U.S. Army Corps
of Engineers

Explore 10

The California Coastline
Point Conception to Point Mugu

The Year of the Coast

The beauty and physical diversity represented by California's coast, bays, harbors and estuaries are exceptional. Uniquely spectacular scenery features mountains dropping steeply to rocky shores, rolling headlands and bluffs, fertile marshes, wide sandy beaches and dramatic vistas extending some 1,100 miles from Oregon to the Mexican border.

The sea acts as the coast's chief architect, and continual changes take place as waves, rains and winds reshape shoreline contours. Currents and tides continually refresh and nourish coastal lands and waters, where life forms are as diverse as their habitats. Here the mighty whale and the tiniest of organisms, salt marsh plants and towering redwoods, live together with man in an intricately balanced state of interdependence.

The coast means something different to each individual. Some cherish the fresh salt air, the sea breezes and the opportunities for contemplative solitude. Others enjoy the coast as a place to picnic and swim, to fish, sun or sail, while many choose to search for driftwood or study the mysteries of rocky tide pools. Many choose bird-watching in coastal bays, marshes and lagoons, while others value the potential for commercial and recreational development.

To the U.S. Army Corps of Engineers, California's bay and coastal areas mean a continuing dedication to management and preservation through effective coastal engineering, interdisciplinary investigations, exercise of regulatory authority, flood prevention and water quality control, harbor development and protection, and conservation of fish and wildlife.

To assist you in developing a greater knowledge and appreciation for California's coastline and its valuable resources, the Corps of Engineers has prepared a series of brochures which highlight both natural and man-made features. The sites included in each brochure were selected for their unique scenic significance, recreational opportunities and accessibility. Related information on various natural phenomena such as tidal action, beach formation and movement of currents has also been included, along with reference to numerous indigenous plants and animals. Such detail provides the visitor with the opportunity to gain an increased understanding of the many fascinating aspects of coastal areas.

Bring your camera and binoculars, your curiosity and sense of adventure and join us in exploring nature's wonderful gifts.

Point Conception to Point Mugu

At Point Conception, California's most significant promontory, the coastline orientation changes from predominantly north-south to east-west. This dramatic shift in direction significantly affects both inland and coastal characteristics.

Between Point Conception and Point Mugu, which is located about 85 coastal miles to the east, the coastline offers diverse and beautiful scenery as well as a variety of recreational alternatives. Many of Southern California's most praised attributes—wide, sandy beaches, warm temperatures, and gentle breezes—are represented. The geographic and topographic diversity displayed here ranges from rocky, wave-eroded cliffs and sandy beaches to the wide expanse of the Oxnard Plain. Here, also, are quiet lagoons, marshlands and busy harbors.

The Channel Islands significantly affect the area between Point Conception and Point Mugu by reducing the energy of waves approaching the shoreline. In the offshore waters of the Santa Barbara Channel, formed by the Channel Islands, and along adjacent nearshore lands there are rich supplies of oil and gas. The exploration and development of these precious resources is one of the most visible industries. Citrus, avocado, flower and vegetable growing are also economically important, as are commercial fishing and tourism.

Recorded information concerning man's habitation begins with the history of the Chumash Indians, a fishing and boat-building people who found the pleasant climate and the abundant bounties of land, ocean and stream ideal. Early Hispanic explorers, including Juan Cabrillo, in 1542, and Sebastian Vizcaino, in 1602, were the first to write of their encounters with these Native Americans. The area's rich history continued with the large ranchos of the Spanish occupation period and the subsequent development of the Franciscan missions.

The Corps of Engineers hopes that you will enjoy your explorations of this section of the California coast and that your appreciation for its natural beauty and abundant resources will be enhanced.

Hwy 1
101
Santa Ynez Mountains
The Beach at Gaviota State Park 1
2
El Capitan State Beach
101
Santa Barbara Harbor
3
Goleta Beach County Park and Slough
4
5
6
Rincon Point and Rincon Island
Carpenteria Marsh and State Beach
Ventura River
Santa Clara River
101
Ventura Harbor 7
Oxnard
Santa Barbara Channel
Channel Islands Harbor and Port Hueneme 8
Point Mugu and Mugu Lagoon 9
San Miguel Island
Santa Rosa Island
Santa Cruz Island
Anacapa Island
Pacific Ocean
0 1 5 10 Miles

1 The Beach at Gaviota State Park

The beach at Gaviota State Park is located about 15 coastal miles east of Point Conception, where Highway 1 joins the coast. This beach provides the first point of coastal access south of Jalama Beach County Park.

Immediately north, the highway runs through scenic Gaviota Pass. Here, dramatic, steep-sided mountains create an environment markedly different in appearance from roadside scenery immediately to the north and south. Named in 1769 by Gaspar de Portolá for the sea gulls observed in the area, Gaviota Pass and the surrounding hills provide a habitat for numerous species of wildlife and birds, including the endangered southern bald eagle and the American peregrine falcon.

Adjacent to the beach at Gaviota State Park steep cliffs feature a visually fascinating geological composition. The formations consist primarily of marine conglomerate layers of shales, diatomites and sandstone. Originally deposited as sediments, the shale was formed from clay particles, the diatomites from silica secreted from diatoms, and the sandstone from sand. These former ocean floor sediments have been uplifted and folded during tectonic movements of the earth's crust and major earthquake activity. The cliffs serve as a major sand source for area beaches.

The beach here, once called Alcatraz Landing, is situated at the mouth of one of dozens of small *arroyos,* or stream-cut gulleys, leading from nearby mountain ranges to the sea. A 545-foot recreational fishing pier extends from the west end of the beach. Here catches include perch, halibut and kelp bass. Canopies of giant kelp can be seen bobbing on the surface of the water. These kelp beds, so characteristic of the Southern California coast, create a mini-ecosystem consisting of hundreds of varieties of fish and marine invertebrates.

Directly offshore is the Santa Barbara Channel, the expanse of water between the coast and the most northern Channel Islands — San Miguel, Santa Rosa, Santa Cruz and Anacapa, located from 25 to 40 miles offshore. The Channel, which begins at Point Conception, ends near the city of Oxnard, about 70 miles downcoast. The coastline extending to the east and west is typified by narrow, sandy beaches backed by wave-cut marine terraces. In the Gaviota area, as many as 22 levels of marine terraces, or land benches, have been noted, ranging in elevation from

Fishing pier at Gaviota State Park

Beach at Gaviota

Caution

To fully enjoy your explorations of the California coast, it is important to be aware of its innate, and often unexpected hazards.

In some areas, the possibility of landslides makes hiking on the cliffs particularly dangerous. Because loose materials can suddenly cascade to the water below, walking should be restricted to areas well away from cliff edges. Those walking beneath the cliffs should be aware of the possibility of falling rocks.

Non-slip, protective footgear should be worn at all times while exploring tide pools or climbing rocks near the water's edge. Always be watchful of incoming tides, and beware of the dangers of rip currents, backwash and occasional large waves.

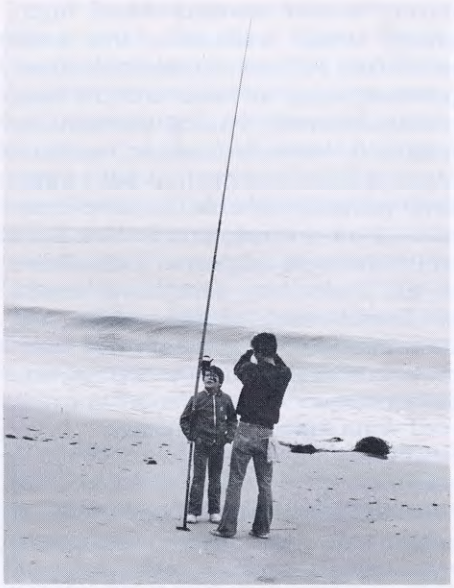
Marine conglomerate layers of Gaviota Beach cliffs

Western end of Gaviota Beach

six to more than 300 feet above the sea.

About nine miles downcoast from Gaviota State Park is Refugio State Beach. The beach at Refugio, as at Gaviota, is crescent-shaped, having been formed as waves moving predominantly from the west refract, or bend, around an upcoast headland. Refugio offers lifeguard facilities as well as picnic and camping facilities. The wide, sandy beach is popular with swimmers and surfers. Here, as in many other areas along the Santa Barbara Channel, oil drilling platforms and moored tankers are visible offshore.

