wetland. Sedimentation continues to fill the lagoon at a rate that could turn it into an upland in less than 50 years.

Most of these wetland losses are permanent. In the case of San Dieguito Lagoon, the habitat that remains is healthier than it was ten years ago, but only as a result of a million-dollar restoration project. Another major restoration project is planned for Batiquitos Lagoon. Numerous laws now regulate the filling of coastal wetlands. But have these efforts gone far enough? Will our remaining wetlands disappear as well? The next section reviews the current problems our wetlands face.



water boatman (Trichocorixa reticulata)

Endangered Species: The Homeless of the Animal World

When I hear of the destruction of a species I feel as if all the works of some great writer had perished.

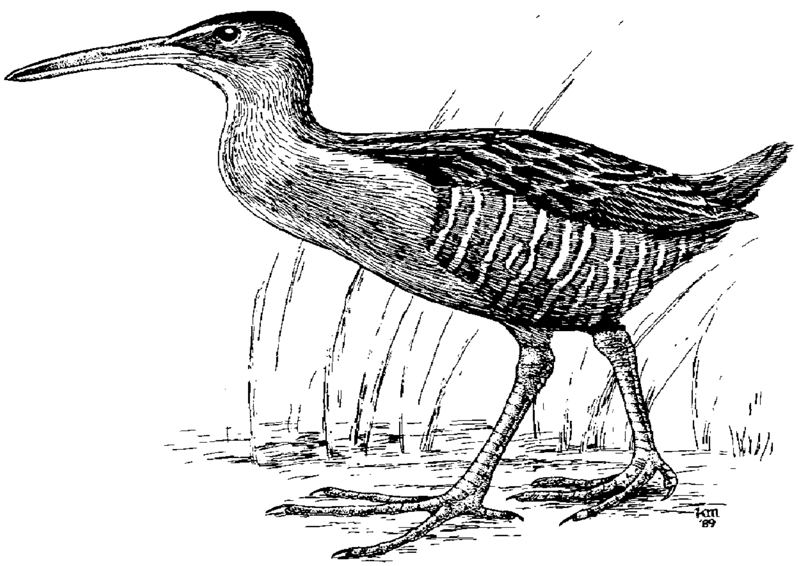
– Theodore Roosevelt

Along most of the Southern California coast, marinas, houses, harbors, and roads have replaced vast estuaries and wetlands. The few pieces of marsh remaining are often in poor condition, surrounded by development or cut off from tidal flows. For the animals that depend on marshes and estuaries, this loss of habitat has been devastating. Drastic population declines have accompanied human expansion on the coast, creating "endangered species" whose existence is in peril. Six bird species and one plant species are now so diminished in number that any further reductions could cause their extinction. The federal and state Endangered Species acts provide a measure of protection to these plants and animals. Preservation of their habitat is the key to stopping their decline. Each time more nesting or feeding habitat is lost or human disturbance is increased, the survival of these species is threatened.

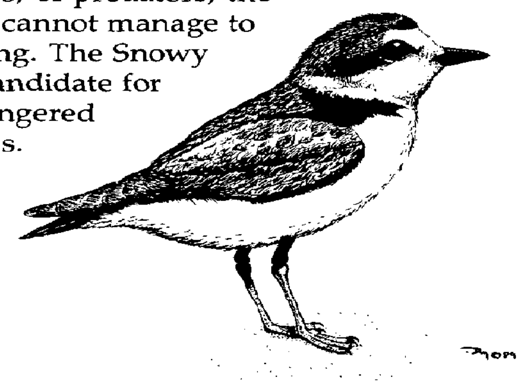
The **California Least Tern** once had the beach to itself and nested in large, noisy colonies on the upper beach sands and dunes. Terns hunt small fish in nearby estuaries and migrate south for the winter. Since the beaches of Southern California have become famous for sunbathers and surfers, the terns have had to look elsewhere for nesting spots. They have not located many, and their numbers have steadily declined. When they do nest, they are often disturbed by dogs or other predators and lose their eggs or hatchlings. The least tern is officially listed as a federal and state endangered species.

DANA ECHOLS

The **Light-footed Clapper Rail** is a resident of the salt marsh. It lives year-round in the dense cover of cordgrass, feeding on invertebrates, larval fish, and vegetation. The platform nest it builds in the marsh rises during high tide, but does not float away because the tall grass holds it in place. Now few healthy stands of tidal cordgrass marsh remain, and these only occur in consistently tidal estuaries. Los Peñasquitos Lagoon once supported this species. The current non-tidal condition of the lagoon does not favor the survival of either cordgrass or the clapper rail. The Light-footed Clapper Rail is found only in Southern California salt marshes and is listed by the state and federal governments as an endangered species.



The **Snowy Plover** is a small shorebird that once nested on open beaches and dunes. Like the tern, it has had a hard time finding nesting spots. It has resorted to using salt flats, levees that surround salt ponds, and old fill sites. When disturbed by humans, pets, or predators, the plover often cannot manage to raise its young. The Snowy Plover is a candidate for federal endangered species status.



Also endangered is the **Belding's Savannah Sparrow,** a small songbird that lives and nests in the pickleweed marsh and has adapted to drinking seawater. It eats insects, seeds, and some vegetation. When nesting, sparrows are sensitive to disturbance and have been known to desert their nests if their egg-laying cycle is interrupted. The sparrow has suffered population declines with the loss of suitable high pickleweed marsh. The state has recognized it as an endangered species.

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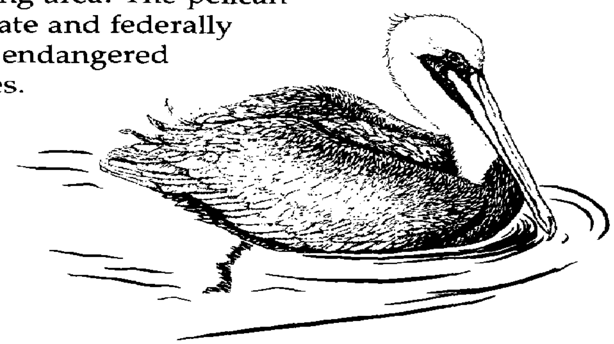
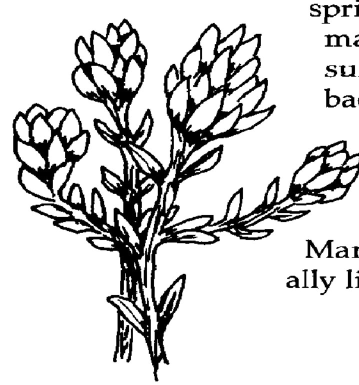
The **Least Bell's Vireo** is a small migratory songbird of riparian wetlands. Since riparian forest has suffered nearly the same level of destruction as salt marsh wetlands in Southern California, this bird must struggle to find appropriate nesting sites. It must also contend with nest parasitism by the Brown-headed Cowbird, a species that frequents agricultural lands. As agriculture has spread to the edge of riparian lands, the cowbird has increased in numbers. Its reproductive strategy involves laying eggs in the nests of other birds such as the vireo. The cowbird chicks then outcompete the vireo chicks, and the vireo parents raise young of the wrong species. The vireo is a state and federally listed endangered species.

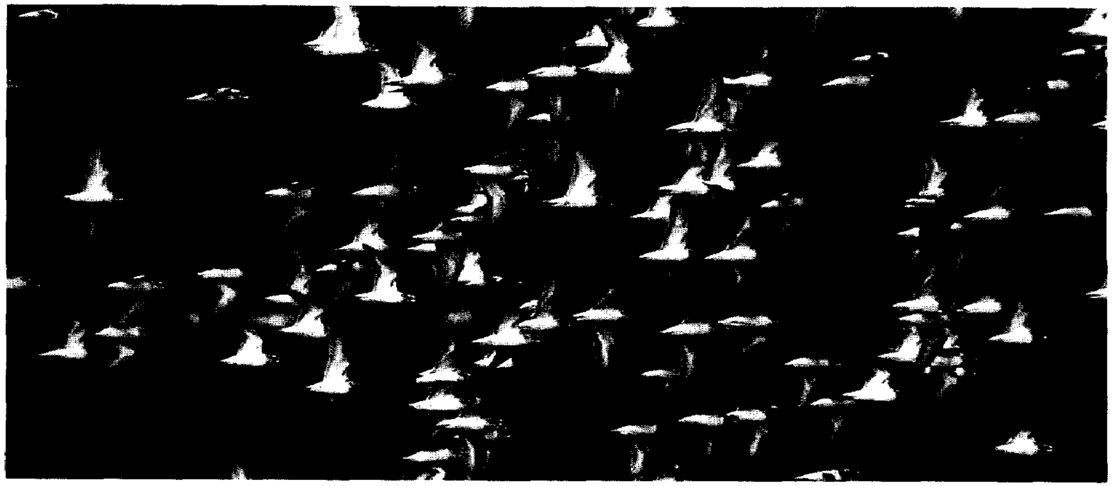
The **Brown Pelican** feeds and rests on the open water of bays and estuaries. It makes spectacular head-first dives into the water to catch fish. The decline in pelican populations is directly attributable to pesticide pollution, particularly DDT, which has concentrated in the food chain and caused a thinning in bird eggshells. When a parent sits on its egg, the egg breaks. Since the banning of DDT in the 1970s, the pelican has made a comeback, but still relies on estuaries as a source of fish and a roosting area. The pelican is a state and federally listed endangered species.

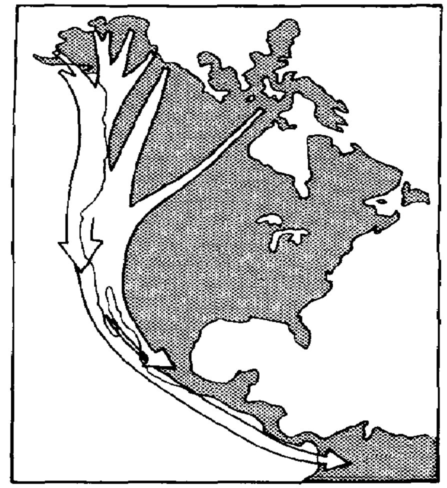


The **Salt Marsh Bird's Beak** (*Cordylanthus maritimus maritimus*) is an endangered plant of the high salt marsh zone. It is an annual, germinating in spring and parasitizing other marsh plants to survive the summer and then dying back. Both loss of marsh areas and human disturbance to marshes have severely reduced populations of this plant. Salt Marsh Bird's Beak is a federally listed endangered species.



KENNETH W. GARDNER

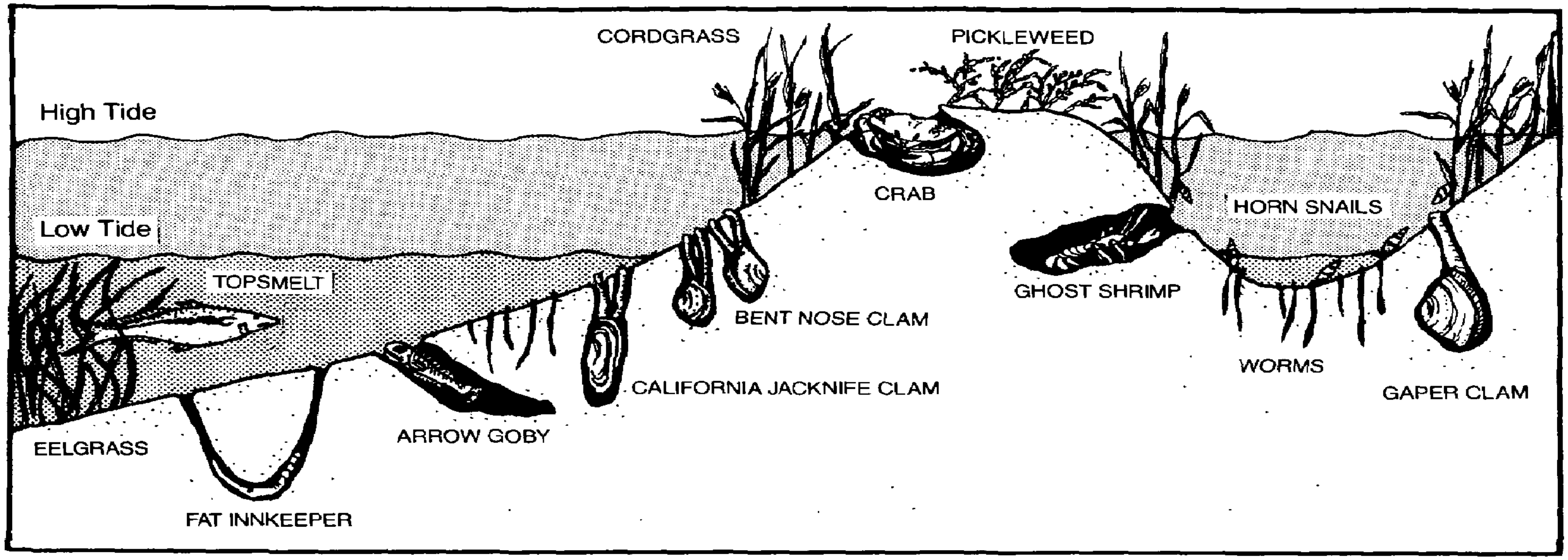




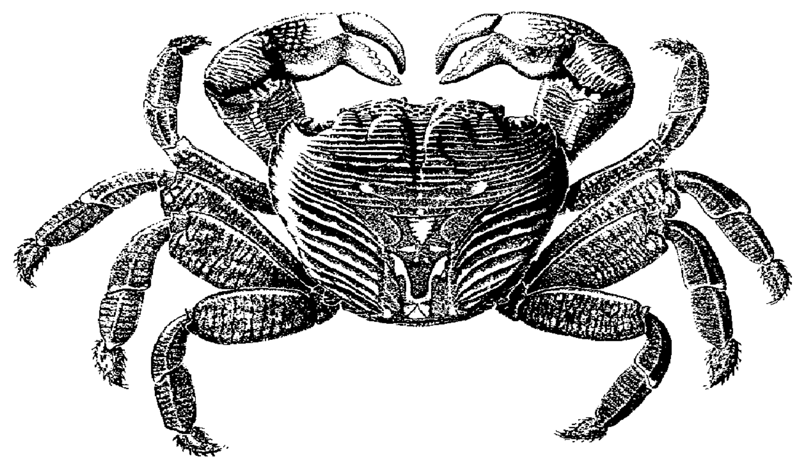
Migration

Each year millions of birds, fish, and mammals thrive in coastal wetlands. Birds are most conspicuous among the wetland inhabitants. The yearly arrival of flocks of shorebirds and waterfowl signals both the end of summer and the renewal of a timeless pattern of movement. The migratory flyway along the Pacific coast has linked San Diego to the Arctic and parts of the Northern Great Plains for centuries. Millions of shorebirds nest on the wet tundra of Alaska and Canada, exploiting the profusion of insects, invertebrates, and fish of the arctic summer. Many duck species nest in the prairie pothole wetlands of the Great Plains. After fledging their young, these flocks return south, stopping at the bays and estuaries of the Pacific coast or at interior freshwater wetlands. Each wetland is a link in a chain of feeding stations where the birds must find adequate food to survive the winter season.

