U.S. Army Corps
of Engineers

Explore 8

The California Coastline
Davenport to Cape San Martin

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 birdwatching 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 an 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.

Davenport to Cape San Martin

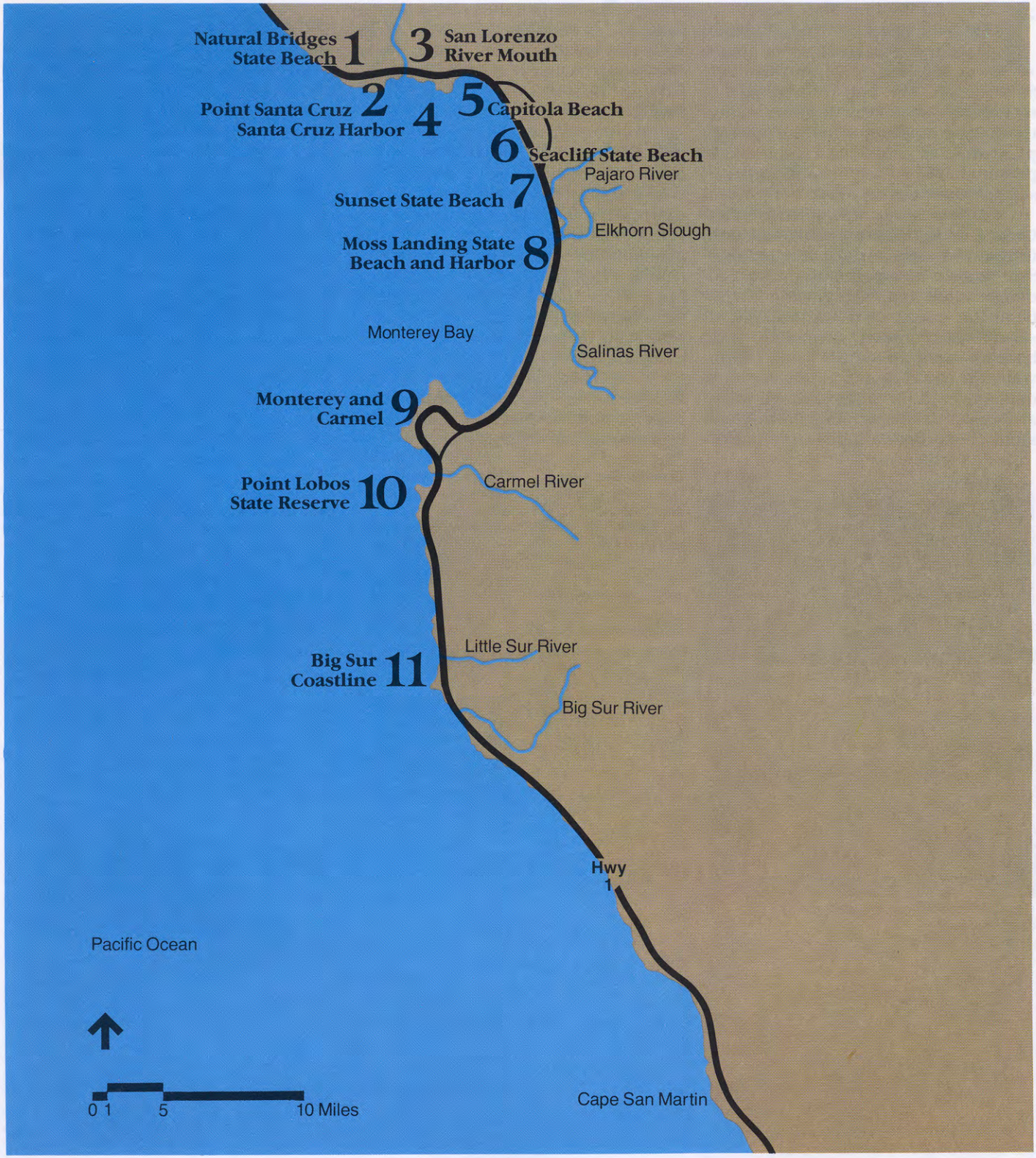
Beneath the gray shroud of early morning fog, the granite cape of Point Lobos is swept by crashing waves. The water pounds with resounding thunder on the stalwart stone. Sharp, biting winds whip across the neighboring coastal chaparral.

On the other side of the point, in an old whaling cove, a group of California sea otters quietly feeds and plays among the canopies of giant kelp. Surfacing from a dive to the bottom, one of the otters floats on his back and cracks open a shellfish against a stone held on his stomach. Such extreme contrasts of power and calm characterize this section of California's coast.

The sweeping beaches, sloughs and harbors of Monterey Bay offered an ideal location for early settlements. The earliest inhabitants of this area were the Costanoan Indians, believed to have migrated from Siberia thousands of years ago. The region was discovered by Europeans in 1542 when Juan Rodríguez Cabrillo, in the service of King Charles V of Spain, adventured to the shores of California to "look for cities rich with gold." Cabrillo did not find gold, but he did find the bay later named Monterey by Sebastian Vizcaíno in the early 1600s. Cabrillo named the Bay's southern headland *La Punta de los Pinos,* or "Point of the Pines." Today, a lighthouse stands on this point, now separated from the sea by sand dunes.

After the initial Spanish exploration it was nearly two centuries before Spain made the decision to expand its frontier to California. In 1769, Don Gaspar de Portolá led the first European overland expedition in California. His party of Spanish soldiers and Indians traveled from Mexico to search for Monterey Bay. Accompanying the expedition was Father Junipero Serra, a Franciscan missionary who founded Carmel Mission, the second of 21 California missions. Soon after, the area around the mission was colonized by Indians and pioneer men and women who planted crops and tended herds of livestock.

Despite subsequent development of this area of the coast, numerous wildlife habitats have been set aside as protected refuges so that future generations may benefit from the coast's natural communities. As you explore the beautiful coastal area between Davenport and Cape San Martin, we hope that you will enjoy and come to appreciate the importance of preserving the natural features that characterize this highly valued environment.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Cape San Martin

1 Natural Bridges State Beach

From the historic whaling town of Davenport, travel south on Highway 1 to reach Natural Bridges State Beach. The low, rolling marine terraces of this area support many types of agriculture, including flowers, pumpkins and artichokes. About ninety percent of the nation's supply of Brussels sprouts are grown here.

Nearly one mile north of Santa Cruz, exit right onto Swift Street and follow the signs to Natural Bridges State Beach. Turn right into the park to enter an observation area overlooking a beautiful ocean vista and an arched sandstone sculpture extending from beneath the bluff. Natural bridges form when the less resistant materials which once covered the sandstone are worn away by abrasive action of water and sand. This process, called *differential erosion,* has formed the arched bridge and cave. At one time there were three sandstone bridges here. A few years from now, this last remaining arch will fall into the sea as have the two other natural bridges before it.

Behind the bridge is a deep pocket beach which was formed at the mouth of what was once a river. Between the former riverbanks visible upstream, a creek discharges water and sediments into a marshy area just inland of the beach. This is a butterfly habitat where hundreds of thousands of butterflies settle in the eucalyptus trees between September and December during their annual migration south to Pacific Grove.

Picnic tables and other park facilities make Natural Bridges State Beach a popular place for family outings, surfing and beachcombing.

Looking north from the beach, the eroded faces of sandstone cliffs are visible. Topping the cliffs are marine terraces composed of *lenses,* or deposited layers made up of large pebbles. Ice plant has been planted to help preserve the cliff top from erosion. Below the cliffs are tide pools rich with a variety of marine life.

Leaving the beach, bear to the right and continue south on West Cliff Drive. This winding route provides expansive vistas of the Pacific Ocean. A path along the edge of the bluffs is ideal for biking, roller skating or a leisurely stroll. Numerous park benches allow for moments of quiet solitude and reflection.

