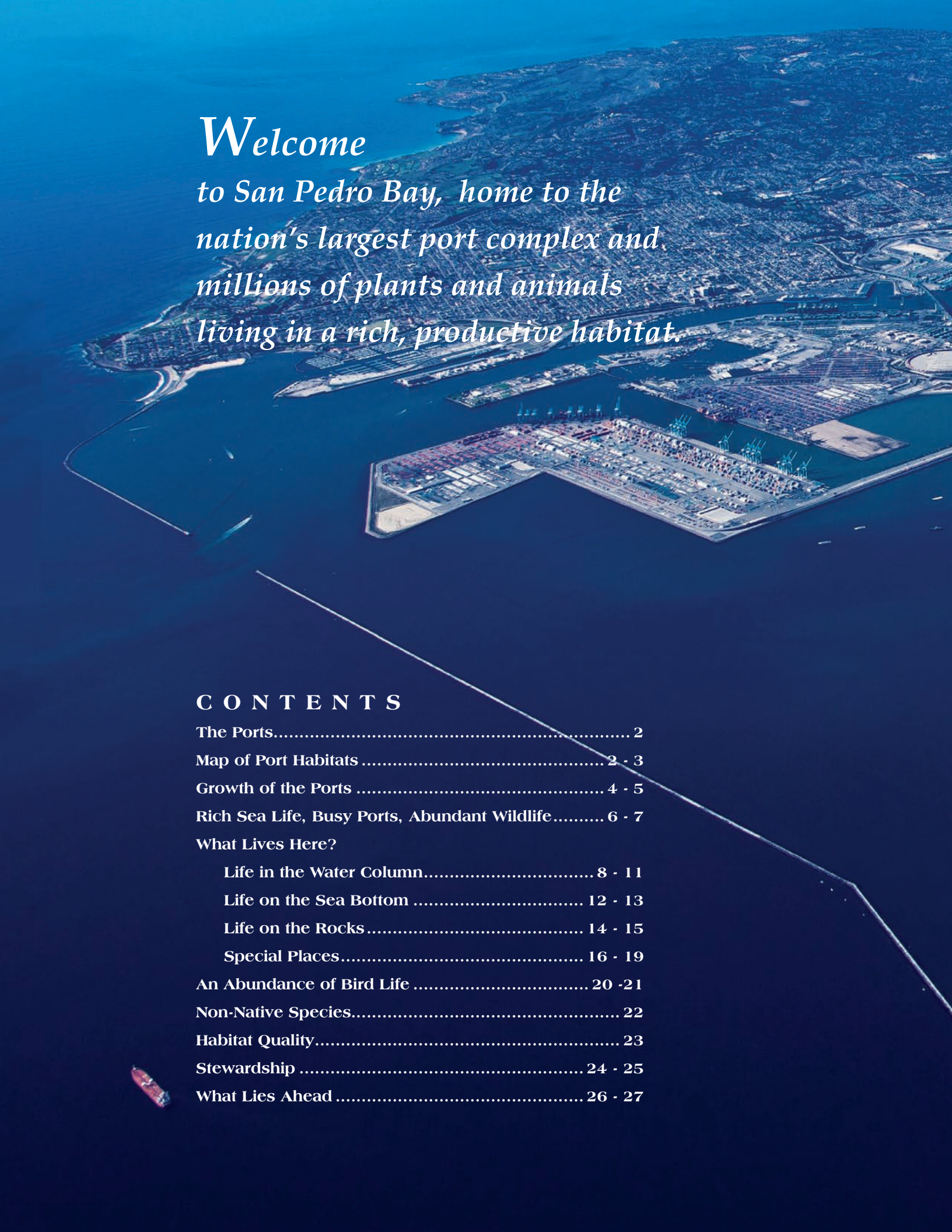
LOS ANGELES & LONG BEACH

HARBOR HABITAT

OUR BIOLOGICAL TREASURES



Welcome

to San Pedro Bay, home to the nation's largest port complex and millions of plants and animals living in a rich, productive habitat.

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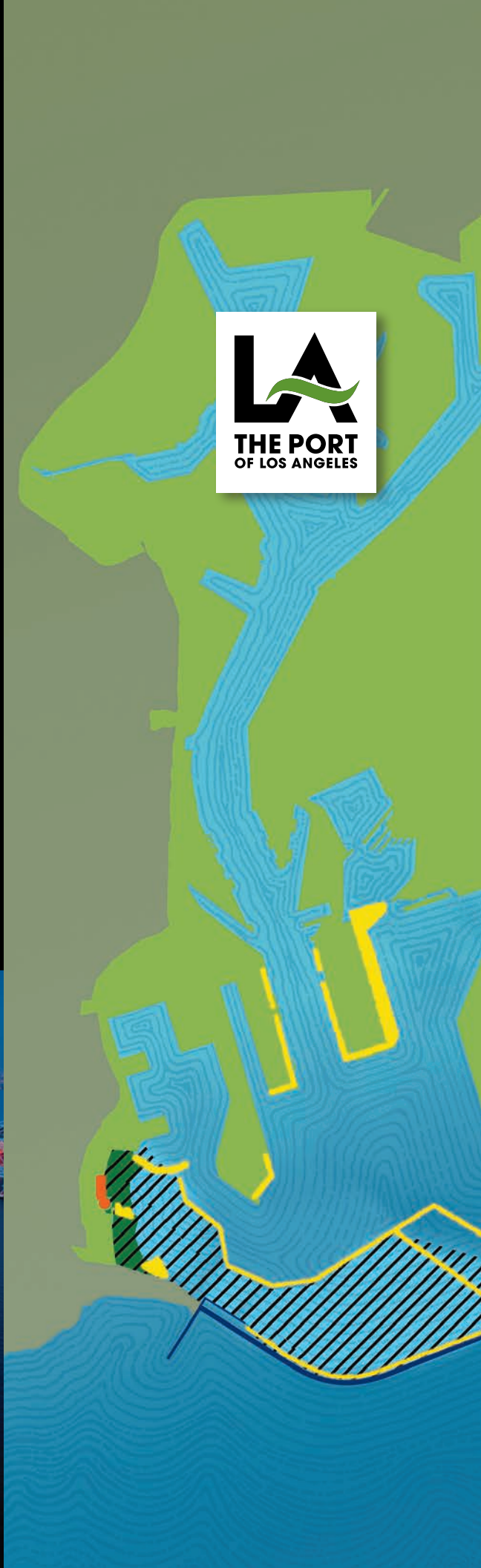
THE PORTS

Economic Engines & Environmental Stewards

Welcome to San Pedro Bay, home to the ports of Long Beach and Los Angeles (Ports)– this country's largest port complex and one of the world's major seaports. The Ports act as an important portal for cargo entering and leaving the U.S., handling 40 percent of imported containers. They are also a major source of jobs and tax revenues for California. The Ports are more than cargo handling facilities, they also provide valuable coastal recreational and educational resources. Equally important is their public trust role as caretakers of the harbor environment and its wildlife. The Ports are charged with ensuring that port operations, including the expansion that is necessary to handle ever-increasing volumes of cargo, does not come at the expense of those natural resources.

This publication presents the marine environment of Los Angeles-Long Beach Harbor as it existed in 2008 and describes how that environment and its natural resources have improved over the decades as a result of the successes of environmental protection efforts.




Port of
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Kelp Forest
Eelgrass
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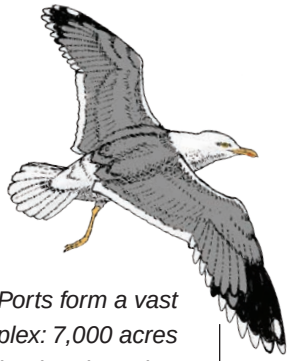
Tern Habitat
Shallow Waters



The Ports form a vast complex: 7,000 acres of land and another 7,000 acres of water.

5,000 oceangoing cargo vessels visit the harbor each year, and hundreds of cruise ships, fishing vessels, and other harbor craft use the Ports.

GROWTH OF THE PORTS

Balancing Trade & Protection of Our Natural Resources

The Ports' task of balancing the needs of international trade with the protection and improvement of natural resources is challenging because of the amount of growth and activity that takes place at the Ports. Altogether, the Ports include over 7,000 acres of land and another 7,000 acres of water. The Ports handled 234 million tons of cargo in 2010, valued at more than $350 billion. That cargo was carried by 5,000 huge oceangoing cargo vessels, and those ships were joined by the thousands of recreational boats and the hundreds of fishing vessels, tugboats, and other harbor craft that navigate the waters of the harbor.

This enormous harbor complex is the result of a century of dredging, filling, and wharf construction that were prompted by increases in population and industry, national defense needs, and the discovery of oil. To protect the harbor and naval bases, enormous breakwaters, which now stretch for over eight miles along the coast from San Pedro to eastern Long Beach, were constructed in the first half of the twentieth century. The breakwaters changed the seashore from an open coast to a much quieter embayment, and the development of piers and other land changed what was once marshes to dry land and ship channels. Since then, more cargo and larger ships have driven the need for deeper channels and more land for terminals, resulting in the port complex of today. At the same time as the Los Angeles-Long Beach Harbor complex was being constructed, large deposits of oil were discovered. In fact, the Wilmington and Long Beach oilfields supplied a significant portion of the nation's petroleum for several decades. The development of the oilfields prompted more land creation and industrial development in both Ports.

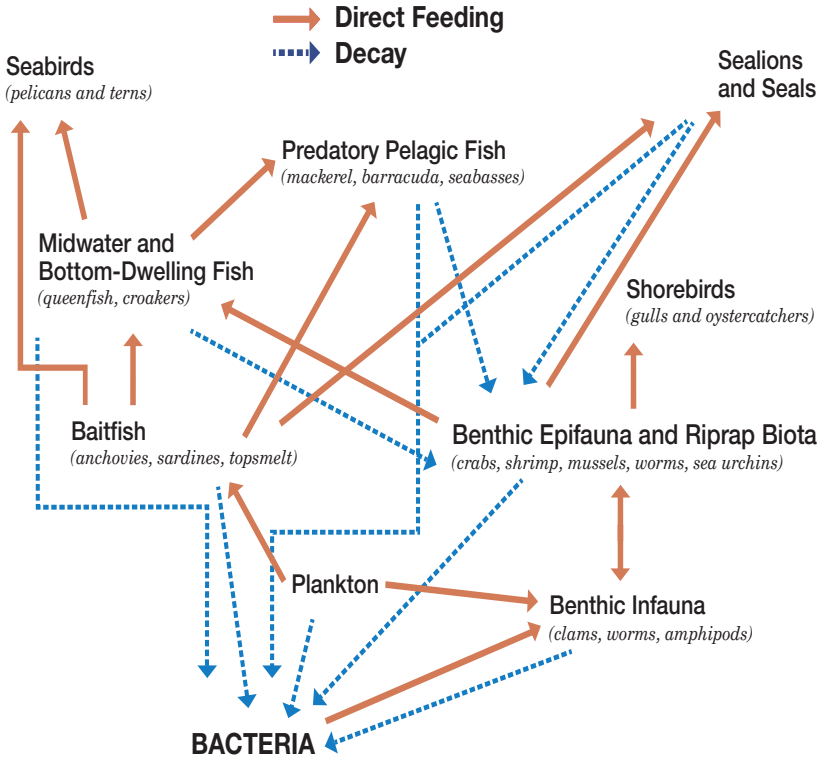
Biological surveys have been conducted periodically from the early 1970s up to the most recent in 2008.