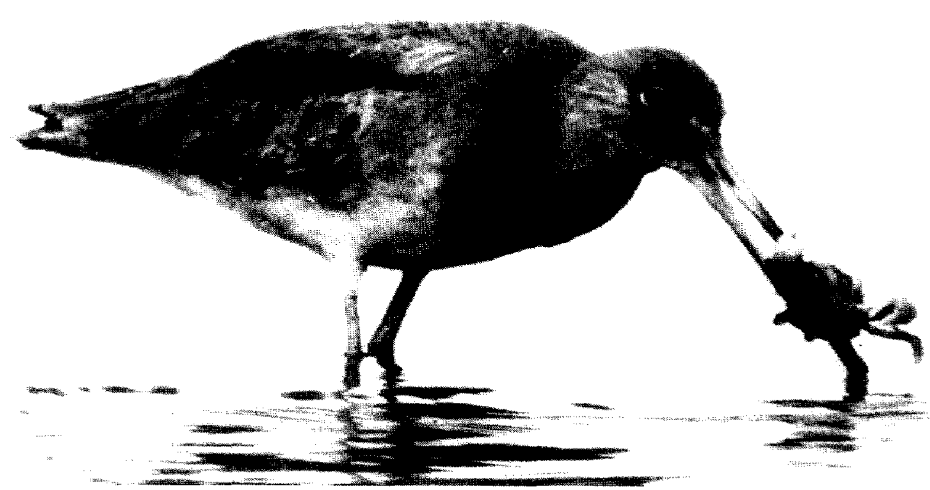
Wetland birds come in all shapes and sizes, from small sandpipers to terns to dabbling ducks. Most are highly specialized to catch and eat only particular animals. Shorebirds, for instance, each have a different bill shape and leg length. A short-legged bird with a small bill pokes in the mud surface for small worms and crustaceans. Longer beaks probe deeper, curved beaks scoop through the mud surface, thick beaks crack shells. One species, the Northern Phalarope, turns in circles to stir up insect larvae and small crustaceans from the muddy bottom and then snatches them out of the water. In contrast, a Forster's Tern dives into the open water to grab small fish, while herons and egrets stand motionless, then suddenly stab a fish. Dabbling ducks flip end-up to graze on snails, crustaceans, and vegetation in shallow water. Diving ducks, grebes, cormorants, and others swim underwater in pursuit of small fish. Each bird species feeds on particular types of animals—worms, clams, crabs, shrimp, crustaceans, marsh insects, or small fish.



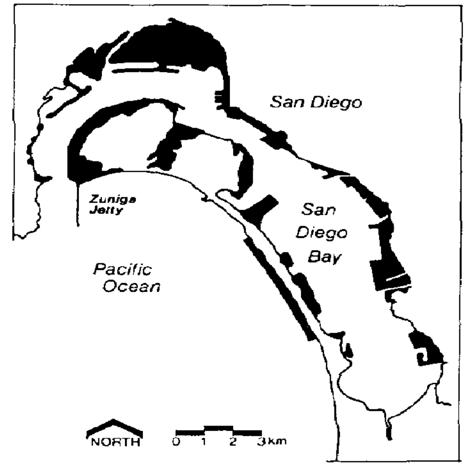
Each wetland contains an assemblage of habitats, each of which provides different invertebrates and fish for certain bird species. Mudflats, for instance, are a smorgasbord of different animals. Surface dwellers like horn snails and amphipods graze the thin layer of algae covering the mud. Crabs venture out of their mudflat burrows to search for bits of food during low tide. But most mudflat residents are hidden, residing from barely beneath the surface to several inches down. They include worms of many sizes, shrimp, several types of clams, and other mollusks. Each invertebrate filters copious amounts of tidal water, and sometimes mud as well, to sieve out bits of food. Large and small shorebirds poke and probe for different invertebrates. The bill of each bird species reaches a different level in the mud and sucks out a different type of invertebrate.



rock crab (Pachygrapsus crassipes)



IAN C. TAIT



Wetlands filled in San Diego Bay

A large flock of birds overwintering in an estuary attests to the enormous productivity of wetland systems. The photosynthetic material of the plant cell turns sunlight into sugar and creates food. Studies at Tijuana Estuary by Joy Zedler found that the mats of algae which carpet the open spaces in the marsh contributed a very large percentage of the primary production of the estuary. These algae and the marsh plants form the base of the wetland food web. This plant material finds its way into the animal world in several ways. Snails, crabs, larval fish, amphipods, and other invertebrates graze the algal mats. Bacteria and fungi break down dead plant parts and algal cells into bits of detritus. Tidal waters circulate a soup of detritus and free-floating algae, called plankton, through marsh channels and over mudflats, bringing food to worms, clams, small fish, crabs, and other animals. These small animals in turn are eaten by larger fish and birds. Even larger predators hunt these birds and fish.

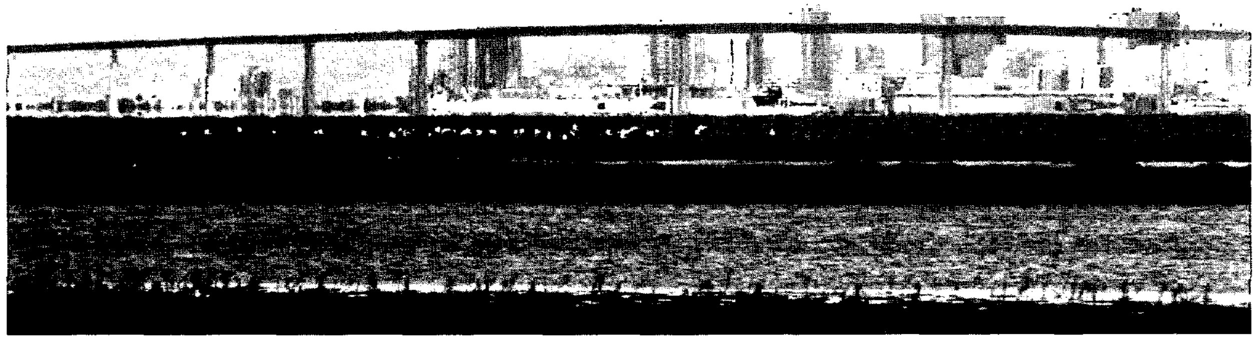
This web of interaction is intricate and vulnerable. Loss at one level—such as an invertebrate population wiped out by a sewage spill affects all of the higher levels. Many of the migratory bird flocks along the Pacific Flyway depend upon the health of San Diego wetlands. Each coastal wetland is both a local asset and an international resource. With over 75 percent of California's coastal wetlands already gone, the loss of even one wetland in the chain strains the remaining links and forces bird populations to depend on an even smaller food supply. On the San Diego coast many researchers believe that the birds make use of different coastal wetlands during the winter, depending on which one has the right conditions to produce a large food base. Since each wetland varies in the types of habitat it contains, different species will concentrate in different lagoons or bays, making each wetland and its continued health an essential factor in the survival of these birds.

Preserving What's Left

Going back to California is not like going back to Vermont, or Chicago; Vermont and Chicago are relative constants against which one measures one's own change. All that is constant about the California of my childhood is the rate at which it disappears.

– Joan Didion

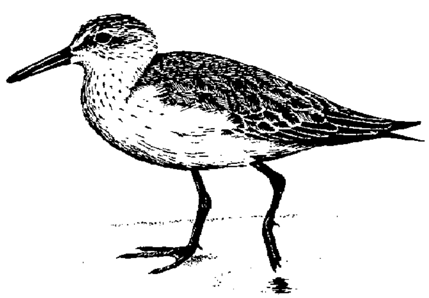
SAN DIEGO UNIFIED PORT DISTRICT



Each year, half a million more people move to California from other states and abroad, and many of them settle in San Diego County. To accommodate this enormous population growth, subdivisions, industrial parks, shopping centers, and freeways are hastily being built, especially near the coast. For coastal wetlands, this development means rising sedimentation rates from eroding watersheds, raw sewage spilling into lagoons from overloaded sewer lines, and pressures to fill remaining wetlands as coastal land prices soar. San Diego's largest wetland, Tijuana Estuary, is now on the verge of ecological collapse caused by sewage inflows and sedimentation. Many of the county's lagoons could fill with sediment in the next 30 to 50 years.

Theoretically, the wetlands are now protected by law and government regulations. Several state and federal agencies regulate filling and dredging through permit authority. Other state and federal agencies work to preserve remnant natural wetlands and restore the health of degraded wetlands. But can these public efforts suffice to ensure our wetlands' survival? There are strong indications that the answer is no.

Even when the laws and regulations are diligently implemented and fully complied with, they offer insufficient protection. Coastal wetlands can only be protected within the context of their entire system—both watershed and tidal entrance channel. Coastal developments and highways block beaches and stop tidal inflows to wetlands. Projects upstream have major impacts on coastal wetlands. But jurisdictional lines fail to provide for a broad enough view. Unless local governments assure that developments throughout each watershed are planned with consideration of their downstream effects, wetlands will silt up, lose their tidal flow, and require repeated costly restoration at public expense.



Western Sandpiper

Wetland Preservation and Restoration: A Public Investment

In the 1970s and 1980s considerable acreage of coastal wetlands was bought and preserved. State and federal agencies, and private conservation groups spent millions of dollars in San Diego County to purchase wetlands and create a series of reserves and refuges. As a result, most of the north county lagoons as well as parts of Mission Bay, San Diego Bay, and most of Tijuana Estuary are now publicly owned.

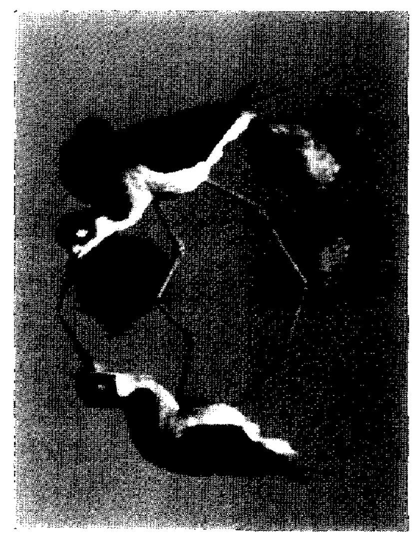
However, to preserve these areas as wetlands it is not enough to own them or to regulate filling or dredging them. Almost all of these wetlands suffer from extremely high sedimentation rates due to upstream development that is completed without adequate erosion control measures or stormwater planning. Local governments typically regulate land grading in watersheds and rarely have an adequate erosion control ordinance. Additionally, few inland local governments even recognize a need for strict erosion control and allow such destructive practices as land grading in winter rains, and clearing and grading of stream channels. The typical reason given for not requiring better land development practices is economic—additional requirements burden the developer. However, this reasoning disregards the fact that these developments create a growing need for expensive restoration projects to maintain downstream wetlands. Without any restoration, sedimentation will change these public reserves into uplands.

Wetland restoration projects may remove not only sediment, but also structures; they may restore tidal or freshwater flows, re-create particular habitats, or enhance the productivity of the wetland. There are restoration programs currently underway or being planned for nearly all of San Diego's publicly owned wetlands. In most instances the restoration is required to remove accumulated sediment or to restore tidal flows. Most of these will be financed by large sums of voter-approved bond funds administered by the Coastal Conservancy and several other agencies or by other public funds.

Restoration projects represent a hopeful trend for coastal wetlands. They are complex, require detailed and thoughtful planning, and are often expensive. In most cases the wetland, criss-crossed by road fills, cannot be restored to its original state. Instead its value to wildlife can be enhanced, and it can be carefully managed to avoid further damage from its urban neighbors. Several restoration projects have occurred in San Diego.

A portion of San Dieguito Lagoon was restored in 1983 to remove accumulated sediment and re-create tidal habitats. The southwestern corner of the lagoon, called the "fish hook," was smothered by an avalanche of sand in the early 1980s. A subdivision on the bluff above the lagoon had a poorly designed stormdrain system, which released large volumes of stormwater into Crest Canyon, a local city park. After several large storms, Crest Canyon became a deep gully, sending tons of sediment directly into the lagoon.

In 1983 the Coastal Conservancy granted $1.3 million to the City of Del Mar to dredge this sediment out of a 70-acre area and to create a tidal basin with mudflats. The dredging generally followed a plan for this lagoon that the Conservancy, City of Del Mar, and local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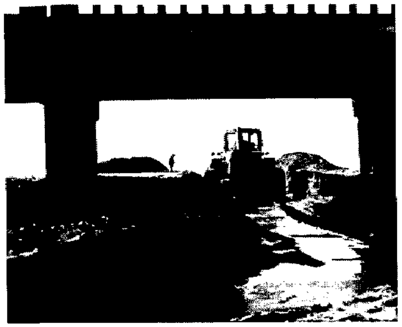


DON COPPOCK

A bulldozer clears the entrance channel of Los Peñasquitos Lagoon. The Los Peñasquitos Lagoon Foundation has been carrying out a program of opening and monitoring the lagoon since 1986.

citizens had developed in 1978. The dredge spoils were placed back into the gullied canyon and planted over with native trees and shrubs. The City of San Diego, using over $300,000 of its own funds, installed new underground stormwater pipes through Crest Canyon and corrected the original problem. The lagoon mouth was bulldozed open, and tidal flows were restored to the lagoon and reached up the river channel to El Camino Real.

