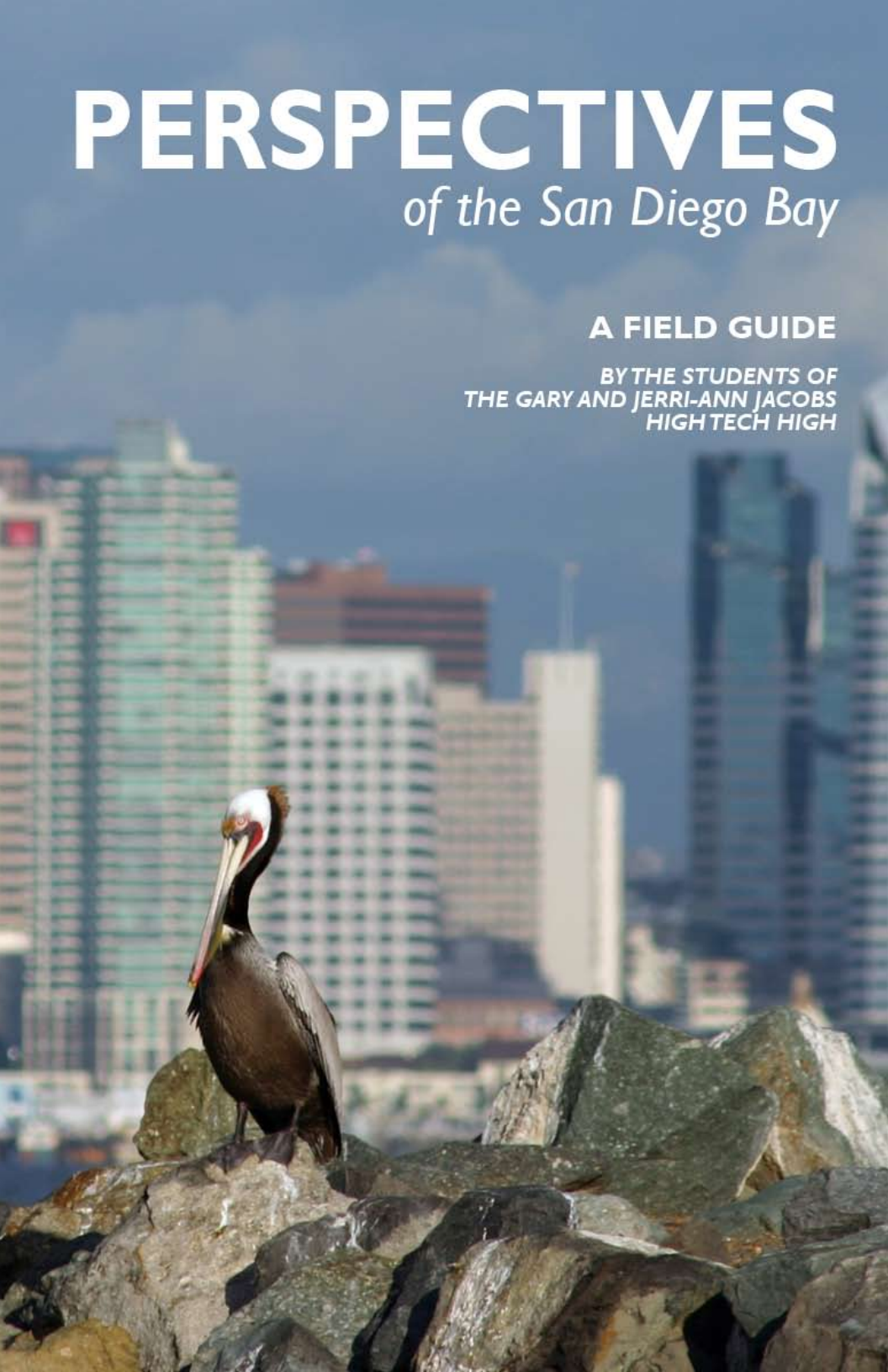
PERSPECTIVES
of the San Diego Bay

A FIELD GUIDE

BY THE STUDENTS OF
THE GARY AND JERRI-ANN JACOBS
HIGH TECH HIGH



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Intent of Study:

The San Diego Bay Field Guide is a diverse exploration into the many facets of life, civilization, culture, and history of the Bay. By merging cartography, humanities, biology, and art, a comprehensive guide was created that not only explains concepts and creatures, but also draws connections between the possibilities that exist within the waters of San Diego.

These waters are not dead by any means. Even through enduring industrialization and development, marine creatures still thrive in certain areas throughout the Bay. Some of the most interesting and dissimilar creatures appear in the intertidal zones along the shoreline. As the tides are pulled away by the moon and the sun, vast expanses of life are uncovered. This guide provides insight into the many creatures that live and thrive in these areas between the tides. From the simplest sponge to the many sea birds and marine mammals, the San Diego Bay Field Guide offers quick ways to identify some of the common species found around the Bay during a scientific expedition or a casual stroll. If the original and highly detailed photographs and information are not enough to identify a creature, a dichotomous key has also been provided to identify an organism based on a series of questions and simple observations.