Continuing east along Highway 101, the Santa Ynez Mountain range, which begins at Point Conception, rises to heights of 3,000 feet within two to four miles of the coast.

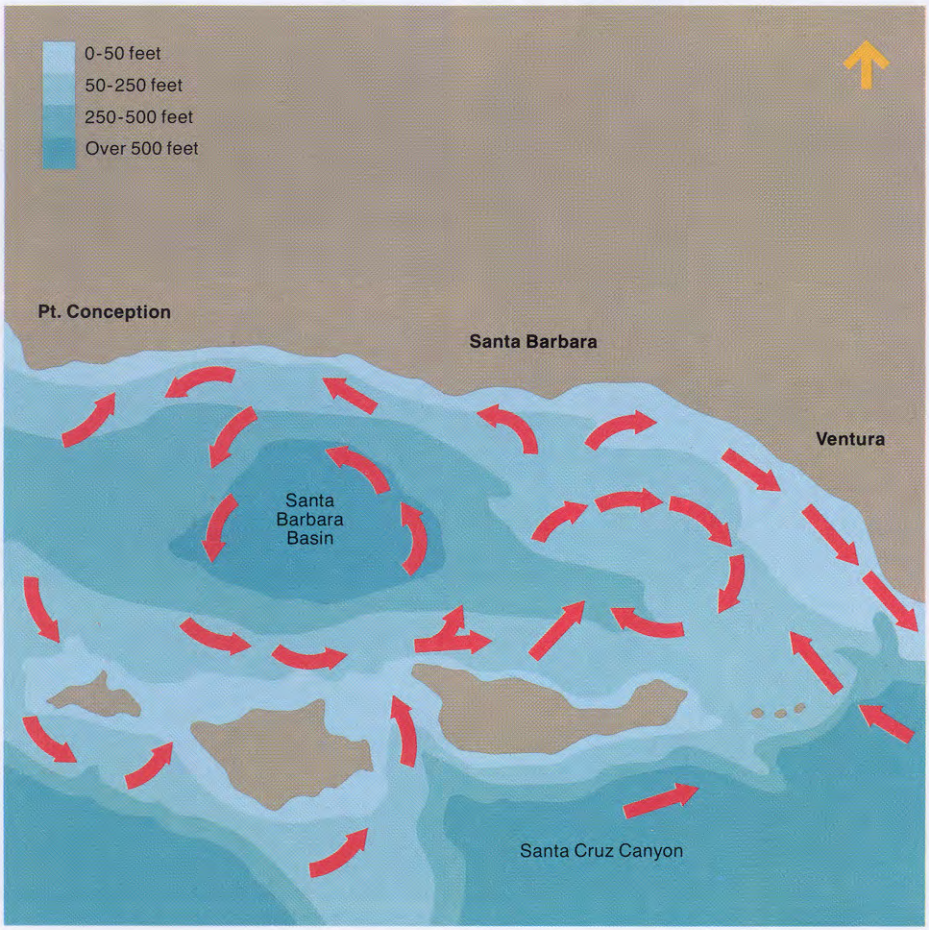


Refugio State Beach surf fishermen

2 El Capitan State Beach

About three miles downcoast from Refugio, turn right at a sign indicating the entrance to El Capitan State Beach. Approaching the beach parking lot, the roadway runs through a moist, densely vegetated area; a sharp contrast to the scattered scrub common to the semi-arid hillsides nearby.

From the parking lot, walk along the pathway that leads to El Capitan's gently sloping beach. This attractive wave-fronting beach is backed by stable, vegetated dunes and grassy areas. The heavy boulders on El Capitan Point help provide protection from waves approaching from the west. Waves refracting around the point form the crescent contour of the beach, which gradually straightens as it nears the downcoast promontory. Because refracted waves



Santa Barbara Channel

The Santa Barbara Channel, recognized as one of the most varied and productive marine ecosystems in the United States, is located in a unique biogeographic environment. Here, the cold, nutrient-rich waters of the northern-temperate province are brought southward by the California Current to mix with the waters of the warm-temperate province, which are carried northwest by the Southern California Countercurrent. The abrupt coastal reorientation at Point Conception creates an eddy, or gyre, that is instrumental in combining the waters of the two provinces. As a result, marine life indigenous to each province melds with a third and thriving population with the combined attributes of the two climates.

The biological environment is also affected by the dramatic ridges and valleys common to the ocean floor in the vicinity of the Channel Islands. The resulting variation in water depth encourages a proliferation of marine life attuned to differing levels of light, temperature and water pressure. The variety of substrate, or type of sediment, found on the ocean floor also encourages biological diversity.

These many unique conditions create an extraordinary quantity and quality of life in the Santa Barbara Channel. Large numbers of underwater expeditions, both recreational and scientific, are sent here each year.

lose much of their energy in the bending process and break parallel to the beach, suspended sediments drop out on the downcoast area to form the beach.

This area of the California coastline is exposed to waves approaching from the west, and is partly protected from southerly waves by the sheltering effect of the Channel Islands. For a time during Spanish occupation, El Capitan was known as a center for smugglers who received goods from foreign ships anchored offshore. Such smuggling activity was in direct opposition to a Spanish rule which forbade trade with foreign countries.

The 1.8 miles of ocean frontage at El Capitan offer visitors an opportunity to observe the large cobblestones typical of many of the area's beaches. These stones are particularly evident during winter months when high-energy waves wash away the sandy beach face. Primarily of sandstone composition, many of these cobbles have round, smoothly eroded indentations formed by wave erosion. At one time some of these indentations held small, hard pebbles, believed to have been part of an ancient stream bed from which the rocks originated. Other holes in the rocks may have been caused by animals such as sea urchins and clams whose boring action and natural secretions gradually formed the indentations.

In the cliffs adjacent to the beach, natural asphalt seams in the shale outcroppings are evident. These seams break off as the cliff erodes and form cobble-size black lumps. The gooey black lumps commonly found along the beach are a product of volatilized natural nearshore oil seepage. This natural tar, called *pismo* by the Chumash Indians, was used as a caulking material for boats.

The stream that enters the sea at El Capitan State Beach is typically blocked at its mouth by sands carried in by wave action during summer periods when stream flow is low. During the heavy rains of winter, higher flows wash the sand barrier away, allowing the stream to flow directly into the sea.

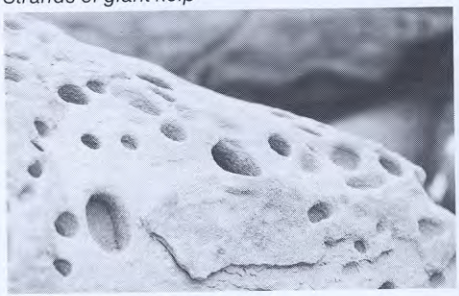
Seasonal lifeguard services are available at El Capitan State Beach, along with campsites and picnic facilities. A visitor information center offers interesting historical and environmental information.

Stream entering ocean at El Capitan State Beach

El Capitan's cobbled beach

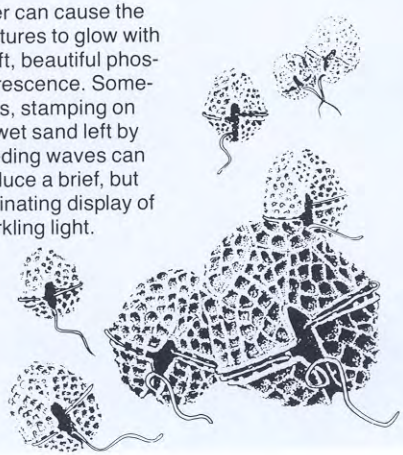
Morning Glory on El Capitan State Beach

Strands of giant kelp



Indented shoreline rocks

Phosphorescence
Although phosphorescence can be observed in certain marine organisms such as squid and shrimp, the phenomenon most commonly seen results from the light produced by tiny plankton. These microscopic, light-producing animals are called *dinoflagellates* because they have whip-like appendages that propel them through the water. Phosphorescence produced by these minute, single-celled animals can best be observed on dark moonless nights during spring and summer. Their spectacular displays of greenish-white light, a result of nervous stimulation, can be seen only when they are disturbed. Impacts such as waves splashing on the shore, or boats, swimmers or fish passing through the water can cause the creatures to glow with a soft, beautiful phosphorescence. Sometimes, stamping on the wet sand left by receding waves can produce a brief, but fascinating display of sparkling light.