The newly dredged tidal basin sprang back to life. Monitoring studies found that fish and invertebrates quickly invaded and multiplied, bird life increased in numbers and diversity, and endangered species started visiting the area. The project is generally regarded as successful. By removing sediment and restoring tidal flushing, it restored habitat that had been lost from the lagoon. The project was completely funded by public money. The 107-acre reserve is owned by the Department of Fish and Game. Volunteers from local nonprofit groups monitor the wildlife of the reserve.

Another promising enhancement project is underway in Buena Vista Lagoon. It is especially interesting because it addresses the cause of sedimentation in the wetland by restoring the watershed. Buena Vista Lagoon is an impounded freshwater lagoon that has filled in considerably. Large urban stormwater flows are eroding Buena Vista Creek. As development of the watershed continues, this problem increases, and the long-term prognosis for the lagoon is not good. Without either continued dredging of the lagoon at a cost of $2 million every few years or watershed restoration, the lagoon could completely fill in within 20 years.

The Conservancy, working with the three cities in the watershed, the Buena Vista Lagoon Foundation, and the lagoon's owner, the Department of Fish and Game, completed a watershed erosion control plan in 1985. The plan called for strict erosion control measures in the three cities and for retrofitting the upper watershed to restore its hydrologic balance. In 1987 the Conservancy granted $850,000 to the City of Vista to construct a large stormwater detention basin to lower the peak volume and the erosive force of stormwater, and to design a creek channel with riparian vegetation and drop structures to slow water velocities and curb erosion of the channel. Another $1 million or more will be needed to completely restore the watershed.

Wetland restoration is a science in its infancy and is often considered more of an art form by its practitioners. But with careful steps, detailed study, and large amounts of funds, restoration can perhaps undo past degradation and return many of San Diego's coastal wetlands to a healthier state.

But undoing past problems will not be enough. Projects like those at San Dieguito and Buena Vista lagoons are only the beginning of what will be needed to maintain coastal wetlands as their watersheds are being developed. The effects of this watershed disturbance may not be seen for decades—until a great storm hits. We are left with a choice between reducing this disturbance now through strict local control of development practices or by spending millions of dollars of public money to restore the damage later. Our grandchildren may wish we had made a better choice.

How You Can Help

As a resident of San Diego County, you can make a difference in preserving coastal wetlands. The following list suggests ways to get involved.

Get to know your wetlands. This booklet includes a listing of public trails and nature centers for each wetland. Experience the serenity of a lagoon or marsh or sneak a peek at some shorebirds. Maybe you'll see an endangered animal.

Join one of the many nonprofit organizations associated with San Diego's wetlands and listed in this booklet. These groups work in varied ways to preserve wetlands, monitor wildlife, and educate the public.

Contribute funds to nonprofits that are actively working to protect wetlands. Most of the groups listed are designated as charitable organizations by the IRS, and your contributions are tax exempt.

Volunteer as a docent at one of the nature centers. Contact the centers for more information.

Volunteer to patrol San Elijo Lagoon to stop trash dumping and other destructive practices. You could organize a similar squad for your local lagoon to eliminate dumping and abuse.

Volunteer to monitor bird species through one of the Audubon Society's bird walks. You will need to learn to identify bird species well and to use a pair of binoculars. Contact either of the local Audubon chapters.

Initiate a wetland restoration plan if your favorite wetland lacks one. The Conservancy can assist in funding certain plans.

Become involved in local government actions that affect coastal wetlands. You can request to receive the agenda of city council and county supervisors meetings. Copies of development proposals, EIRs, and other documents are available at the city or county offices or at a local library.

Speak out for wetland and watershed protection to your elected officials. Let them know that wetlands have a vocal constituency.

A local nonprofit group can work to revise erosion control ordinances to reflect the rules used in the coastal zone. These rules were designed to protect wetlands.

The local group or individual can visit development sites plan in hand and see if the practices being used are those required. Call the local building inspectors to report violations. One local nonprofit, the Buena Vista Lagoon Foundation, established an erosion hotline to report violations.

Local governments in a watershed can work cooperatively by forming a joint powers authority to address erosion problems. The Conservancy can assist in forming these groups and in funding watershed erosion control plans for most wetlands.

LIZA RIDDLE

Mudflat in lower San Diego River channel

Nonprofits can petition local governments to revise their policies regarding creeks and zone them as open space or conservation areas. A policy of retaining natural vegetated creek channels should be adopted.

Review proposed projects and plans to see if the following questions are adequately addressed. Recommend that the responsible government agency address all these questions in their environmental review:

Wetland Filling or Dredging

Recent studies by Joy Zedler of San Diego State University compared a man-made mitigation marsh with a nearby natural marsh in an evaluation of a wetland fill project for a highway expansion at the Sweetwater Marsh. The research found that the mitigation marsh does not function as a natural marsh and does not provide the habitat it was designed to compensate for. Mitigation is a widely applied concept based on the assumption that man-made wetlands function the same as natural wetlands. This research, the first of its kind, seems to prove this assumption to be false and points to a need to preserve existing wetlands and relocate projects out of wetlands to upland areas. Typically the U.S. Army Corps of Engineers and California Coastal Commission have the primary permit authority over filling and dredging in coastal wetlands. The most pertinent questions to ask:

- Is fill absolutely necessary or can the project be relocated or designed to avoid wetland losses?
- Is mitigation proposed to compensate for the fill? If so, is the mitigation nearby and of the same habitat type?
- Are endangered species using the proposed fill site, and how can their use of the mitigation site be assured?
- Is the project sponsor providing long-term monitoring, maintenance, and, if necessary, alteration of the mitigation site to achieve a functioning wetland, not just a specified acreage of wetland plants?

Developments Near Wetlands

Projects that directly border lagoons, marshes, and creeks can cause the greatest amounts of both sedimentation and disturbance. The local government and sometimes the Coastal Commission will have permit authority. They should consider the following questions:

- Is there an adequate buffer (a minimum of 100 feet, but the larger the better) between the development and the wetland?
- Is the development designed so that noisy,

KARYN GEAR

intense activities are located away from the wetland to protect wildlife?

- Is there a provision for fencing to protect wetland wildlife from domestic pets?
- Are erosion control measures adequate to avoid silting up the wetland?

Watershed Developments

In most cases the local government has direct permit authority over all subdivisions, commercial and industrial developments in upland areas. Large projects typically require an EIR that should address all of the following questions and determine if the project will significantly affect downstream wetlands. There are three primary types of problems caused by watershed developments—increased erosion, loss of natural creeks, and increased stormwater flows.

Erosion Control The goal should be for the project to have no detrimental effects on water quality downstream, by retaining all disturbed soil on the grading site with no movement onto adjacent streets or down creeks and stormdrains.

- Does the project use the minimum of grading and limit grading on steep slopes?
- Is there a requirement for the project sponsor to post a performance bond with the local government to ensure that grading is done correctly?
- Is grading prohibited during the winter rainy season, October 15-March 15? It is very important that this be required.
- Are sediment basins, straw bales, or other erosion control measures required?
- Are there provisions that the project sponsor have slopes stabilized and revegetated prior to October 15?
- Are there provisions that the project sponsor perform long-term maintenance of sediment basins and other structures?

Creek Improvements The goal should be to retain natural vegetated creeks that do not increase the velocity of stormflows and cause downstream erosion. In addition to local government jurisdiction, the Department of Fish and Game and Army Corps of Engineers probably have permit authority over the creek.

- Does the project alter creeks on the site?
- Is there a provision for vegetated channels that retain natural or replanted riparian habitat?
- Is there a provision that the new creek channel not increase the velocity of stormwaters in excess of 6 feet per second for the 100-year flood and not cause erosion of creeks downstream?

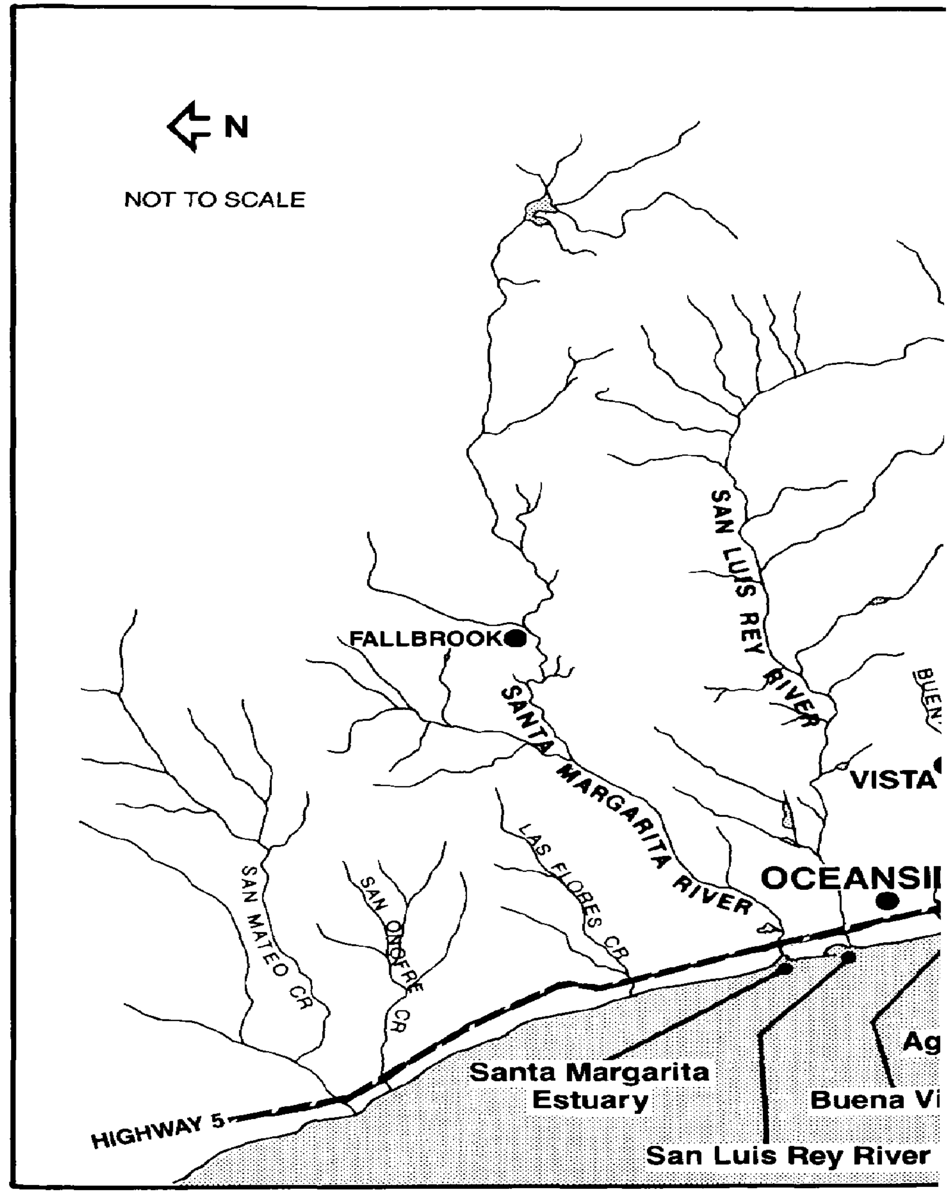
Stormwater Management Most developments are designed with the notion of moving stormwater off the site quickly with little regard for its effect on downstream creek channels or canyons. Most local cities and counties have master drainage plans that are periodically updated and should address the overall effect of watershed development and stormwater on creeks and wetlands.