RICH SEA LIFE, BUSY PORTS, ABUNDANT WILDLIFE

Studying the Harbor

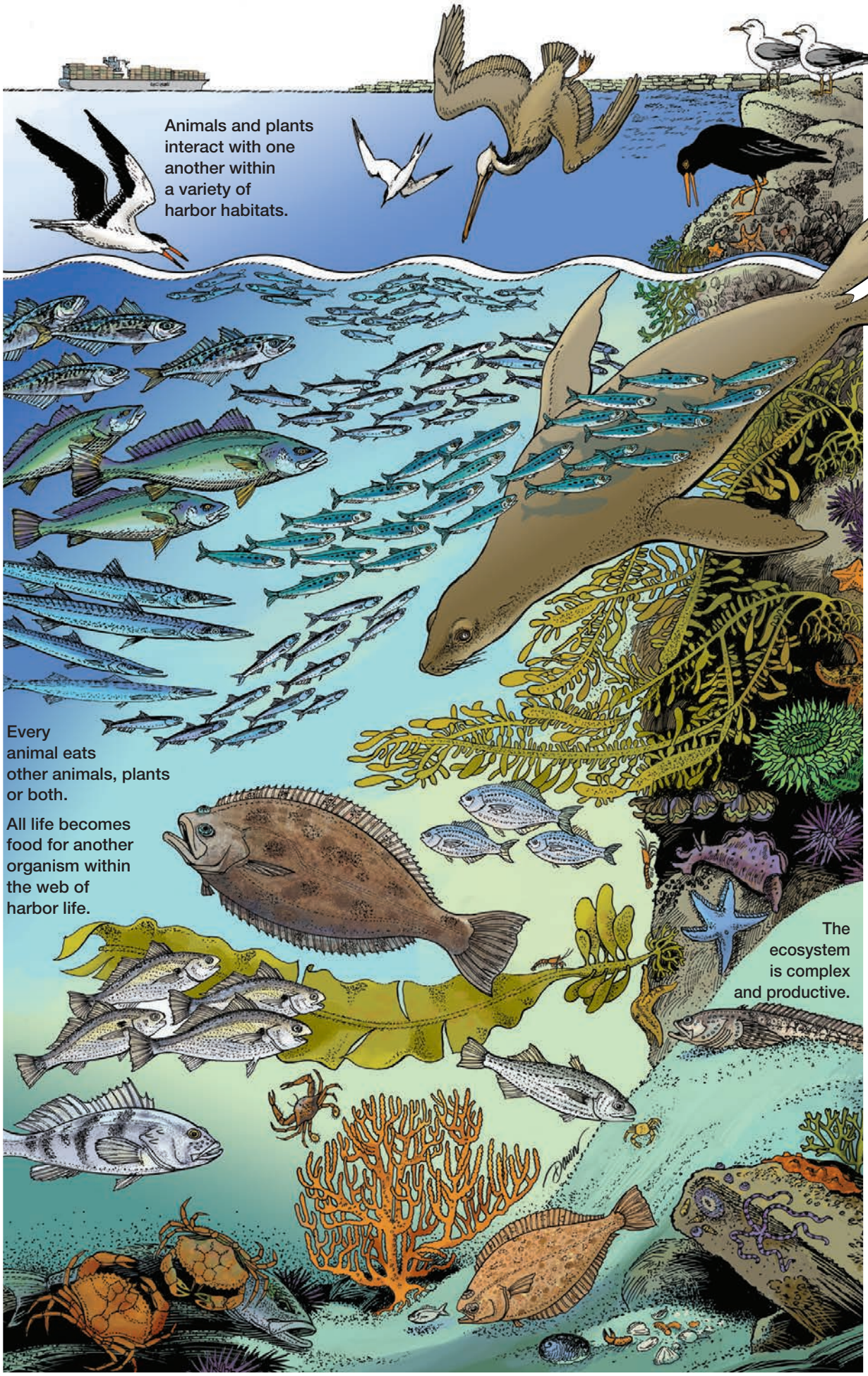
Despite nearly 100 years of development, Los Angeles-Long Beach Harbor is home to a huge variety of sea life and birds. As we will see, hundreds of species of animals and plants flourish in the harbor complex. Scientists know what lives in the harbor because the two Ports, as part of their environmental stewardship, cooperate in conducting periodic, harbor-wide surveys of the marine life within their boundaries. The first comprehensive survey was conducted in the early 1970s; additional surveys were conducted in the mid-1980s, throughout the 1990s, in 2000, and most recently in 2008.

The 2008 study involved three harbor-wide surveys – in January, April, and July – that sampled aquatic animals and plants at more than 40 points throughout the Ports. In addition, water quality was measured at 13 locations, and 20 surveys of birds were conducted that covered the whole Los Angeles-Long Beach Harbor. The effort was large, involving dozens of scientists and technicians, as well as several research vessels. They collected and analyzed fifty-seven samples of fish eggs and larvae, 284 samples of adult and juvenile fish, and 96 samples of bottom-dwelling animals. Approximately 100,000 fish were identified, weighed, and measured, 125,000 birds were identified, and over 30,000 tiny animals were separated from samples of sediment and then identified and weighed. It took nearly a year to process the samples and analyze the data from this extensive field effort.

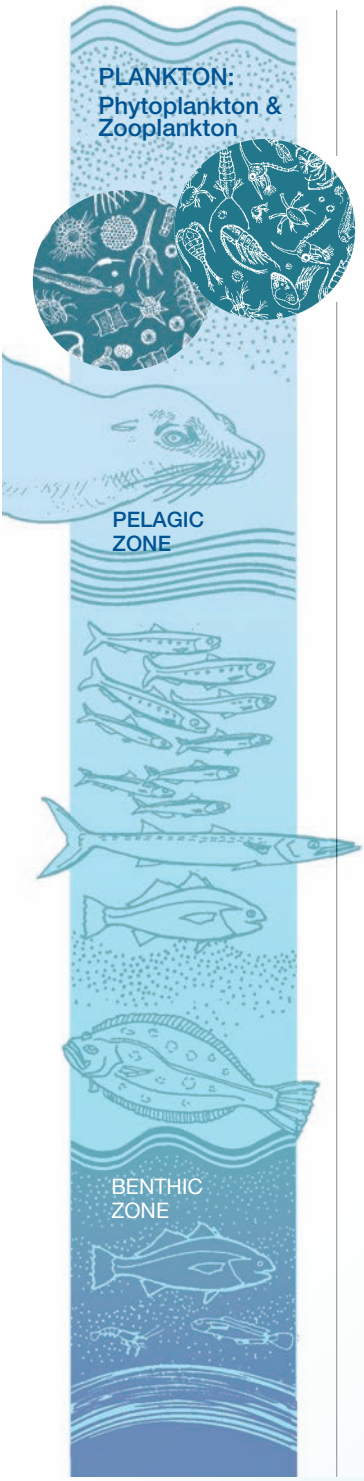


The WEB of HARBOR LIFE

The variety of habitats in the harbor means that many types of animals and plants can find places where they can thrive. The open-water areas of the harbor provide vast amounts of water-column habitat for plankton, fish, and marine mammals. The sandy and muddy sea bottom supports small fish and burrowing animals, as well as larger organisms that roam the surface of the mud. Many animals, as well as most seaweeds, need hard surfaces to attach to, and the miles of breakwaters, seawalls, rock dikes, and pilings provide plenty of living space for those organisms. Finally, shallower areas, especially the eelgrass and kelp beds that thrive in the harbor, serve as nursery areas for many species of fish and as feeding areas for fish and seabirds. The plants and animals in these habitats interact with one another in many ways. The most obvious is food: every animal eats plants, other animals, or both, and every plant and animal becomes food for another organism at some point.



Biologists use the concept of a food web – a very simplified example of the food web of the Los Angeles-Long Beach Harbor is shown here – to describe these complex feeding interactions among the animals and plants in a particular area. It's called a food web instead of a food chain because of the many directions of the interactions. For example, larger animals eat smaller animals, but small animals also consume larger animals after they die. These interactions show how complicated marine ecosystems actually are; that complexity is what makes the harbor ecosystem rich and productive.



WHAT LIVES HERE? *Life in the Water Column*

Let's look a little closer at just what lives in each of the harbor habitats we just encountered: the open-water areas of the channels, basins, and outer harbor; the mud and sand of the sea bottom throughout the harbor; hard surfaces such as breakwaters, pilings, and the rock dikes of the piers; and special areas of distinct or especially productive habitats. In the next few pages we will see how each of these habitats is unique but also how they interact with one another through the food web we have just seen. We'll also look at the rich bird life of the harbor and see how birds are an important part of several harbor habitats.

Open Water: Life in Three Dimensions

Open water is the first thing we see as we look out over the harbor, and open water is by far the largest habitat in the harbor. It includes the channels and basins of the inner harbor as well as the expanses of the outer harbor, from the shoreline to the breakwaters. Despite how large these open water areas appear to be, they are actually part of a coastal embayment formed by the curvature of the shoreline between San Pedro and Long Beach and protected by the breakwaters. Most of the open-water areas in the harbor are between 20 and 70 feet deep, forming a water-column habitat stretching from the air-water surface to the mud-water bottom.

Scientists call the ocean's water column habitat the "pelagic zone". This pelagic zone is home to plankton – tiny floating animals and plants and the eggs and larvae of larger animals – as well as fish and marine mammals. Plankton are vital as food for larger organisms, especially fish larvae and

the many invertebrates (animals without backbones) such as clams, mussels, worms, and barnacles, that make their living filtering water. The plankton, being too small to swim from place to place, are carried around by currents (the term "plankton" comes from a Greek word meaning "wandering"). The most common types of plankton are single-celled plants called dinoflagellates and diatoms, and tiny, nearly transparent animals called copepods that are related to shrimp and spend their whole lives suspended in the water column. The water column teems with these organisms: each quart of harbor water typically contains hundreds of copepods and many thousands of plant cells. Often, too, the floating larvae of fish and bottom-dwelling invertebrates such as urchins, starfish, crabs, clams, and worms are abundant in the plankton because being carried by ocean currents is an effective way for small animals to reach new habitats.