3 Goleta Beach County Park and Slough

For anyone interested in the geology and physical beauty of the highly eroded cliffs typical of this portion of the Santa Barbara County shoreline, a visit to Isla Vista Beach Park is worthwhile. The steep cliffs here tell the story of the uplifting of ancient ocean bottoms and of long-term erosion by wind and waves. The undercutting along the base of the cliffs is characteristic of the area's extensive erosion.

To reach the park, which is located about midway between Coal Oil and Goleta points, exit from Highway 101 on Storke Road about nine miles downcoast from El Capitan State Beach. Turn left from Storke on El Colegio Road; make a right turn on Camino del Sur. At the end of the street, turn right on Del Playa to the beach parking lot.

Further downcoast, about a mile from Isla Vista Park, Goleta Beach County Park lies in the lee of Goleta Point. The Point, a low coastal promontory terminating in a 30-foot cliff, is also known as Campus Point, due to its proximity to the University of California at Santa Barbara. Coal Oil Point, named for its natural oil seepage, is just upcoast from Goleta Point and is also part of the University campus.

The wide, flat barrier beach at Goleta State Park runs along the shoreward perimeter of a 360-acre marsh known as Goleta Slough. To enjoy this popular recreational beach and the slough's fascinating beauty, turn right on Fairview Avenue from Highway 101 in the town of Goleta. Make a right turn on James Fowler Road, cross the slough, then turn left on William L. Moffat, near the airport. Continue seaward to the beach parking lot.

Portions of the marshy slough, including its main channel, can be seen from the parking area. About 75 acres of the marshlands are replenished with sea water during periods when an opening in the barrier beach allows tidal exchange. The artificial opening of the barrier beach ensures the intermittent tidal action that creates continuously changing salinity levels in the marsh. Fresh water is supplied primarily by two streams that carry runoff from the Santa Ynez Mountains.

Goleta Slough is one of the few publicly owned coastal salt marshes in Southern California. Until the mid-1800s, the slough was an open harbor capable of accommodating shallow-draft vessels. However, the combined effects of a major flood that occurred in 1861, the years of stream sediment de-

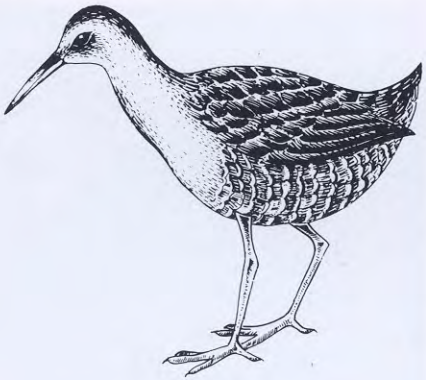
Recreational pier at Goleta Beach County Park

Waters of Goleta Slough

Footbridge crossing Goleta Slough marshlands

Undercut cliff at Arroyo Burro County Beach Park

Tree endangered by undercutting



Light-footed Clapper Rail

The light-footed clapper rail, one of California's endangered species, restricts its habitat to salt marshes along the Pacific coast–from Marin County south into the northern coastal areas of South America.

Considered a shy bird, the clapper rail tends to search for food in protected areas of dense cordgrass and pickleweed, only occasionally venturing into adjacent mudflats and narrow channels. It feeds primarily on fish, worms and small crustaceans such as crabs and snails.

The feathers of the light-footed clapper rail are medium brown, with white bars marking its sides. A slightly downcurved beak and stocky, long-toed feet are other identifiable features. The clapper rail's fluffy, black chicks hatch from pale, spotted eggs.

position, the development of the barrier beach and the addition of man-made fill and dikes slowly changed the harbor to a marshland. Hundreds of species of birds, mammals, fish, insects and invertebrates thrive in the slough's rich environment. Typical inhabitants include plovers and sandpipers, ruddy ducks, mallards, raccoons and jackrabbits, topsmelt, shrimp and worms.

The predominant vegetation at Goleta Slough is pickleweed, a grey-green plant whose reddish autumn colors add a colorful patina to the marsh's otherwise somber tones. Pickleweed accounts for about 90 percent of the slough's ground cover.

Leaving Goleta Beach County Park, turn right on Clarence Ward Memorial Road, also known as Highway 217, and continue inland to return to Highway 101. Follow the highway into the City of Santa Barbara. Arroyo Burro County Beach Park is a small, attractive park located near the western edge of the city. To visit this popular family beach, turn right from Highway 101 on Los Positas Road, drive shoreward and turn right on Cliff Drive. The beach offers visitors a fine opportunity to enjoy the beautiful environment of sun, sand, and wave-cut eroded cliffs.

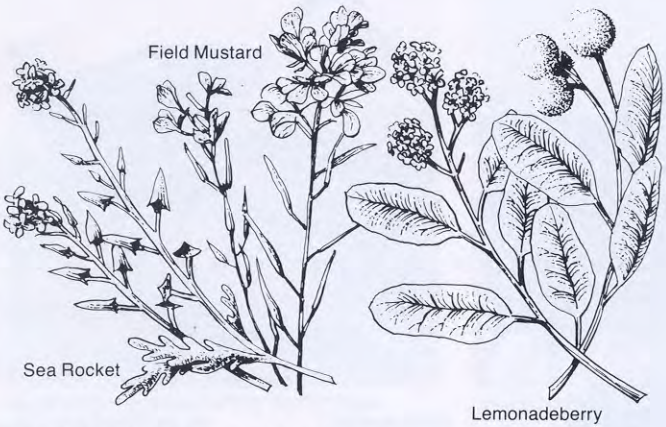
After visiting Arroyo Burro, continue eastward on Cliff Drive and turn right on Meigs Drive. Meigs later becomes Shoreline Drive. This coastal route, part of Santa Barbara's Scenic Drive, passes Shoreline Park, a beautifully landscaped, grassy park atop steep coastal cliffs. Pathways along the cliff's edge offer fine vistas of the Channel Islands on clear days. Leadbetter Beach and Santa Barbara Harbor can be seen from the downcoast end of the park.

4 Santa Barbara Harbor

Santa Barbara Harbor, home port to more than 700 pleasure, sports and commercial fishing vessels, is situated at Point Castillo in the lee of Santa Barbara Point.

The harbor's 2,400-foot breakwater and the offshore Channel Islands offer protection from waves approaching the harbor from the south and southwest.

A walkway along the top of the breakwater provides an excellent vantage point from which to watch harbor activities. Be aware, however, of large, overtopping waves and slippery conditions. To reach the breakwater, which runs south and east from Point Castillo, turn right on Harbor Way and continue to the harbor area. The Spaniards who settled here in the late 18th century named the area *La Tierra Adorada,*



Coastal Vegetation
Coastal plants typically grow in distinct communities, dependent upon intrinsic conditions such as the amount of moisture and sunlight, area topography, and soil composition. Numerous species thrive in the typically arid environment of the Southern California coast.

One of these species is the sea rocket, a fleshy plant that grows on sand dunes and cliffs just above the high tide level in what is known as the "coastal strand community." It thrives in spite of the strong winds and salty air by conserving moisture in its succulent tissues.

Lemonadeberry, a member of the sumac family, is one of a group of short, semi-woody shrubs that grows in the arid "sage and scrub community" just above the coastal strand. This species, which grows from three to nine feet in height, sends long tap roots deep into the soil in search of water.

Field mustard is characteristic of the area, extending inland above the sage and scrub community where the soil is still predominantly sandy. The bright yellow flowers of this prolific plant brighten the landscape along the Southern California coast during early spring.

Santa Barbara Harbor and breakwater

Santa Barbara fishing fleet

Lagoon behind Cabrillo Beach

meaning "the beloved land." Typically sunny skies and mild temperatures, coupled with an outstanding natural beauty, make Santa Barbara widely renowned as a tourist and retirement center.

Santa Barbara Harbor, which consists of approximately 84 acres, was originally a small port partially protected by an 1,800-foot detached breakwater. The original breakwater was completed in 1929. Following its construction, a tombolo, a build-up of sand in the lee of the breakwater, developed. The shoaling effect interfered with use of the western portion of the harbor and denied downcoast beaches their usual supply of sand. In an attempt to reduce the problem, the detached breakwater was extended to Point Castillo. In 1938, following the recommendation of a Corps of Engineers study, a pipeline dredging program was implemented to remove sands that accumulated at the eastern end of the breakwater in the entrance channel.