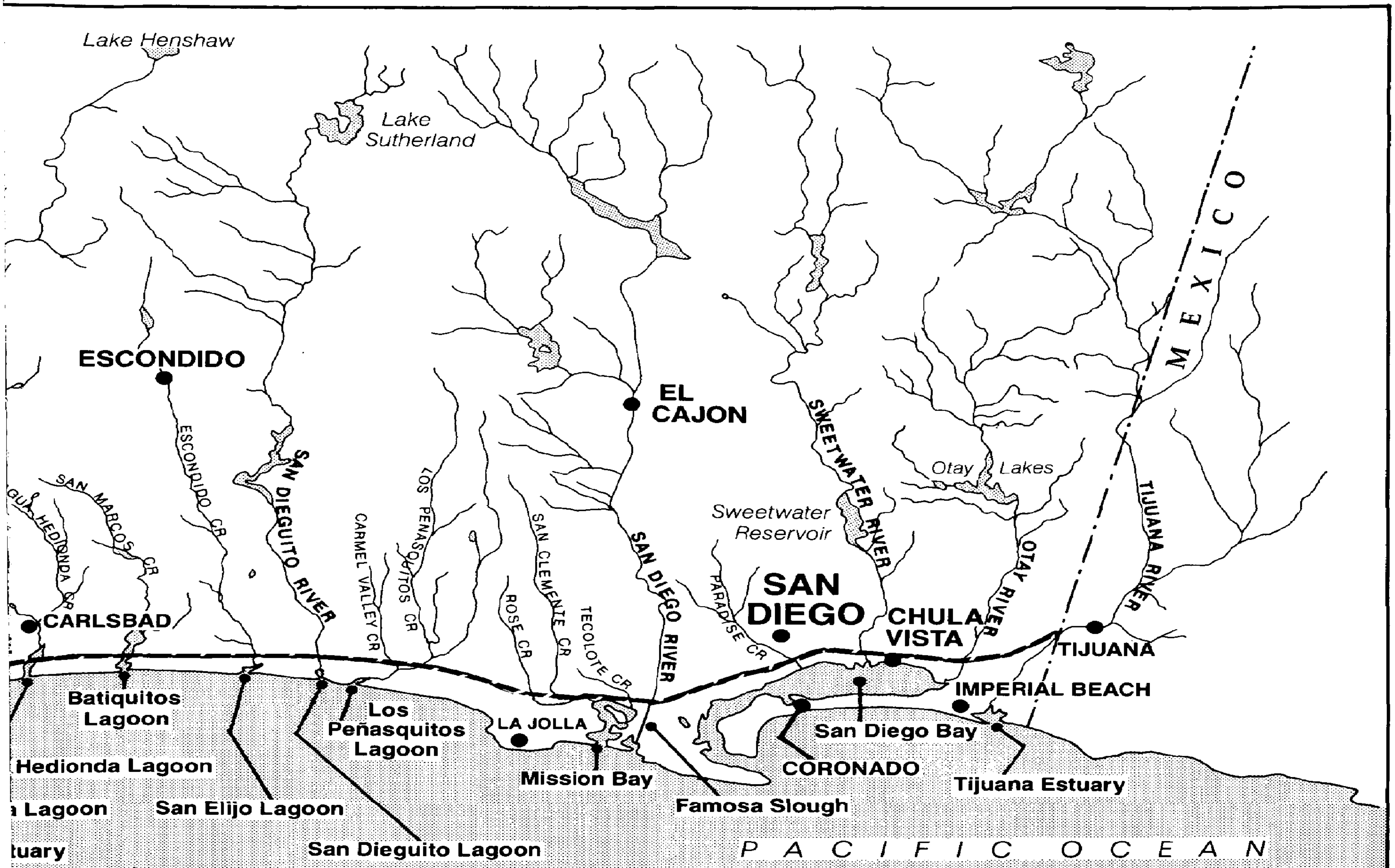
- Does the project provide that peak stormflows leaving the site shall not increase over the flows that occur without the project?
- Does the project employ stormwater detention basins or other measures on-site to hold peak stormflows and release them at a slow rate?
- Are the release points of stormdrains adequately protected, or will they create gullies that silt up wetlands?

Inventory of San Diego Coastal Wetlands

This map depicts the coastal wetlands and watersheds of San Diego County. We have made an effort to delineate most tributary streams within each watershed, but may have missed a few creeks. The map illustrates how large a land area drains into each coastal wetland and affects its functions and its wildlife.

The inventory which follows describes the history, natural resources, problems and public access opportunities for San Diego's eleven largest coastal wetlands. Many smaller creeks and wetlands dot the northern area of the coast. These small creeks provide habitat for migratory birds, fish and several endangered species. Beginning at the northern end of the county these include - San Mateo Creek (marsh-30 acres, 132 square mile watershed); San Onofre Creek (marsh-2 acres, 30 square mile watershed); Las Flores Creek (lagoon-10 acres, freshwater marsh-60 acres, 20 square mile watershed); French Canyon (lagoon-10 acres, 5 square mile watershed); Little Cocklebur Creek (marsh-3 acres, 5 square mile watershed); Loma Alta Slough (lagoon-8 acres, 20 square mile watershed). All but two of these areas are closed to the public due to their location on Camp Pendleton. San Mateo Marsh is managed by San Onofre State Beach. Loma Alta Slough, located in Buccaneer Beach Park in Oceanside, is an eight acre remanant of an original 40-acre wetland.





Lake Henshaw
Lake Sutherland
ESCONDIDO
EL CAJON
ESCONDIDO CR
SAN DIEGUITO RIVER
LOS PENASQUITOS CR
CARMEL VALLEY CR
SAN MARCOS CR
AGUA HEDIONDA CR
SAN CLEMENTE CR
ROSE CR
TECOLOTE CR
SAN DIEGO RIVER
SWEETWATER RIVER
Sweetwater Reservoir
PARADISE CR
Otay Lakes
OTAY RIVER
TIJUANA RIVER
MEXICO
SAN DIEGO
CHULA VISTA
TIJUANA
CARLSBAD
IMPERIAL BEACH
Batiquitos Lagoon
Los Peñasquitos Lagoon
LA JOLLA
Mission Bay
San Diego Bay
CORONADO
Tijuana Estuary
Hedionda Lagoon
San Elijo Lagoon
Famosa Slough
San Dieguito Lagoon
PACIFIC OCEAN

Santa Margarita River and Estuary

Location and Size

Estuary—Camp Pendleton Marine Base, 268 acres. Watershed—Camp Pendleton Marine Base, San Diego and Riverside counties, 740 square miles.

History

The Santa Margarita River is the least disturbed river system on the Southern California coast. The lower 1.7 miles of the river channel floods with tidewater, making it an estuary.

The earliest aerial photographs date from 1928 and 1938 and show about 370 acres of tidal channels and marsh in the estuary extending south nearly to the present location of the Oceanside Harbor. In these same photographs, the estuary of the San Luis Rey River extends far northward from its present mouth. Only a narrow strip of land separated the two estuaries, giving the Oceanside coastline an almost continuous border of wetlands.

In 1942 Camp Pendleton was established and the Del Mar Boat Basin was carved out of 153 acres of the southern Santa Margarita Estuary. Until 1970, the Marines used the salt flats of the estuary for tank training exercises. Amphibious personnel carriers practiced landing along the estuary beach berm. During this same period, wastewater was discharged directly into the estuary. These practices were stopped in the early 1970s.

Three enhancement projects have improved the habitat for wildlife. In 1965 the river channel was dredged deeper for waterfowl. Six years later, the brackish marsh along the north side of the estuary was dredged, transforming it into a salt marsh. In 1985 a one-acre least tern nesting island was constructed in the estuary.

Land Ownership

The U.S. Marine Corps owns the entire Santa Margarita Estuary, the lower watershed, and the lower 17 miles of the river. The Marines manage the estuary as a natural preserve.

Wildlife Values

The Santa Margarita Estuary provides several types of habitat for wetland wildlife and is well protected from human disturbance. Currently, the estuary west of Interstate 5 covers 268 acres, including 95 acres of salt marsh, 35 acres of open water, 7 acres of mudflat, 6 acres of brackish marsh, and 125 acres of salt flats. Monitoring studies of the aquatic life in the estuary in 1987 found 16 species of invertebrates, including mollusks, tube worms, crabs, horn snails, and 16 species of fish. Numerous waterfowl, terns, gulls, and some shorebirds use the estuary as well.

The Santa Margarita Estuary has a large number of threatened or endangered species, including the largest concentration of nesting least terns in the world. The Marine Corps has constructed a one-acre tern nesting island in the salt flat area. The terns also nest on the beach berm. Their colonies are fenced off each year for protection. The estuary also supports clapper rails in its brackish areas, savannah sparrows in its pickleweed marsh, brown pelicans on its open water, and tidewater gobies in its brackish waters. The goby is a very small fish found in only a few streams in Southern California and is a candidate for endangered species status.

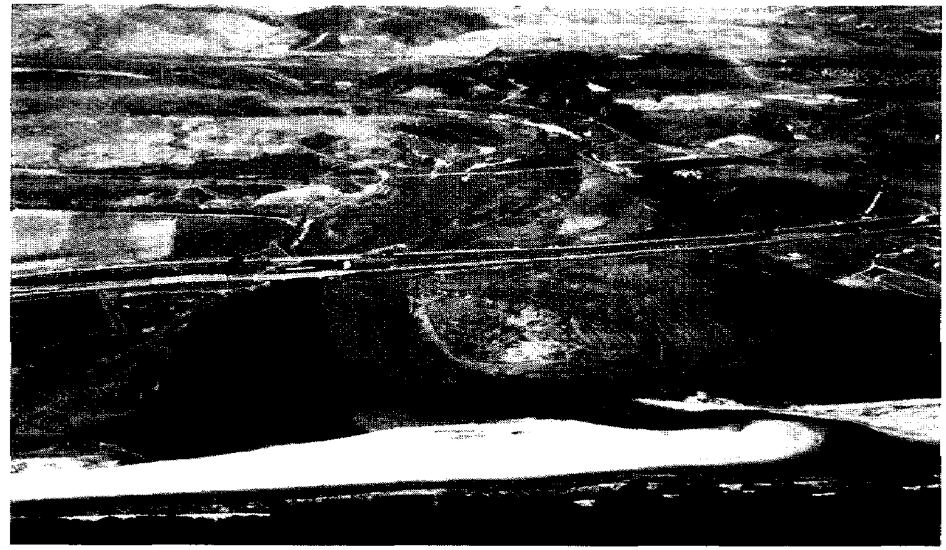
The Santa Margarita River contains the most extensive corridor of riparian habitat in the county. The largest remaining population of Least Bell's vireos occurs on this river system. The riparian habitat here is of particularly high quality because the Santa Margarita is one of the last rivers in the county unimpeded by large dams. Therefore it still floods, periodically scouring and changing the floodplain. The habitat can then regrow and contains scour pools, freshwater marsh, young understory trees and herbs, and large older trees that survive the floods.

Current Problems

Before the 1940s, the estuary mouth remained open year-round, but following 1941, it began to close periodically. Although the estuary had lost a portion of its tidal prism, the cause of the mouth closures may be related to developments down-coast. The building of the breakwater at Oceanside Harbor has blocked the southerly movement of sand and caused a buildup of sand along the Santa Margarita estuary channel. This abnormally large sand buildup makes a formidable barrier for the estuary's ebb tide, and it cannot consistently clear the channel.

The Marines plan a major enhancement project for the Santa Margarita Estuary. The main river channel will be dredged and deepened from the highway bridge to the ocean, and a second least tern island created. Several smaller channels would be dredged north of the main channel to improve the habitat for clapper rail. It isn't clear yet if these improvements will allow the estuary to maintain an open channel.

The Santa Margarita River is the longest free-flowing river in coastal Southern California. Two small dams impound tributary streams, but 27 miles of the main river are undammed. The town of Fallbrook has been attempting to build a dam on the Santa Margarita River since the 1960s, but has met with great opposition from local conservationists. Such a dam would affect large areas of Least



WILLIAM BROWN

Bell's Vireo habitat. The Marine Corps no longer supports damming the river. However, the Fallbrook Public Utilities District continues to pursue its proposal.

In Riverside County near Temecula some large land development projects are being planned. The land grading envisioned for these projects could cause a great deal of sedimentation into the river and estuary.

Public Access

Camp Pendleton owns and manages the Santa Margarita Estuary for protection of its natural resources. Public access is not allowed without specific written permission of the commanding general and then only for scientific research purposes.

The Friends of the Santa Margarita River is a nonprofit membership organization that provides information about the river and the estuary. Contact: P.O. Box 923, Fallbrook, CA 92028.

San Luis Rey River

U.S. ARMY CORPS OF ENGINEERS

1936

Location and Size

Lagoon—City of Oceanside, 40 acres.
Watershed—City of Oceanside and San Diego County, 558 square miles.

History

The San Luis Rey River once flowed into a 100-acre estuary before reaching the sea. Both the 1888 and 1898 maps of the San Luis Rey River indicate the river valley was filled with wetlands. Marsh was indicated from bluff to bluff and filled most side canyons. These early maps do not differentiate types of wetlands, but it is likely that the floodplain above the current location of Interstate 5 was freshwater marsh and riparian forest.

European settlement of the area, beginning with the establishment of the Mission San Luis Rey de Francia in 1798, brought reclamation of floodplain wetlands for agriculture. In the mission subbasin, which encompasses the lower 11 miles of the river valley, water was pumped for agriculture and for export to Carlsbad and Oceanside. Logs of wells in the area show a continuous drop in groundwater level, reaching an extreme low point in the early 1960s. On arid river floodplains like the San Luis Rey, riparian trees need groundwater to survive the long, dry summer. All this pumping led to the intrusion of seawater into the mission groundwater basin. To alleviate this problem, the City of Oceanside discharged treated wastewater into the San Luis Rey River from 1958 to 1974. Additional irrigation water was also released. Following these actions both groundwater levels and riparian vegetation increased.

The estuary at the mouth of the San Luis Rey was dredged in 1964 to create the Oceanside Harbor, primarily for recreational boats. A road now crosses the beach berm at the mouth, further restricting tidal flows.

Land Ownership

The City of Oceanside owns Oceanside Harbor and the lower river channel from the railroad to the beach. The vast majority of the San Luis Rey River floodplain is privately owned. The City of Oceanside, in constructing its flood control project, will need to purchase the lower seven miles of river floodplain.

Wildlife Values

The primary wildlife values on the San Luis Rey River are associated with riparian habitat and the small marsh area at the river mouth. This area contains brackish marsh and supports a few shorebirds, waterfowl, and water birds. Brown pelicans and least terns feed and roost in the lagoon.

Riparian habitat covers nearly 1700 acres of the San Luis Rey River floodplain from I-5 inland to Lake Henshaw. The densest areas of riparian forest occur in the lower river valley, along Pilgrim Creek, and from Guajome Regional Park extending upstream to I-15, and in scattered areas above I-15. Monitoring studies have found the third largest vireo population in San Diego County on the San Luis Rey River.

Current Problems

The area surrounding the lower San Luis Rey River is rapidly urbanizing, and many developers and landowners see the floodplain as a prime development area. In a classic situation of misplaced development, industrial and residential projects were constructed in the lower floodplain and became subject to flooding. The owners took it upon themselves to build levees, often without permits. These actions have created a large number of illegal fill projects and losses of riparian habitat. The primary permitting agency, the Army Corps of Engineers, has been unsuccessful at enforcing the regulations in this area. Illegal sand and gravel mining has also removed riparian forest.

These developments then created a need for a major public works project to control the flooding of the river over its own floodplain. The City of Oceanside and the Corps of Engineers began construction of a large flood-control project on the lower seven miles of the river in 1988. The river will be confined for most of this length in a 400-foot-wide earthen channel bounded by two levees. This channel would significantly shrink the width of the existing floodplain in most areas and allow for additional development as well as reducing the flood risk to existing buildings.

