PERSPECTIVES

of San Diego Bay

A FIELD GUIDE

by the students of
THE GARY AND JERRI-ANN JACOBS
HIGH TECH HIGH

Foreword by Jane Goodall

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Foreword
by Jane Goodall

Perspectives of San Diego Bay is a unique field guide—indeed, it is quite extraordinary. It was hand delivered to me by Jay Vavra in my seventeenth-floor hotel room overlooking San Diego Bay. I have known Jay for nine years, ever since he first got involved in Roots & Shoots, the Jane Goodall Institute's conservation and humanitarian education program for youth. And this field guide represents an end product of Jay's Roots & Shoots group at High Tech High school in San Diego. Jay, along with his teaching partners, Tom Fehrenbacher in the humanities and Rod Buenviaje in math, have mentored a very creative and versatile group of students to produce this wonderful book. Now I could look out of my windows and over the bay and, with book in hand, learn something of the history, geography, and biology of San Diego Bay, and also about the threats to the ecosystem as a whole.

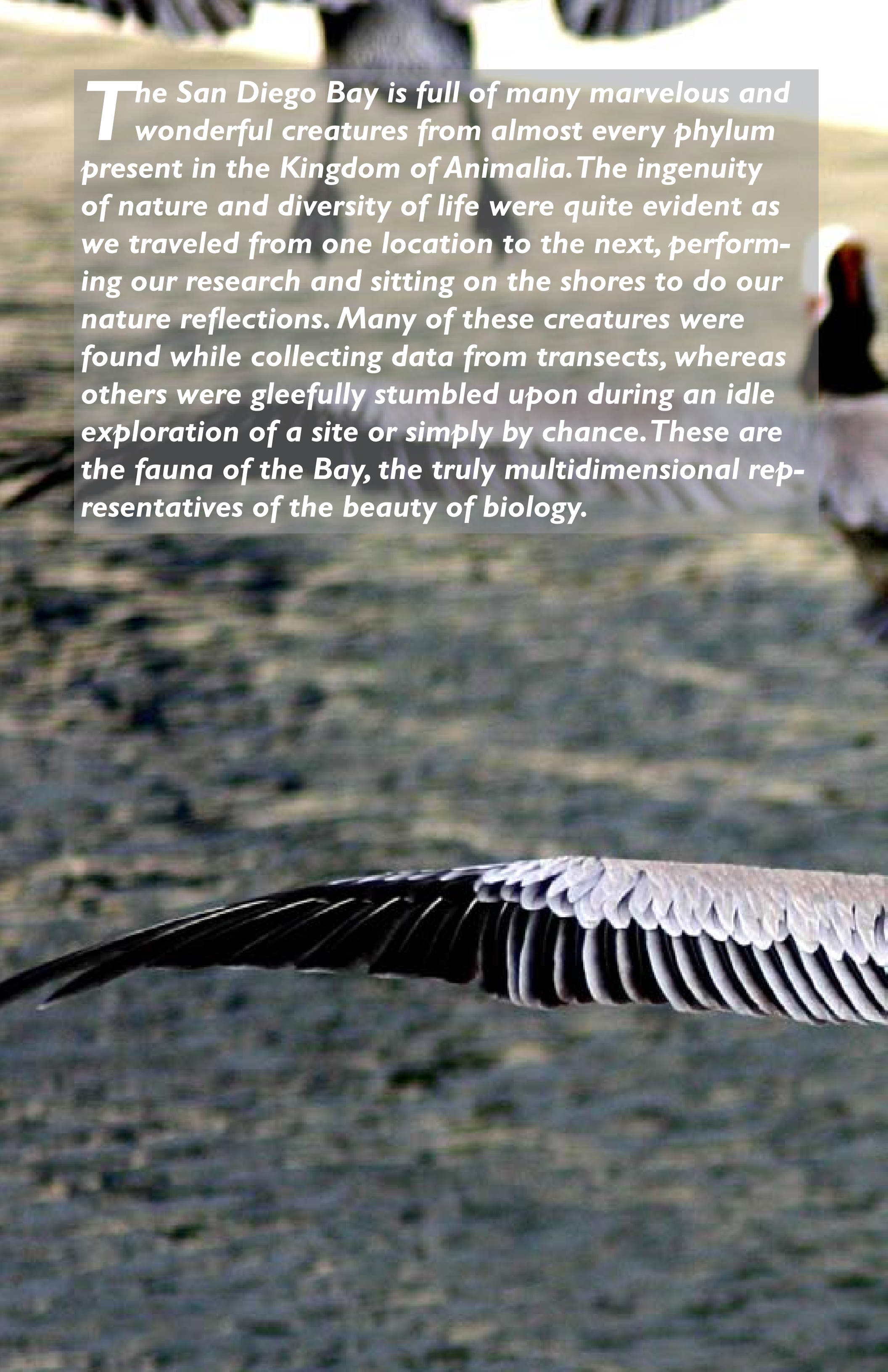
One of the primary goals of Roots & Shoots is to help young people better understand the environment around them and to use this knowledge to take positive action to make the world a better place for all living things. *Perspectives* is a superb example of the kind of work that motivated and environmentally aware high school students can do when empowered to act. High Tech High has proved its ability to deliver a very high standard of environmental education, and the Roots & Shoots program requires that students pursue their interests outside the classroom. This particular group of HTH students, by integrating rigorous science with humanitarian principles, are learning to understand their community and their environment from a whole variety of perspectives. This has fostered in many of them a desire for action. The result of all this is that they have produced this incredibly well researched, informative and sensitive book. It will be useful for the people who live, work, and play in the Bay area—a place of great natural beauty that has been extensively developed, too often at the expense of its wildlife.

The students have seen for themselves the beauty and biodiversity of those areas of the Bay that have been protected, observed how easily we can damage such places, but noted too how effective conservation efforts can be. Not content with merely presenting their results clearly and concisely, they have become advocates for better environmental stewardship. They have taken the problems to heart and prescribed solutions to many of them, outlining a course of action that will help to revitalize the Bay and lead to a more healthy environment for both wildlife and humans. It is the kind of material that can impress lawmakers, for these young people of today are the voters and the leaders of tomorrow.

I was in San Diego to present the keynote address at the 25th Annual ESRI Users Conference for Geographic Information Systems. And I was excited to find that Jay and several of these students were presenting also, sharing with the audience some of the methods and technology that had informed sections of this book. They clearly demonstrated the importance of using GIS technology as a teaching tool in conservation biology: it had enabled them to have a much better understanding of complex, ecosystem level, biogeography. They attended the conference as representatives of Roots & Shoots, and I met with them and was so proud of them—and of Jay.