Los Angeles-Long Beach Harbor, like most protected coastal embayments, is important as a nursery area for marine fish. As a result, scientists have included studies of fish eggs and larvae in the biological surveys of the harbor. Most marine fish reproduce by releasing their eggs into the open water, where they hatch into larvae that have to make their own way in the world. The larvae lucky enough to end up in bays, estuaries, and harbors find favorable conditions for growing into juveniles and making their way to their adult habitats. The 2008 survey identified nearly 40 species of fish larvae from Los Angeles-Long Beach Harbor, and previous surveys identified still more. Not surprisingly, many of the larvae come from fish known to be abundant in the harbor, such as gobies, queenfish, anchovies, blennies, and halibut and other flatfish. Some of the most abundant larvae, however, belong to species not commonly collected in the harbor as adults, including fish from reefs and kelp beds such as garibaldis, ronquils, and kelpfish. The variety and abundance of fish larvae confirms the value of the harbor complex as a nursery area for local marine fish.

The open waters of the harbor teem with life, from one-celled plankton to fish and sea lions.

WHAT LIVES HERE?

COMMON PELAGIC ZONE FISH

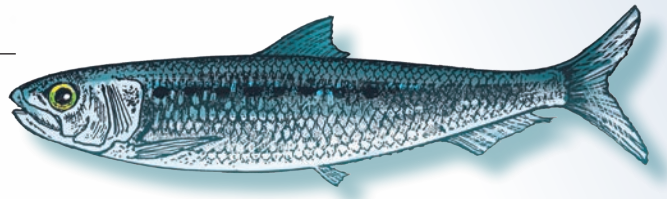
2008 SURVEY PELAGIC FISH

Northern anchovies are the most abundant fish in the harbor.

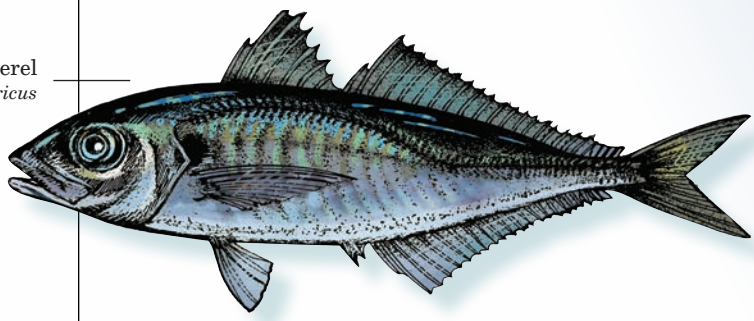
Northern Anchovy
Engraulis mordax

Topsmelt
Atherinops affinis

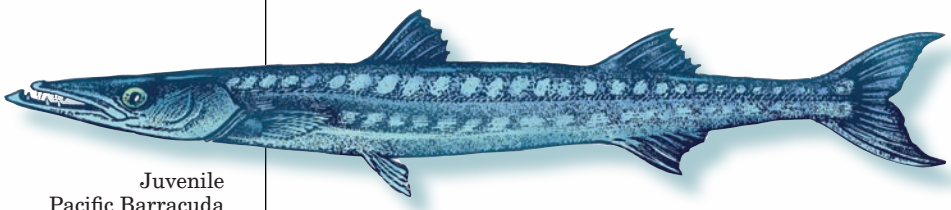
California Grunion
Leuresthes tenuis



Pacific Sardine
Sardinops sagax



Jack Mackerel
Trachurus symmetricus



Juvenile
Pacific Barracuda
Genyonemus lineatus

2008 Survey-Pelagic Fish	
Northern Anchovy	87%
Topsmelt	7%
California Grunion	2%
Pacific Sardine	2%
Other Species	2%

The pelagic zone is also home to larger animals: fast-swimming, open-water fish species and marine mammals. The 2008 survey captured 20 species of fish in the pelagic samples, some represented by only one or two individuals, some, like the northern anchovy, by over 70,000. Most of the pelagic fish are small “baitfish”, including northern anchovies (the most abundant fish in the harbor), topsmelt, grunion, and Pacific sardines; these four species accounted for 98% of the catch from the pelagic zone in the 2008 survey, and were also among the dominant species in previous surveys.

Predatory fish in the pelagic zone include mackerel, barracuda, white croaker, queenfish, sand bass, and white sea bass. These larger fish are generally much less common than baitfish, but they are among the commercially and recreationally important species in the harbor.

Four species of marine mammals (California sea lion, bottlenose dolphin, common dolphin, and harbor seal) were seen inside the harbor during the 2008 survey.

Long-beaked common dolphin, *Delphinus capensis*

California sea lion, *Zalophus californianus*

WHAT LIVES HERE?

The 2008 Survey identified more than 400 invertebrate species living in the infauna.

Echinoderms
Sea stars, urchins, sea cucumbers.

Mollusks
Clams and snails.

Crustaceans
Amphipods, isopods, crabs, etc.

Polychaete Worms

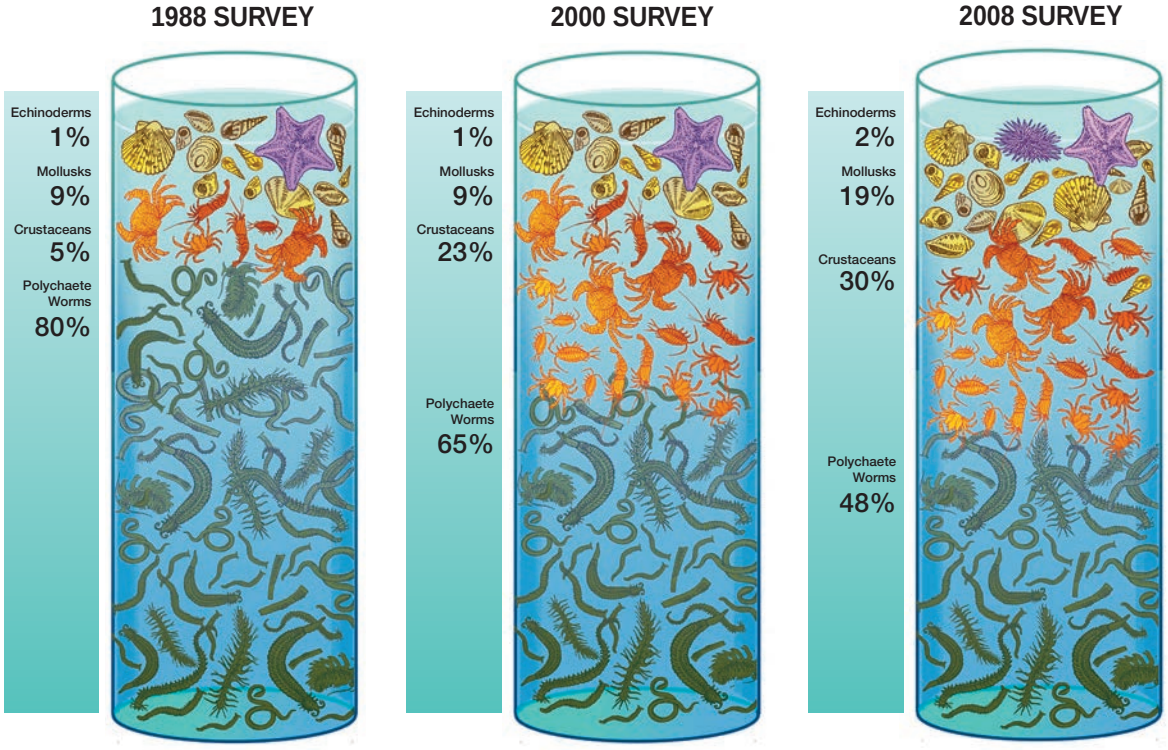
LIFE ON THE SEA BOTTOM

The mud and sand at the bottom of the harbor, which is called sediment, is home to an amazing variety of sea life. Hundreds of types of invertebrates, as well as many species of fish, live in, on, or just above the sediment. Together these animals form a thriving, productive ecological community – the benthic community. Recent surveys have identified some 400 species of invertebrates living in the sediments (the infauna) and another 60 species that live on the sediment surface (the epifauna), as well as over 60 species of fish that live on or near the bottom (demersal fish).

Infauna

In 2008 the ten most abundant infauna species included a non-native clam (*Theora lubrica*), a small crab, two species of small shrimp-like crustaceans known as leptostracans and amphipods, and six species of polychaetes (a type of marine worm). These species have consistently been among the most common organisms in the infauna since the 1980s, but before that more pollution-tolerant species, in particular the polychaete worm *Capitella capitata,* dominated the infauna. The most abundant animals in the sediments are polychaetes. In recent years, as the pictures on this page show, animal groups other than polychaetes worms have steadily increased in abundance. Scientists believe this increasing diversity indicates a steady improvement of water and sediment quality in the harbor complex, allowing more types of animals to thrive.

The benthic infauna interests scientists and environmental managers for two reasons. The first is its ecological role in the food web and the second is as an indicator of environmental quality, which will be discussed on page 24. As both consumers and prey, the benthic infauna are a vital link in the food web, cycling energy and matter through the living community. They feed on the constant rain of organic matter – dead and living plankton, debris from the land and from beds of seaweed, and larger dead animals – that falls to the sea bottom, and on the bacteria that convert that matter to biomass (biomass is the term used by scientists for the amount of living material in a particular place). As they feed, grow, and reproduce, the infaunal organisms become food for other invertebrates, for bottom-dwelling fish, and for marine mammals that hunt for food on and around the bottom.



Epifauna

The 2008 survey found that the most abundant epifauna in the harbor are shrimp (mostly species of *Crangon*), ridgeback prawns (species of *Sicyonia*), a spider crab (*Pyromaia tuberculata*), and a swimming crab (*Portunus xanthusii).* Other shrimp and crab species, as well as spiny lobsters, sea cucumbers, predatory cone snails, and brittle stars, are also common on harbor sediments. Shrimp, which made up over 80 percent of the epifaunal animals, are important as food for bottom-dwelling fish.

Demersal Fish

Many bottom-dwelling fish that are common in the harbor are part of the benthic community and depend on the invertebrates of the infauna and epifauna for food. Gobies, sculpins, blennies, and midshipmen, for example, live most of their lives half buried in the sand, waiting for unlucky shrimp or other epifauna to come within reach. Others, such as flatfish and lizardfish, live right on the sediment surface or cruise just above the bottom, picking off shrimp, worms, amphipods, and crabs. Some fish species, such as adult California halibut, feed on other fish, which they often capture by lying in ambush until their unwary prey draws near enough to seize. Two very abundant species, white croaker (*Genyonemus lineatus*) and queenfish (*Seriphus politus*), are primarily demersal, feeding mostly on benthic organisms. Both species are often found up in the water column, however, and are captured along with pelagic species. This means that these species form an important link in the food web by connecting the water column and benthic habitats.