The flood-control project would remove a total of 146 acres of riparian habitat, of which 14.5 acres is inhabited by Least Bell's vireos, and 46.5 acres is suitable for vireo nesting. Another 85.5 acres of lower-quality riparian habitat would also be lost. Due to the presence of the endangered vireo, the City and the Corps must mitigate the loss of riparian wetland and re-create the vireo habitat and assure it is maintained. However, there are no assurances the vireo will use the new riparian forest.

The San Diego Association of Governments recently completed a habitat conservation plan for the vireo in the San Luis Rey River watershed. This plan sets forth measures meant to avoid the extinction of the vireo in this drainage.

Public Access

There is currently very little public land (and no access trails) along the river. The flood control project includes a bike path atop the southern levee that will be constructed by 1992. A parking lot at the river mouth provides an overlook of the lagoon.

SANDAG

Endangered Least Bell's Vireo

Buena Vista Lagoon

LAUREL MARCUS

Location and Size

Lagoon—Cities of Oceanside and Carlsbad, 220 acres. Watershed—Cities of Oceanside, Carlsbad, and Vista, 20 square miles. Buena Vista Creek is the main tributary stream.

History

Buena Vista is one of the smallest of San Diego's coastal lagoons. Originally a tidal system, this lagoon used to have a small tidal prism and probably closed off most summers. Artesian springs in Buena Vista Creek, the main tributary, would have provided fresh water in summer and given the lagoon a brackish character with shallow water, mudflats, and marsh. Duck club ponds once marked several acres in the eastern lagoon. Road fills were constructed through the lagoon in 1881 for the railroad, in 1912 for the original Pacific Coast Highway (now Hill Street), and in 1965 for Interstate 5. These roads separated the lagoon into four basins.

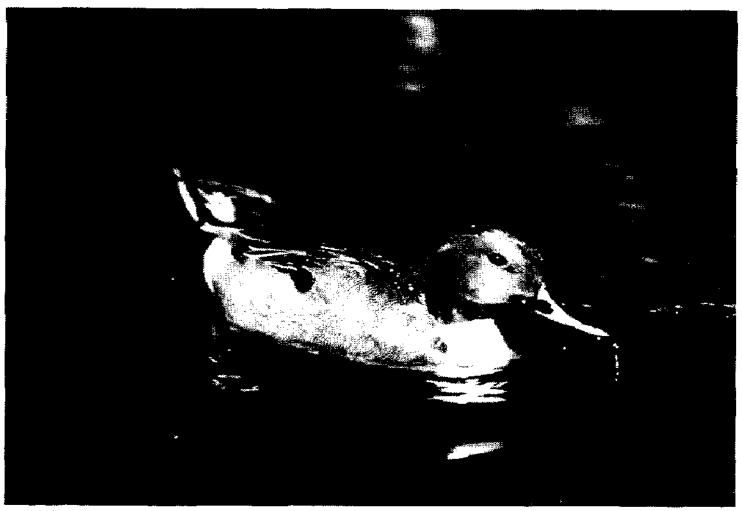
In 1940 a weir was placed at the mouth and the beach berm was covered with housing, changing the basic function of the lagoon. The weir impounded fresh water, greatly increased water depths, and excluded all tidal influence. The lagoon was transformed into a calm-water lake. Then, in the 1970s, a 100-acre marsh at the eastern end of the lagoon was filled for a shopping center. Both the installation of the weir and the loss of this eastern marsh have played a major role in creating the problems that the lagoon faces today. Treated sewage was discharged directly into the lagoon until 1967.

Land Ownership

Most of Buena Vista Lagoon is a State Ecological Reserve managed by the Department of Fish and Game. Land preservation began here in the 1950s through the efforts of local citizens groups. A few small parcels on the lagoon boundaries and the far western basin are privately owned.

Wildlife Values

Buena Vista Lagoon provides one of the only freshwater habitats on the Southern California coast. Numerous migratory waterfowl and some shorebirds visit each year. There are also a lot of fish in the lagoon; catching a 3-pound bass is not uncommon. Small fish attract diving birds including brown pelicans, least terns, and Caspian terns as well as herons, egrets, and cormorants. Least terns use the area for foraging following the fledging of their young and have attempted to nest on the islands in the eastern basin.



Northern Pintail

Current Problems

Buena Vista Lagoon suffers from extreme sedimentation due to the effects of urbanization in the watershed. Increased peak storm flows have caused erosion of Buena Vista Creek. After the lagoon's eastern marsh, which once filtered and collected incoming sediment, was filled in the 1960s and the lagoon was changed to a freshwater lake dissected by road fills, the eastern basin became a sediment catchment basin. In 1978-79, a series of large storms sent tons of sediment into the lagoon. The State spent $1 million to remove a portion of this sediment and to create four islands.

In 1983, the Conservancy began working with local cities in the watershed to lower peak flows and thus reduce both erosion in the creek and sedimentation of the lagoon. Preservation and restoration of a natural, riparian creek channel is a primary goal. The Conservancy has spent nearly $1 million to further this goal and enhance the lagoon.

Public Access

Nature study and fishing (with a license) are allowed from shoreline access points. The lagoon shoreline may be reached from Hill Street, Jefferson Street, and a cul-de-sac off Marron Road near Highway 78. The Buena Vista Audubon Society operates a nature center at 2202 Hill St. in Oceanside. It is open Tuesday through Saturday from 10 a.m. to 2 p.m. On the second Saturday of each month, the center offers a wildlife demonstration. More information and arrangements for special group presentations may be obtained by calling (619) 439-BIRD.

The Buena Vista Lagoon Foundation is a nonprofit membership organization whose purpose is restoring and conserving this lagoon. Contact: P.O. Box 157, Carlsbad, CA 92008.

Agua Hedionda Lagoon

SAN DIEGO GAS & ELECTRIC COMPANY

The wetlands of Agua Hedionda Lagoon were dredged in 1954 to provide a source of cooling water for the adjacent power plant.

Location and Size

Lagoon—City of Carlsbad, 400 acres. Watershed—Cities of Carlsbad, Vista, and Oceanside, and San Diego County, 29 square miles. Agua Hedionda Creek is the main tributary stream.

History

When Spanish explorers reached Agua Hedionda in the 1700s, it was a tidal estuary, and it held a great deal more salt marsh than it does today. The earliest map of the lagoon dates from 1887 and depicts marsh covering the western half of the lagoon. Maps from the 1920s show a large delta covering the eastern end, where Agua Hedionda Creek empties into the lagoon. Road fills now separate the lagoon into three distinct basins.

In 1954 the lagoon was completely dredged to provide a deep basin and a source of cooling water for the Encinas power plant. Over 4 million cubic yards of material were removed from the lagoon. A portion of the power plant was built on filled wetland. Jetties were placed along the mouth of the lagoon to assure that the mouth does not close. A separate channel allows for warm water outflows. A small residential marina development was built on fill in the eastern basin.

Land Ownership

San Diego Gas and Electric owns most of the lagoon. In the eastern end of the lagoon an area of about 200 acres is privately owned. This land will be transferred to the Department of Fish and Game as a condition of the Kelly Ranch development and dedicated as an Ecological Reserve in 1989.

Wildlife Values

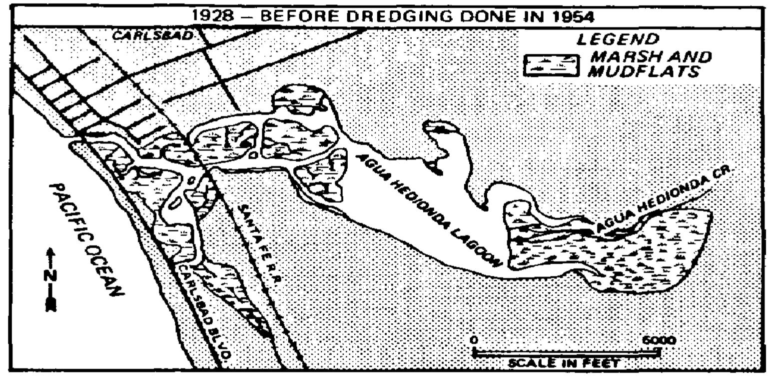
The primary wildlife habitat is open water. Various marine fish species inhabit the lagoon. Eelgrass beds provide protection to juvenile fish and crabs. Diving ducks as well as gulls, grebes, pelicans, and other fish-eating birds use the lagoon. An aquaculture operation in the western basin raises mussels and oysters. The only marshland lies in the eastern basin and as a thin band along small areas of the shoreline. The Belding's Savannah Sparrow inhabits this marsh. Mudflats are exposed in this area during low tide and are feeding areas for migrant shorebirds. Least terns have nested in salt pannes in the eastern lagoon.

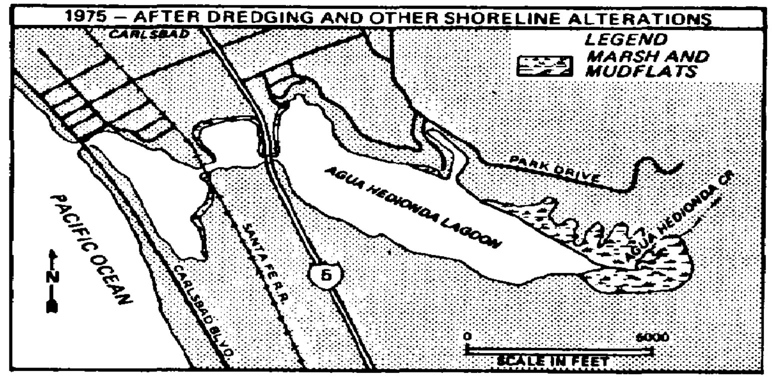
Agua Hedionda and Macario creeks contain well-developed riparian forests with habitat for many species of small songbirds.

Current Problems

The watershed of Agua Hedionda Lagoon is largely in agricultural use or undergoing development. Agricultural operations often use erosion-causing techniques such as non-contour and wet-weather plowing. Land, graded for development during the winter, can cause large sediment inflows to the lagoon. Since the 1954 dredging, the delta of Agua Hedionda Creek has extended 50 feet into the open waters of the lagoon. A recent mitigation project in the eastern basin has largely been unsuccessful. The dredging was not done to adequate depths to create the expected tidal habitats and least tern areas. The restoration of riparian forest was not completed properly either.

The outer lagoon fills with sand brought by the inflowing tide. San Diego Gas and Electric dredges this sand from the western basin to avoid clogging the power plant intake pipes. The sandy spoils are placed on the beach. Neither the middle nor the eastern basins have been dredged since 1954.





Public Access

The eastern basin is leased by the City of Carlsbad and operated as a water recreation area for boats. There is fishing from the western shoreline of the western basin. For further information, contact the Parks and Recreation Department of the City of Carlsbad. Access to the Ecological Reserve in the eastern basin will be available from Park Drive off of Tamarack Avenue sometime in 1990.

Batiquitos Lagoon

Location and Size

Lagoon—City of Carlsbad, 600 acres. Watershed—Cities of Carlsbad, Encinitas, and San Marcos, and San Diego County, 53 square miles. San Marcos and Encinitas creeks are the main tributaries.

History

Studies of Indian middens along the shores of Batiquitos Lagoon indicate that the previous inhabitants harvested a variety of marine shellfish here. These shellfish require continuous tidal flows to survive and grow. From this evidence, we may assume that Batiquitos Lagoon was a fully tidal system until the 1800s. The earliest maps date from 1898 and show marsh extending east and south of present-day El Camino Real. The railroad, built in 1881 across the lagoon mouth, separated the lagoon from the ocean and constrained tidal flows. In 1912 the Pacific Coast Highway further separated the lagoon from tidal flows and created another fill across the lagoon mouth. As a result of these changes as well as sedimentation and loss of tidal prism from watershed erosion, the lagoon was only open to tidal flows intermittently by 1930.

From 1901 to 1910, the California Salt Company operated 25 acres of salt evaporator ponds in the far eastern area of the lagoon. A few of the dikes from these ponds remain. A 1934 map of the lagoon shows duck ponds in the same area. Sediment and thick marsh now cover the formerly open water ponds. Beginning in the 1940s, the lagoon rarely opened to the tide and often was dry for much of the year. San Marcos Creek was dammed in 1952, reducing freshwater flows to the lagoon. Between 1967 and 1974, treated wastewater was discharged into the lagoon.

In 1989, Batiquitos Lagoon had not been open to tidal inflows in many years and seasonally ponds water up to 12 feet deep.

Land Ownership

Most of Batiquitos Lagoon is owned by the State Lands Commission and the Department of Fish and Game. The Fish and Game lands are managed as an Ecological Reserve. A few parcels along the edges of the lagoon remain privately owned.

Wildlife Values

The lagoon is a valuable habitat for migratory shorebirds and dabbling ducks. However, its value to these species is directly related to its water levels and thus to rainfall. Shallow water levels in early fall are particularly important to provide feeding habitat for short-legged shorebirds and ducks. If water levels are several feet deep, these same species must seek food elsewhere. Diving ducks, herons, egrets, terns, pelicans, gulls, and other species feed in the lagoon.

The endangered least tern nests at several sites in the lagoon during the summer. If water levels are still covering these sites during nesting season, the terns are forced to use other areas. The Belding's Savannah Sparrow resides in the pickleweed marsh that rings the lagoon.

Current Problems

Water levels in the lagoon vary widely year to year, creating a habitat of undependable value to migratory birds. In its current state, the lagoon also accumulates all sediment which flows in, particulary fine sediment which is not collected by the sediment basins that have been installed on several lagoon tributaries. Topographic surveys over a three-year period showed substantial filling of the eastern lagoon. This problem can be expected, given the large amount of development occurring in the watershed. If sedimentation rates remain at their historic levels, the entire lagoon could be filled in within 50 years.