In this area, note the rubble revetments, large stone structures, stacked against the cliff face. These stones, which were placed here by the

Remaining bridge at Natural Bridges State Beach

Revetment, in foreground, protecting Santa Cruz shoreline

Sea lions on rock off Point Santa Cruz

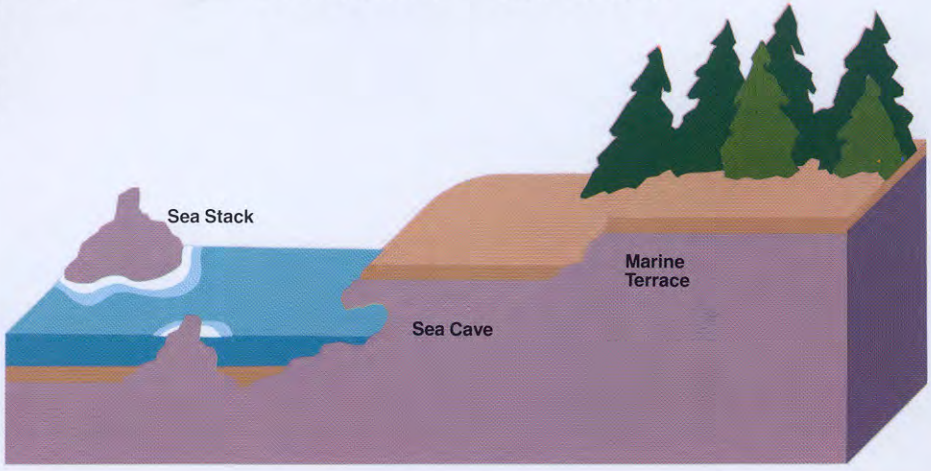
Coastal Geology

Low bluffs of shale and sandstone extend along the coastline from Natural Bridges State Beach to Point Santa Cruz. The vertical cliffs are capped with marine terraces composed of lenses of large pebbles. Typically 100 feet in height, the terraces continue along the northern reach of bow-shaped Monterey Bay as far south as the Pajaro River Valley.

Differential erosion of sandstone cliffs has resulted in the area's many sea caves and interesting offshore formations. These structures were created as pounding waves washed away the softer stone, leaving behind the less erodable rock.

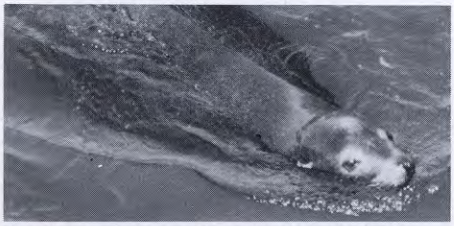
The bays at Carmel and Monterey are separated by a hilly peninsula with rocky granite shores. The promontory south of Carmel Bay, known as Point Lobos, is primarily composed of granite mixed with sedimentary layers of stone.

The rocks exposed along the Big Sur coast include wave-resistant granites, quartzites and marbles, along with more easily eroded shales and sandstones. Here, rocks sheared by fault line movement are visible. Sea stacks and coastal cliffs are continually exposed to wave attack. Eventually the cliffs wear away and the stacks disappear. Their sedimentary remains flow along the coast. Some pebbles and sand form beaches while others become new sediments on the ocean floor.



Army Corps of Engineers in the 1960s, protect the base of the cliff from erosion by absorbing the impact of incoming waves.

The ragged cuts in the cliffs are another result of differential erosion. In many places along the steep shoreline, detached sections of the sandstone cliffs have formed *sea stacks,* steep-sided rocks appearing above the water line offshore. These stacks provide nesting sites for cormorants and other shorebirds.



Sea lion near Santa Cruz Municipal Wharf

2 Point Santa Cruz

Point Santa Cruz marks the boundary between the Pacific Ocean and Monterey Bay. Here, the coast bends sharply to the north, protecting the eastward-facing cliffs and Santa Cruz Beach from the predominant northwesterly waves. As waves approach the coast, they refract and bend around the point, then move along the cliffs into the beach area.

Wave refraction coupled with the deep waters of Steamer Lane, located just off Point Santa Cruz, makes this one of the best big-wave surfing spots in California. The deep water here allows ocean swells to approach the coast unaltered. The orientation of the coast combined with the shape of the ocean bottom creates ideal conditions for the formation of long-crested, plunging waves. The Mark Abbot Memorial Lighthouse, named in memory of a youth who lost his life while surfing, provides light for modern sailing vessels.

In the deep waters offshore are extensive kelp beds. Here, California sea lions can often be seen at low tide, basking in the sun on their favorite rocky shelves. Occasionally the flippers of a group of sea lions can be seen protruding from the water. Because the flippers have no protective blubber, they are sometimes extended above the water surface to take advantage of the sun's warmth.

Looking past the lighthouse toward the immediately upcoast shore, note a sea cave that has been sealed off with concrete to prevent erosive wave action from further undermining the cliffs.

To the north, directly opposite

Caution

To fully enjoy the lovely California coast, it is important to be aware of the area's innate, and often unexpected, hazards.

Hiking along cliffs can be hazardous because loose materials can suddenly cascade to the water below. Walking should be restricted to areas well away from cliff edges.

Swimmers, surfers, fishermen and boaters should be aware of dangerous rip currents. Swimming and surfing often require wet suits because of the cold water temperatures.

Those exploring tide pools or climbing rocks near the water's edge should be watchful of incoming tides. Non-slip, protective footgear should always be worn during coastal explorations.

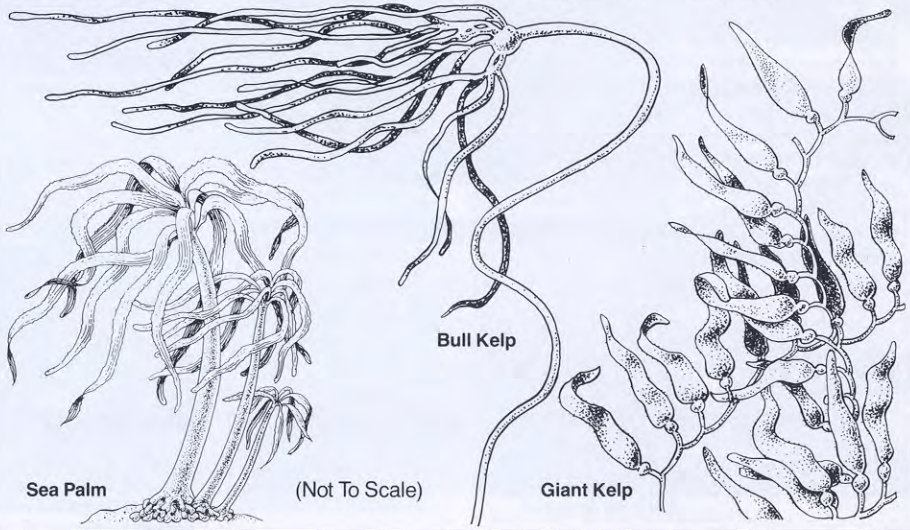
Kelp

Three types of kelp common to this section of the California coast are giant kelp, bull kelp, and sea palms — all members of the same family of brown algae. The underwater environments of the giant kelp and the bull kelp, as well as the shallow tide zone where sea palms live, provide a haven for small sea animals. Crabs and snails live in these crowded environments, where sponges, tube worms and barnacles encrust the shells of larger sea creatures.

The giant kelp grows up to 600 feet long, the greatest length attained by any plant. The base, a holdfast three feet or more in diameter, anchors the kelp to the sea bottom in water as deep as 90 feet. On the water's surface float long leaflike fronds, supported by air bladders.

Bull kelp, a smaller form of giant kelp found in depths varying from 15 to 75 feet, often attains lengths up to 270 feet. Its massive holdfast anchors a long slender stipe, or stem, topped with large air bladders which are frequently mistaken for the heads of California sea otters.

Sea palms grow on rocks where ocean swells expend their full force. The palms, which are rarely taller than three feet, survive by bowing resiliently to the power of the waves.



the Santa Cruz Municipal Wharf, West Cliff Drive runs along the top of another revetment constructed by the Corps of Engineers. Continue downcoast on West Cliff Drive past a variety of charming homes. Turn right on Beach Street, then right on Front Street toward the wharf. This almost half-mile-long wharf touches shore at the west end of long, crescent-shaped Santa Cruz Municipal Beach. Sea lions enjoy resting on the beams beneath the pier, while starfish, barnacles and mussels cling to the pilings supporting the pier.

From the pier, turn right to Beach Street and proceed toward the amusement park. Then turn left on Riverside Avenue, which crosses the San Lorenzo River. Turn right on San Lorenzo Boulevard and drive along the river. The levees and channel here are a joint flood control project of the Corps of Engineers and the County of Santa Cruz. After San Lorenzo Boulevard becomes East Cliff Drive, the road veers left to follow the coast. Stop to view the broad beaches up and downcoast of San Lorenzo Point, located at the mouth of the San Lorenzo River.