The 2008 survey found 62 species of fish in trawl nets dragged along the bottom to capture demersal species. Interestingly, anchovies were the most abundant species in the bottom-trawl samples, constituting 30 percent of the total catch, but the anchovy is actually a pelagic animal – it is caught in bottom trawls because its schools can fill the whole water column from surface to bottom. The most abundant demersal fish species in the trawls were white croaker and queenfish (together accounting for 46 percent of the total catch and 67% of the catch of demersal species). None of the other species accounted for more than 7 percent of the catch, but among the top 15 species were the recreationally important California halibut, barred sand bass, and sanddabs. Other common species include skates and rays, rockfish, California scorpion fish, and several species of flatfish.

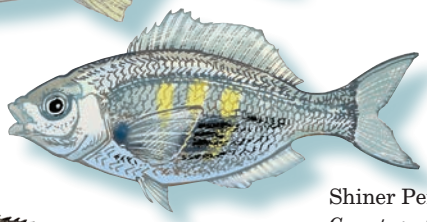
2008 Survey-Demersal Fish

White Croaker	39%	Bay Goby	2%
Queenfish	28%	California Halibut	1%
Shiner Surfperch	10%	Pacific Sanddab	1%
White Surfperch	5%	Barred Sand Bass	1%
Specklefin Midshipman	4%	Speckled Sanddab	1%
California Tonguefish	2%	California Lizardfish	1%
Yellowchin Sculpin	2%	48 Other Species	4%

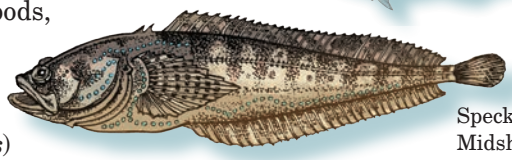
COMMON DEMERSAL FISH

White Croaker
Genyonemus lineatus

Queenfish
Seriphus politus



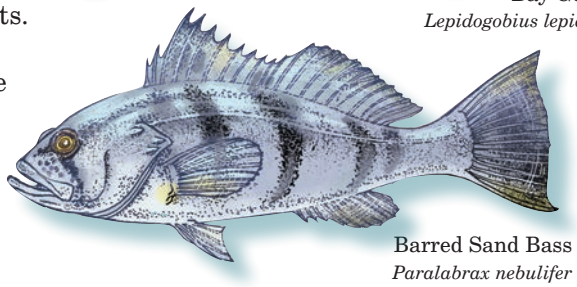
Shiner Perch
Cymatogaster aggregata



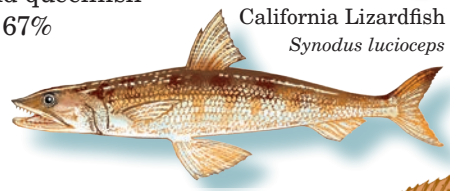
Specklefin Midshipman
Porichthys myriaster

Yellowchin Sculpin
Icelinus quadriseriatus

Bay Goby
Lepidogobius lepidus



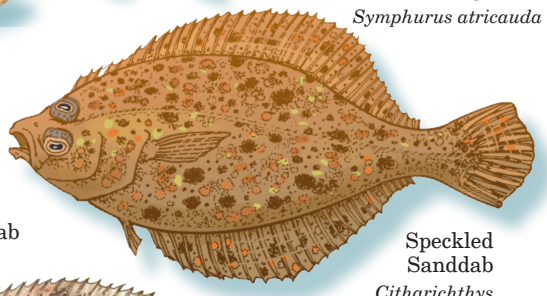
Barred Sand Bass
Paralabrax nebulifer



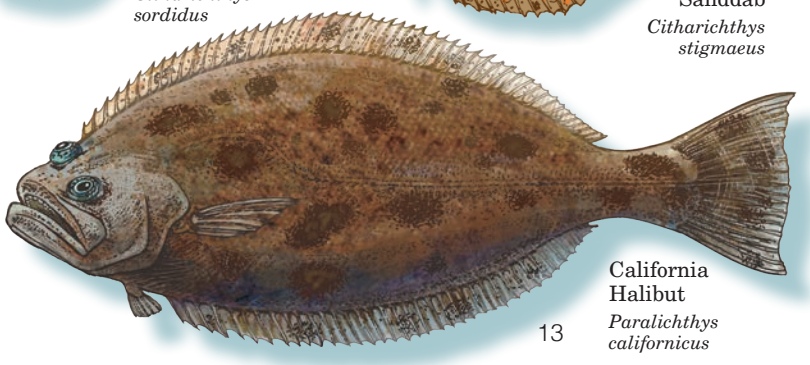
California Lizardfish
Synodus lucioceps

California Tonguefish
Symphurus atricauda

Pacific Sanddab
Citharichthys sordidus



Speckled Sanddab
Citharichthys stigmaeus



California Halibut
Paralichthys californicus

WHAT LIVES HERE?

The 2008 biological survey found 334 species of animals on the riprap throughout the harbor.

LIFE ON THE ROCKS

The development of the harbor has created hundreds of acres of rocky shoreline – the breakwaters, dikes, and pilings – where little existed before. Riprap is the name given to the boulders and rock rubble that line the sides of the channels and slips and that form the breakwaters protecting the harbor. Much like natural rocky shores, riprap supports a rich, dense community of plants and animals. The 2008 biological survey found 334 species of animals on the riprap throughout the harbor. The concrete pilings and seawalls throughout the harbor also provide hard surfaces where the animals and plants of the rocky shore habitat can flourish.

The riprap and other hard surfaces are in the intertidal zone, where the rise and fall of the tide exposes the organisms living there to the air for part of the day, and in the subtidal zone, where animals are rarely or never uncovered. Organisms in the intertidal zone have to contend with breaking waves and strong currents, extreme temperature changes and drying out when they are exposed to air, and to predation from two different worlds: terrestrial animals such as birds, and marine animals such as fish and sea lions. There are two major intertidal zones: the high intertidal, where organisms may only be submerged in water for a few hours a day, and the lower intertidal, where animals are submerged more of the time than they are exposed. Below the intertidal zone, a third zone of the rocky shoreline, called the subtidal, is almost always submerged.

High Intertidal Zone

In the harbor, as on rocky shores around the world, the high intertidal zone supports just a handful of species because few types of animals can survive the severe conditions. As an example, the 2008 survey found that, on average, 19 species were found at a given station in the high intertidal zone. This is less than a third as many as samples as was found in the subtidal zone.

The high intertidal throughout the harbor is dominated by four species of barnacles, a limpet (related to snails), and a tiny clam. In the 2008 survey these six species accounted for 75 percent of the abundance of animals in the high intertidal. The barnacles form crusty patches, often almost completely covering the rock surface, and the limpets are scattered around between the patches of barnacles.

Lower Intertidal Zone

More species can make a living lower down in the intertidal, where conditions are not as harsh as in the high intertidal. This greater diversity is indicated by the fact that the 2008 survey found an average of 61 species at a given station in the lower intertidal throughout the harbor. In Los Angeles-Long Beach Harbor, the abundant animals in this zone are shrimp-like crustaceans known as amphipods, brittle stars, sea squirts, and tube-dwelling worms. In contrast to the high intertidal, the most abundant six species in the lower intertidal accounted for only 44 percent of the animals.

The lower intertidal is also home to seaweeds and other marine algae, which can form dense mats that shelter and feed intertidal animals. The 2008 survey found 21 species of large marine algae attached to intertidal and subtidal riprap throughout the harbor. Some of these algae form a low fuzz-like layer on the rocks, but most of the seaweeds, such as *Sargassum*, *Ulva*, and *Colpomenia*, are large and very easy to see at low tide.

Finally, birds and fish play important roles in the lower intertidal. At low tide, shorebirds such as gulls, oystercatchers, godwits, and black-crowned night herons wander among the rocks looking for tidbits exposed by the tide. At high tide fish come in with the rising water to pick off whatever animals they can find or to graze on the algae.

Subtidal Zone

The lowest level of the rocky shoreline, the subtidal zone, is almost always submerged – only extreme tides once or twice a month expose these plants and animals, and then only for a couple of hours or less. Many of the lower intertidal zone species are abundant in the subtidal zone, but they are joined by a host of species that cannot tolerate exposure, including sea urchins, starfish, snails and nudibranchs, abalone, various crabs and amphipods, worms, sponges, and mats of tiny coral-like animals known as hydroids and bryozoans. In the 2008 survey, scientists found nearly 200 species of animals in the subtidal samples. The six most abundant species in the subtidal zone made up less than 40 percent of the animals, and it took 24 species to make up about 60 percent of the animals. These findings show how diverse the subtidal rocky habitat is compared to the intertidal zones, where far fewer species make up most of the individuals. The subtidal zone is also home to some fish species that live in tide pools and crevices, such as sculpins, and many that inhabit the water column right next to the riprap, such as damselfish (garibaldi and blacksmith), surfperches, kelpfish, and wrasses. These fish depend on the animals and plants of the rocky habitat for some or all of their food.

Pilings, breakwaters, and seawalls in the harbor support dense beds of barnacles, mussels, and seaweeds that provide food and shelter for over 300 species of animals in the intertidal and subtidal zones.

2008 Survey-Abundant Rocky Shoreline Animals

HIGH INTERTIDAL ZONE	LOWER INTERTIDAL ZONE	SUBTIDAL ZONE
Barnacle (*Chthamalus fissus*)	Amphipod (*Caprella simia*)	Amphipod (*Photis* spp.)
Barnacle (*Balanus glandula*)	Brittle star (*Amphipholis squamata*)	Brittle star (*Amphipholis squamata*)
Barnacle (*Balanus crenatus*)	Tube worm (*Spirobidae*)	Mussel (*Mytilus galloprovincialis*)
Barnacle (*Tetraclitus rubescens*)	Amphipod (*Gammaropsis thompsoni*)	Amphipod (*Caprella californica*)
Limpet (*Collisella scabra*)	Amphipod (*Erichthonius brasiliensis*)	Marine snail (*Crepipatella dorsata*)
Clam (*Lasaea adansoni*)	Amphipod (*Caprella californica*)	Sea squirt (*Ascidia* spp.)

Kelp forests like those in the harbor are home to many animals, including the state marine fish the garibaldi (above), and many other fish and invertebrates.

WHAT LIVES HERE?