Most people will be amazed to think that high school students have produced this guide. I am no longer amazed by the capabilities of informed and empowered youth. There are Roots & Shoots groups in more than 90 countries, many of them involving high school students. Indeed, though it now provides materials for all ages, from pre-school through university and beyond, the program began with a group of high school students in Tanzania. It is immensely reassuring to know that the energy, enthusiasm and passions of youth can, under the mentorship of dedicated and wise adults like Jay, Rod, and Tom, lead to the production of a field guide like this. It gives me reason for hope. Hope for the future of our much abused planet. Hope that the youth of today will be better stewards than we have been and will gradually restore the health of our much abused planet.

Dr. Jane Goodall, DBE
Founder, Jane Goodall Institute
and U.N. Messenger of Peace
www.janegoodall.org



The San Diego Bay is full of many marvelous and wonderful creatures from almost every phylum present in the Kingdom of Animalia. The ingenuity of nature and diversity of life were quite evident as we traveled from one location to the next, performing our research and sitting on the shores to do our nature reflections. Many of these creatures were found while collecting data from transects, whereas others were gleefully stumbled upon during an idle exploration of a site or simply by chance. These are the fauna of the Bay, the truly multidimensional representatives of the beauty of biology.

FAUNA
OF THE SAN DIEGO BAY

Exploring Life in the San Diego Bay

INTRO TO BIOLOGY

The intricacies of life have confounded, challenged, and puzzled scientists since the beginning of modern man. What is this mysterious aspect of the universe that we call life? The quest to understand this question and to grasp the reason behind all living things has become the impetus behind the study of biology. To study biology is not just to study that which is around us, but to study and define life itself. There can be no science without life, and as such there can be no life without science.

Throughout this guide, life is discussed and analyzed in all of its forms. Biology is the backbone of this book and connects all of the guide's many features. As we peer through crevices, under rocks, and in the sands of the intertidal zones, we become aware of life everywhere. In an attempt to make conclusions, we must first photograph, classify, and describe the natural history of the creatures in this guide. A brief guide of animals describes the attributes of many common intertidal creatures found throughout the Bay and categorizes them based upon phyla and evolutionary development. By progressing from the simplest sponge, through mollusks and up to vertebrate animals, the patterns and paths of evolution can be observed within the confines of San Diego Bay's intertidal zones.

In order to attain a complete understanding of biology, connections to the environment must be made. By studying not only the biodiversity of the San Diego Bay, but also its human aspects, history, and sociological connections, our scientific results can have a larger impact and meaning. It is this multitude of perspectives that causes the study of life to be enriching in avenues far beyond what most think of as just science.

The study of life is so diverse and complicated that it sometimes becomes hard to believe that such a phenomenon could have occurred naturally. Yet scientists and future scientists continue to study and experiment on life in order to gain a better understanding of the true nature of life; for if they can understand what life is and how it works, it may bring us closer to answering questions of human existence.

MOLLUSCA

MOLLUSCA

Mollusca (L. *mollis* meaning soft) is one of the three most successful groups in the animal kingdom. Over 160,000 species have been described, of which around 128,000 are living and about 35,000 are recorded as fossil species. Mollusks are found in nearly all habitats. In the sea they inhabit regions from the deepest ocean trenches to the intertidal zone. They may be found in freshwater as well as on land where they occupy a wide range of habitats. The phylum Mollusca contains eight classes: *Gastropoda, Pelecypoda, Cephalopoda, Aplacophora, Monoplacophora, Polyplacophora, Scaphopoda,* and *Caudofoveata*. The most advanced class of living mollusks is the *Gastropoda,* which comprises more than 80% of all living mollusk species.

The *Gastropoda* have approximately 40,000 living species. Most gastropods have shells; however, there are quite a few groups that have either reduced or internal shells, or no shell at all. Shelled forms are generally called "snails" and forms without shells are called "slugs"; however, terrestrial slugs are not closely related to the various marine slugs as one might think. Although most gastropods are marine, there are numerous forms in both freshwater and terrestrial environments. The San Diego Bay houses many kinds of gastropods. The snails found in the bay include file limpets, rough limpets, gray periwinkles, slipper snails, and the tube snails. The other kinds of gastropods found in the bay are slugs. We found bubble snails, many navanax, a dorid nudibranch, and a sea hare.

The *Pelecypoda* includes the bivalves, which are laterally compressed animals, with two shell "valves" that are hinged on the animal's dorsal surface. They are found in just about every marine environment, from the intertidal zone to the deepest marine habitats. They are suspension feeders, filtering small organisms and organic particles from the water such as bacteria, phytoplankton, zooplankton, and nonliving organic detritus. Only two kinds of creatures have been found in the San Diego Bay. They are the bay mussels and Pacific oysters.

The *Cephalopoda* include the familiar squid and octopus. They are the most intelligent and the fastest swimming aquatic invertebrates. This family includes squid, octopi, and cuttlefish. Cephalopods have a closed circulatory system, which is an adaptation to their active lifestyle, as opposed to the open circulatory system found in other Mollusks. There has been only one *Cephalopoda* found in the San Diego Bay: the two-spot octopus.

The *Polyplacophora* are commonly known as chitons. These mollusks have seven or eight dorsal shell plates, although they may be covered mostly or entirely by soft tissue in some species. The approximately 600 described species are generally flattened and elongated animals that are typically found in the intertidal zone grazing on epibenthic algae. The chiton commonly found in the San Diego Bay is the mossy chiton.

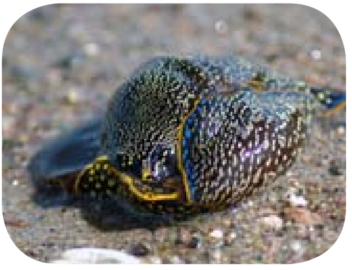
SCALED WORM SHELL *Serpulorbis squamigerus*

Class *Gastropoda* | **Order** *Heterogastropoda* | **Family** *Architectonicacea*
Morphology: The distal end of the scaled worm shell houses its tentacles. The worm has a whitish, pinkish and yellow tinge to it. The shell curves around and there are a few of them on top of each other.

Range: Mostly live on humid rocky environments on the sea floors or in fresh seawater. They attach to algae, kelp, shells, rocks and below low tide lines. Most commonly seen in California, along the Pacific coast and central Baja California.
Feeding: Are sessile, therefore dependent on water currents to bring them food. They feed by entrapping food particles, bacteria, and minerals present in sea water in their mucous threads and nets.
Reproduction: The females lay massive amounts of fertilized eggs, sometimes over 600 that are placed in about 67 capsules during the summer season. Almost all the eggs in the capsules hatch, releasing swimming larvae. These larvae move around and attach themselves to a rock or tubes of an adult, developing a shell around their body.
Etymology: *Serpulorbis sqamigerus* (L. Serp worm *L. squamigerus* Shell).
Other: Japanese name is Mimizugai, *Serpulorbis squamigerus* .