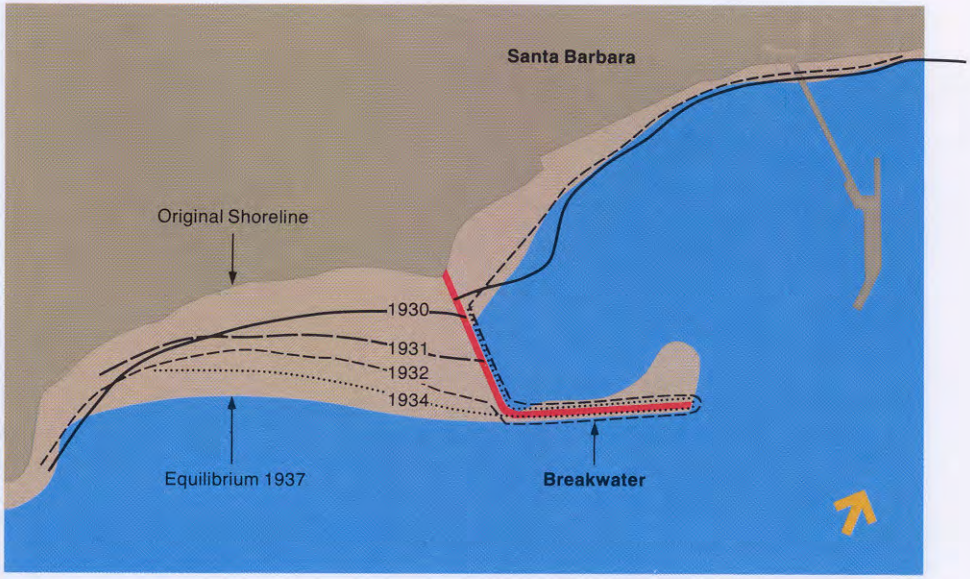
Dredged sands are placed on a downcoast "feeder" beach, as well as on a small, protective spit that extends into the harbor near the seaward end of the breakwater. This sand spit creates a breakwater effect by protecting the inner harbor from waves approaching from the southeast. Sands placed on the feeder beach are picked up by longshore currents and carried downcoast.

After exploring Santa Barbara Harbor from the Point Castillo side, return to Shoreline Drive, turn right and continue downcoast. The drive, which soon becomes Cabrillo Boulevard, runs around the perimeter of the harbor, along wide, sandy Cabrillo Beach and beautifully landscaped Cabrillo Park.

Roller skating along Cabrillo Beach pathway

Cabrillo Beach volleyball game

Andree Clark Bird Refuge scene



Beach Equilibrium

When the contours of a beach are changed by the addition of man-made structures, the natural equilibrium is affected. The affected area will, however, eventually attain a new equilibrium as the result of the changed refraction, diffraction and reflection of waves. An example of the progressive reorientation of a shoreline to a dynamic equilibrium is clearly portrayed in the case of Santa Barbara Harbor.

When the harbor's offshore breakwater was constructed, the normal pattern of littoral drift was interrupted. After the breakwater was connected to land in 1930, the interaction of waves and littoral currents with the breakwater caused sand to drop out of suspension and accumulate immediately upcoast of the structure, rather than continuing on to downcoast beaches. Sand progressively filled the area west of the breakwater. As a result, Leadbetter Beach was created and Point Castillo became a less distinctive coastal promontory. Downcoast beaches were starved for sand until a relatively stable shoreline developed about seven years later.

A visit to three-block-long Stearns Wharf, a recreational and commercial pier extending from the foot of State Street into the middle of the harbor, offers visitors an opportunity to enjoy yet another perspective of harbor activities.

Behind the downcoast portion of Cabrillo Beach is another interesting stop – Andree Clark Bird Refuge, located off Cabrillo Boulevard on Los Patos. Here, gulls, ducks and geese inhabit a small freshwater pond. Park benches and a pathway along the edge of the pond offer opportunities for enjoying the area's quiet beauty. From the bird refuge, continue downcoast on Cabrillo Boulevard to Highway 101 south. Carpinteria State Beach, another popular Santa Barbara County beach, is located about seven miles downcoast.

5 Carpinteria Marsh and State Beach

The drive along Highway 101 between Santa Barbara and Carpinteria closely follows the coastline. Groves of citrus trees, common to Santa Barbara and Ventura counties, line portions of the roadway. In several places along the railroad tracks that run between the highway and the shoreline, rock revetments protect the coast from wave erosion.

Just north of Carpinteria State Beach, *El Estero* spreads inland behind Sandy Point. The 230-acre wetland complex is commonly known as Carpinteria Marsh. This coastal lagoon and marsh area extends along the coast for about a mile, varying in width from a few to several hundred feet. Vantage points from which to view the marsh are available along Del Mar Avenue. To reach this area, take the Carpinteria Avenue exit from Highway 101 and turn left on Sandyland Cove Road toward the coast. Public access is limited, since the marsh is owned predominantly by private interests.

Two streams – Santa Monica and Franklin Creeks – drain into the marsh from the southern slopes of the Santa Ynez Mountains. These two waterways traverse the marsh through dredged flood control channels and enter the sea through the narrow opening that separates the two coastal sand spits. Tidal exchange continually flushes and refreshes the marshlands.

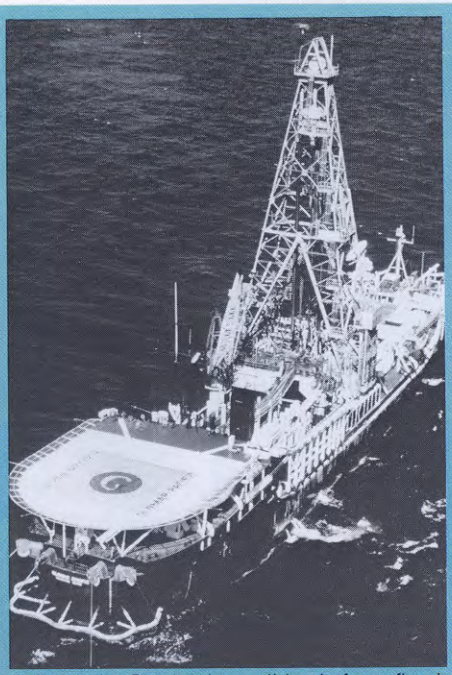
Within the area, several distinct habitats have been identified, including tidal salt marsh, mudflats, salt flats and freshwater. Virtually thousands of wildlife species inhabit these varied environments. Although pickleweed is the

Offshore Oil Drilling
The first offshore oil drilling rigs used in the Santa Barbara Channel were erected in 1896 along the Summerland coastline east of Santa Barbara. These first rigs were simple drills attached to the ends of long piers. Since then, equipment has become increasingly sophisticated. The offshore oil drilling facilities today consist of two types – fixed and mobile.

Fixed platforms are permanently attached to the ocean floor. Used for development drilling as well as for production and operations, each can accommodate up to 30 individual wells.

Mobile platforms are moved from place to place and used predominantly for exploratory drilling. There are three major types of mobile platforms. The drill ship, most often used in the deepest waters, operates through a hole in the ship's hull called a "moon pool." The semi-submersible, a large surface platform connected by columns to submerged hulls, is typically used in water depths of 1,000 feet or more. The third type, the jack-up, has legs that extend to the ocean floor. It is used in shallow waters ranging up to approximately 350 feet.

The fixed platform, used primarily for production, is the most commonly seen rig in the Santa Barbara Channel.



Left to right: Semi-submersible platform, fixed platform, drill ship

primary form of vegetation, patches of alkali heath can be seen scattered throughout the area. This prolific marsh was once the site of a Chumash Indian village.

Continuing downcoast on Carpinteria Avenue, visit beautiful Carpinteria State Beach by turning right on Seventh Street and then right on Linden to the beach parking lot. This long, wide beach is approximately 36 acres in size and extends for about a mile along the Pacific. The beach is backed by a flat plain that extends inland to the base of the Santa Ynez Mountains. Through the years, the beach has remained relatively stable in size due to a sand replenishment program administered by the State Division of Beaches and Parks. A rock reef located about 2,000 yards offshore, acts as a natural breakwater, protecting the shoreline from large winter waves and making the waters safer for swimming. Skin divers often explore the reef searching for spiny lobsters and abalone. A fishing pier, as well as camping and picnicking facilities, is also available.