Surfer at Steamer Lane in Santa Cruz

3 San Lorenzo River Mouth

The mouth of the San Lorenzo River is located just downcoast of the amusement park known as the Santa Cruz Boardwalk. Adjacent to the river mouth, San Lorenzo Point extends into the surf. A walkway leading to the end of the point provides an excellent view of area beaches.

Sediment eroded from the Santa Cruz Mountains during heavy rains is washed downstream into the river. The sand deposited along the river's banks during these high flow periods is eventually washed to the shore, providing a major source of sand for nearby beaches. An estimated average of 100,000 cubic yards of sediment flow through the mouth of the San Lorenzo annually. At least 20 percent of this sediment is sand. Cliff erosion also contributes sand to area beaches.

Types of Breaking Waves

Waves move toward shore until water depth becomes shallow enough to initiate breaking. The type of breaker depends on wave height, wave steepness and beach slope.

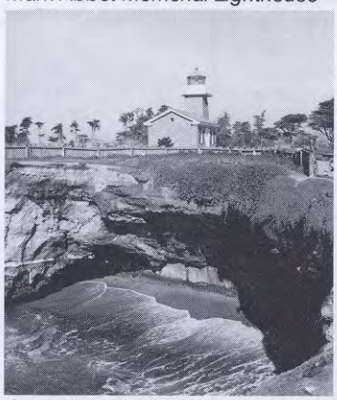
A plunging breaker has a near vertical face prior to breaking, pitches over the crest and forms a tubular shape before collapsing. A spilling breaker forms foaming water at its crest that gradually cascades down the wave face. A surging breaker builds a near vertical face and the wave's base rushes up the beach before the crest plunges forward.

Plunging breaker

Spilling breaker

Surging breaker

Mark Abbot Memorial Lighthouse



Sea cave sealed with concrete to prevent further cliff erosion

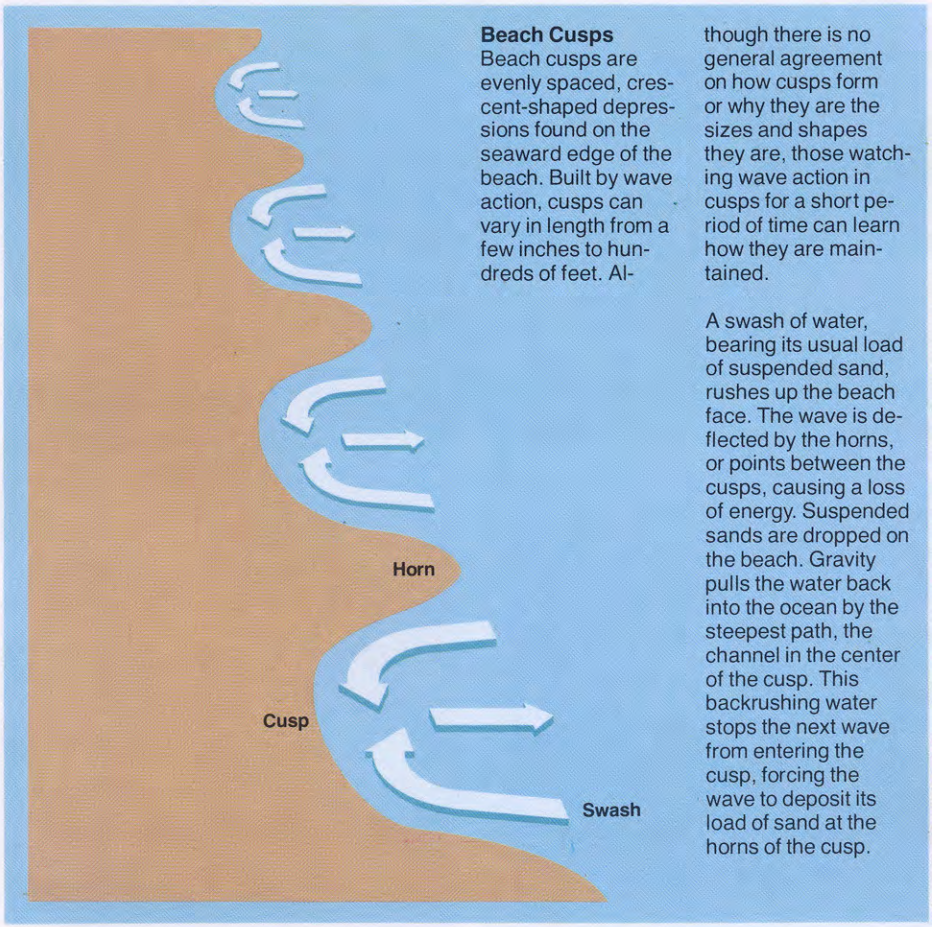
Fishing from Santa Cruz Municipal Wharf

When river flow is high as the result of winter rains, wave and current interaction helps to transport the sediments carried by the river. Fine muds and silts can often be seen suspended in the ocean waters near the mouth of the San Lorenzo. The direction in which the sediment-laden water extends from the river's mouth indicates the direction in which nearshore currents are moving. The San Lorenzo is the largest river in this vicinity, with a drainage area of about 135 square miles.

Sediments move predominantly west to east on the beach west of the Santa Cruz Harbor entrance. The quantity of sand transported along this area of the coastline depends upon the severity of the winter storm season, but is estimated to vary from 60,000 to 300,000 cubic yards a year. These sands shift slowly along the shore during most of the year. A single winter storm, however, can move up to 30,000 cubic yards of sand downcoast. The sand is either transported past the harbor or shoals the harbor mouth. The sand which bypasses the harbor entrance, together with sand dredged from the harbor, feeds the beaches east of the harbor.

San Lorenzo Point and the Santa Cruz Harbor jetties form the headlands which trap sand to create the long pocket beach. The sand on this beach continually reorients to maintain equilibrium with the energy coming from ocean waves and longshore currents. During winter storms, the beach sand is eroded either offshore or downcoast towards the harbor. This seasonal movement causes the alignment of the shoreline to change up to an average of 10 degrees annually.

Continue downcoast from San Lorenzo Point on East Cliff Drive. Enroute, visit the Santa Cruz City Museum and Grant Junior Museum. The museums offer fascinating exhibits, information on tide pools, Santa Cruz historical information and Indian artifacts. Continue on East Cliff Drive, then turn left at Seabright Avenue. Make a right turn on Atlantic Avenue, and continue to the west jetty of Santa Cruz Harbor.



Beach Cusps
Beach cusps are evenly spaced, crescent-shaped depressions found on the seaward edge of the beach. Built by wave action, cusps can vary in length from a few inches to hundreds of feet. Although there is no general agreement on how cusps form or why they are the sizes and shapes they are, those watching wave action in cusps for a short period of time can learn how they are maintained.

A swash of water, bearing its usual load of suspended sand, rushes up the beach face. The wave is deflected by the horns, or points between the cusps, causing a loss of energy. Suspended sands are dropped on the beach. Gravity pulls the water back into the ocean by the steepest path, the channel in the center of the cusp. This backrushing water stops the next wave from entering the cusp, forcing the wave to deposit its load of sand at the horns of the cusp.

Mouth of the San Lorenzo River

Aerial view of San Lorenzo Point

4 Santa Cruz Harbor

Santa Cruz Harbor is located at the former site of Woods Lagoon. The two entrance channel jetties, an inner channel and a turning basin were completed by the Corps of Engineers in 1963. The Santa Cruz Harbor District expanded the harbor to its present size.

Prior to the construction of the harbor, the beach beyond the west jetty had an average elevation of about 12 feet. After the 1,125-foot-long west jetty was constructed, sand carried in by waves and wind extended the west beach. The dunes eventually grew to a point where vegetation could be supported. Over the years, various types of dune grasses established themselves here, and since these grasses tend to trap additional quantities of sand, the dunes are maintained. This, in concurrence with the widening of the beach during summer—an increase from about 100 to 500 feet—has given protection to the cliffs behind the beach. The cliffs are no longer subject to wave attack, except during the rarest of severe winter storms.