SPECIAL PLACES | KELP FOREST

As important and productive as open water, sea bottom, and riprap habitats are to the Los Angeles-Long Beach Harbor ecosystem, they are not the whole story; there are some other habitats in the harbor that are worth exploring. These special places increase the diversity of sea life and provide valuable nursery and feeding areas for many species in the harbor.

Kelp Beds

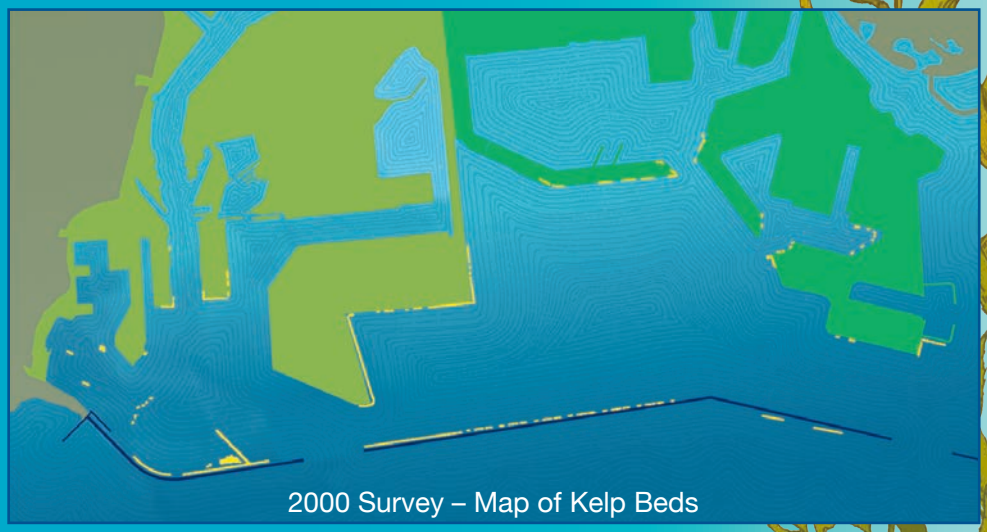
The waters of the Southern California coast are rich with marine plants and seaweed. The golden fronds of giant kelp (*Macrocystis pyrifera*) rise from rocky patches of the seafloor (the kelp plants need rocks to anchor them against the currents) to form great beds all along the coast. These kelp beds, which include smaller seaweeds as an "understory", form a rich marine ecosystem that can support sea otters, sea lions, fish, abalone, lobsters, and a myriad other invertebrates.

People usually think of giant kelp as being found only along the open coast, where good water quality and strong currents ensure clear water and a steady supply of nutrients. That's why the kelp beds inside the harbor are so interesting – they show how good the water quality is in the outer harbor areas. In 1977 the Port of Los Angeles transplanted about 500 giant kelp plants to the inside face of the breakwater next to Cabrillo Beach. A survey in 1986 found that the transplanted kelp bed was flourishing, occupying approximately two acres along the breakwater, but did not notice kelp anywhere else in the harbor. The kelp began to spread, forming linear beds along the breakwaters and riprap throughout the outer harbor of both Ports. By the spring of 2000 there were 25 acres of kelp bed in the harbor, and the 2008 survey mapped nearly 78 acres of kelp bed. Not only had the size of the beds noted in 2000 increased, but kelp had spread from the breakwaters and riprap to other areas of the outer harbor and even to the entrances to some inner harbor areas.

The scientists who conducted the 2008 survey pointed out that this dramatic expansion of the kelp beds is as great as or greater than the coast-wide increase in kelp measured by the California Department of Fish and Wildlife over the same period of time. That finding shows that water quality and circulation in the outer harbor are allowing the kelp to thrive.

Harbor Seal
Phoca vitulina

Kelp beds in the harbor tripled in size between 2000 and 2008, which scientists say is at least as great as the increases seen along the whole coast of Southern California during the same time. The presence of healthy kelp beds in the harbor is a sign of good water quality and circulation.



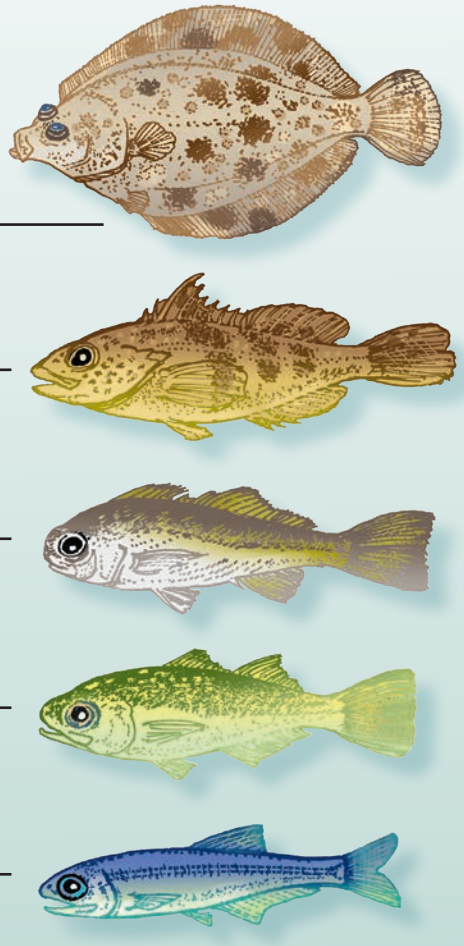
2000 Survey – Map of Kelp Beds

2008 Survey – Map of Kelp Beds

WHAT LIVES HERE?

SPECIAL PLACES | Shallow WATERS

Productive areas of shallow water – less than 20 feet deep – scattered throughout the harbor provide fish nursery habitat and a valuable resource for fish-eating birds.



Juvenile
California Halibut
Paralichthys californicus

Juvenile
Barred Sand Bass
Paralabrax nebulifer

Juvenile
White Croaker
Genyonemus lineatus

Juvenile
Queenfish
Seriphus politus

Juvenile
Northern Anchovy
Engraulis mordax

Not all of the sea life in the harbor occurs in the deeper open waters – marine biologists have found that shallow-water areas along the coast are especially productive. The reason they are so productive is that they provide plenty of food and shelter for many kinds of invertebrates and for juvenile fish. Juvenile halibut, for example, migrate into the shallow waters of coastal bays to feed on shrimp and other large invertebrates. Certain species of seabirds, including the endangered California least tern, a small seabird that nests in Los Angeles Harbor and elsewhere along the coast of Southern California, are drawn to the shallows because the small fish they feed on are abundant there and easy to see and catch.

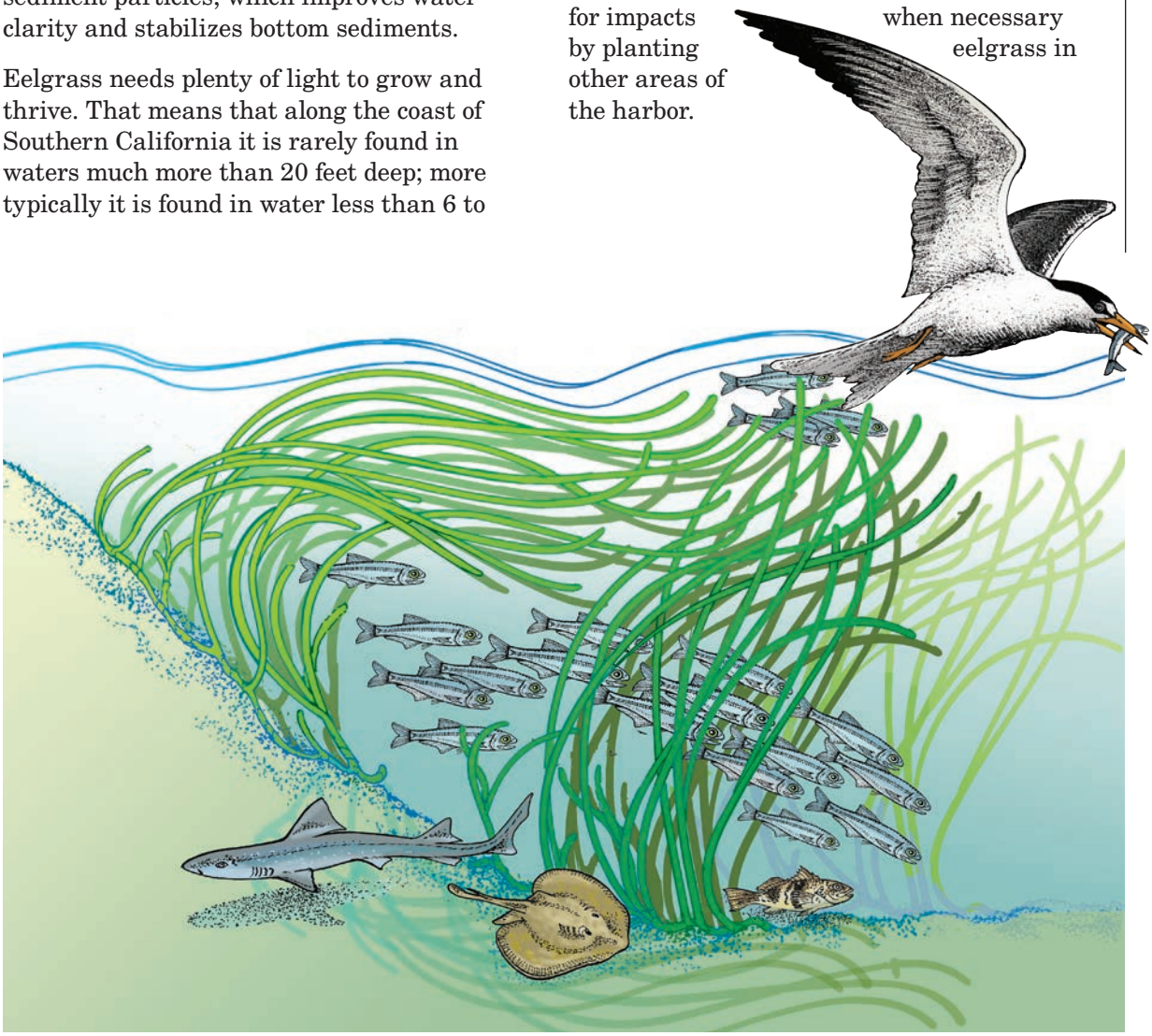
Most of the original shallow areas of the bay have been converted to deep channels and basins and to dry land in the course of port development. To offset the loss of such areas, both Ports have created new shallow-water areas: the 326-acre Cabrillo Shallow Water Habitat inside the San Pedro Breakwater (currently being expanded by another 50 acres) and 190 acres just east of Pier 300, both created by the Port of Los Angeles, and over 20 acres between the Navy Mole and the Pier 400 Transportation Corridor created by the Port of Long Beach. Both the 2000 and 2008 surveys found that topsmelt (*Atherinops affinis*) and gobies were the most abundant fish in these areas. Topsmelt are a key food of the California least tern during the nesting season, and their abundance allows the birds to feed their young. Larger fish such as halibut and sand bass visit the shallows in order to feed on the schools of topsmelt and the abundant gobies, as well as on the numerous shrimp and other invertebrates.