The Port of Los Angeles evaluated the lagoon for a large mitigation project beginning in 1986. The Port must compensate for filling its open-water areas by re-creating marine habitat elsewhere. Although Batiquitos Lagoon lies 100 miles south of the Port, it has been chosen as the primary mitigation site. The controversy regarding this proposal centers on the proposed change of the brackish habitat to intertidal and marine habitats and on the amount of intertidal habitat needed to support the shorebird and duck species that now use the lagoon. The Port would dredge the lagoon to create a tidal prism and stabilize the lagoon mouth with riprap. Most existing marsh would remain. The dredging and other construction activities will cost over $20 million.

The Coastal Conservancy played a key role in preparing the 1987 enhancement plan for Batiquitos Lagoon and an erosion control plan for the lagoon watershed. In 1988 the Port of Los Angeles, City of Carlsbad, and Corps of Engineers began the environmental review and permitting process for the project.


TOM MIKKELSEN

Public Access

There are two trails along the north shore of Batiquitos Lagoon. Sections of the trail are undergoing improvement in conjunction with two upland developments. The trail for the east basin shoreline may be reached from Batiquitos Drive on the west end or El Camino Real or Arenal Road on the east end. The trail along the western basin may be reached from Windrose Circle off Ponto Drive. Nature study and fishing are allowed only from shoreline trails.

The Batiquitos Lagoon Foundation is a membership organization dedicated to protecting and enhancing the lagoon by providing information about the lagoon to the public and reviewing enhancement plans for the lagoon and development proposals in the watershed. They are a cosponsor of this booklet. Contact: P.O. Box 3103, Carlsbad, CA 92009.

San Elijo Lagoon

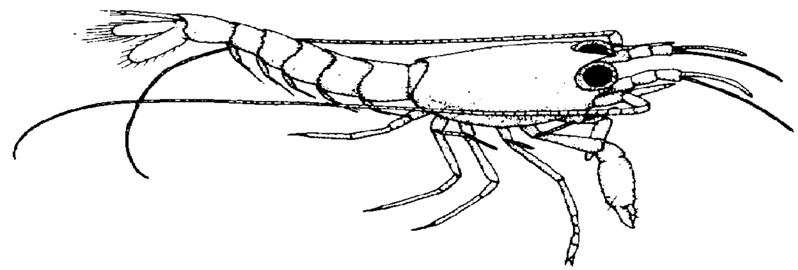
Location and Size

Lagoon—City of Encinitas, 530 acres. Watershed —Cities of Encinitas, Solana Beach, and Escondido, and San Diego County, 77 square miles. Escondido and La Orilla creeks are the main tributaries.

History

San Elijo Lagoon was once a fully tidal system, as evidenced by archaeological studies. Field notes that accompany the first map of the lagoon, dating from 1887, state: "it is for a mile inland a shallow lagoon in winter and in the dry season a glistening akaline plain." This description indicates that year-round tidal inflows may have stopped by this time; however, the map does show an open lagoon mouth. At the time of the description, two man-made obstructions crossed the lagoon—the railroad, set mostly on fill with a small bridge, and a 1000-foot-long levee across the middle of the lagoon.

Between the 1880s and 1940s numerous dikes and levees were built in San Elijo Lagoon. Some were for duck ponds and roads, and later ones were for sewage treatment ponds. The large fills for highways and railroads no doubt reduced stormwater velocities and increased the rate of sediment deposition. Several large reservoirs on Escondido Creek also reduced freshwater inflows. Highway 1 created a large dike along the lagoon's western boundary and severely restricts the entrance channel and tidal inflows. From 1940 until as late as 1973, San Elijo Lagoon received wastewater from the City of Escondido. These changes have transformed the lagoon from its 1887 description.



Land Ownership

The Department of Fish and Game owns the middle basin and a portion of the western basin. San Diego County owns much of the eastern basin. Both the middle and eastern area are managed as an Ecological Reserve. The western basin is owned partially by the San Elijo Lagoon Foundation and partially by private owners.

Wildlife Values

San Elijo Lagoon is primarily a shallow-water brackish wetland that rarely experiences tidal flows. Following winter storms, water levels increase and the lagoon mouth opens, draining the stormwater and allowing tidal inflows for a short period. Most of the year the lagoon mouth is closed. Migratory shorebirds and waterfowl visit San Elijo Lagoon in large numbers. The shallow water areas are productive feeding grounds rich in invertebrates and aquatic insects. Small fish also flourish in the lagoon when water quality is good. Seven species of terns feed on these small fish as do herons, egrets, and other water birds.

The former users of the lagoon have left many levees and diked-off ponds. These areas are somewhat isolated from the rest of the lagoon and harbor freshwater marsh or, in several cases, salt marsh. This patchwork of marsh types makes for a high diversity of habitats and a large number and variety of wildlife species.

Nine endangered species visit or reside in San Elijo Lagoon. Least terns feed here and nest on the islands created for them in the eastern basin. Clapper rails inhabit the eastern lagoon and also live in the dense freshwater marsh. Not far from the rails, Belding's Savannah Sparrow nests in pickleweed marsh. Brown pelicans use the open water areas of the lagoon to rest and feed.

Current Problems

Sedimentation problems are not well studied at San Elijo Lagoon. Much of the Escondido Creek floodplain directly above the lagoon remains natural, covered with marsh and riparian forest. Sediment is stored within this area and little may be reaching the lagoon. Efforts to channelize the creek could easily change this situation since this floodplain remains privately owned and subject to development proposals. Erosion of the bluffs surrounding the lagoon by urban stormwater, and sedimentation of wetlands, are quite apparent, particularly along the southeastern lagoon edge.

Beginning in 1989, the County Parks Department plans to open the lagoon mouth more frequently and increase tidal flows to the lagoon. The railroad and Highway 1 bridges constrain the lagoon mouth, making it difficult to maintain an open channel for very long.

Public Access

The public is allowed to hike or fish from designated trails around the lagoon. These trails may be reached from the end of Rios Avenue, the end of Santa Carina Drive on the south side of the lagoon, along El Camino Real near the corner of Rancho Serena at the east end of the lagoon, and off Manchester near San Elijo Drive on the north side of the lagoon. Contact the Parks and Recreation Department of San Diego County at (619) 694-3030 for more information.

Three organizations are concerned with this lagoon. The San Elijo Lagoon Volunteers patrol the lagoon for illegal hunting, fishing, dumping, and other activities. Contact San Diego Parks and Recreation for more information.

The recently formed San Elijo Lagoon Conservancy monitors and assists in maintenance, planning, and management of the reserve. Contact: 2365 Newcastle Ave., Cardiff, CA 92007.

The San Elijo Lagoon Foundation monitors maintenance and management of the lagoon and owns some land in the western basin. Contact: P.O. Box 1001, Solano Beach, CA 92075.


CAROL ARNOLD

San Dieguito Lagoon

Location and Size

Lagoon—Cities of Del Mar and San Diego, 300 acres. Watershed—City of San Diego, County of San Diego, 350 square miles. The San Dieguito River is the main tributary.

History

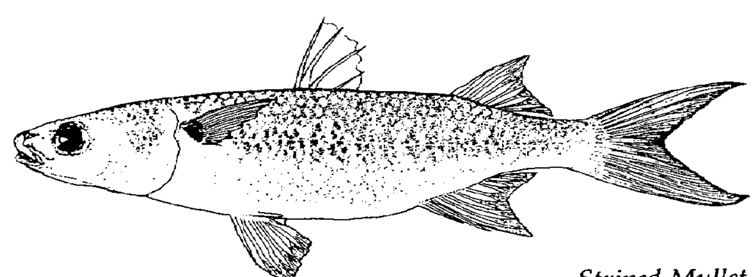
San Dieguito Lagoon was the largest of the six San Diego coastal lagoons and has the largest watershed. Near the mouth of San Dieguito Lagoon are Native American midden sites that contain some of the oldest dated shell material in California. These shells are over 50,000 years old, suggesting that ancient man inhabited the shores of this lagoon.

The earliest maps of this lagoon date from 1887 and depict several miles of tidal channels, marsh, and mudflat extending from the lagoon mouth well inland past the present location of Interstate 5. Although the railroad had been built by this time, the lagoon mouth clearly had an open channel. The marsh area alone is believed to have been over 600 acres, while the entire lagoon probably covered 1,000 acres.

San Dieguito has undergone major filling activities and lost over half of its marshes. The railroad, Highway 1, and Jimmy Durante Boulevard were built on fill in the lagoon. Early land development (1905) by the South Coast Land Company filled the southern lagoon between Highway 1 and the railroad. The Del Mar Fairgrounds were built on a 200-acre section of the northern lagoon in 1935. The wetlands east and west of Jimmy Durante Boulevard were progressively filled or developed. Del Mar airport was built on lagoon wetlands during World War II. The construction of Interstate 5 in 1966 through the middle of the lagoon isolated the wetlands on the eastern edge of the lagoon. Another fill for a shopping center in the 1970s further reduced the wetland acreage.

From 1940 to 1974, 200,000 to 300,000 gallons of sewage effluent were discharged daily into treatment ponds in the western area of the lagoon. The liquid portion of this sewage was released into the lagoon channels and created a thick layer of sludge on the lagoon bottom. Two large dams were constructed on the San Dieguito River, greatly reducing freshwater inflows. The result of all these activities was year-round closure of the lagoon mouth beginning in the 1940s. Only large winter floods forced the mouth open.

The Conservancy began an enhancement project for San Dieguito Lagoon in 1978. The original enhancement plan produced by the City of Del Mar was implemented in part with a $1.3 million grant from the Conservancy in 1983. A tidal basin was dredged in a 70-acre area of the southern lagoon, and an enormous gully in Crest Canyon was restored with the dredge spoils. The lagoon mouth was opened, returning tidal flows in the river channel all the way to El Camino Real.



Striped Mullet

Land Ownership

The Department of Fish and Game owns and manages 107 acres of the restored area of the lagoon as an Ecological Reserve. The City of San Diego owns a 20-acre abandoned sewage treatment pond now overgrown with riparian trees as well as another 29 acres of wetlands. The 22nd District Agricultural Association owns 23 acres of wetlands and beach in the western lagoon in addition to the fairgrounds. The remainder of the western lagoon as well as the river channel and remnant wetlands east of I-5 are privately owned.

Wildlife Values

Tidal salt marsh has survived along the river channel and in the tidal basin, and non-tidal pickleweed marsh exists in several areas of the eastern lagoon and near the old airport site. Tidal mudflats cover the river channel and tidal basin margins. There is also riparian habitat in the lagoon as well as considerable filled area that could be restored to tidal marsh.

Since the restoration of tidal flows and dredging of a new tidal basin, water birds are more common at San Dieguito Lagoon. Shorebird use in particular has increased as intertidal feeding areas were restored. Osprey recently began using the western lagoon. The flooded grassland in the eastern river valley is visited by Canada geese in the winter.

Two endangered species use San Dieguito Lagoon. The least tern forages for fish in the tidal basin, but has not been successful at nesting in the western basin recently. The terns used to nest just east of I-5 on the salt panne areas now surrounded by tomato fields. The Belding's Savannah Sparrow inhabits the pickleweed marsh of the lagoon. Fish and Game is currently planting cordgrass on a trial basis to create new habitat and reintroduce the clapper rail to the lagoon.

The restoration project created additional shallow-water fish habitat that is used by mullet, mudsucker, and topsmelt, among others. A wide array of invertebrate species has recolonized the restored area and the river channel as well.

Current Problems

San Dieguito Lagoon is the only lagoon in which most of the land is not publicly owned. The privately owned lagoon and river channel are constantly being threatened with development.

On the western side of I-5 there are several development proposals. The Fairgrounds is seeking to build an additional off-ramp from northbound I-5. Another private landowner of the western lagoon attempted to develop a hotel on the old airport site and met with vigorous local opposition. A small housing development is proposed for an area near the lagoon shoreline and Crest Canyon. Another adjacent development caused sedimentation into the restored tidal basin, and the developer must redredge the damaged area. In 1988 the Port of Los Angeles and the Port of Long Beach began a feasibility study of using this lagoon as a mitigation site for their proposed landfills.

Public Access

The only area of the lagoon open to public access is the Department of Fish and Game Ecological Reserve. Nature study and fishing are allowed from the shoreline and the Grand Avenue bridge. Crest Canyon, a local park, has hiking trails with views of the lagoon.

Two nonprofit organizations are associated with this lagoon. The San Dieguito River Valley Land Conservancy was formed to conserve, restore, and enhance the river valley. Contact: 201 Oceanview, Del Mar, CA 92014. The Friends of the San Dieguito River Valley are concerned with the conservation of open space through lobbying and education efforts. Contact: P.O. Box 973, Del Mar, CA 92014.

Los Peñasquitos Lagoon

Location and Size

Lagoon—City of San Diego, 630 acres. Watershed—Cities of San Diego and Poway, and San Diego County, 98 square miles. Los Peñasquitos and Carmel Valley creeks are the main tributaries.

History

When the Spanish explored the coast and named Los Peñasquitos Lagoon in 1769, they encountered a comparatively deep-water estuary that supported numerous kinds of marine animals. The 1889 map of Los Peñasquitos Lagoon, also labeled Soledad Valley, shows an open mouth located at the northern edge of the beach berm. Marsh extended up Carmel Valley and far up Sorrento Valley. At this time the railroad crossed the eastern edge of the lagoon and followed west along the present course of Carmel Valley Road. In 1925 a new railroad embankment was built through the center of the lagoon, creating a major impediment to tidal flows. Twelve years after the railroad construction, Highway 1 was built across the mouth of the lagoon. As with the other lagoons, this highway constricted the lagoon mouth, and the lagoon began closing.

Analysis of sediment cores in the lagoon showed a substantial increase in the sedimentation rate since the plowing and grading of the lagoon watershed. Before European settlement, the lagoon had been slowly filling in at a rate of 10cm (4 inches) per century. The sedimentation rate in 1980 had increased to 50cm (20 inches) per century and may be considerably higher now due to the grading and development in the watershed over the last nine years.

Sewage effluent was discharged into the lagoon from 1962 to 1972 in quantities ranging from 500,000 to 1 million gallons per day. Accidental spills of millions of gallons of raw sewage have been a continual problem in the lagoon since 1984. The City of San Diego has now completed some repairs of their sewer pumps, which should help to avoid these spills.