Because of extensive shoaling, the Corps of Engineers dredges the Santa Cruz Harbor entrance channel more often than is typical for most other coastal entrance channels. The sand migrates into Santa Cruz Harbor three ways. Winds blow beach sand over the jetty into the harbor. The sand filters into the channel through the porous jetty, and sand drifts around the tip of the jetty forming a shoal at the channel's entrance.

From Atlantic Street, turn right onto Seabright, then right again onto Murray Street toward the harbor. Turn right onto Lake Avenue and continue to East Cliff Drive and the Harbor's 850-foot-long east jetty.

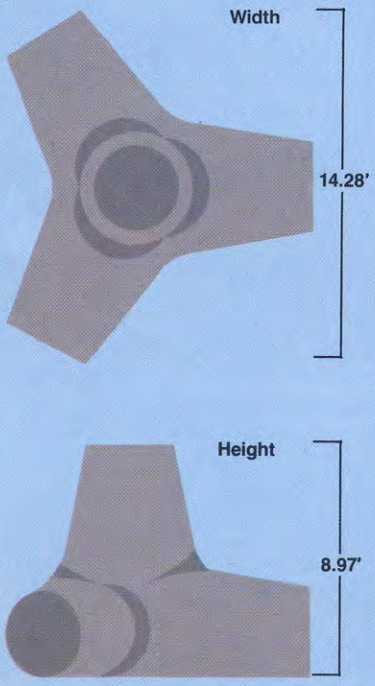
Downcoast from the east jetty is Twin Lakes Beach. During winter storms, Twin Lakes Beach is cut back and the sands migrate downcoast.

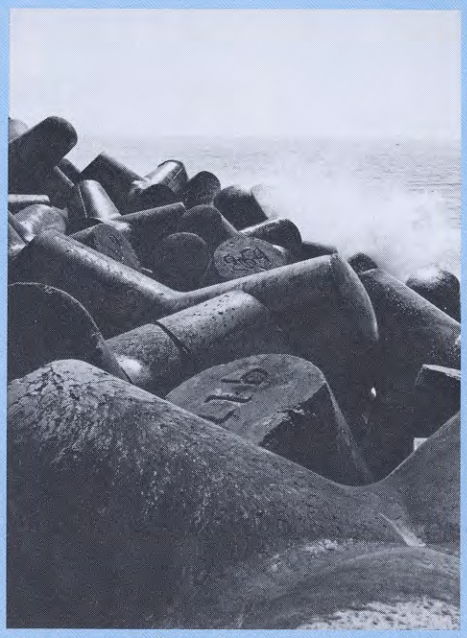
Continue downcoast on East Cliff Drive toward Schwann's Lagoon and Capitola Beach. Here, the coastal route passes many small inlets, coves and pocket beaches, as well as many small, pleasant lagoons which provide valuable wetland habitats for wildlife. Schwann's Lagoon, once a mixed saltwater and freshwater lagoon, is now a freshwater lake separated from the ocean by a tide gate at East Cliff Drive. Near Pleasure Point, a popular surfing area, kelp beds extend offshore, calming the approaching, choppy wind waves.

Quadripods

Quadripods line the outer edge of the west jetty at Santa Cruz Harbor, providing protection from the area's high-energy waves. These quadripods are twenty-five-ton concrete armor units.

Concrete armor units are used to protect breakwaters and jetties when equivalent stone is not economically available. Quadripods are usually manufactured on-site by filling pre-set forms with concrete. As waves break into the spaces between the interlocking, irregular shapes of the quadripods, the energy of the waves is dissipated into turbulence and high-flying spray.



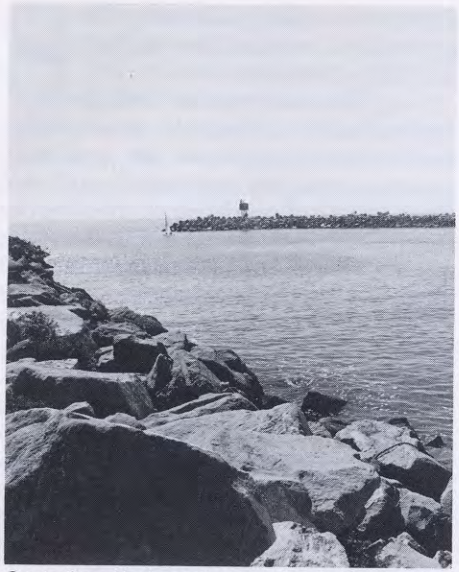


Quadripods on Santa Cruz Harbor's west jetty

Sailboats berthed at Santa Cruz Harbor

One of the coastal lagoons in vicinity of harbor

Maintenance dredge at Santa Cruz Harbor



Santa Cruz Harbor entrance channel flanked by east and west jetties

5 Capitola Beach

Capitola State Beach is one of the most popular in the area. From the cliffs above the beach, the smokestacks of the Moss Landing power plant, and the mountains of the Monterey Peninsula are visible in the distance. During the winter, cloudy waters indicate the suspended sediments from Soquel Creek flowing into the Bay. The sand for Capitola Beach comes from Soquel Creek and other upcoast sources.

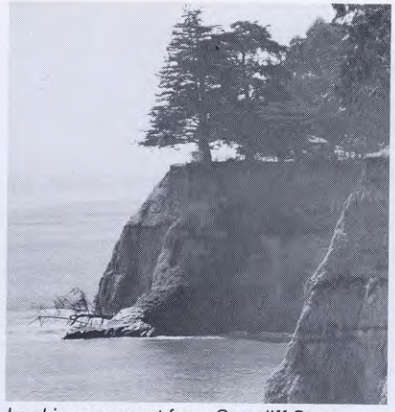
The creek provides a freshwater swimming area as an alternative to the colder, rougher bay water. Nearby surf fishing is good.

One of the few groins in Northern California is located at Capitola Beach. It was built to trap the longshore movement of sand and maintain a recreation beach.

6 Seacliff State Beach

Seacliff State Beach, located just a few miles south of Capitola, offers two miles of sweeping ocean frontage on scenic Monterey Bay. This broad, sandy beach annually draws over a million visitors. Picnic gazebos, benches and fire-pits line the shoreline. At the end of the fishing pier is one of the famous concrete ships built during the First World War. In the 1920s, this vessel, the *Palo Alto,* was towed here and sunk in order to extend the pier. Several years ago, a severe winter storm broke the ship in half, attesting to the powerful forces of the ocean. Today, fishermen board the ship in hopes of bringing in a catch of perch, sole, flounder and other coastal fish. This is also an excellent place to observe the activities of numerous species of graceful shorebirds.

Capitola beach and pier



Looking upcoast from Seacliff State Beach

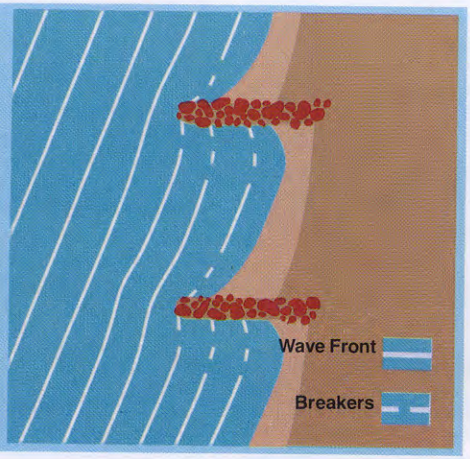
Popular fishing pier and concrete ship at Seacliff

Groins

Groins are beach erosion control structures. They extend into the ocean, perpendicular to the shoreline. Groins usually rise several feet above sea level and are several hundred feet long.

Although similar in appearance to a jetty, a groin is designed exclusively to trap materials, while a jetty is designed to stabilize a harbor entrance.

Constructed from timber, steel, stone or concrete, a groin impedes the flow of sand along the coast. In this way, groins help to create and preserve beaches. Capitola Beach, once severely threatened by erosion, is now replenished by the drifting sands trapped on the upcoast side of the groin.



Strolling at Seacliff Beach

Wide wooden stairs lead from a cliff-top parking lot down to the beach. There is also a parking area on the beach protected from wave erosion by a seawall of timbers behind the fishing pier.

Leaving Seacliff State Beach, stay on State Park Drive, cross the railroad tracks and continue straight onto Highway 1 south toward Watsonville. Leave the freeway at the sign for Sunset State Beach. Then, turn right on Riverside Drive. Follow signs toward Watsonville State Beach and make a left turn on Beach Road. After passing several food processing plants and fruit packing facilities turn right on San Andreas Road. Continue to a point where Monterey cypress trees line the road. Then turn left at the sign for Sunset State Beach.