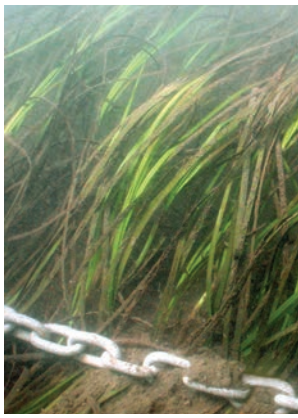
WHAT LIVES HERE?

SPECIAL PLACES | Eelgrass BEDS

Some of the shallow-water areas in the harbor are also important as eelgrass habitat. Eelgrass is not a seaweed, but actually a flowering plant, like lawn grass, and is one of the few flowering plants that can tolerate high salinities and constant submergence. Eelgrass beds provide habitat and nursery areas for commercially and recreationally important marine fish and invertebrates, making them highly valuable as a marine resource. In fact, federal law designates eelgrass as "essential fish habitat" and provides it with strong protection. In addition to sheltering animals, eelgrass filters out pollutants and absorbs excess nutrients from the water, which helps prevent toxic algal blooms. Eelgrass beds also trap sediment particles, which improves water clarity and stabilizes bottom sediments.

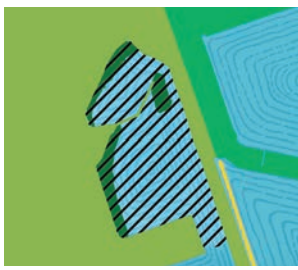
Eelgrass needs plenty of light to grow and thrive. That means that along the coast of Southern California it is rarely found in waters much more than 20 feet deep; more typically it is found in water less than 6 to 8 feet deep. Eelgrass was introduced into the harbor in the late 1980s, but because it needs shallow water, eelgrass can only grow in a few areas of the harbor. The 2008 survey investigated two areas that support eelgrass, both in the Port of Los Angeles. One is a 36-acre bed off Cabrillo Beach and the other is a series of beds totaling 30 acres in the shallow water next to Pier 300. These beds were about the same size in 2008 as they were in 2000. The fact that the beds have maintained their size over ten years means that they are a permanent, stable fixture in the harbor area that adds to its biological productivity. The Port of Los Angeles has undertaken extensive efforts to protect the eelgrass beds from the effects of its development projects and will mitigate for impacts when necessary by planting eelgrass in other areas of the harbor.





Extensive eelgrass beds in the Port of Los Angeles at Cabrillo Beach and Seaplane Lagoon off Pier 300 are important as fish nurseries and feeding areas.

See map on pages 2 and 3 for locations in the harbor.



Seaplane Lagoon Eelgrass Beds

Cabrillo Beach Eelgrass Beds

AN ABUNDANCE OF BIRD LIFE

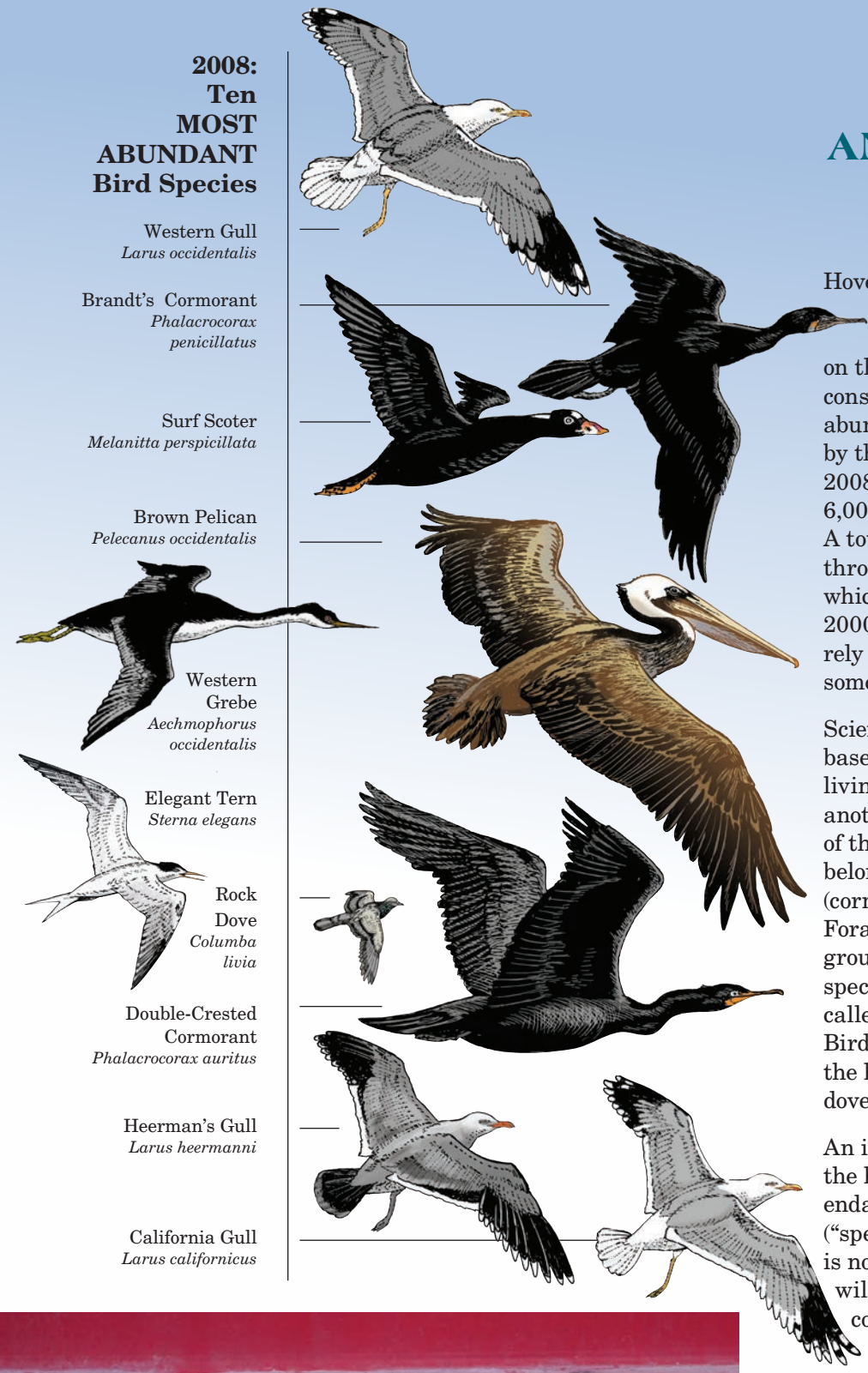
Peregrine Falcon
Falco peregrinus

Hovering in the sky, resting on riprap and pilings, diving into the water for a fresh meal, or begging for handouts on the fishing piers, birds are a constant, conspicuous presence in the harbor. The abundance of birds in the harbor is illustrated by the fact that on any given survey day in 2008 the scientists counted an average of over 6,000 birds belonging to nearly 50 species. A total of 96 species of birds were identified throughout the harbor in the 2008 survey, which is about the same number as in the 2000 survey. Three quarters of those species rely on harbor habitats for food and shelter, some seasonally, some year-round.

Scientists divide bird species into groups based on how or where they make their living or how they seem to be related to one another. In the harbor area, over 90 percent of the birds that were counted in 2008 belonged to three groups: Gulls, Waterfowl (cormorants and grebes), and Aerial Fish Foragers (pelicans and terns). These three groups included nine of the ten most abundant species. The tenth is the rock dove (the so-called "city pigeon") and is in the Upland Birds group. Other groups are also present in the harbor but only Upland Birds such as rock doves and starlings are abundant.

An interesting feature of bird populations in the harbor is the abundance of threatened, endangered, and special-status species ("special status" means that while the species is not considered threatened or endangered, wildlife agencies are concerned about its continued abundance in California). Thirteen species considered special status by the State of California live in or regularly visit the harbor. Seven of those species, including one endangered species, the California least tern, were nesting in the harbor during the 2008 survey, and several others are known to have nested in the harbor in the recent past. The special-status species brown pelicans, double-crested cormorants, and elegant terns are among the ten most abundant birds in the harbor area.

2008: Ten MOST ABUNDANT Bird Species



Western Gull
Larus occidentalis

Brandt's Cormorant
Phalacrocorax penicillatus

Surf Scoter
Melanitta perspicillata

Brown Pelican
Pelecanus occidentalis

Western Grebe
Aechmophorus occidentalis

Elegant Tern
Sterna elegans

Rock Dove
Columba livia

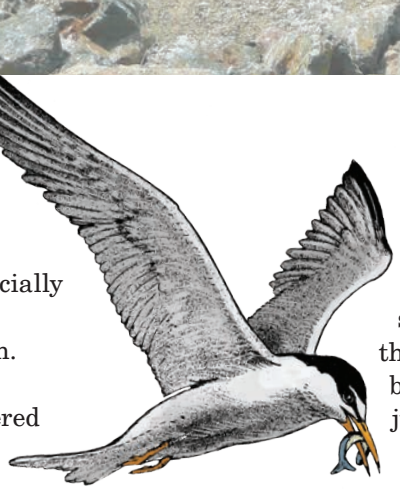
Double-Crested Cormorant
Phalacrocorax auritus

Heerman's Gull
Larus heermanni

California Gull
Larus californicus

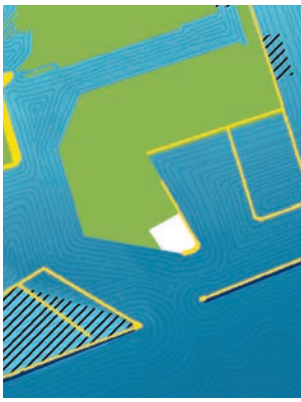
2008 Survey - Endangered, Threatened, and Special-Status Bird Species