NAVANAX

Navanax inermis



Class *Gastropoda* | **Order** *Cephalaspidea* | **Family** *Aglajidae*
Morphology: Fully grown, at least 22 cm in length, dark brown to black with yellow lines going lengthwise up and down the body; edges of the creatures have an orange to yellow line extending all along edge. A series of bright blue spots also fringes the edges.
Range: East Pacific, North America, and West Atlantic Ocean.
Feeding: Feeds on other sea slugs, bubble snails and occasionally nudibranchs. Sucks in the prey, and then swallows repeatedly which moves the prey into the esophagus. The empty shell is then expelled out the other end of the creature.
Locomotion: Uses radial mussels to suck water in from its front and pushes it out its back.
Reproduction: They are all hermaphrodites. The penis is on the right side of the head, with the genital opening being on the right side of the body in the rear, the creature acting as male approaches the female from behind and attaches. Chains can form with 3-6 creatures on average, the creatures in the middle act as both male and female simultaneously.
Etymology: *Navanax inermis* (L. *Navanax*- not, L. *arma* arms, “unarmed”).
Other: To feed on snails, it has learned to follow the slime trail that the snails leave in their wake.

ANNELIDA

ANNELIDA

The name *Annelida* comes from the Latin word *annelus,* which means "ringed worm." There are two major marine classes of the phylum *Annelida*: *Hirudinia* and *Polycheata*. *Hirudinia* contains 520 species of leeches; most are freshwater with a few marine and terrestrial species. They have a fixed number of segments, usually 34. They have posterior and anterior suckers.

Polycheata contains 5000 species, making it the largest class. Members have bristles that allow them to wriggle and move. Since there are an abundance of polychaets, they are a significant part of the marine food chain. They have a well developed head. They do not have clitella, permanent sex organs, or permanent ducts for sex cells. Fertilization is external. Annelids have a segmented body, and bilateral symmetry. The segments are separated by septa. They have a head and a terminal anus and a complete digestive tract (which is non-segmented). They have a nervous system with lateral nerves in each segment. Their major organ systems are closed. They have a segmental-arranged circulatory system with a digestive system composed of a complete tube from mouth to anus. Gas exchange is performed by diffusion through the skin. Certain types of annelids (mainly leeches) are used for medical purposes.

In the San Diego Bay, annelids are commonly found on mud flats. Two of the families of annelids we found in the San Diego bay are the *Cirratulidae* family and the *Nereididae* family. The *Cirratulidae* comes from the order *Cirratulida*. They are deposit feeders that gather their food from the ocean floor. The *Nereididae* are usually large elongated worms with jaws.

CIRRATULIDAE

Class *Polychaete* | **Order** *Canalipalpata* | **Family** *Cirratulidae*
Morphology: Usually red or orange gelatinous covering. Front end of body has a pair of thick grooved palps and tentacular filaments. Some with anterior ends with several grooved tentacular filaments arranged in a transverse row. Visible palps and long thread-like gills. 40-150 mm in length. Some with slender tentacles of two lengths and heavy black spines protruding from sides of body from middle to end.
Habitat: Shallow water and deep sea. Holes and crevices in rocky tidepools, mussel beds, among roots of surfgrass, rocky and soft bottoms, bays and harbors.
Range: California, Baja California, Oregon, British Colombia.
Feeding: Deposit feeders.
Locomotion: Little bristles or tentacles help them wiggle through the sand. Some are able to burrow through rocks or coral using their jaws.
Reproduction: Reproduce asexually by severed body parts, and sexually by external fertilization. Some spawning occurs in Alatimos Bay in Los Angeles during May and June.
Etymology: Scissor-tailed.

NEREIDIDAE

Class: *Polychaeta* | **Order:** *Phyllodocida* | **Family:** *Nereididae*
Morphology: Two pairs of antennae, a pair of bi-articulate palps, a pair of jaws and many paragnaths. Enlarged peristominium forms a collar around the prostomium. Greatly elongated peristomial cirri. Can be anywhere from 70 mm to 1 meter.
Range: British Colombia, California, Siberian Pacific, Mexico, Peru, Hawaii, Japan, China, Australia.
Feeding: Some feed on algae by catching pieces as they float by and attaching them to the walls of their habitat to grow. Some feed on sessile animals.
Locomotion: Bristles are used to wiggle through sand. Jaws are used to burrow through rock. Certain species can swim up to 80 mm per second.
Reproduction: Reproduce asexually by severed body parts, and sexually by external fertilization.
Etymology: A sea nymph.
Other: Often used as bait for fishermen.

ARTHROPODA

ARTHROPODA

The phylum *Arthropoda* contains some of the most prolific animals on the planet. The word arthropoda was derived around 1877. The biology definition, “those with joined feet,” meaning the invertebrates’ legs are segmented, came about in 1845 by a German scientist. Arthropods can be found in the air, on land, or in the sea. They have the ability to survive in any condition ranging from extreme temperature to extreme toxicity levels. The arthropods make up three-fourths of all known living fossils and organisms. There are over one million species total in this phylum. There are ten important marine classes within this phylum. These important marine classes are T*rilobite* (these are extinct creatures), *Tardigrada, Onychophora, Sprigginida, Vendiamorpha, Anomalocarida, Pycnogonida, Uniramia, Crustaceamorpha,* and *Cheliceramorpha*.

There are so many different kinds of arthropods that it is difficult to define an arthropod. One characteristic that helps define an arthropod is that they have segmented bodies. They can be segmented internally and externally. The segmented parts of an arthropod usually include a head, thorax, and abdomen. Their exoskeleton is composed of chitin which is a strong, flexible, modified polysaccharide. Arthropods have a complete digestive system and a complex nervous system. They have an open circulatory system and a respiration system.

The arthropod’s ability to shed or molt is a unique characteristic of this phylum. Arthropods shed because their bodies are segmented which blocks growth of the organism. Shedding allows the arthropod to have rapid growth in size and significant change to the body until a new exoskeleton is made. During shedding, an arthropod is at the highest risk of attack because there is no hard exoskeleton to protect it from enemies.

Throughout all our studying at numerous locations, we have seen many arthropods. We have seen the molt of a lobster. We have also encountered and seen countless numbers of barnacles (*Balanus*). We have also seen another kind of barnacle (*Cthamalus*). We have also seen tons of shore crabs (*Pachygrapsus*) which vary a lot in size. Two other common creatures we saw were rock louse *(Ligia)*, and burrowing shrimp (*Callianassa*). There are many arthropods in and around the bay and these are just a handful of the ones out there.