7 Sunset State Beach

Broad, rolling hills and prime farmland dominate the approach to Sunset State Beach. After entering the park, turn left to reach the beach. The hills here are actually relic sand dunes. Although tens of thousands of years old, portions of these dunes still migrate inland. At the campground near the park's entrance, pine trees have been planted to assist in dune stabilization. Many of the relic dunes here are covered with pine forests.

A magnificent vista of the straight, narrow beach is visible as the roadway crests a high hill. The beach is backed by extensive sand dunes and beach grasses are prevalent. The strong, predominant northwest winds typical of this area continually blow sand inland. However, ice plant and European dune grass have been imported and planted to slow the migration of the soft, fine sand.

During winter this unprotected beach is directly attacked by storm waves that erode the sand seaward to form offshore bars. Sand from the bars is redeposited on the beach during summer months when waves are mild. Sand dollars are abundant all along the sandy shoreline here.

When leaving Sunset State Beach, turn on Beach Road and turn right on San Andreas Road. At the stop sign, turn left and follow signs leading to Highway 1. A right turn on Lee Street and a left on Highway 1 leads southward toward Moss Landing.

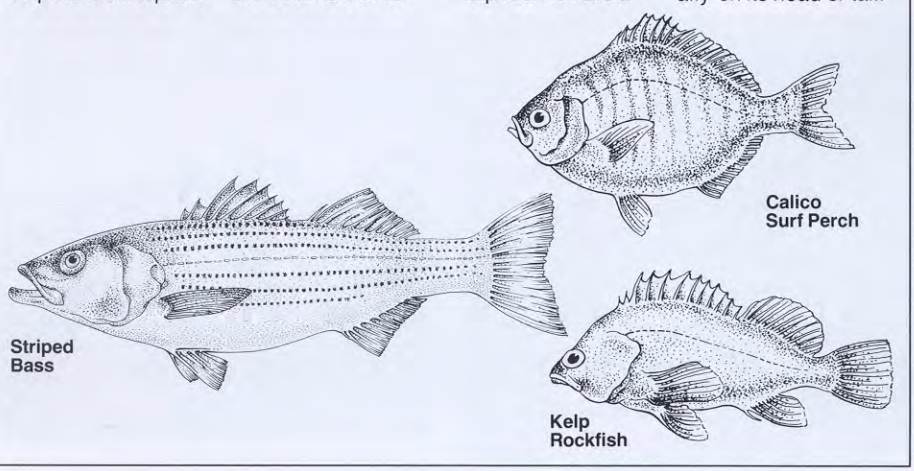
Surf Fishing

Surf fishing attracts the fisherman who enjoys fresh salt air, circling gulls, and the ocean's mighty waves.

Striped bass, or "striper," is one of the surf fisherman's most prized catches. Introduced to California in the late 1800s, the striped bass quickly multiplied and spread along the coast. During summer months, stripers are frequently found within casting distance near sandy beaches and rocky shores. The bass feeds on invertebrates, small crustaceans and other sea life carried by the breaking waves.

The calico surf perch, another frequent catch of the shoreline fisherman, is the most common surf perch found in central California. It is distinguished from the 20 others in its family by the bronze-colored bars and spots that overlay its light-colored body. Calico surf perch tend to congregate in the depressions at the bottom of the surf zone along sandy beaches. Most numerous along Monterey Bay, they may be caught with a hook and line year around. Baits include soft-shell crabs, bloodworms and mussels.

Kelp rockfish are a member of the largest fish family known to California waters. This spiny-headed fish varies in color from dark olive to a tan or brown. The kelp rockfish is most numerous at the lower levels of kelp beds, at depths of about 40 feet. Skin divers often find the kelp rockfish resting in curious poses. Sometimes this unusual fish leans to one side or stands vertically on its head or tail.



View of Sunset State Beach from entrance roadway

European dune grass at Sunset State Beach

Active dunes migrating inland along roadway near beach

8 Moss Landing State Beach and Harbor

The low, rolling hills of the Pajaro Valley surround Highway 1 enroute to the mouth of the Pajaro River and the Monterey County line. Artichoke fields line the road enroute to Elkhorn Slough, one of the few relatively undisturbed coastal wetland habitats remaining in California. The Slough, located adjacent to Moss Landing, extends about six miles inland and consists of some 2,500 acres.

Elkhorn Slough is a vital link in the Pacific Coast Flyway for migratory waterfowl and shorebirds. It is the year-round home of the endangered California clapper rail. Bird-watching, boating, fishing and photography are popular activities here.

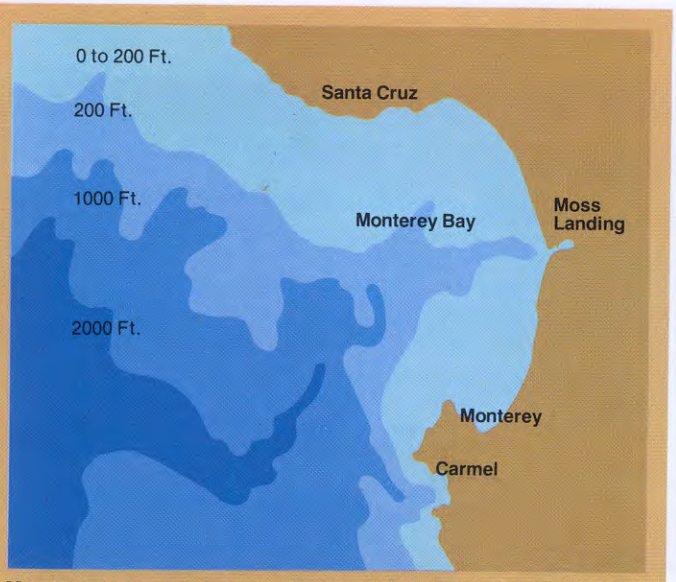
Continuing into the Moss Landing area, a large steam-electric power generation plant is visible on the seaward side of the slough. The barrier dunes that can be seen upcoast of the Moss Landing Harbor are good examples of active and inactive dune formations.

Moss Landing State Beach with power plant in background

Moss Landing is situated near the head of the Monterey Submarine Canyon, halfway between Point Santa Cruz and Monterey Harbor. The harbor at Moss Landing occupies a portion of the former channel of the Salinas River.

Prior to construction of the present harbor entrance, the natural entrance was about one-and-a-half miles north, corresponding to the mouth of the Salinas River before the river course was changed at the turn of the last century. The new location takes advantage of an area of reduced wave energy caused by the presence of the canyon. The canyon maintains deeper water at the entrance and directs wave energy away from the harbor.

In 1947, the U.S. Army Corps of Engineers improved the harbor for commercial fishing by constructing an entrance channel and dredging the



Monterey Submarine Canyon

One of the most interesting and less well-known features of the Monterey area is the submarine canyon that extends close to the shoreline off Moss Landing.

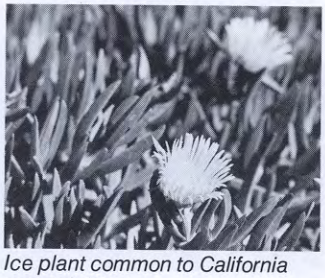
Monterey canyon is one of the deepest in the world, comparable in cross section to the Grand Canyon in Arizona. Just half-a-mile offshore the canyon is 50 fathoms, or 300 feet, deep. While most other submarine canyons are located off the mouths of large rivers, Monterey Canyon is situated off a slough with no appreciable stream flow. At some time in the past, however, the Central Valley of California may have met the sea at this point. Scholars studying drilling records have determined that an old, now filled east-west canyon with a floor 4,000 feet below sea level heads directly toward the present day Monterey canyon.

Clamming at low tide in Elkhorn Slough

Long-billed curlews feeding in slough

Clams being readied for market in Moss Landing processing facility

Artichoke plant photographed near Moss Landing



Ice plant common to California coastal dunes

existing inner channel. Offshore are large mooring buoys for tankers that supply oil to the nearby power plant. A four-hundred-foot-long pier, built a half-mile south of the present harbor in 1874, served coastal trade until World War II.