Children enjoying surf along area beach

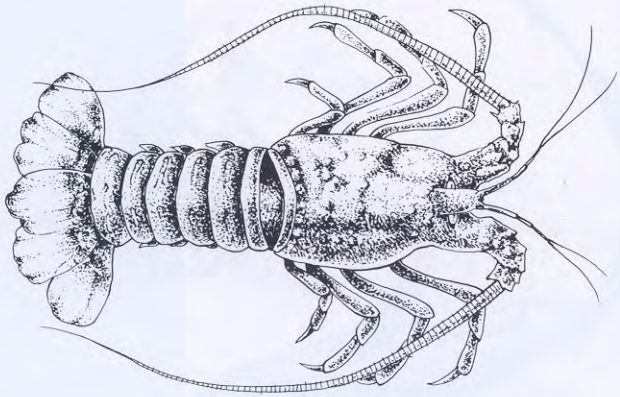
6 Rincon Point and Rincon Island

From Carpinteria, return to Highway 101 and continue downcoast for a short distance to the Base Avenue exit. Make a right turn, then an immediate left up the hill to the parking lot. A short walk along a pathway leads to the beach at Rincon Point.

Rincon Point was once the site of a Chumash Indian village, thought to be one of the oldest along the Santa Barbara Channel. This low, tree-covered point marks the shoreline boundary between Santa Barbara and Ventura counties. It developed as an alluvial fan consisting of cobble materials carried seaward by Rincon Creek many thousands of years ago. The erosion-resistant nature of its cobble composition accounts for the stability and longevity of the point. Waves refract

Carpinteria State Beach

Rincon Point, famous surfing area



Spiny Lobster

The spiny lobster, also known as a rock lobster or "bug," can be caught both in shallow pools and at depths ranging to 20 fathoms, or 120 feet. They are common to the rocky crevices of the coasts of California and Mexico and are particularly prevalent in the numerous kelp beds around the Channel Islands.

As commercially important shellfish, spiny lobsters are typically caught with traps that consist of wire netting stretched over a lath framework. The lobsters, attracted by bait such as decayed fish, enter a hole in the cage that is designed to prevent escape.

Spiny lobsters hatch from tiny, coral-colored eggs. A single female can lay up to 500,000 eggs at a time. Such vast quantities help to ensure that a sufficient number of the fragile, newly hatched larvae will survive the rigors of the sea and its predators. Growth to adulthood occurs through a series of moltings. During the molting process, the lobster slides its body away from its exoskeleton and withdraws from its shell leaving it so nearly intact that it is often mistaken for a live specimen. Until a new, hard shell forms, the unprotected lobster is easy prey for enemies such as sea bass, sheepshead and octopus.

around Rincon Point to form the crescent shaped beach immediately downcoast. The refracted waves create ideal surfing conditions.

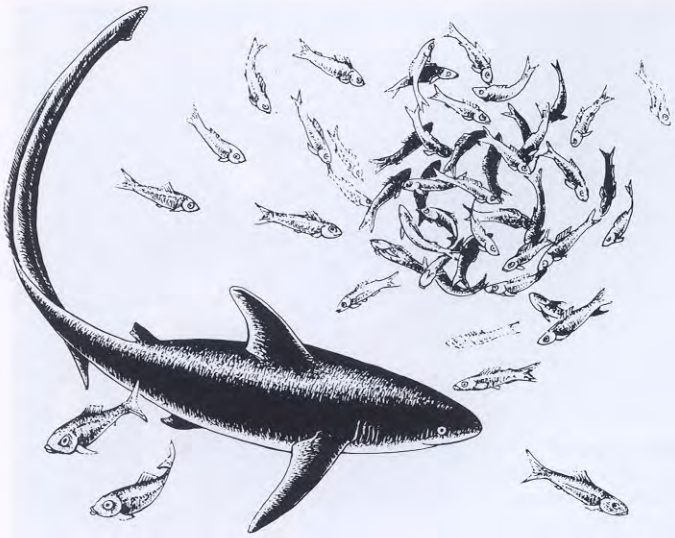
Alluvial deposits over erosion-resistant strata similar to that at Rincon are common to this section of the California coastline. Other examples such as Punta Gorda and Pitas Point are located just downcoast. Each point spreads out seaward at the mouth of a small stream in an asymmetrical formation that originated in an alluvial fan. Each is typified by a long, western wave-fronting section and short eastern crescent. These promontories differ significantly from the steep, rocky headlands of the northern coast.

Continue eastward along the gentle curve of the narrow beach immediately downcoast of Rincon Point. Stone revetments, seawalls and bulkheads line much of the shoreline here, protecting the highway and railroad tracks from wave erosion. In the early 1900s, the highway in this vicinity was built on trestles along the eroding coastline. In the late 1960s and early 1970s, the highway was realigned and land fill was added to form today's stable roadway. The beach continues to Punta Gorda, the next point of land extending into the Pacific. Punta Gorda is relatively low near the waterline then abruptly rises to converge with the prominent contours of Rincon Mountain.

Just off Punta Gorda is Rincon Island, a man-made structure that was built for oil industry purposes in 1958. The private causeway connecting the island to Punta Gorda is used for transporting equipment and supplies to the island's oil drilling facilities. Rincon Island consists of rock revetment built over sand fill. The exposed western face of the island is protected from wave erosion by more than 1,100 concrete tetrapods, twenty-five ton reinforced concrete armor units engineered to dissipate wave energy.

The rock revetments on the island create habitats for numerous marine species such as silverside, surf perch, sea bass and rock fish, sponges, anemones, sea slugs and scallops. Plants thriving here include red and green algae, giant kelp and sea lettuce.

Artificial reefs constructed to create environments attractive to fish are fairly common in Southern California waters. Most, including those located near the Ventura and Channel Islands Harbors, are made of such materials as discarded car bodies, tires and quarry stone. Many of the reefs were built by the California Department of



Thresher Shark
Because of its finely textured sweet meat, the thresher shark has become an increasingly important catch in the deep waters off the Southern California coast. Prime fishing grounds are located in the vicinity of Anacapa Island.

The thresher, also known as the peacock shark or swiveltail, has a long, flexible tail that accounts for more than half its body length. Up to 10 feet long, this enormous tail is primarily used in obtaining food. Upon spotting a school of fish, the shark begins to swim in circles. Threshing its tail, it groups the fish more and more closely together, then, when ready, the shark attacks the mass, rapidly grabbing and gulping its helpless victims.

The skeleton of the thresher shark, like that of others in the shark family, consists of cartilage rather than bone. The shark is, however, considered a vertebrate because it has a spinal column.

Shoreline highway in early 1900's

Revetment-lined highway

Oil production on piers

Fish and Game for the benefit of both commercial and sports fishermen.

In the vicinity of Rincon Point are narrow, cobbled beaches fed primarily by longshore transport moving predominantly downcoast. The Channel Islands reduce the energy of waves approaching the shoreline, although high-energy waves occasionally approach from the south as a result of storm activity.

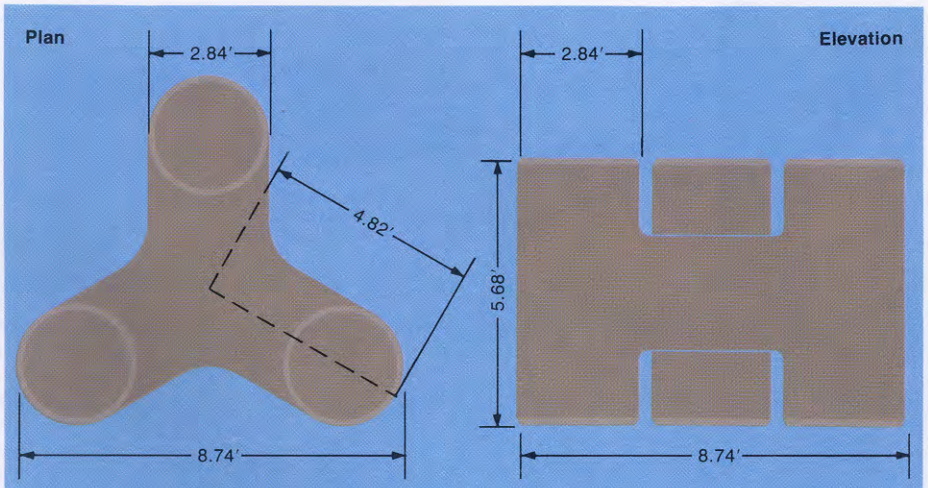
Continuing downcoast, watch for Emma Wood State Beach, a heavily duned beach adjacent to the mouth of the Ventura River. The Ventura, which drains more than 220 square miles, runs coastward through the Ojai Valley and marks the eastern terminus of the Santa Ynez Mountain Range. Both the Ventura and Santa Clara rivers serve as the major sediment sources for Ventura County's recreational beaches.