Common Name	Scientific Name	Occurrence
ENDANGERED		
California least tern	*Sternula antillarum brownii*	Common - Nesting
Belding's Savannah sparrow	*Passerculus sandwichensis beldingi*	Rare - Transient visitor
THREATENED		
Western snowy plover	*Charadrius alexandrinus nivosus*	Infrequent - Transient visitor
SPECIAL STATUS		
Black oystercatcher	*Haematopus bachmani*	Common - Nesting
Black skimmer	*Rynchops niger*	Common - Nesting
Brant	*Branta bernicla*	Uncommon
California brown pelican	*Pelecanus occidentalis californicus*	Common
Burrowing owl	*Athene cunicularia*	Rare
Caspian tern	*Sterna caspia*	Common - Nesting
Common loon	*Gavia immer*	Uncommon - Transient visitor
Double-crested cormorant	*Phalacrocorax auritus*	Common
Elegant tern	*Sterna elegans*	Common - Nesting
Loggerhead shrike	*Lanius ludovicianus*	Rare
Long-billed curlew	*Numenius americanus*	Infrequent - Transient visitor
Merlin	*Falco columbarius*	Rare
Osprey	*Pandion haliaetus*	Infrequent - Transient visitor
American peregrine falcon	*Falco peregrinus anatum*	Nesting - 2-4 pairs annually



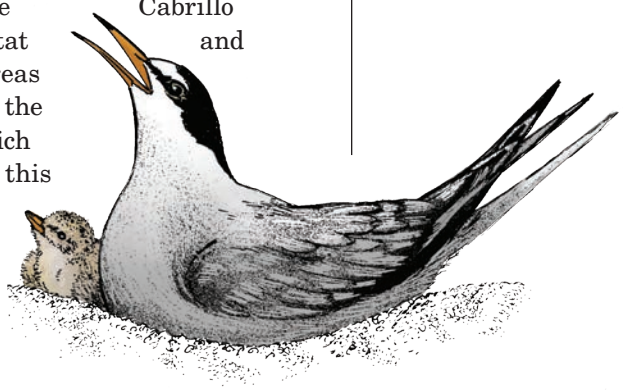
California Least Tern
Sternula antillarum brownii

Among the special-status birds that regularly nest in the harbor, one is especially noteworthy because of the Port of Los Angeles' role in its protection. The California least tern, *Sternula antillarum brownii,* is listed as endangered by the state and federal governments. This small fish-eating bird was nearly wiped out by loss of its nesting habitat and by poor hatching success that was caused by disturbance of nest sites. By the 1970s there were so few breeding pairs left that biologists feared the species was headed for extinction, and the federal government put the species on the endangered list. The least tern spends the winters in Central America, but every spring the birds migrate up to California to breed. They establish colonies on flat, sandy beaches and coastal flats – usually the same spots year after year – and commence courting and mating. Soon enough, the eggs hatch and the parents are kept busy bringing food to the chicks. Because the chicks are tiny – about the size of a ping-pong ball at hatching – they must be fed very small fish. This means that the colony must be near shallow-water areas that are rich in small baitfish and other juvenile fish. For the past 30 years least terns have nested on Terminal Island in the Port of Los Angeles, and for all that time the Port has taken extraordinary steps to provide the birds with the best possible chance to succeed. The Port of Los Angeles monitors and maintains the nesting site on Terminal Island each year. The Cabrillo Shallow-Water Habitat and the shallow-water areas next to Pier 300 and the Navy Mole provide rich foraging grounds for this sensitive species.



Terminal Island
Least Tern Nesting Site

See map on page 3 for location in the harbor.



NON-NATIVE SPECIES

Most Common Non-Native Species in LA-LB Harbor

Fish
Yellowfin Goby
Acanthogobius flavimanus

Mollusk
(Mediterranean Mussel)
Mytilus galloprovincialis

Mollusk
(Eastern Oyster)
Crassostrea virginica

Mollusk
(Clam)
Theora lubrica

Mollusk
(New Zealand Bubble Snail)
Philine auriformis

Polychaete
(Marine Worm)
Pseudopolydora paucibranchiata

Polychaete
(Marine Worm)
Exogone lourei

Crustacean
(Leptostracan)
Nebalia Puggetensis

Crustacean
(Amphipod)
Eochelidium

Crustacean
(Amphipod)
Grandidierella japonica

Crustacean
(Amphipod)
Caprella simia

Alga
(Brown Seaweed)
Sargassum muticum

Alga
(Brown Seaweed)
Undaria pinnatifida

Ships come to the ports of Los Angeles and Long Beach from all over the world, and they can bring non-native sea life with them. Plants and animals can hitch a ride in the ballast water ships use to give them stability, or come attached to the hull, anchors and anchor chains, or in the cargo itself. Most non-native organisms either don't survive the journey or can't survive in their new surroundings. Some do survive and flourish, however, and they can threaten the local marine life and its food web by outcompeting local species for food and living space. The seaweed *Undaria* and the yellowfin goby (*Acanthogobius flavimanus*) are examples of species that likely came to Southern California on ships. A few species, such as the eastern oyster (*Crassostrea virginica*), were deliberately introduced into coastal waters for commercial purposes.

The 2000 and 2008 surveys found that between 10 and 15 percent of the species in Los Angeles-Long Beach Harbor, including some of the most abundant ones, are not native to this area. There are very few non-native birds, fish, or algae, but about one-sixth of the bottom-dwelling invertebrate species are not native. A small clam (*Theora lubrica*) and a primitive crustacean (*Nebalia puggetensis*), both non-native, were the two most abundant benthic invertebrates in the 2008 survey, and in 2000 the New Zealand bubble snail (*Philine auriformis*) and a non-native polychaete worm (*Pseudopolydora paucibranchiata*) were very abundant, although not in the top ten. The yellowfin goby, native to Japan, is the only non-native fish that has been identified in the harbor.

Non-native species have not been the subject of focused monitoring, so it is not easy to determine whether they are spreading. However, the 2008 survey concluded that, in general, there have been few changes in the abundance of non-native animal species in recent years except that *Pseudopolydora paucibranchiata* seems to have declined dramatically in abundance since 2000 and *Theora lubrica* and *Nebalia puggetensis* have increased in abundance. Non-native animals that have arrived in the harbor appear to have fit into the existing community without causing major disruptions.

Two non-native seaweed species are known to live in the harbor. One of them, *Sargassum muticum*, appears to have fit into the local ecosystem without disruption, but the other, *Undaria pinnatifida*, is considered to be an invasive, potentially harmful alga because of its rapid growth and tendency to outcompete local species. Scientists are keeping a watchful eye on this species. A third dangerous algal invader, the mat-forming green alga, *Caulerpa*, has not been detected in the Ports but has been found in two other locations in Southern California. Rigorous control efforts required by the Southern California *Caulerpa* Control Protocol, including underwater surveys carried out before sediment-disturbing activities, such as dredging, have been instituted to help prevent *Caulerpa* from invading the harbor.

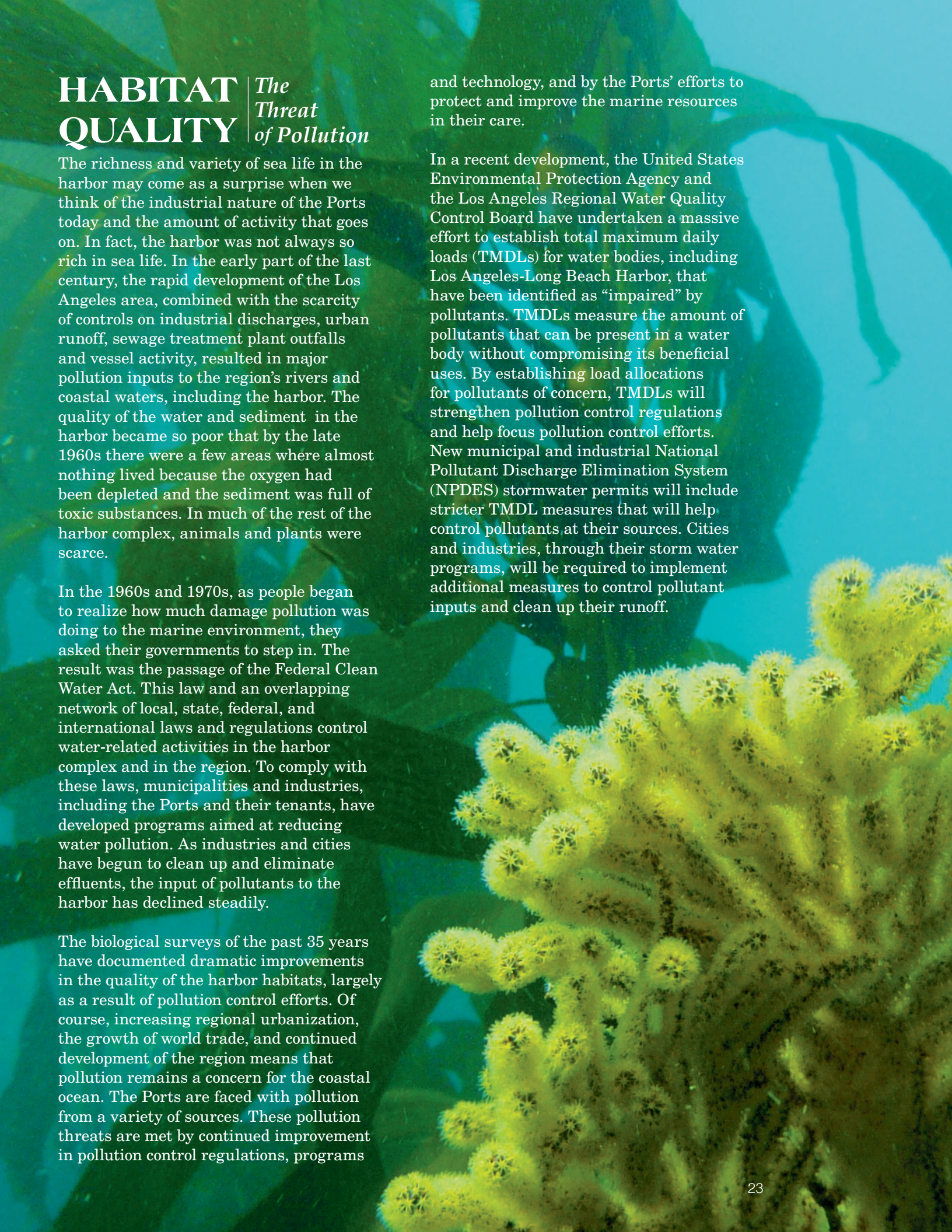
HABITAT QUALITY | *The Threat of Pollution*

The richness and variety of sea life in the harbor may come as a surprise when we think of the industrial nature of the Ports today and the amount of activity that goes on. In fact, the harbor was not always so rich in sea life. In the early part of the last century, the rapid development of the Los Angeles area, combined with the scarcity of controls on industrial discharges, urban runoff, sewage treatment plant outfalls and vessel activity, resulted in major pollution inputs to the region's rivers and coastal waters, including the harbor. The quality of the water and sediment in the harbor became so poor that by the late 1960s there were a few areas where almost nothing lived because the oxygen had been depleted and the sediment was full of toxic substances. In much of the rest of the harbor complex, animals and plants were scarce.