Land Ownership

The State Department of Parks and Recreation owns most of the lagoon and manages it as part of Torrey Pines State Reserve. The Conservancy owns 20 acres of the upper lagoon near the outlet of Los Peñasquitos Creek. The City of San Diego owns much of Los Peñasquitos Creek Canyon and manages it as a preserve.

Wildlife Values

Pickleweed marsh dominates the western portion of the lagoon, while riparian vegetation covers the eastern lagoon and outlets of Los Peñasquitos and Carmel Valley creeks. A series of tidal channels near the lagoon mouth provide open water habitat and mudflat areas for invertebrates. Salt panne that seasonally floods occurs in the upper lagoon and probably supports aquatic insects. Bird use of the lagoon differs between the salt marsh and riparian habitats. Waterfowl and other water birds such as herons and egrets use the western and central portions of the lagoon. Shorebird use is relatively low because there is little intertidal or unvegetated shallow water habitat. The riparian habitat hosts numerous species of songbirds as does the adjacent sage scrub habitat.

Belding's Savannah sparrows inhabit the pickleweed marsh and are particularly abundant in an area of salt grass near the mouth. Clapper rail were more numerous in the lagoon when cordgrass was present before the 1940s. Only two clapper rails have been heard in the past year. Least terns also once nested in the salt pannes in the lagoon. Now the terns only feed in the lagoon area.

Current Problems

Los Peñasquitos Lagoon suffers from two major and interrelated problems: sedimentation and lack of tidal flow. Thousands of acres in the lagoon watershed have been graded and paved in the last eight years. The effect of these massive earth-moving operations is now becoming apparent in the lagoon. The tidal channels have filled in significantly; salt marsh is being smothered and changed to riparian forest or upland. Despite a number of controls on grading in the coastal zone portion of the watershed, the lagoon is filling in. Large sums of public money will be required to restore this lagoon.

Due to both sedimentation and the Highway 1 bridge, the lagoon rarely stays open, even after a bulldozer opens the mouth. The Conservancy and the Los Peñasquitos Lagoon Foundation prepared an enhancement plan for the lagoon in 1985. As part of this program the Foundation has been opening the mouth during periods of low tide, low surf, and lagoon high-water levels. The lagoon has consistently closed off after these openings, staying open a maximum of three weeks.

The Foundation receives funding for these enhancement activities from developments in the coastal zone area of the watershed. The developments pay a small fee for each house or commercial area to compensate for the erosion and sedimentation problems the developments cause in the lagoon. Developments a bit further east outside the coastal zone pay no fees, but may cause problems in the lagoon. It is not clear that these fees will be adequate to complete restoration projects in the lagoon.

CALIFORNIA DEPARTMENT OF FISH AND GAME

Public Access

There are currently no trails that cross through the lagoon or mark its edges. There is a parking lot near the mouth that has access to the beach, and both Carmel Valley and Sorrento Valley roads border the lagoon. The bluffs of Torrey Pines State Reserve above the lagoon offer a panoramic view of this wetland.

The Los Peñasquitos Lagoon Foundation is a membership organization active in enhancing and preserving the lagoon. Contact: P.O. Box 866, Cardiff, CA 92007.

Mission Bay, Famosa Slough, and the San Diego River

Location and Size

Mission Bay—City of San Diego, 4,600 acres. Watershed—City of San Diego, County of San Diego, 53 square miles. Tecolote and Rose creeks are the main tributaries. Famosa Wetlands—City of San Diego, 31 acres. San Diego River—tidal wetland—City of San Diego, 300 acres. Watershed—Cities of San Diego and Santee, and County of San Diego, 440 square miles.

History

The Spanish originally called this large estuary False Bay because its entrance was near enough to San Diego Bay to occasionally fool ship captains. False Bay spread over 5,000 acres and was once a deep-water embayment. At the time of the Spanish settlement the San Diego River drained into northern San Diego Bay. Marshes and mudflats extended from the southeastern shore of False Bay to the northeastern shore of San Diego Bay. High tides isolated Point Loma from surrounding lands.

Shortly after California achieved statehood in 1850, the Army Corps of Engineers, in one of their first river projects, rerouted the San Diego River to drain into False Bay. The old river delta could now be filled and developed and the port facilities in San Diego Bay would no longer silt in. Instead all the sediment from this large watershed began to deposit in False Bay. By the turn of the century, False Bay was very shallow, and local residents claim they could walk across it at low tide.

During the 1940s the City of San Diego began looking at False Bay as a potential small-craft harbor and recreation area. The Army Corps of Engineers began dredging the bay and rerouting the river once again. Dredge spoils were used to build lands within the bay and to construct levees for a new river channel. The final project created Mission Bay Park, a complex of recreational islands, beaches, and waterways, and the San Diego River flood control channel. The channel carries the river flows directly out to sea. Only two remnants of natural marsh remain—Kendall Frost Marsh Preserve and Famosa Slough.

Land Ownership

The City of San Diego owns most of Mission Bay, the lower flood control channel from I-5 to the ocean, and Famosa Channel. The University of California Natural Land and Water Reserve System owns the Kendall Frost Marsh Preserve. Famosa Slough is privately owned.

Wildlife Values

Mission Bay contains three types of aquatic habitats—sandy bottom shallow water, eelgrass beds, and rocky shoreline—and two types of intertidal habitats—mudflat and marsh. The aquatic habitat supports over 25 species of marine fish and numerous invertebrates. Eelgrass is particularly widespread in Mission Bay due to the shallow depths.

Most birds using the bay are species preferring open water habitats—diving ducks, pelicans, cormorants, grebes, and loons. The small area of mudflat limits shorebird use. The small marsh at Kendall Frost supports both clapper rail and savannah sparrows. Least terns nest on several islands in the bay.

The Famosa wetlands and the lower San Diego River channel are important migratory bird habitats. The river channel is a fully tidal system with mudflats, salt marsh, and, east of I-5, riparian forest. Famosa Slough, despite its small size and urban surroundings, hosts a wide variety of bird species and contains freshwater, brackish, and salt marsh habitats. Least terns forage in both the Famosa wetlands and the river channel.

The upper San Diego River floodplain contains over 800 acres of riparian forest and supported over 30 pairs of vireos in 1988. The majority of these vireos nest in Mission Gorge and Mission Trails Regional Park.

Current Problems

Water quality problems at Mission Bay affect both its value as an aquatic habitat and as a water recreation area. The two tributary streams, Tecolote and Rose creeks, carry both urban pollutants such as dead plant materials, oil, grease, and fertilizers, and high sediment loads into the back bay. In addition, sewer lines back up occasionally into the back bay. The lack of water circulation in the back bay allows these pollutants to accumulate, and the area has been quarantined for several months at a time.

In 1989 the City of San Diego completed several projects that should reduce water quality problems. A $1.4 million creek stabilization project should reduce erosion from urban stormwater in Tecolote Creek. The City is also repairing and replacing many of the sewer lines and inspecting local restaurants to reduce grease inflows, the main cause of sewer problems.

Numerous residential, industrial, and transportation developments threaten to remove the riparian forest of the San Diego River floodplain. The San Diego Association of Governments recently completed a habitat conservation plan for riparian habitat on the floodplain. If implemented

SAN DIEGO HISTORICAL SOCIETY—TICOR COLLECTION

Dredging of Mission Bay in 1956.

the plan would conserve the existing riparian forest through redesign of projects and attempt to increase the habitat in some areas through revegetation activities.

Famosa Slough has been a subject of controversy for over a decade. The owner of the slough has consistently sought to develop his land while local citizens groups have fought for public ownership. As of 1989 the City of San Diego was negotiating with the owner to purchase the slough.

Public Access

Mission Bay has numerous public facilities. Contact the City's Visitor Information Center at (619) 276-8200. Hiking and bicycling paths top the levees of the San Diego River flood control channel. Famosa Slough can be viewed from West Point Loma Boulevard.

The Friends of Famosa Slough are a nonprofit organization concerned with public ownership of the slough and protection of lower river channel. Contact: 2776 Nipoma St., San Diego, CA 92106.

San Diego Bay

SAN DIEGO HISTORICAL SOCIETY—TICOR COLLECTION

Filling wetlands in 1915 to build the Embarcadero at the foot of Broadway, downtown San Diego.

Location and Size

Bay—Cities of San Diego, Coronado, National City, Chula Vista, and Imperial Beach; subtidal and intertidal areas—11,130 acres, salt ponds—1,400 acres. Watershed—Cities of San Diego, Coronado, National City, Chula Vista, Imperial Beach, La Mesa, Lemon Grove, and El Cajon, and County of San Diego, 415 square miles. The Sweetwater and Otay rivers and Chollas and Paradise creeks are the main tributary streams.

History

In 1769 the Spanish chose San Diego Bay as the site of their first northern colony to make use of this fine natural harbor. These first explorers saw a very different landscape than exists today. Gray whales used the bay as a calving ground. Native Americans lived along the shoreline, harvesting fish and shellfish from the productive shallow waters.

The earliest maps of the bay show a nearly solid border of mudflats around the shoreline. Marshes filled the mouths of the Sweetwater, Otay, and San Diego rivers as well as Paradise and Chollas creeks. The bay was relatively shallow, contained large wetland areas, and received a great deal of fresh water.

Americans first came to San Diego Bay to trade with the Spanish and to hunt the whales and later to settle in the area. By 1830, sixteen American whaling ships were operating in the bay. This industry peaked in 1871 with the near extinction of the gray whale. Seven years after California became a state in 1850, the Army Corps of Engineers diverted the San Diego River away from the bay into False (Mission) Bay because the river kept silting in San Diego harbor and interfering with shipping. The large marshy river delta was then filled and developed into the City of San Diego.

Major maritime development of the bay extended from the late 1800s to well past World War II. During this period 100 million to 140 million cubic yards of bay sediment were dredged and used to fill tidelands and widen the beaches along the Silver Strand. Piers and port facilities were created for both domestic and military uses. In 1962, the San Diego Unified Port District was created, consolidating the port facilities of five shoreline cities. Naval facilities in the bay are home base to nearly 20 percent of the Navy's active fleet. Other military uses include an amphibious and underwater demolition training base and a Marine Corps recruit base.

The development of San Diego Bay into a major military and domestic port has been accomplished through the destruction of most of its wetlands. The bay is now much deeper and narrower than it was 150 years ago, and most shoreline development sits on fill. Only the south bay contains significant areas of marsh, mudflat, and salt ponds. Overall, 27 percent of the bay's tidal area has been filled.

In 1888 a dam was built on the Sweetwater River to provide drinking and irrigation water. The Otay River also was dammed, in 1919. As a result, freshwater inflows have been reduced to 75 percent of their historic levels, and the bay is now primarily a saline system.

Land Ownership

The San Diego Unified Port District administers 37 percent of both the submerged and the historic tidelands (both filled and remaining natural wetlands) of San Diego Bay under a grant from the California Legislature. The State Lands Commission retains ownership of 42 percent of the bay, mostly underwater areas. The military controls almost 20 percent, and city and county governments have jurisdiction over less than 1 percent of the bay. Over half of the salt ponds in the south bay are privately owned, and the remainder is owned by the State Lands Commission and operated under a lease. As a result of a lawsuit in 1988, the Fish and Wildlife Service received ownership of the entire Sweetwater and Paradise Marsh complex, a 315-acre refuge.

Wildlife Values

Several types of habitat in San Diego Bay are important to wildlife—open water, mudflat, marsh, and salt evaporation ponds.

Open water covers 10,165 acres of the bay below the low-tide line. Deep and shallow subtidal habitats and eelgrass beds predominate. The north and central bay areas have been dredged for ship channels and port facilities and have depths varying from 18 to 70 feet. Shallow subtidal habitat ranges from the low-tide line to 18 feet deep and is concentrated in the southern bay and a few other shoreline locations. Eelgrass beds cover about 800 acres throughout the bay.

Many types of fish and invertebrates inhabit the deep and shallow subtidal areas. Surveys have found 80 to 90 fish species in the bay. Generally, the deeper north bay supports open-ocean fish, while the warmer, shallower south bay supports smaller estuarine fish.

Eelgrass beds are a productive refuge for juvenile fishes and crustaceans. Studies of San Diego Bay found that more species of fish use eelgrass than the other subtidal habitats. Certain species, such as topsmelt and shiner surfperch, use eelgrass beds to spawn. Their offspring remain in the productive, protected eelgrass until they are large enough to enter the open ocean. Recreational and commercial fish as well as small forage fish live in the eelgrass beds.

Diving ducks, primarily surf scoter and scaup, congregate on the open waters of the bay during the winter. These species have declined by 90 percent since the late 1960s. The suspected cause of this precipitous decline is the enormous increase in boat traffic in this same period. During the 1880s great concentrations of waterfowl used the intertidal areas of the north bay. One observer counted 50,000 Black Brandt on a single day in Spanish Bight, an inlet which once existed on North Island. After the filling of much of the bay tidelands, brandt have seldom been seen.

The mudflats of south San Diego Bay are the largest shorebird feeding area in San Diego County and are a significant stopover for shorebirds of the Pacific Flyway. Only half of the mudflat habitat that existed in 1850 in the bay remains, a total of 766 acres. In winter months, feeding shorebirds and other water birds crowd onto these mudflats.

The salt ponds of the south bay provide additional feeding habitat for shorebirds and roosting and nesting areas for many species. Salt production creates water-filled hypersaline ponds, which are inhabited by tiny brine shrimp. Northern phalaropes, eared grebes, and other birds feed in these ponds. The drawdown and drying of the salt ponds create a mudflat-like feeding ground for numerous shorebirds. Waterfowl and many other water birds rest on the water that remains calm during high tides and storms. The levees surrounding the ponds, which are isolated and typically barren of vegetation, serve as nesting grounds for five species of terns, including least terns, as well as black skimmer and snowy plover.