Ventura Harbor from Marina Park

7 Ventura Harbor

North of Ventura Harbor, formerly known as Ventura Marina, seven rubblemound groins extend from the shoreline of San Buenaventura Beach State Park into Pierpont Bay. This groin field, which begins just south of the 960-foot-long Ventura pier, was constructed between 1962 and 1967 by the Army Corps of Engineers for the purpose of trapping sands necessary for the stability of area beaches. Following the construction of the groins, approximately 880,000 cubic yards of sand were deposited to begin the beach-building process.

The groins, which range in length from 420 to 542 feet, are visible from Marina Park. To reach this grassy, well-maintained park, take the Seaward exit from Highway 101. Turn left on East Harbor Boulevard, right on Peninsula



Tribars

Tribars are massive concrete armor units, engineered to dissipate the energy of waves. Designed by Robert Q. Palmer of the Corps of Engineers in the late 1950s, tribars consist of three vertical cylinders connected with a triangular-shaped bar.

Typically used in the absence of suitable natural stone, tribars are one of several armor units found to be effective in protecting breakwaters and jetties along the California coast. Others are quadripods, tetrapods and dolosse. Unlike their counterparts, which are usually placed in a more or less random fashion, tribars are carefully nested. Each of the tribars protecting the Ventura Harbor entrance jetties measures more than 142 cubic feet in volume and weighs more than 10 tons.

Although masonry breakwaters have been constructed since early Roman times, it was not until the early 1900s that engineers began to realize that randomly placed boulders or quarrystones helped to dissipate wave energy. Rubblemound structures then became prevalent. Since mid-century, numerous types of concrete armor units have been developed throughout the world for the purpose of reinforcing rubblemound jetties and breakwaters.

Ventura Harbor entrance jetties and beach

Rubblemound groin at San Buenaventura Beach State Park

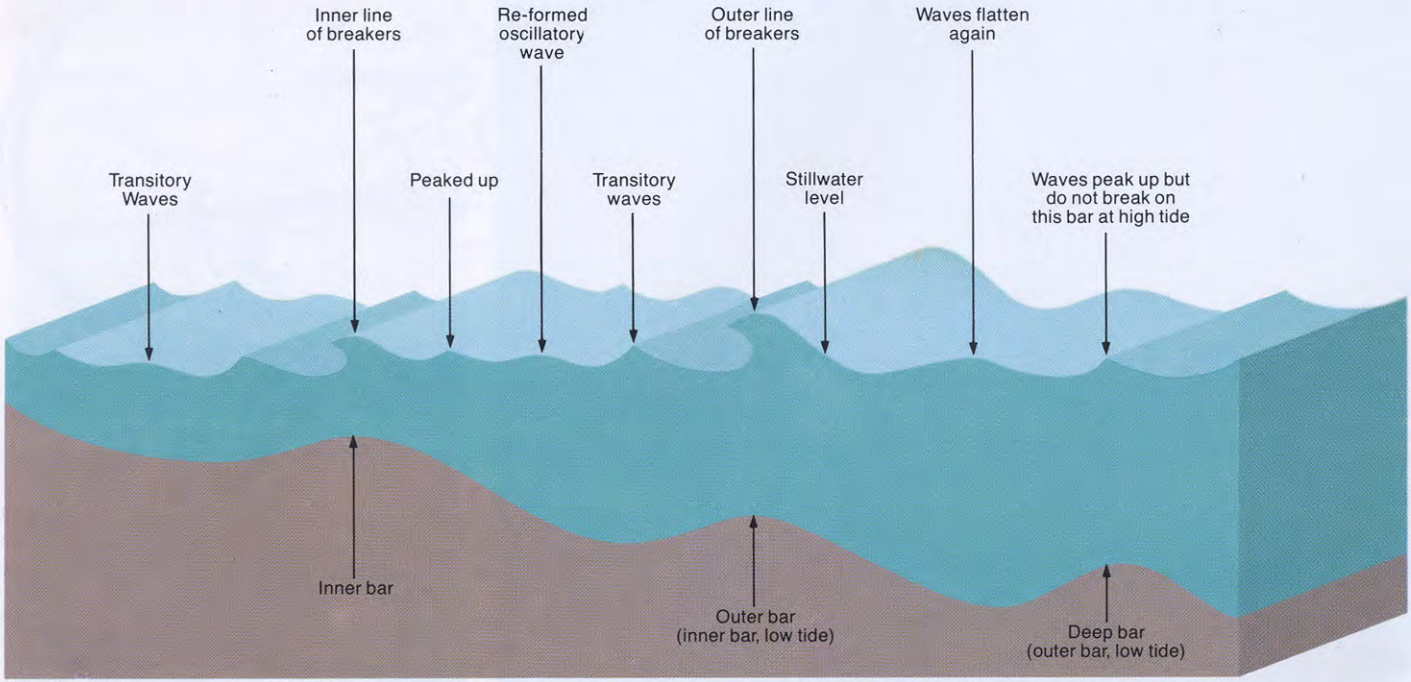
Street, and then left on Pierpont Boulevard. A paved walkway leads from the parking lot through the dunes to the beach. The dunes here are planted with European beach grass to slow their inland migration.

Also visible from the park is Ventura Harbor. Completed in 1963, the harbor primarily serves as a port for recreational boaters. It also houses the headquarters of Channel Islands National Park, a recent addition to the national parks system. The park encompasses San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Barbara islands.

To explore the harbor, return to East Harbor Boulevard from Marina Park, turn right and continue to Bayshore Drive. Turn right on Bayshore, and, after crossing a small bridge, make an immediate right to one of Ventura Harbor's parking lots. The 1,500-foot detached breakwater that extends upcoast from the harbor's north entrance jetty was constructed in 1972 to prevent sands carried by longshore currents from blocking the channel. Transported sands now accumulate in a wedge-shaped entrapment area formed between the north jetty and the breakwater. Accumulated sands are periodically dredged from this protected area and placed on McGrath State Beach, a short distance downcoast. The system results in approximately 800,000 cubic yards of sand annually bypassing the harbor. McGrath State Beach serves as a feeder beach, where sands picked up by littoral currents are transported downcoast to beaches as far south as Channel Islands Harbor.

In addition to the north jetty and detached breakwater, a dogleg-shaped south entrance jetty extends into the sea on the harbor's downcoast side. Tribars have been placed on the seaward end of the entrance jetties to reduce the energy of waves approaching the harbor. A short, 250-foot middle jetty runs parallel with the entrance channel. The Corps of Engineers is responsible for the maintenance of Ventura Harbor's breakwater and jetties.

Immediately downcoast, the Santa Clara River enters the Pacific. The river, which flows westward out of the San Gabriel Mountains, drains some 1,600 square miles and brings approximately a million cubic yards of sediment to the coast annually. In 1969, runoff from heavy rains caused the Santa Clara to flood. Extensive damage was caused to Ventura Harbor and other areas adjacent to the river. More than 13 million cubic yards of sediment are estimated to have been carried seaward at that time.



Offshore Bars
Offshore, or longshore bars, are underwater ridges of sand that generally run parallel to the shore. The bars are created as cross shore currents release sands that were previously held in suspension by wave action. These sandy offshore ridges typically slope more steeply on the ocean side, causing waves approaching the shoreline to break and dissipate their energy.

The number and configuration of offshore bars in a given area will depend upon the tidal range, the slope of the ocean floor and the size of the waves. For example, two bars can form when the tidal range is five or more feet. Three bars can develop if the underwater slope is relatively flat.