To enter the Harbor, turn right on Moss Landing Road, then turn right again on Sandholt Road. The former Salinas River bed today provides berthing facilities for a fishing fleet of more than 300 vessels. The area also contains antique stores, fish processing facilities and the Moss Landing Marine Laboratories of the California State University and Colleges System. Moss Landing is one of the key commercial fishing centers on the northern California coast.

From the Harbor, return across the single-lane bridge to Moss Landing Road and turn right on Highway 1 south. Once again, the road is bordered with fields of artichokes growing in rich, fertile soil. Salt water intrusion is an agricultural problem in the Salinas Valley. The land here is irrigated with water pumped from fresh water aquifers, or natural underground water sources. The lowering of water levels in these underground aquifers allows salt water from the ocean to seep into the freshwater supply. Unless remedial action is taken, an unfavorable situation may eventually develop.

9 Monterey and Carmel

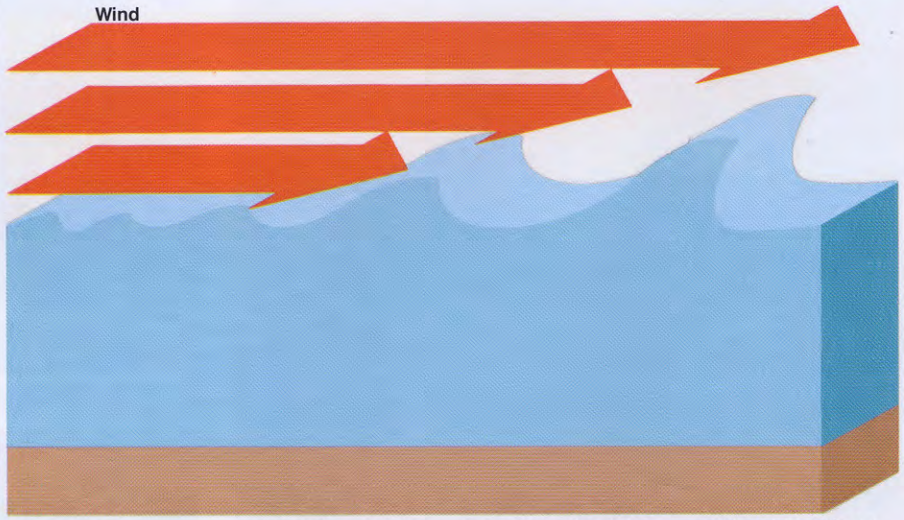
Adjacent to Highway 1, in the sand dunes north of Monterey, a sand mining operation excavates and loads the area's commercially valuable sand onto railroad cars. This exceptionally fine-grained sand is used in grinding, aerator filtration, sandblasting and the manufacture of glass.

The area's broad beaches and extensive sand dunes result from the enormous quantities of sand brought to the sea by the Salinas and Pajaro Rivers. The sand is carried south along the shore then blown inland to form the area that is today known as Sand City. One of the longest dune tracts along the California coast is located here. Older dunes, further inland, are covered with vegetation and housing. Fort Ord, the area's large U.S. Army Reservation, is built partially on the ancient

Monterey Harbor scene

Fort Ord from Highway 1

Rocky shoreline of Lover's Point



Wind Waves

Wind waves are formed when wind passes over the surface of the water. As the moving air drags on the water's surface, the water is pulled and ripples are created. The air presses against the ripples' steep sides, effectively transferring the energy of the moving air to the water. The resulting small waves grow rapidly until the limits of wave steepness are reached.

Wave steepness is the ratio of wave height to wave length. For ocean water, this limit is about 1:7 — that is, a wave seven feet long will be no more than about one foot high.

As smaller waves continue to grow, reach their limits and break, they contribute their energy to larger, longer waves. The larger waves increase in size until a fully developed wave pattern occurs. The development of this pattern depends on several factors: the strength of the wind, its duration, or how long it blows, and the *fetch,* which is the length of the water surface over which the wind blows. If wind waves form in a shallow bay, the depth may be the limiting factor.

dunes. Closer to the shoreline, the younger, active dunes continue to migrate inland.

Exit from Highway 1 at Pacific Grove/Del Monte Avenue and bear right. Notice the many lagoons along the roadway enroute to Monterey Harbor. A turn right on Figaro Street leads to the harbor and the Monterey fishing pier. At the western end of the harbor is a 1700-foot breakwater that was completed by the Corps in 1934. The eastern pier is connected to an offshore, concrete, sheet-pile breakwater that extends parallel to the beach, protecting the harbor's interior basin from the waves of southern Monterey Bay. Boats in the outer harbor behind the breakwater are moored to buoys or anchored, while those in the inner portion of the harbor are berthed in slips. East of Monterey Harbor is an anchorage area for visiting yachts.

Although the north-northeast facing harbor is protected from waves approaching from the south and west, as well as from northwesterly swells, it may be subjected to long-period wave action, called *seiching.* The water here, however, is typically blue and clear. In clear weather Point Santa Cruz and the upper end of Monterey Bay are visible from Monterey Harbor. West of the harbor is Cannery Row.

Lone Cypress along 17-Mile Drive

After visiting the harbor, return to Del Monte Avenue and turn right at Lighthouse Avenue. Pass through a tunnel and the beautiful grounds of the Presidio of Monterey, a U.S. Army post. Then turn right onto Foam Street and make another right onto Cannery Row. A right turn on Drake Avenue and a right on Ocean View Boulevard leads to Pacific Grove and the clear waters of Lover's Point.

Pacific Grove is known as Butterfly Town, U.S.A. For over a hundred years, tens of thousands of orange-and-black Monarch butterflies

Concrete breakwater in Monterey Harbor

Carmel Beach

Point Pinos Light Station

The Beaks of Shorebirds

The beaks of shorebirds are designed by nature to aid in gathering and consuming food. The shape and size of each bird's beak determine the method by which it obtains food. Beaks and methods of feeding vary in a fascinating number of ways.

The curlew has a long, down-curved beak that can skillfully probe deep into the sand in pursuit of fiddler crabs and other small morsels.

The oystercatcher's large, scarlet bill is stout and chisel-like. The bird paralyzes limpets and mussels by inserting its bill into the bivalve's shells. The shells can then be easily opened.

The long, up-curved beak of the avocet swings back and forth through the water to strain out food in a motion called "side-sweeping."

The pelican dives from considerable heights to scoop up fish with its enormous beak. The fish are temporarily stored in the beak's expandable pouch. The pelican often swims in groups near shore, with its bill pointed straight down as it prepares to close in on a school of fish.

have wintered in the trees here. The area also hosts the world famous Hopkins Marine Station of Stanford University. While in Pacific Grove, be sure to visit the Pacific Grove Museum of Natural History, which has displays on local birds, sea life, geology, and Indian history. The museum holds several annual exhibits, including a Wildflower Show in April and a Watercolor Show in September.

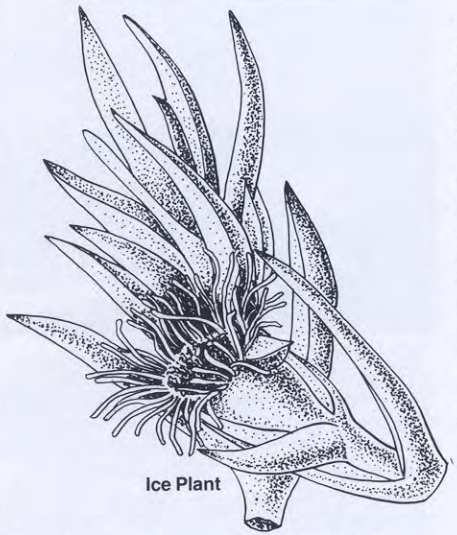
Ocean View Boulevard eventually becomes Jewell Boulevard. Upon reaching Del Monte Boulevard turn right and follow the coastal route by making another right turn onto Beach. The bold rocky shoreline is virtually without sand due to the striking, powerful force of ocean waves. Along this beautiful shoreline route, many turn-out areas provide splendid views of the coastline. Accentuating the scenic beauty are the sounds of crashing waves and the calling of gulls.

Point Pinos Light Station is located near the beach at the southern end of Monterey Bay in Pacific Grove. This small lighthouse continues to provide a navigation light for mariners. This lighthouse is the oldest continuously operating lighthouse in California. In this area, tide pool inhabitants are splashed by crashing waves.