Of the marshes that once bordered San Diego Bay, only 10 percent remain. This remnant consists of 203 acres, primarily at the Sweetwater and Paradise Marsh complex. Resident birds include savannah sparrow and clapper rail. Least terns nest on a large fill within the marsh complex.

Current Problems

Current resource problems in San Diego Bay fall into several categories—water quality issues, proposed dredge-and-fill projects in wetlands, and a proposed southern bay entrance.

During the 1940s and '50s the bay was described as a "metropolitan cesspool." Fifteen sewers discharged raw or minimally treated sewage directly into the bay. The water was a murky green-brown almost devoid of aquatic life. An ocean outfall was constructed at Point Loma in 1963 at the insistence of the Regional Water Quality Board. Long-term studies of the bay's fish and invertebrates have shown that those species that died from the pollution of the 1950s began to return in the 1970s.

Current water quality problems are less obvious and center on high levels of certain toxins in bay sediments. PCBs occur in several locations, most notably in Convair Lagoon, where contaminated shellfish are quarantined. Copper in the mud at the 24th Street Marine Terminal copper ore loading facility exceeds safe levels and must be cleaned up. Both copper and tributyltin leach from antifouling paint on boat hulls, and mud near shipyards contains large amounts of paint chips and toxins. These compounds kill shellfish. Storm drains bring oil and grease washed off sidewalks and roads into the bay, causing fin rot in fish. As the bay watershed is developed, the concentrations of these compounds could greatly increase. The Regional Water Quality Control Board has initiated the San Diego Bay Clean Up Project, which is sampling toxin areas, identifying their sources, and regulating toxic discharges.

The demand for private, recreational marinas in San Diego Bay is very high. Several marinas that would affect wetlands have been proposed. One would be constructed in National City, near 32nd Street, and another in Imperial Beach, along the Otay River. Both could have detrimental effects on wetlands.

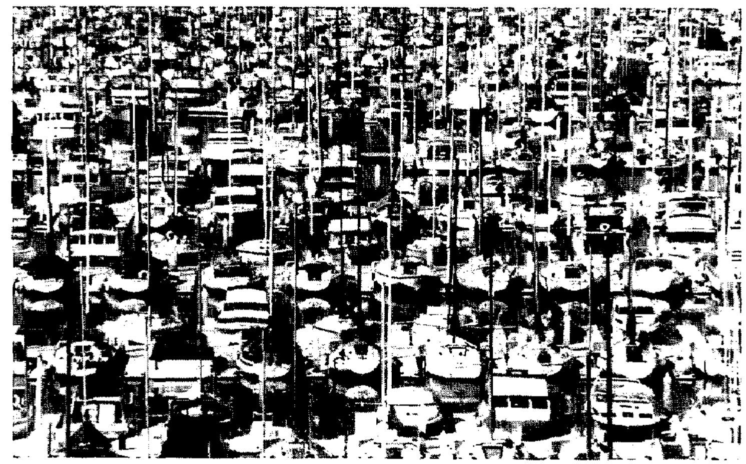
A second entrance to San Diego Bay has been proposed for many years. It would be constructed through the Silver Strand at Crown Cove. Because of the length of the bay, boat travel from marinas in Chula Vista or Coronado Cays to the open ocean is considered to be too long. A second entrance would make the south bay more accessible to recreational boats. The effects of such a second entrance on the south bay wetland habitats would be damaging, however. The shallowness of the south bay and its broad mudflats attract thousands of birds and support many fish. Increasing tidal circulation and deepening of this area would decrease the size and quality of the habitat. As of 1989 this proposal was being studied by a coalition of several south bay cities and remained very controversial.

The riparian forest of the Sweetwater River supports endangered Least Bell's vireos. The largest congregations of this species occur around the southeastern Sweetwater Reservoir and upstream to Jamacha Valley. A number of developments could affect this area, including sand mining, highway expansion, increased water storage, and housing developments. The San Diego Association of Governments released a habitat conservation plan for the river in 1988. Numerous development proposals along the riparian floodplain of the Otay River have been made. The Conservancy and local governments began an enhancement plan for the lower river floodplain in 1989.

Public Access

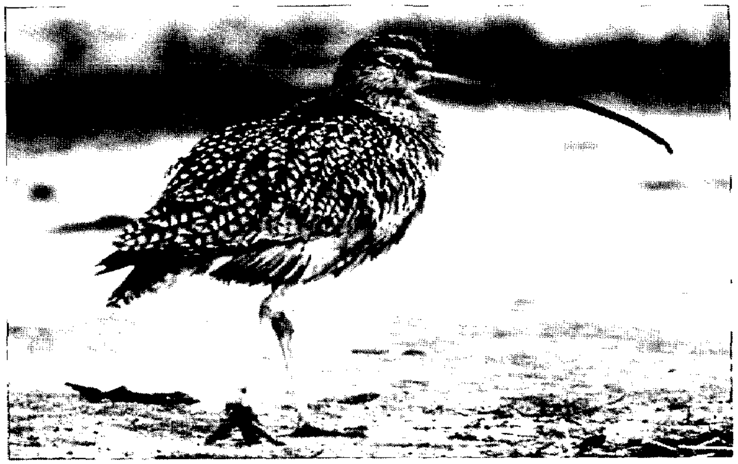
Numerous points on the bay shoreline are accessible to the public. Contact the Port of San Diego at (619) 291-3900 for information. The nonprofit Bayfront Conservancy Trust operates the Chula Vista Nature Interpretive Center. The Center is open from 10 a.m. to 5 p.m., Tuesday through Sunday, and is accessible only by shuttle bus. The bus leaves from the corner of E and Bay streets, just off I-5 in Chula Vista, at 5 and 35 minutes after the hour. Admission to the center is free, but the bus costs 50 cents for anyone over 17. The Center offers numerous special programs including bird walks the first and second Sundays of every month from September through April. Special group tours may be arranged by appointment. Contact: 1000 Gunpowder Point Dr., Chula Vista, CA 92010. (619) 422-BIRD (-2473).

The Southwest Wetlands Interpretive Association is a nonprofit organization concerned with preservation of the south bay. Contact P.O. Box 575, Imperial Beach, CA 92032.



SAN DIEGO UNIFIED PORT DISTRICT

Tijuana Estuary



Long-billed Curlew

Location and Size

Estuary—Cities of San Diego and Imperial Beach, 1320 acres. Watershed—Cities of San Diego and Imperial Beach, County of San Diego, State of Baja California Norte, Mexico, 1730 square miles.

History

Unlike many of San Diego's wetlands, Tijuana Estuary is not dissected by highways and railroads. Development has proceeded along the estuary's edge and filled some marshes. The estuary's features have been affected mainly by sedimentation from watershed erosion and wash over of sand from denuded sand dunes. Since 1852, the estuary has lost 80 percent of its tidal prism. Between 1852 and 1986 the Tijuana River flooded severely seven times and sediment filled 200 acres in the estuary. The southern arm lost 250 acres due to both sedimentation and agricultural reclamation.

The destruction of sand dunes along the estuary's seaward edge has resulted in waves washing sand directly into the marsh. Vegetated dunes protect wetlands by capturing and holding sand blown inland from the beach. They gradually grow taller until large waves erode the sand away and the process resumes. During the 1960s and '70s, apartment buildings were erected on most of the northern dunes, the beach, and some filled marshland. Dune plants cannot withstand much trampling or off-road vehicle abuse. As the population of Imperial Beach grew, the dunes became more and more denuded. Without shrubs and grasses, the dunes no longer captured sand and shrank in height. In 1983 waves washed over the dunes during high surf and high tides, moving sand into the northern marsh and the entrance channel. Four months later the mouth closed, and both the northern marsh and the mouth had to be dredged. The entrance channel now measures only 100 feet wide and is susceptible to closure.

Land Ownership

In 1982 NOAA designated Tijuana Estuary a National Estuarine Sanctuary (later it was renamed a National Estuarine Research Reserve). The Conservancy purchased a large area for the Reserve and turned it over to the City of San Diego. The U.S. Fish and Wildlife Service, U.S. Navy, and California Department of Parks and Recreation are also major landowners. Of the 2,530 acres in the Reserve, only 800 are still privately owned.

Wildlife Values

Tijuana Estuary is one of the largest and best studied wetlands in Southern California. It contains several habitat types; intertidal salt marsh is the most extensive.

In the high marsh, pickleweed supports a large population of Belding's Savannah Sparrow, which feed on abundant insects. The endangered Salt Marsh Bird's Beak also grows here. The lower marsh is dominated by cordgrass and is home to the Light-footed Clapper Rail. In 1983 Tijuana Estuary supported 17 percent of the statewide population of this endangered species. After the estuary mouth closed in 1984, much of the cordgrass died and the rail became extinct in the estuary. Since then several rails have been seen, but the population has not recovered.

Salt pannes are ponds in the marsh that dry out in the summer. In winter waterfowl feed on the blooms of aquatic insects and vegetation. In summer the dry, salt-encrusted panne has an underground world of burrowing insects. One species of these insects, the tiger beetle, is proposed for federal and state listing as threatened. Least terns and snowy plovers also nest on these dry pannes.

Intertidal channels and mudflats are the primary feeding area for shorebirds that migrate to the estuary. There is some evidence that birds which feed at Tijuana Estuary also feed at south San Diego Bay and move between the two wetlands. Tidal channels support estuarine fishes, which attract least terns from their large nesting colony on the beach and dunes.

Current Problems

Tijuana Estuary faces three primary problems—watershed pollution and sedimentation, nearby large-scale land grading, and disturbance from illegal immigration.

Over two-thirds of Tijuana Estuary's watershed lies in Mexico and encompasses the City of Tijuana. This booming border town of 1.5 million people has a limited and often non-functional sewer system. One outdated sewage treatment plant serves only a


KARYN GEAR

The City of Tijuana, Mexico

part of the city. The sewer line breaks and leaks raw sewage into the southern portion of the estuary. An intercept line carries 15 million gallons of sewage a day to the Point Loma treatment plant for processing. But over half the city lacks a sewer system of any kind. Septic systems, pit toilets, or street gutters serve thousands. Stormwater washes much of this raw sewage into the Tijuana River and down into the estuary. A sewage flow of 12.5 million gallons a day was measured in 1988 in the river. Within the next five years a new water supply pipeline will reach Tijuana, greatly increasing this wastewater outflow.

The wastewater has two effects on the estuary. It carries large amounts of nutrients, pollutants, and possibly toxins into the estuary, causing quarantine and public health risks. It also reduces summer salinity levels, killing many marine invertebrates and fish.

The United States and Mexico are cooperatively evaluating many proposals for how to stop the flow of sewage into the estuary. These proposals range from building a larger pipeline to bring more sewage to Point Loma, to building a new regional wastewater plant on the California side of the border, to building a new treatment system in Mexico with a new ocean discharge pipe. Most of the proposals do not address the problem of extending a sewer system to the households in Tijuana that currently lack one. For Tijuana Estuary the primary concern will be to minimize freshwater inflows during the dry season.

The Tijuana River also brings sediment into the estuary. After the 1980 flood, over two inches of sediment had accumulated in parts of the marsh. Sedimentation, which contributes to the loss of tidal prism in the estuary, is caused by poor agricultural practices in the watershed on both sides of the border. The County of San Diego is investigating the possibility of buying portions of the lower river valley, restoring its riparian habitat, and so possibly reducing sediment flow into the estuary. In 1988 the Conservancy funded an environmental review of a major enhancement plan for the estuary which would remove accumulated sediment and restore a large tidal prism.

A large sand and gravel excavation project is being proposed on Spooners Mesa bordering the southern estuary. Over 50 million cubic yards of sand and gravel would be removed, diminishing the height of the mesa substantially and producing copious dust, noise, and disturbance to the estuary's wildlife. As of mid-1989 the environmental review for the project was just beginning.

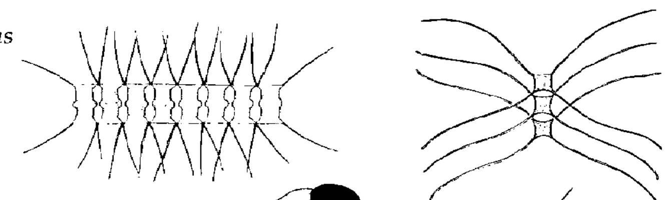
Because Tijuana Estuary lies next to the Mexican-U.S. border and is isolated, it is a nightly highway to hundreds of illegal immigrants. Border patrol officers pursue them both on the ground and in helicopters. This ground traffic has damaged the marshes and created numerous compacted trails.

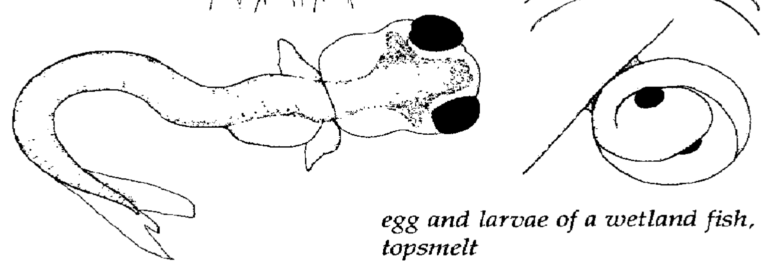
Public Access

Views of the estuary are available from the Imperial Beach side of the Reserve. There are nature walks on the first Saturday of every month. Meet at 9 a.m. at Fifth and Iris streets. Special walks for school groups are available once the group's teacher has completed a training session. Contact Pat Flanagan, reserve education coordinator, at (619) 238-3189 for information.The sand dunes are closed to all public access to protect their fragile plants. On the southern side of the Reserve, Border Field State Park at the end of Monument Road offers a good overview. Call the Department of Parks and Recreation to see if the park is open before visiting: (619) 237-6766. The interpretive center at 301 Caspian Way in Imperial Beach is scheduled to open in 1990.

The nonprofit Southwest Wetlands Interpretive Association has been concerned with preservation and restoration of Tijuana Estuary for the past ten years. Contact: P.O. Box 575, Imperial Beach, CA 92032.

Diatoms





egg and larvae of a wetland fish, topsmelt

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