AVES: DIVING BIRDS

The amazing feat of flight continues to make birds some of the most amazing animals on the planet. The entire class of birds, descended from dinosaurs, includes some of the most magnificent creatures on the planet. Since their dinosaur ancestors, birds have evolved to come in all types and shapes. Some are large birds of prey that feed on rodents; others are small fruit eaters; others sift through the ground to find bugs, and some cannot even fly. Some of the most prominent and magnificent birds are the fish-eating diving birds.

The term “diving birds” refers to the many water birds that dive for their prey, usually fish. These friends of sailors and fishermen include the kingfisher, cormorant, grebe, tern, and pelican. It is hard to go to the ocean and not see the signature outline of these magnificent birds. A bird high in the air, wings outstretched, floating on columns of air scans the water with its super-sharp eyes. In one swift movement, it pulls its wings tight to its body and slices through the air towards the water. This Olympic-class diver barely makes a splash as it enters the water and flies up again with a fish in its beak.

Nearly all of the diving birds found in the San Diego Bay eat fish. As a result, they are most commonly found near the ocean, bay, and marinas where the fisherman are unloading their catches. It has been well known for hundreds of years, that these birds are the best fishermen on the planet. While on land, the birds follow the fishermen; however, out on the ocean, it is the fishermen that follow the birds.

These animals use their keen sense of sight to see schools of fish just below the surface of the water. With the gift of flight, they soar high overhead out of sight from the fish. With their fighter jet-tuned aerodynamics, they can swoop down onto the ocean with amazing accuracy and catch up their prey. Other types of diving birds such as the common loon use a more subtle approach. They sit calmly on the surface of the water and wait for fish to calmly pass underneath them. In the blink of an eye, these peaceful looking birds can thrust themselves underwater to catch the unsuspecting fish below.

The skill and elegance of the diving birds has made them some of the most popular and well-known types of birds. Their signature dives and elegant flight denote a truly unique animal.

OSPREY

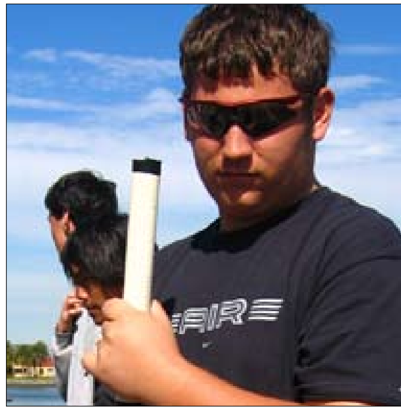
Pandion haliaetus

Class: *Aves* | **Order:** *Falconiformes* | **Family:** *Pandionidae*
Morphology: Is 52-60cm long with a 152-167cm wingspan. It has white under parts and long, narrow wings with four "fingers", which give it a very distinctive appearance. They have reversible outer toes, and closable nostrils to keep out water during dives.
Communication: A series of sharp, annoying whistles, cheep, cheep, or yewk, yewk. Near the nest, a frenzied cheereek!
Range: Worldwide, almost cosmopolitan – mainly found by lakes, rivers, and oceans.
Feeding: Fish.
Locomotion: Flies. Osprey dive, then plunge feet first to catch their prey.
Reproduction: In March or earlier, they begin a five-month period of partnership to raise their young. Females lay 3–4 four eggs by late April, and rely on the size of their nest to help conserve heat. The eggs are the size of chicken eggs, and become fliers within eight weeks.
Etymology: *Pandion haliaetus* (Gk. *Pandion* – King of Athens exiled for overfishing, L. *haliaetus* – eagle).
Other: Observed on top of light posts, trees, and other perches around the bay. The fish carcasses can be commonly found underneath the perch.

RED-SHOULDERED HAWK

Buteo lineatus

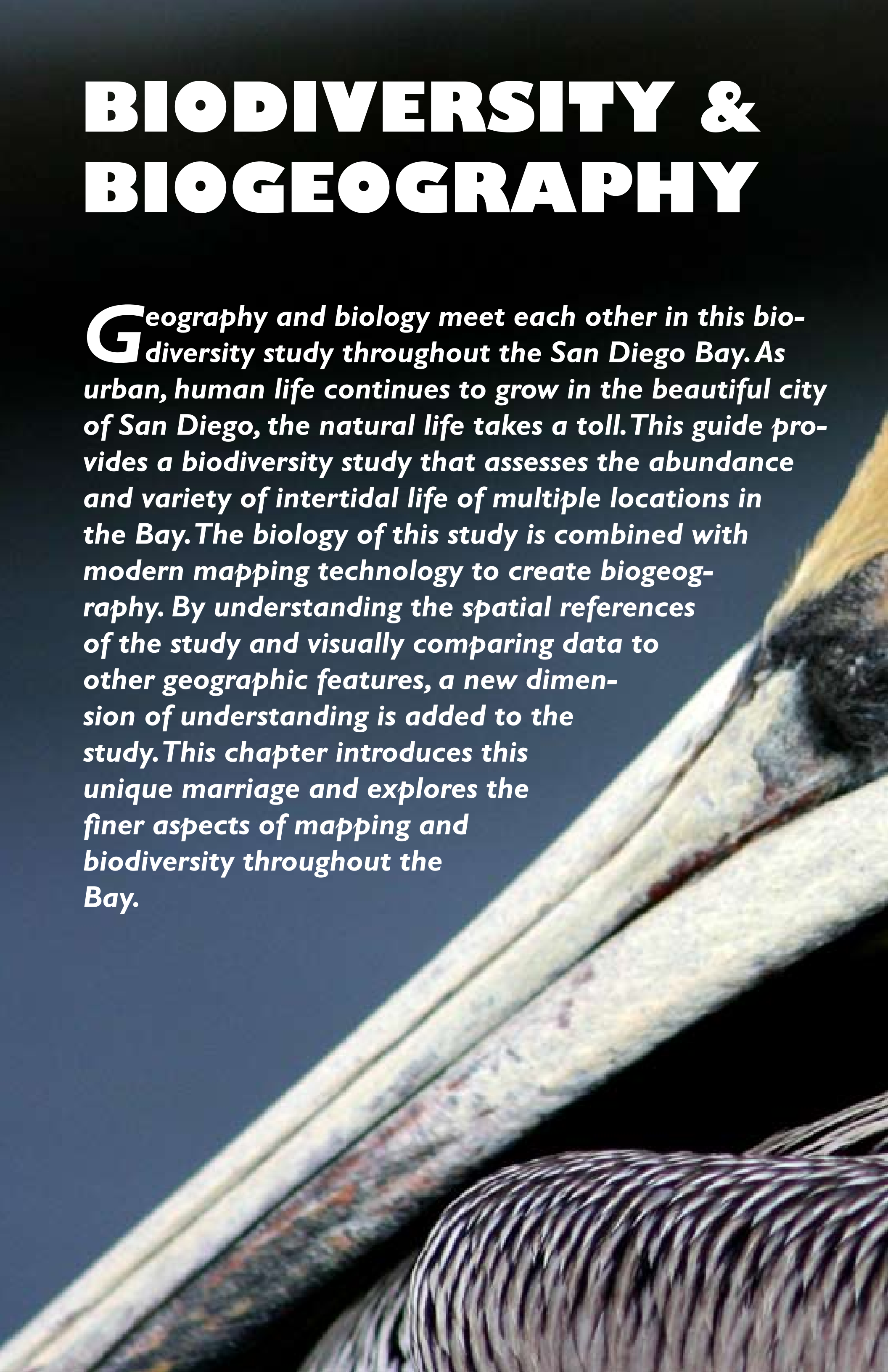
Class: *Aves* | **Order:** *Falconiformes* | **Family:** *Accipitridae*
Morphology: 16-24 inches long with a wingspan of 3 feet 4 inches. A hawk that looks similar to the Red-tailed Hawk, but is smaller than one, with long wings with white barring on dark wings, rusty shoulders, pale underparts barred with rust, and a narrow banded tail.
Communication: Shrill scream, kee-yeeear, with a downward inflection.
Range: Breeds from Minnesota east to New Brunswick and south to Gulf Coast and Florida, and on the Pacific Coast of California.
Feeding: Frogs, snakes, insects, and small rodents.
Locomotion: Flies with several quick wing beats and then a glide. Smoothly hovers in thermals and wind until a steep dive to catch prey.
Reproduction: Like most hawks, they build nests. The female lays 2 - 5 eggs that are incubated for 33 days. When hatched the young hawks fledge about 45 days later. In about 2 years they are sexually mature.
Etymology: *Buteo lineatus* (L. *buteo* - "a kind of hawk", L. *lineatus* - "striped").
Other: Buteo hawks are referred to as buzzards in other parts of the world. The name was mistakenly applied to vultures in North America by the early settlers.