Enter the famous Seventeen-Mile Drive in Pacific Grove and continue along this scenic Monterey Peninsula route to Carmel-by-the-Sea. The turbulence of the sea in this area results from the confluence of conflicting ocean currents, and the varying shape of the ocean's floor. Further south, the highly-eroded cliffs of Carmel are visible.

Entering Carmel, turn right on Ocean Avenue to reach Carmel Beach. This beautiful, white-sand pocket beach is adjacent to steep cliffs topped with grassy, wave-cut terraces. From the beach, return to Ocean Avenue and continue through downtown Carmel. Turn right on Sunset Avenue and proceed to Highway 1. The many turn-outs along the way afford unexcelled vistas of Carmel Bay's turbulent waters, offshore rocks, kelp beds and broad sandy beaches.

The Carmel River, to the south is surrounded by a nature preserve and estuary. Immediately offshore is the Carmel submarine canyon. From the shore's edge, one can easily throw a stone into the head of the canyon. Although the canyon's rapid drop-off limits swimming at Carmel River State Beach, it remains a popular scuba diving area.



Ice Plant

Dune Vegetation
The sand dunes at the margin of the sea create an ecologically harsh environment. Because of salt spray and the poor nutritional value of sand, plant growth is limited to highly specialized vegetation. Growth usually occurs only on the protected backsides of dune-hillocks and landward portions of the dune field. Dune plants tend to hold the sand against wind erosion, stabilizing the movement of the dunes.

American dune grass is one of the earliest plants to colonize unstable dunes. Identifiable by its long, slender green leaves and large flower-heads, dune grass binds the dune's surface by means of an extensive network of *rhizomes,* or underground creepers and fibrous roots.

European beach grass is similar in appearance to American dune grass. Introduced to California in the late 1800s, this hardy grass is now used worldwide in dune-stabilization programs. Its rhizomes grow both horizontally and vertically, resulting in a strong root network that effectively traps blowing sands.

Ice plant is one of the most easily established dune plants because it adapts well to sandy, saline soils. Also known as the sea fig, this sturdy plant has elongated succulent leaves. The two varieties common to California have either red or yellow flowers.

American Dune Grass

European Beach Grass

Whaler's Cove on west shore of Point Lobos State Reserve

Ground squirrel photographed at Whaler's Cove

Turn right on Highway 1 and travel south to Point Lobos State Reserve. Watch for a large cross that stands between the ocean and the artichoke fields next to the highway. Erected in 1969 as a commemoration, the cross marks the 1769 landing point of Portolá's California expedition. Just after cresting the hill, a right turn leads to Monastery Beach, named for the Carmelite Monastery. The monastery's white-walled chapel can be seen on the wooded hill above. Looking north, Carmel and the green rolling lawns of the Pebble Beach Golf Course are visible in the distance.

10 Point Lobos State Reserve

Point Lobos, a Registered National Landmark since 1968, has been called "the greatest meeting of land and water in the world." The sea surrounding this solid granite promontory is incredibly active, often displaying colors ranging from dark blue to pastel turquoise.

Point Lobos was named for the sea lions so prevalent to its shoreline because the Spanish sailors thought they resembled wolves. The area was originally acquired by the State of California for the purpose of preserving one of the last remaining groves of Monterey Cypress trees. This grove is named after A. M. Allen, a local engineer and entrepreneur who owned much of the area and was instrumental in preserving the local Monterey Cypresses. Collecting plant and animal specimens is prohibited here, in an attempt to preserve the area's unique qualities for future generations.

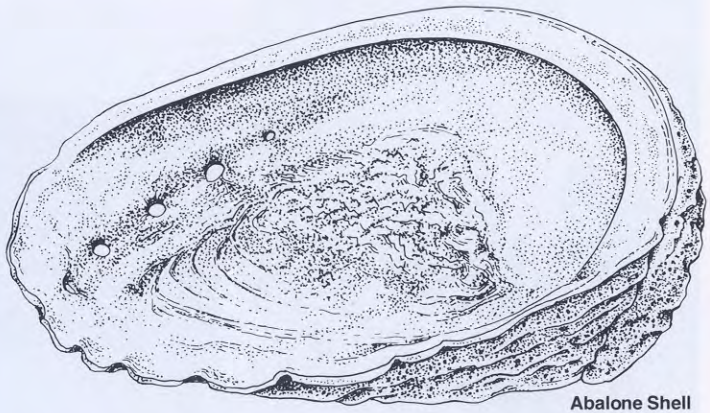
Numerous hiking trails cover the 1,250-acre Point Lobos State Reserve. Several pamphlets on area plant and animal life are available at the ranger station. Visitors are required to stay on the trails, both to preserve the area and to avoid the ever-present poison oak.

At Whaler's Cove, on the reserve's northwest side, many sea caves have formed along the water's edge as a result of differential erosion. The cool, nutrient-rich water fosters a variety of marine life. Scuba divers can enter the water here to explore and study the world below the water's surface. California sea otters are frequently seen floating on their backs in the thick kelp

Commercial Fishing
Once the capital of California, Monterey has always owed its importance to its bay location. Even before the arrival of European settlers, Monterey was a fishing center for Indian tribes. Commercial fishing continues to be an important industry here. Among the millions of pounds of fish caught and brought into Monterey Bay are herring, anchovy, tuna and cod.

The first canneries opened at the turn of the century. At that time, the small, silvery sardine predominated. After several years, the sardines disappeared, arresting the once-thriving industry. Their disappearance is thought by some to be partially the result of long oceanic cycles. Another theory proposes that overfishing, combined with oceanic conditions — water temperatures, and winds — critically affected the hatching and growth of young sardines. It is possible that the sardines shifted their spawning areas south off Baja California. The reason for the depletion of the sardines is still a matter of controversy, and the real cause has not been incontrovertibly determined.

Commercial fishing boats in Monterey Harbor


Abalone Shell

Abalone
The abalone, a member of the marine family of gastropods or snails, resists the unrelenting force of the waves by clinging to rocks with its powerful, muscular foot. Easily loosened if taken when relaxed, the abalone can, when disturbed, create a powerful suction. The abalone is primitive in form and structure. Its shells have been found to date back some 30 million years.

There are eight different varieties of abalone found along the California coast. The largest is the red abalone, common to northern California, which grows slowly to a diameter of from 10 to 12 inches. The outside of its shell is often overgrown with algae and encrusting animals. The inside of its reddish or pinkish shell is beautifully iridescent. Abalone meat is highly valued for its delicate flavor. Although a mature red abalone annually produces from one to two million eggs, its population has been greatly reduced by sport and commercial fishing and natural predators such as the sea otter.

Other abalone types include the green abalone, which is considered by many to be the most beautiful, and the black abalone, whose shell, unlike the red variety, is not cluttered with miniature crustaceans.

beds of Whaler's Cove. Although usually shy, many sea otters in the Point Lobos area will occasionally take food from a diver's hand.

At Sea Lion Cove on the reserve's southern shoreline, the headlands are formed from a bed of sandstone intermixed with well-rounded cobbles transported long distances by ancient streams. The sedimentary layers were subjected to high pressures and temperatures, forming the metamorphic rocks, which have since folded and uplifted to form the present dramatic shapes. Erosion of these rocks by the sea has created the craggy formations typical of this area of the coast.

Leaving Point Lobos, continue south on Highway 1 along the Big Sur Coast where precipitous cliffs drop dramatically to the ocean far below.

11 Big Sur Coastline

Entering the Carmel highlands, a sheer cliff plummeting to the ocean signals the beginning of the Big Sur coastline. The area known as Big Sur extends about 120 miles down the central California Coast between the Santa Lucia Mountain Range and the Pacific. The section of Highway 1 between Carmel and San Simeon is often described as the most spectacular coastal road in the United States. Following edges of coastal terraces and southwest-facing cliffs, Highway 1 is a breathtaking 400 to 1,000 feet above the waves.

El pais grande del sur, "the big country of the south," was the name given to this area by the Carmel Mission fathers in the late 1700s. There are no harbors, and there are few accessible beaches in this region. Because the Pacific Ocean cools the air in summer and warms it in winter, seasons are not pronounced. The temperature rarely drops below 40 degrees during the winter rainy season. In summer, a morning mist usually forms a veil that provides moisture for thirsty vegetation.