In the 1960s and 1970s, as people began to realize how much damage pollution was doing to the marine environment, they asked their governments to step in. The result was the passage of the Federal Clean Water Act. This law and an overlapping network of local, state, federal, and international laws and regulations control water-related activities in the harbor complex and in the region. To comply with these laws, municipalities and industries, including the Ports and their tenants, have developed programs aimed at reducing water pollution. As industries and cities have begun to clean up and eliminate effluents, the input of pollutants to the harbor has declined steadily.

The biological surveys of the past 35 years have documented dramatic improvements in the quality of the harbor habitats, largely as a result of pollution control efforts. Of course, increasing regional urbanization, the growth of world trade, and continued development of the region means that pollution remains a concern for the coastal ocean. The Ports are faced with pollution from a variety of sources. These pollution threats are met by continued improvement in pollution control regulations, programs and technology, and by the Ports' efforts to protect and improve the marine resources in their care.

In a recent development, the United States Environmental Protection Agency and the Los Angeles Regional Water Quality Control Board have undertaken a massive effort to establish total maximum daily loads (TMDLs) for water bodies, including Los Angeles-Long Beach Harbor, that have been identified as "impaired" by pollutants. TMDLs measure the amount of pollutants that can be present in a water body without compromising its beneficial uses. By establishing load allocations for pollutants of concern, TMDLs will strengthen pollution control regulations and help focus pollution control efforts. New municipal and industrial National Pollutant Discharge Elimination System (NPDES) stormwater permits will include stricter TMDL measures that will help control pollutants at their sources. Cities and industries, through their storm water programs, will be required to implement additional measures to control pollutant inputs and clean up their runoff.



STEWARDSHIP

Balancing Trade & Protection of Our Natural Resources

The ports of Long Beach and Los Angeles are no exception to the requirements for improved pollution control. The Ports have developed a wide range of water pollution programs over the decades, and those programs have been important to the improvement in the harbor habitats.

Water Resources Action Plan

As an example, the Ports recently worked together to develop a comprehensive approach to water pollution control and sediment cleanup, called the Port of Los Angeles-Port of Long Beach Water Resources Action Plan, or WRAP. The WRAP gathers all of the existing programs and initiatives into a set of control measures, and also introduces several new control measures aimed at vessel activities, sediment pollution, and regional influences. The WRAP helps the Ports respond effectively to more rigorous state and federal water quality regulations, including the NPDES permit program. Through their WRAP programs, the Ports are focusing their efforts to clean up contaminated sediments that are a legacy of past activities and to reduce pollution from the two major sources – landside runoff and on-water sources – that are under their control. They will also continue to work with upstream entities to reduce regional inputs to the harbor. These efforts will allow the Ports to improve their pollution control efforts and their effectiveness as stewards of the marine resources of the harbor.

Continual Improvement

These pollution control efforts have restored oxygen levels and removed or sequestered many sediment pollutants, allowing marine life to recover. A key indicator of this improvement is the composition of the benthic infauna – the small invertebrate organisms that live in the mud and sand of the harbor bottom. The infauna serve as indicators of environmental quality because most of them live their entire adult lives in a restricted area. They are a bit like trees on land – once they have settled in a spot they must take whatever the environment gives them. That means that organisms that settle in areas where water quality is poor or the sediments are full of chemical contaminants face additional challenges beyond the usual struggles to survive and flourish. Some animals are better than others at withstanding such challenges and can thrive in poor-quality habitats. Scientists can often recognize a stressed habitat by the fact that few kinds of animals live there, and the kinds that do are known to be tolerant

The steady improvement in harbor habitat quality, despite greater port activity resulting from ever-increasing cargo volumes, clearly shows the effectiveness of the many pollution control efforts that the Ports, their tenants and cities, the State of California, and the U.S. government have undertaken in the harbor area. Because of these efforts, fish and other marine life flourish in areas once thought nearly dead, giant kelp grows along the breakwaters where huge cargo ships pass, endangered species are common sights, and eelgrass meadows nurture a wealth of fish and invertebrates adjacent to busy cargo terminals.

of pollutants, low oxygen, or other adverse conditions. In the 1960s and 1970s, for example, the sediments in many of the dead-end slips in the harbor were populated almost entirely by a polychaete worm (*Capitella capitata*) that is known to be very pollution tolerant.

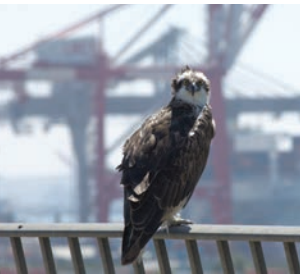
The surveys of the harbor conducted in the 1980s showed a dramatic improvement in habitat quality. No areas were actually devoid of life, although areas such as Fish Harbor, the Consolidated Slip, and dead-end slips still had very few species and abundant *Capitella capitata*. Everywhere else the surveys found more diversity and more sensitive species. The survey authors concluded that habitat quality had improved dramatically in just 10 or 15 years.

The 2000 survey showed still more improvement. Several species of small crustaceans known to be sensitive to contamination, such as the tiny shrimp-like animals *Ampelisca*, *Corophium*, and *Euphilomedes*, and a number of sensitive polychaete worm species, had become very abundant. Pollution-tolerant species were restricted to dead-end slips, and statistical analysis showed less difference in species composition between inner and outer harbor areas than ever before.

The improvement was so great that the wildlife agencies – National Oceanic and Atmospheric Administration (NOAA) Fisheries, the U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife – re-classified large areas that had formerly been considered inner harbor, and therefore of less habitat value, as outer harbor and therefore more valuable.

The latest survey, in 2008, showed even more improvement. The most notable change was that the inner harbor areas resembled the outer harbor even more closely than they had in 2000. Scientists also noted that the dead-end slips, including the Consolidated Slip, had somewhat greater species diversity than they had in 2000, indicating continued improvement in habitat quality.

The journey continues.



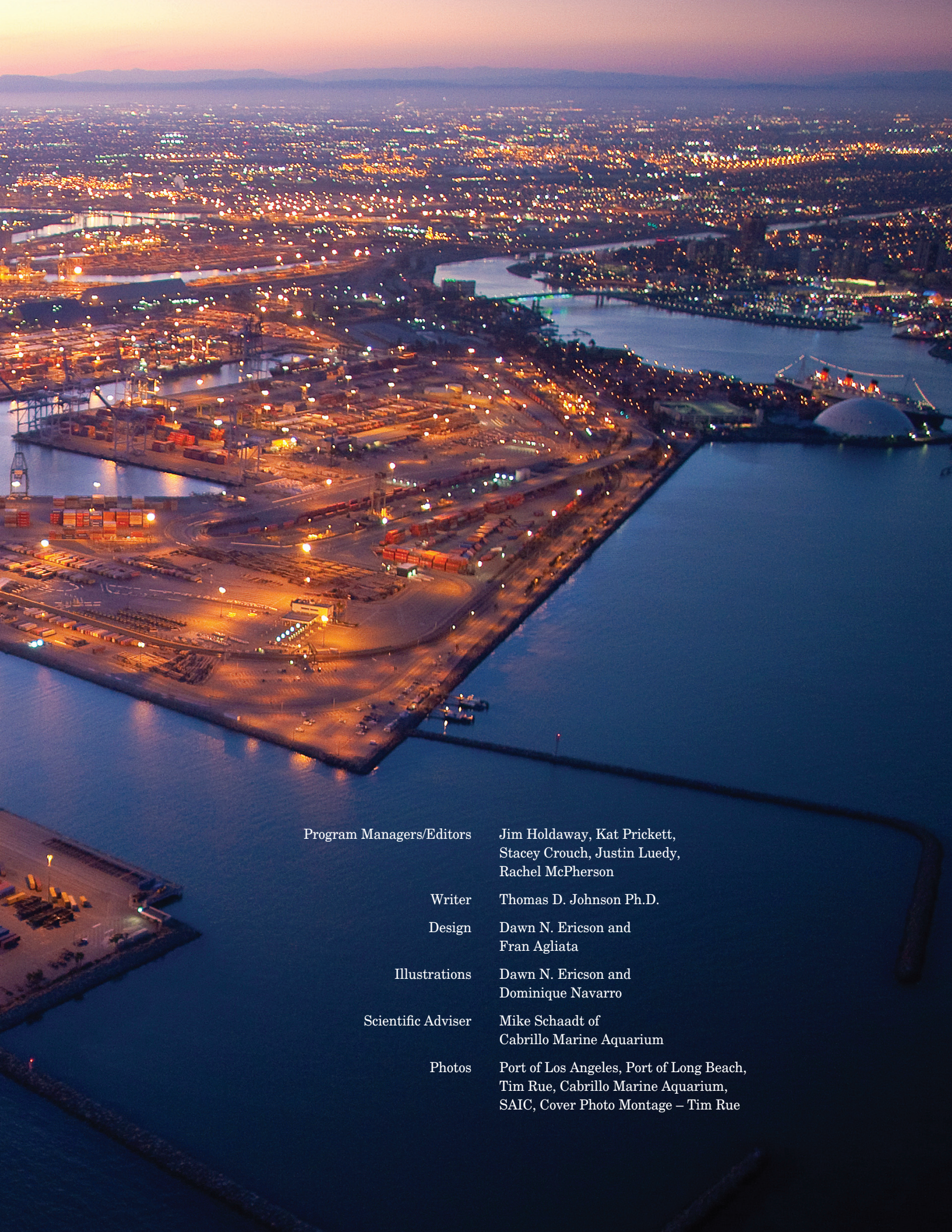
WHAT LIES AHEAD

Meeting Tomorrow's Challenges

As dramatic and encouraging as these improvements have been, the journey is not over. Pollution from regional runoff, vessel activity, and legacy sediment contamination still threaten water quality, and non-native species continue to enter the waters of Southern California. These challenges will be met by the Ports and their tenants, the regulatory agencies, and industry working together with improved control programs and new regulations. The Ports will continue to conduct periodic biological surveys to monitor the condition of the harbor habitats; in fact, planning for the next survey is already underway.

These efforts will enable the kelp and eelgrass beds in the Ports to continue to expand, the diversity of bottom-dwelling species to increase, and the quality of the biological habitat to continue to improve. As a result, the ports of Los Angeles and Long Beach will continue to share the coastline successfully with California's rich, diverse treasure of marine life, and will continue to provide a valuable biological resource for Southern California.


KRISTIN KNUTSEN
ROWLEY



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Sampling was conducted throughout the Los Angeles-Long Beach Harbor. The effort was large, involving dozens of scientists and technicians from the consulting firms of SAIC, Keane Biological, Seaventures, Tenera Environmental, ECORP Consulting, and Tierra Data.

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2013 HARBOR HABITAT

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