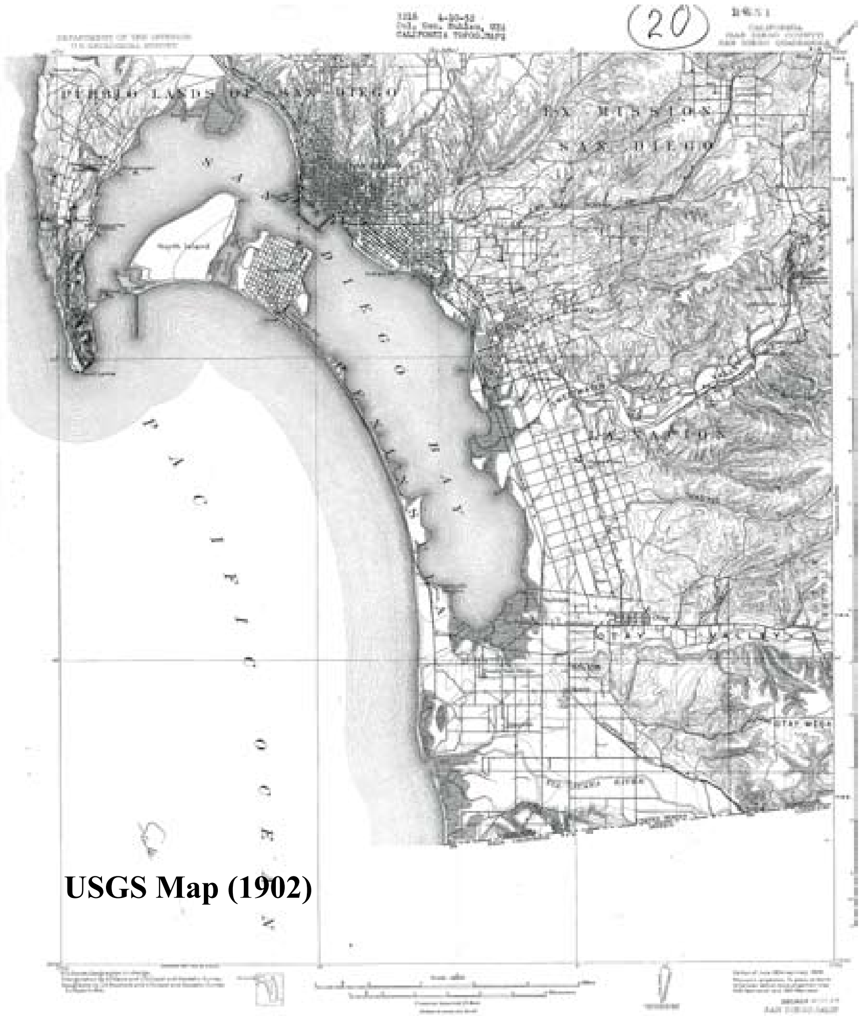





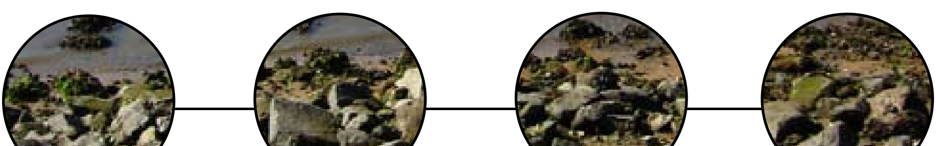
BIODIVERSITY & BIOGEOGRAPHY

Geography and biology meet each other in this biodiversity study throughout the San Diego Bay. As urban, human life continues to grow in the beautiful city of San Diego, the natural life takes a toll. This guide provides a biodiversity study that assesses the abundance and variety of intertidal life of multiple locations in the Bay. The biology of this study is combined with modern mapping technology to create biogeography. By understanding the spatial references of the study and visually comparing data to other geographic features, a new dimension of understanding is added to the study. This chapter introduces this unique marriage and explores the finer aspects of mapping and biodiversity throughout the Bay.