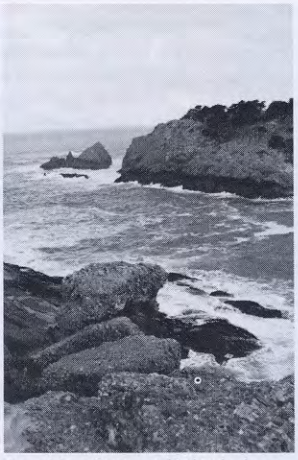
Bixby Bridge, renowned for its symmetrical beauty, is a graceful 320-foot arch spanning Bixby Creek. This formidable engineering task was completed in 1932. Bixby Landing, protected by a point of land upcoast of the Little Sur River mouth, is one of the few boat landings in this region. A steep grade approaches Hurricane Point, named for the area's strong westerly winds. Driving requires full attention since there are few guard rails. Scenic vistas can be enjoyed, however, from the many overlook areas along the highway.

Scuba divers preparing to enter the sea

Scuba Diving

Point Lobos and the 750 acres of surrounding sea floor constitute the Point Lobos State Reserve. Although permitted, diving in the reserve is carefully regulated. Only a few divers are allowed in the water at any one time and collecting plant and animal life is prohibited in order to maintain a well-balanced, natural environment.

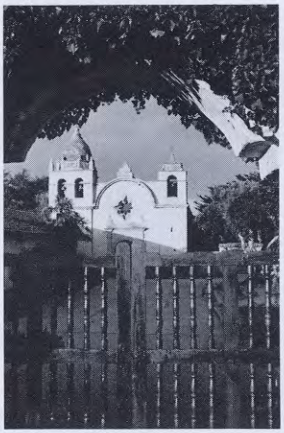
The submarine vegetation of the area is typically dense. Thick kelp beds can impede the diver's progress. In spite of such density, nature reveals fascinating underwater sights including sea lions, otters and a wide variety of fish and invertebrates.



Sea Lion Cove at Point Lobos

Big Sur coastal scene

Visitors enjoying drama of Big Sur coastline



Carmel Mission

Mouth of Willow Creek

The Little Sur River, approximately a mile to the south, meanders across a small barrier spit. Here, changes in the direction of approaching waves shift sand back and forth along the beach. Changes in the river's flow constantly modify the hydraulics of the river. These changes result in a migrating S-shaped river mouth. Sand blown inland from the flat spit has formed a dune that reaches up the slope about 400 feet above sea level.

Two-hundred million years ago the Big Sur cliffs were a solid mass of sedimentary rock at the bottom of the sea. The mass was overlaid with volcanic rock more than 10 million years ago. At that time, the Big Sur coastline was believed to be several miles east of its present location. A series of violent fault movements thrust the coastal ranges northwest to where they stand today. The continual erosive forces of winds and waves contribute to the jagged contours of the coastline.

Late afternoon at Big Sur

Point Sur is connected to the mainland by a broad, sloping tombolo, an accumulation of sand connecting an offshore landmass to the shore. Downcoast of the ancient, metamorphosed, highly colored lava flows that make up Point Sur, extensive kelp beds float along the shore.

The color of the water here often changes from turquoise to darker blue as you look farther seaward. The lighter colors sometimes visible close to shore indicate a high concentration of suspended sediments that have been eroded from the coastal limestone deposits.

Perched 350 feet above the sea on the northwest edge of Point Sur is the Point Sur Light Station. Prior to its

Colors of the Sea

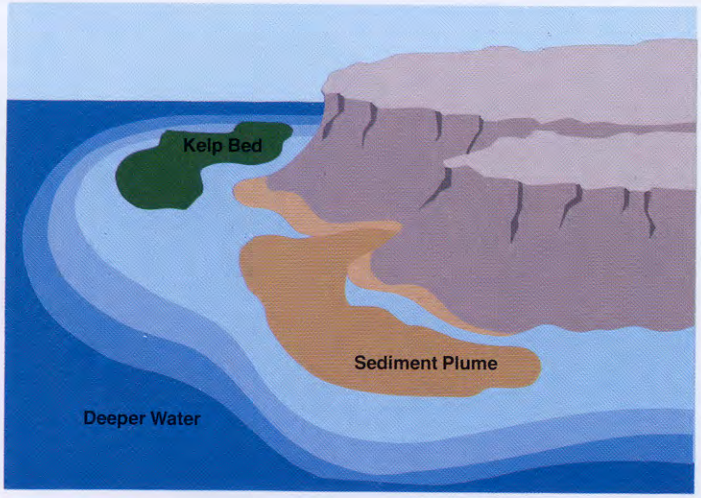
The color of the sea varies greatly from place to place and from time to time. Tones of blue, green and brown predominate.

The purest seawater appears bright blue due to the scattering of sunlight by water molecules. Open oceans are usually a dark blue because of the water's quality and purity.

Silt and clays from coastal rivers and streams feather into the ocean creating yellow, brown and gray-green plumes. The specific color depends upon the mineral content of the sediments.

Waves breaking on the shore force air into the water, producing light shades of blue. As more air is entrained, more light is reflected to the eye of the observer. The beautiful turquoise-colored waters often seen off Point Lobos are created in this way.

A path of light blue or turquoise water moving directly away from shore usually indicates the presence of a rip current. Light blue water can also mean that zooplankton or phytoplankton are present. When plankton is abundant, the water can vary from green to orange. When the water is reddish, the phenomenon is known as "red tide." Patches of brownish green or blackish green may indicate floating canopies of kelp beds.



Point Sur

California poppies at Sand Dollar Picnic Area

Coastline north of Cape San Martin

construction in 1899, many ships were wrecked on the adjacent treacherous coast. The light was first powered by kerosene. Now automated, this U.S. Coast Guard facility's electric light is visible for up to 23 miles.

Past Andrew Malaras State Park, Highway 1 turns inland to enter the Big Sur Valley and the entrance of Pfeiffer-Big Sur State Park. The Big Sur River winds its way through this outstandingly scenic park, and tall redwoods line both river bank and roadway.

Continue down Highway 1 through the isolated beauty of Big Sur Valley to the entrance of Los Padres National Forest. This sparsely inhabited area of Big Sur is characterized by steep hills with deep canyons. The long scenic drive winds along the coast, overlooking rolling waves hundreds of feet below.

Just north of Big Creek is a sea stack called Little Slave Rock. Here, the phenomenon of wave diffraction can often be seen. When incoming waves pass the sea stack, they bend, or diffract, wrapping around the rock and coming together on the opposite side.

Sand Dollar Picnic Area, a few miles to the south, is easily accessible from the highway. A large parking area, picnic tables and barbeque grills are available here. Creeks have formed small valleys in this flat, grass-covered marine terrace. A short walk leads to the edge of the terrace, where a gray-and-black sanded beach is visible at the base of steep cliffs. Numerous craggy sea stacks and rocks lie offshore.

Further south is Jade Cove, one of a series of coastal coves. This cove, surrounded on three sides by 150-foot cliffs, can be viewed by walking a short distance from the highway and descending a path to an observation platform. Jade can occasionally be found here during low tide and after storms. In 1971, a 9,000-pound specimen was brought up by divers.

To the south, at Old Creek Bridge, Willow Creek enters the ocean through a beach strewn with smooth, greenish boulders. Sea birds often float at the creek's mouth, looking for food among the bull kelp.

To the south, beyond the area's wind-swept kelp beds, the rocky promontory called Cape San Martin is visible. Here, patient observers can sometimes see the spouts of grey whales making their semi-annual migration between northern and southern waters.

Sea Otters
Sea otters live in many of the large kelp beds found along the California coast They can often be seen sleeping on their backs, wrapped in kelp strands. This prevents the otters from drifting away as they are gently rocked by the waves.

The fine, dark brown fur of the sea otter was highly prized during the early 1900s, when the animal was aggressively hunted. When the sea otter swims, its inch-thick fur traps bubbles of air, providing insulation from the cold water.

When feeding, the otter removes a shellfish from under-water rocks, places the catch in its chest pouch and returns to the surface. If the shell is especially hard, the otter places a flat stone on its stomach and, lying on its back, pounds the shell on the rock to break it.

Sea stacks in vicinity of Cape San Martin

One of area's cobbled beaches

Cape San Martin

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 manmade 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
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Explore 9
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Explore 13
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