Series of bars typically extend offshore at increasing depths from the water's surface. When tides are low and the water more shallow, waves will break on the outermost bar, then reform to break on the second bar. When tides are high, however, the outer bar will likely be passed over and the waves will tend to break on those bars in the shallower, nearshore water.

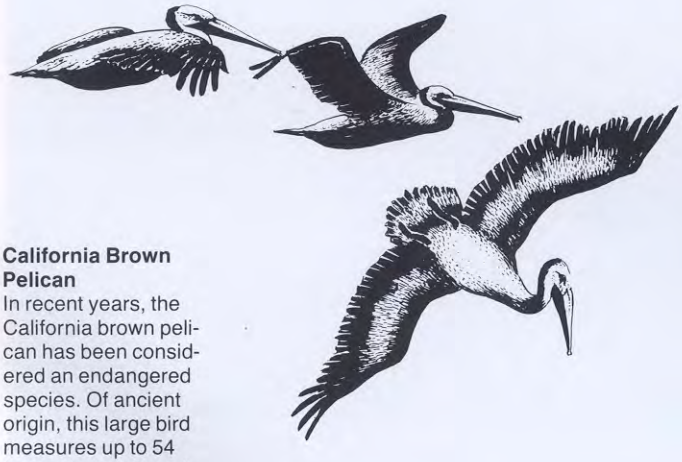
Children playing along shoreline of Channel View Park

8 Channel Islands Harbor and Port Hueneme

Channel Islands Harbor, a small-craft facility about 5.5 coastal miles south of Ventura, is home port to more than 1,800 sports fishing and pleasure boats. The harbor is unique because it was once a dune field. Excavation took place on dry land and it was only after concrete was poured and set that the harbor's entrance was opened, allowing sea water to enter. A good place from which to view harbor activities is Channel View Park, located at the end of Ocean Drive in the City and Port of Hueneme. To visit the park, follow Harbor Boulevard past its intersection with Channel Islands Boulevard, turn right on Los Feliz Street and right on Ocean Drive.

The offshore breakwater, entrance jetties and entrapment area can be seen from the park. The detached breakwater and north entrance jetty together create a protected sand entrapment area upcoast of the harbor entrance, similar to that at Ventura Harbor. Sand is periodically removed from the area through a series of submerged pipelines and placed on a downcoast beach. Also visible across the channel are two short groins. Built prior to the construction of the breakwater, these groins were designed to trap sands necessary for beach maintenance and also to absorb some of the energy of waves entering the channel. The Corps of Engineers is responsible for dredging the channel approximately every two years. Without this ongoing maintenance system, the harbor's entrance would shoal, making navigation into the harbor extremely difficult.

Also visible from Channel View



California Brown Pelican

In recent years, the California brown pelican has been considered an endangered species. Of ancient origin, this large bird measures up to 54 inches in length and has a wing span varying between six and seven feet. Its feathers are predominantly grey-brown, with whitish areas on the head and neck. The male and female are indistinguishable.

The pelican's diet consists primarily of fish which it can spot from heights up to 60 feet. Once it has sighted its prey the pelican dives directly downward with wings and feet tucked back, and captures the fish in its large, expandable pouch. When the bird returns to the surface, gulls and other small birds often try to snatch its meal before it can be swallowed.

Although the return from water to air appears to be exceedingly awkward, once airborne the pelican glides easily and gracefully.

Hueneme Beach Park

Channel Islands Harbor scene

Park on a clear day are Anacapa, the easternmost island in the northern Channel Islands grouping, and its neighbor, Santa Cruz. These islands are located about 11 and 15 miles offshore, respectively.

From the park, return to Channel Islands Boulevard, turn right and cross the harbor's main channel. Continue to Ventura Road, which runs along the eastern perimeter of Port Hueneme, a U.S. Navy Construction Battalion Center. Port Hueneme is the original home of the Pacific "Seabees." A Construction Battalion museum on the grounds, open for public viewing, reviews Seabee history and displays artifacts from around the world. Watch for signs along Ventura Road indicating the museum's location.

Follow Ventura Road to the coast and continue to 50-acre Hueneme Beach Park. At the entrance to Port Hueneme a submarine canyon extends seaward. Because much of the sand moving downcoast drops into and moves offshore down the canyon, this beach and those downcoast would experience severe sand depletion were it not for the area's continuing sand bypassing program.

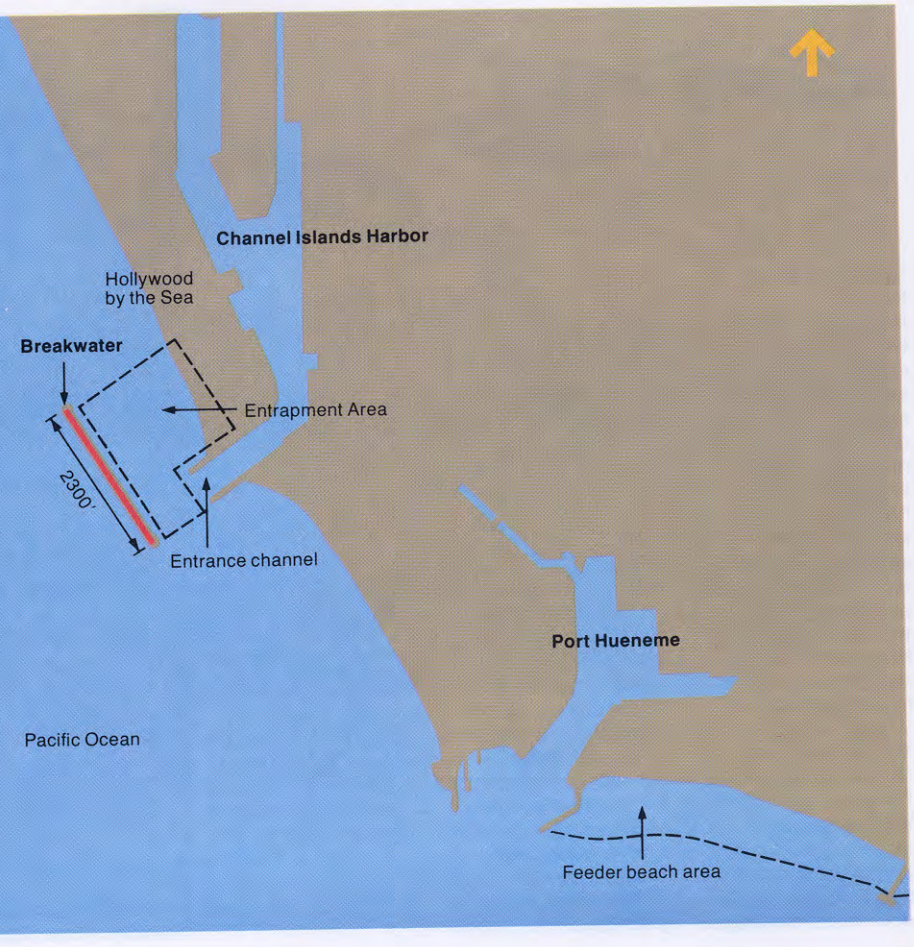
At the downcoast end of Hueneme Beach is a 1,200-foot recreational pier. The attractive, well-landscaped park also features picnic and play facilities. Port Hueneme Harbor, located immediately upcoast, is the only land-locked port suitable for large, deep-draft vessels between Los Angeles and San Francisco. Originally built to accommodate the exportation of agricultural products, the port was acquired by the U.S. Navy in 1942, and partially returned to commercial use following World War II.

After visiting Hueneme Beach Park, follow Ventura Road for a short distance to Port Hueneme Road, turn right and continue to Highway 1 south. At the highway intersection, note Point Mugu extending offshore downcoast.

Channel Islands Harbor jetty with breakwater in background

Sand Entrapment
The creation of an entrapment area from which sands can be mechanically dredged is an effective method for maintaining harbor entrance channels and dealing with sand-depleted downcoast beaches. The entrapment zone provides an area in which sand can drop before entering the navigation channel. Here, also, dredges can work, protected from the effects of wave action.