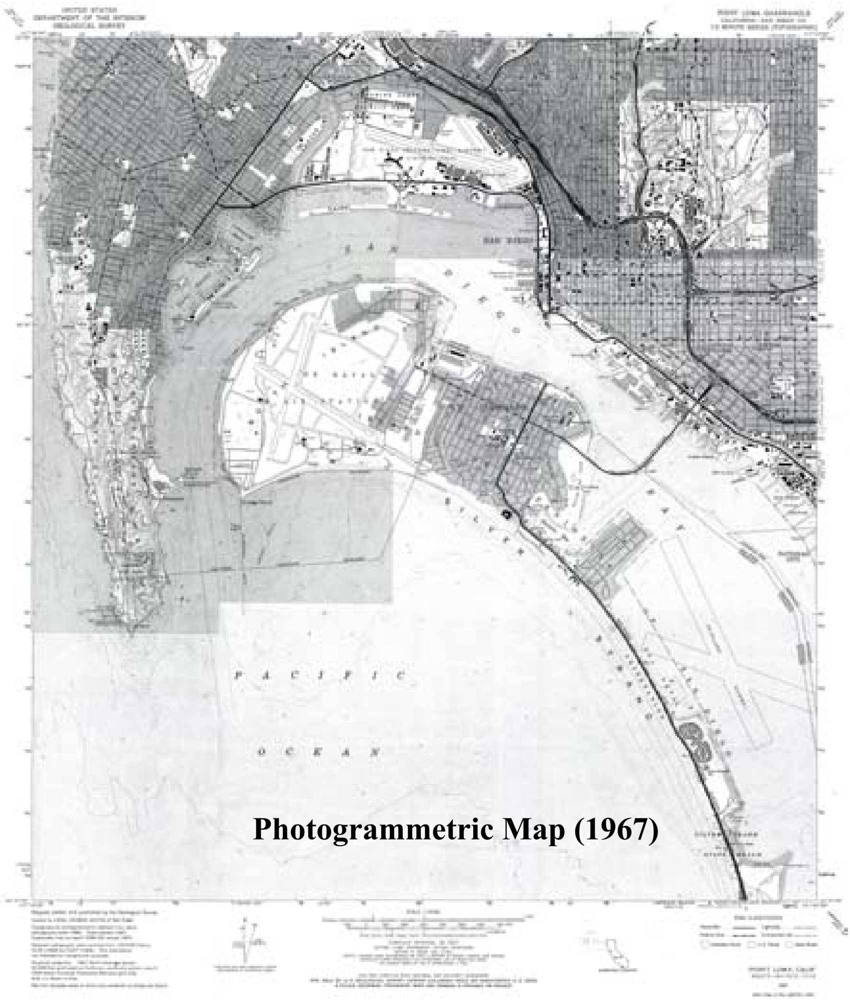




USGS Map (1902)





Photogrammetric Map (1967)

The Empty Channel
A Nature Reflection

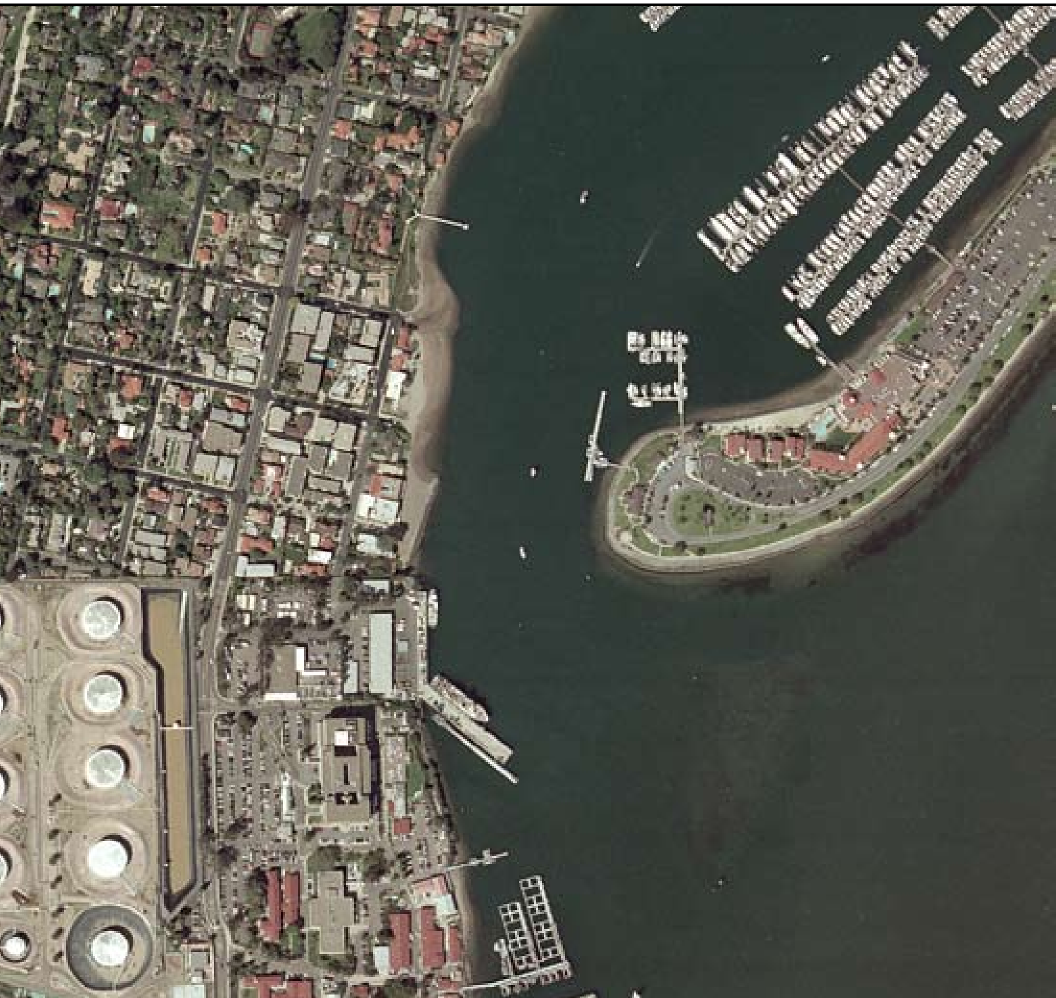
Above the water's surface, the Boat Channel is a desolate place. Slime, mussels, and the occasional predatory bird mark the shoreline. Factory drain pipes, the airport, buildings and construction sites all spill across the water. The wake of a boat occasionally breaks against the shore, disturbing the dull silence. I enjoy the break in the monotony for a moment, until the sky splits in half from the sound of the jet turbines screaming overhead. I can't stay up here any longer; I'm dying to dunk my head below the surface of the water to chat with the fishes. For now, I must find contentment sitting here in the hot sun, breathing the dry air and the jet fumes.

—Merlin Gunn-Cicero

Potential
A Nature Reflection

Taking in this whole place, I have seen a Mecca of human exploration and recreation. I haven't seen much natural life by the shore. Maybe the shore isn't where I should be looking. I don't know what dwells beneath the water's surface. In the hour that I have been here, I have seen boat traffic; but my vision has been confined to this narrow Boat Channel. All that traffic will spread out when the Channel opens into the Bay, and the bay opens into the Pacific Ocean. I see potential focused in one spot, and all those boats are ready to carry that potential.

—Merlin Gunn-Cicero



SCRIPPS FACILITY

History of the Scripps Facility

Scripps Institute of Oceanography was founded in 1903 by Professor William E. Ritter, from the University of California. At that time the research institute was named the Marine Biological Association of San Diego. The seaside laboratory was founded under the University of California's zoology program. The original laboratory was located in Coronado, and it wasn't until 1907 that it moved to where it is today at the end of Point Loma. In 1912, the Institute was renamed Scripps Institution for Biological Research. It wasn't until 1925 that it inherited the name it now has, Scripps Institute of Oceanography, Marine Physical Lab. ("History of SIO" 2005)

Thomas Wayland Vaughan took over as president after Professor Ritter retired in 1923. Vaughan had great expectations for the Institute. Vaughan planned

The bay serves many purposes. From a military port, a recreational center, and even a research institute, the bay is a diverse place. The Scripps Institute of Oceanography adds to this diversity and docks their many oceanographic research vessels in the bay. While Scripps looks at life deep in the ocean, we observe the life neighboring the facility.

to upgrade the scientific staff, buy a new oceanographic vessel, build an aquarium, and repair the sea wall. Vaughan was successful in laying the groundwork for many of these items, but was never able to fully fund all of them. Vaughan was frustrated at the University's lack of support and funding. Vaughan retired on September 1, 1936 and was succeeded by Harald Ulrik Sverdrup. (History of SIO" 2005)

Harald Ulrik Sverdrup, a Norwegian oceanographer and aretic scientist, accepted the position of director for only three years. Sverdrup focused on converting Scripps from a local institution to a world-renowned organization. He persuaded Robert Paine Scripps to purchase a new vessel capable of deep water exploration. The vessel named R/V E.Wh. Scripps conducted the first hydrographic survey of the Gulf of California. ("History of SIO" 2005)

Ballad of the Dead Seagull

Tick tock tick tock
How fun the Bay can be
From big fat crabs
To oyster halves
A sea anemone.

Oh lo behold
I see I see
A seagull I do see
A closer look
Reveals to me
He's dead as dead can be.

Decay decay
Here at the Bay
The putrid smell of rot
A twisted wing
Raw flesh showing
The seagull must have fought.

Or maybe not or maybe not
Maybe he ate some trash
Eating the junk
Filled veins with gunk
Blood clots made the full crash

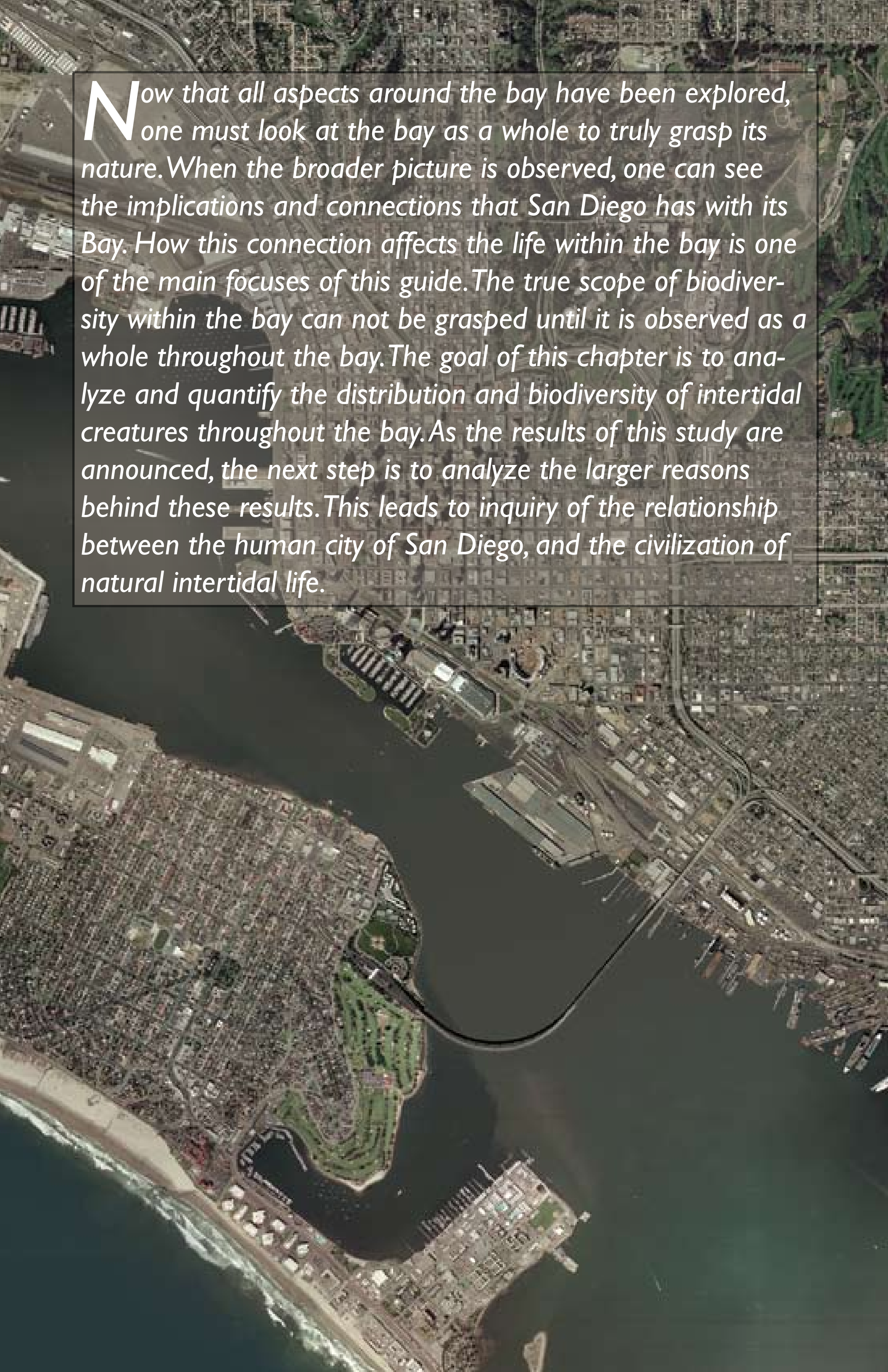
All that begins all that begins
Must end, it's only fair
But when it ends
Oh that depends
On how much one takes care

Tick tock tick tock
Time is up for the gull
The bay lives on
But when it's gone
Depends on how we live.