Aerial view of harbor dredging activity



9 Point Mugu and Mugu Lagoon

Point Mugu is a highly visible promontory located about 10 coastal miles south of Port Hueneme. Situated on the upcoast edge of 13,350-acre Point Mugu State Park, this promontory is recognized as one of the most dramatic coastal features of the area – particularly because of its visual contrast with the flat profile of the Oxnard Plain to the northwest. The Point marks the western terminus of the Santa Monica Mountains, a mountain range that extends in a predominantly east-west direction between the Point and Los Angeles.

At one time, the coast highway ran around the ocean side of Point Mugu. Excessive wave erosion resulted in the decision to carve the roadway through its tip, which created the appearance of two separate rock formations. A turnout on the upcoast side of Point Mugu provides excellent opportunities for enjoying the mass of this impressive granite formation.

Immediately upcoast is Mugu Lagoon, one of California's largest coastal wetlands. The lagoon and surrounding wetlands, measured in the early 1900s at 3,000 acres, have been identified as one of the few remaining examples of the rich marshland ecosystems once prevalent along the Southern California coastline. Ponds, channels, mudflats, salt marshes, salt pan, ocean beach and sand dunes are among the area's diverse habitats. Mugu Lagoon lies within the U.S. Navy's Pacific Missile Test Center and Point Mugu Naval Air Station, one of the world's most advanced missile testing facilities.

Mugu Lagoon is fed primarily by Calleguas Creek, which enters the northwest portion of the lagoon. As is often typical of coastal lagoons, a barrier beach consisting of two sand spits runs along its entire face. The spits encourage the deposition of silts and clays within the lagoon, a process that has resulted in rich substrate. The silts and clays in the lagoon overlay a base of ancient beach sands. Several beach ridges running in successive series parallel to the ocean beach have been identified.

The lagoon opens to the sea just upcoast from Point Mugu. This area is occasionally dredged to ensure ongoing tidal interchange. At times the interchange is such that the salt content of the water within the lagoon is very similar to that offshore. This changes, however, during flood periods, when increased freshwater input reduces sa-

Point Mugu

Citrus groves and windbreak along Hueneme Road

Shoreline in vicinity of Point Mugu

Mugu Lagoon

linity levels.

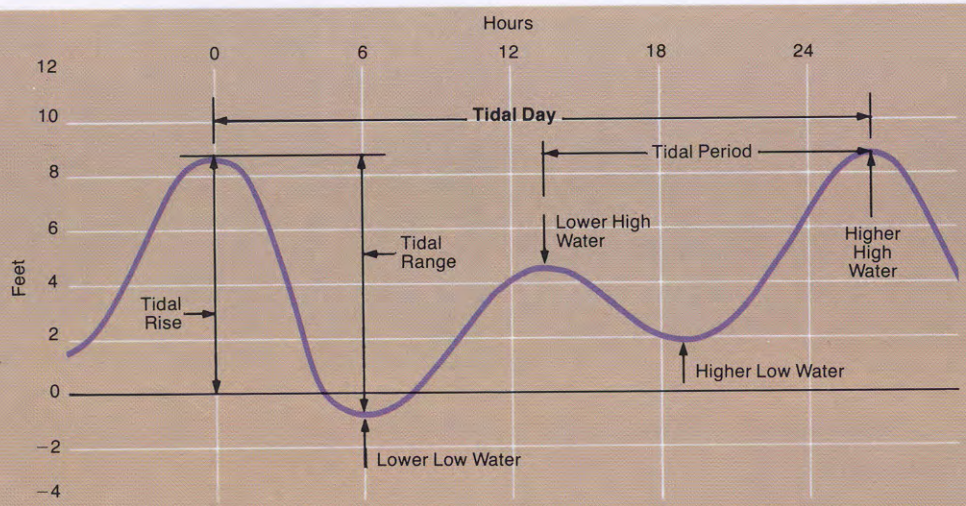
The Mugu submarine canyon extending offshore from the edge of the lagoon is believed to have once been part of a land drainage system that developed following a 400-foot drop in sea level which occurred some 15,000 years ago.

Coastal Indians once lived in the vicinity of Mugu Lagoon. At the time when Cabrillo and his party visited here, in 1542, approximately 50,000 Chumash Indians were believed to be occupying the area, including the Channel Islands. The lagoon, now approximately half of its original size, was isolated during California's early days, and although it became part of the 45,000-acre "Rancho del Rio de Santa Clara a La Colina" after secularization of California's missions, it was virtually ignored until the Navy's acquisition in 1946.

An impressive variety of birds, animals and marine life inhabits Mugu Lagoon and surrounding areas. Endangered birds such as the California least tern, American peregrine falcon, California brown pelican and light-footed clapper rail have been identified. The lagoon vicinity is also recognized as a haulout area where harbor seals and California sea lions rest, molt, breed and birth. In an effort to maintain the natural ecological balance of the lagoon and adjacent wetland areas, picnicking, fishing, boating, swimming and clamming are prohibited.

Downcoast from Mugu Lagoon and Point Mugu, the Pacific Coast Highway runs parallel to the shore at the base of the Santa Monica Mountains. The rugged shoreline and narrow beaches here are reminiscent of the Northern California coastline. Portions of old groins and sea walls, constructed to control wave erosion, are often visible along the coastline.

Late afternoon vista downcoast of Point Mugu



Tides

Tides are created as the earth rotates under bulges in the water level. These bulges, produced by gravitational and centrifugal forces, result from the combined effects of the earth, sun and moon. Even though the mass of the sun is about 27 million times that of the moon, the closer proximity of the moon results in its effect being more than twice that of the sun. This means that tides tend to follow a lunar day, about 50 minutes longer than a solar day.

When the sun and moon are in line, as during a new or full moon, tides are higher than when the two are working at cross purposes. The effects of both sun and moon depend on their distance from earth. Monthly and annual changes in distance, therefore, cause additional variation in tidal height. The location of the earth's tide-producing bulges changes with latitude and time of year, since the axis of the earth and the plane of the moon are tilted relative to the sun's position. Thus, as the moon moves through its orbit, tides of unequal height occur.

The shape of bays and inlets can have a strong local effect on tidal height. Such influences cause ranges along the California coast to vary from three and a half to five feet. At Anchorage, the range is about 30 feet, while in the Hawaiian Islands, tides rarely vary more than a foot. Tidal height can often be quite different than predicted, since flood runoff, storm surges and areas of high or low atmospheric pressure have a significant influence.

The number of daily tides in a given area is affected by land mass size and coastal shape. Along the Atlantic coast, for example, there are usually two equal daily tides, while along portions of the Gulf Coast there is but one. The Pacific basin experiences twice-daily tides, with the two highs and two lows often varying substantially.

The Year of the Coast

In keeping with President Carter's declaration of 1980 as "The Year of the Coast," the U.S. Army Corps of Engineers has joined other public agencies and private organizations in focusing attention on the need to manage, preserve and protect our nation's coastal areas. To assist in this worthwhile objective, the U.S. Army Corps of Engineers will, throughout 1980 and 1981, publish a series of brochures highlighting key natural and man-made features of the California Coast. It is hoped that this series will both inform the public of coastal features and processes and assist in the development of a greater appreciation of the critical need to insure the protection and management of coastal resources.

For additional details on these brochures and other public information and education programs available from the Corps of Engineers, please contact the following Public Affairs Offices:

South Pacific Division
630 Sansome Street
San Francisco, CA 94111
(415) 556-5630

San Francisco District
211 Main Street
San Francisco, CA 94105
(415) 974-0356

Los Angeles District
300 N. Los Angeles Street
Los Angeles, CA 90012
(213) 688-5320

Sacramento District
650 Capitol Mall
Sacramento, CA 95814
(916) 440-2183

California Coastline
Explore Series

Explore 1
Oregon Border to
Klamath River

Explore 2
Klamath River to
Punta Gorda

Explore 3
Punta Gorda to
Arena Cove

Explore 4
Arena Cove to
Golden Gate

Explore 5
San Francisco Bay

Explore 6
Sacramento —
San Joaquin Delta

Explore 7
Golden Gate to
Davenport

Explore 8
Davenport to
Cape San Martin

Explore 9
Cape San Martin to
Point Conception

Explore 10
Point Conception to
Point Mugu

Explore 11
Point Mugu to
Point Fermin

Explore 12
Point Fermin to
Newport Beach

Explore 13
Newport Beach to
The Mexican Border

Prepared by U.S. Army Corps of Engineers