--Alexander N. Chee

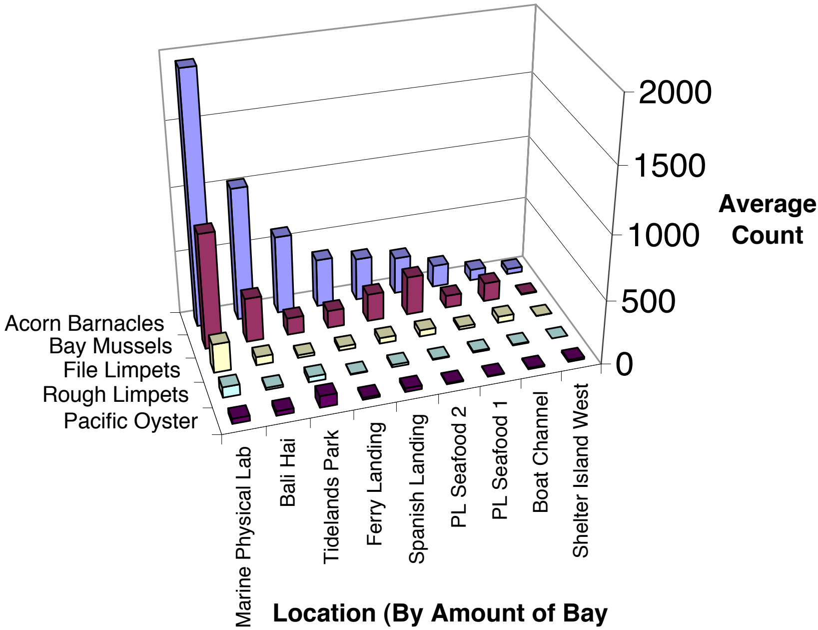
Summative Analysis
of the San Diego Bay

The Aspects of the Bay in Its Entirety



Now that all aspects around the bay have been explored, one must look at the bay as a whole to truly grasp its nature. When the broader picture is observed, one can see the implications and connections that San Diego has with its Bay. How this connection affects the life within the bay is one of the main focuses of this guide. The true scope of biodiversity within the bay can not be grasped until it is observed as a whole throughout the bay. The goal of this chapter is to analyze and quantify the distribution and biodiversity of intertidal creatures throughout the bay. As the results of this study are announced, the next step is to analyze the larger reasons behind these results. This leads to inquiry of the relationship between the human city of San Diego, and the civilization of natural intertidal life.

Average Creature Count Per Species Per Location (Bay Exposure Graph)



The above graph shows the average species abundance at a certain location for a certain species. On the bottom on the x-axis are the different survey sites arranged on two factors. The primary is the amount of average exposure to the bay while the secondary is the distance from the mouth of the bay. The other axes are the same as they were in the previous graph.

This graph shows a direct correlation of the amount of bay exposure with the average number of creatures living in the location. The furthest left bars represent data taken at the Marine Physical Lab. This location is on a beach that is not hindered by any sort of harbor or breakwater. Similar conditions are found at Bali Hai and Tidelands Park. The Ferry Landing and the Spanish Landing both are somewhat sheltered by piers and man made islands. Both Point Loma Seafood sites, the Boat Channel, and the western side of Shelter Island are encased inside of harbors or inlets with extremely little direct Bay exposure.

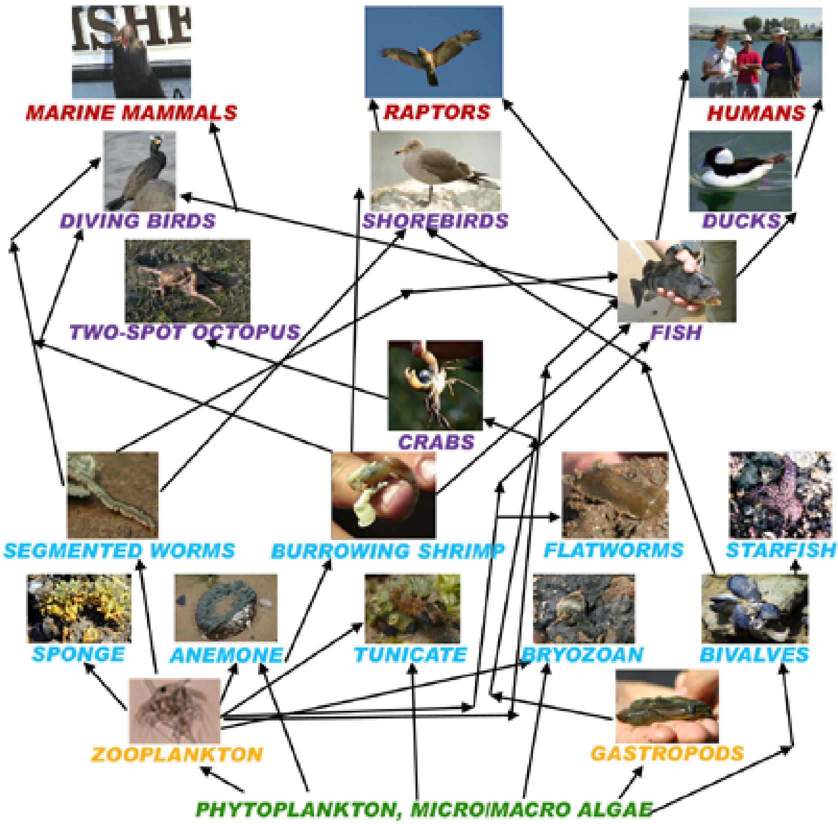
SPECIES KEY

Great Blue Heron: 1
Least Tern: 2
Osprey: 3
Pigeon: 4
Kingfisher: 5
Brown Gull: 6
Harbor Seal: 7
Bay Bass: 8
Brant: 9
Brown Pelican: 10
Bufflehead: 11
Crested Cormarant: 12
Malard: 13
Least Grebe: 14
Ruddy: 15
Redhead Duck: 16
Pintaill: 17
Greater Scaup: 18
Loon: 19
Brants Cormorant: 20
Red Shoulderd Hawlk:21
Snowy Egret: 22
Barn Swalow: 23
Black Phoebe: 24
House Finch: 25
Western Grebe: 26

SPECIES KEY

Barnacles:1
Flat Worm:2
Bryozoans:3
Ghost Shrimp:4
Shore Crab:5
Solitary Anemone:6
Pacific Oyster:7
Navananx:8
Octopus:9
Periwinkle:10
Rough Limpet:11
Sea Hare:12
Dorid Nudibranch:13
Muscle:14
Unk Snail:15
Curlew:16
Scooter:17
Western Gull:18
Sanderling:19
Marbled Godwit:20
Willet:21
Solitary Sandpiper:22

FOOD WEB



COLOR KEY

RED: QUATERNARY

PURPLE: TERTIARY

BLUE: SECONDARY

YELLOW: PRIMARY

GREEN: PRODUCERS