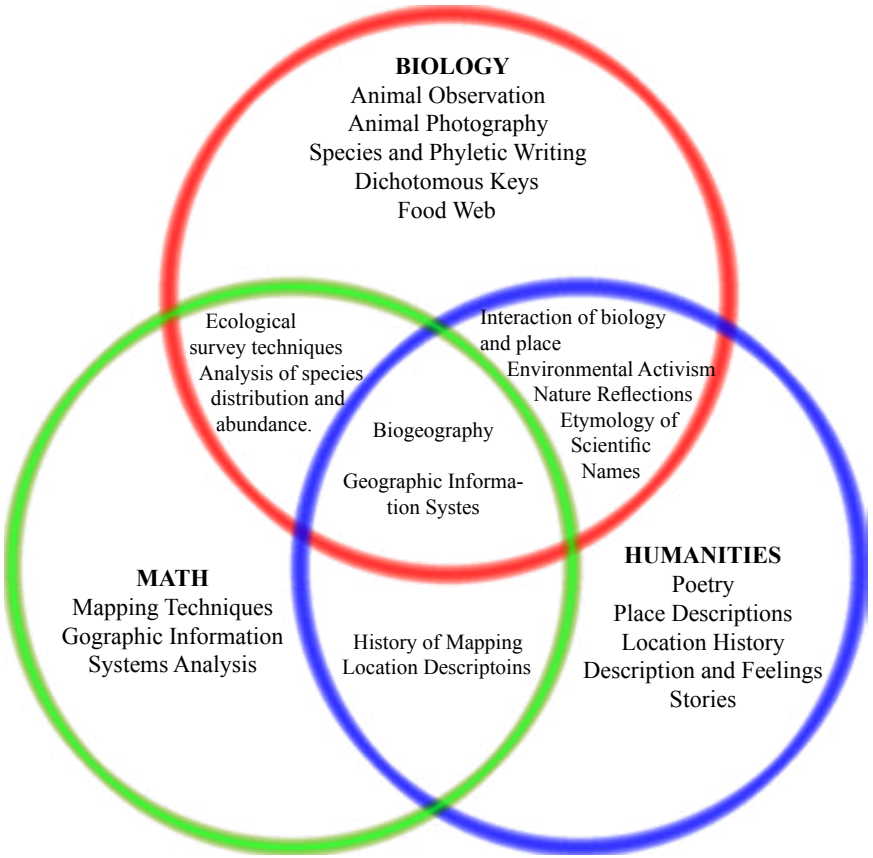
Not only does this book provide information on the various animals of the San Diego Bay, it also includes a scientific study on the distribution of the more common animals. One key aspect of the Bay is that no two areas are exactly the same. As the Bay gets used for various purposes, the life in different areas inevitably changes as well. In order to document, observe, and analyze these shifts, a biodiversity study was conducted at six locations around the Bay. Surveys, analysis, and observation were carried out from the Boat Channel by the old Naval Training Center, to the historic Spanish Landing near Harbor Island, to the tip of Shelter Island, to the Ferry Landing on Coronado Island, to America's Cup Harbor, and the Scripps Nimitz facility in Point Loma.

To add extra dimension to the study, advanced cartography and mapping systems were used to plot biodiversity results on high resolution satellite imagery of the Bay. Through collaboration with the University of San Diego, Geographic Information Systems (GIS) were used to plot biodiversity surveys using high accuracy Global Positioning Systems (GPS). Data was then overlaid onto the satellite image using a computer to create magnificent maps that give spatial, not just quantitative, information about the organisms around the Bay.

To parallel the scientific aspects of these endeavors, this guide also embraces the beauty of thought, nature, and reflection in order to join the sciences and the arts in harmony. The many research expeditions made in order to create the major part of this book were paused for an hour or two to allow imaginations and inspiration from nature to soar. As a result, this guide is filled with poems and prose whose subjects stretch from simple musings on the beauty of the waterfront to lengthy commentaries on the importance of ecological conservation. In the analysis of nature, history, and culture, the meanings of both humanity and human interactions were pondered upon and interpreted. When one looks around and sees drainage pipes, concrete blocks, and pollution to one side with one eye, and fish, mollusks, and sea lions with the other; the task to find the connection and the change between nature and civilization is an interesting one indeed.

It is this merging of thoughts and ideas that this guide hopes to embrace and explore in an attempt to bring the different perspectives of the San Diego Bay together in a comprehensive field guide for your perusal. We hope our studies inform and inspire you to explore the many different parts of the Bay and discover for yourself which perspective you like the best.

INTEGRATED PROJECT BASED LEARNING



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 behind 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 the 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 only 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.

TAXONOMY

Taxonomy is the science of classification. All living things have been classified based upon their attributes and similarities. While some differences may be obvious, other differences between one species and another can be undetectably minute. Scientists have been attempting to classify living creatures since the time of Aristotle. Aristotle was able to classify living creatures by whether they fly, swim, or walk using only his culture's view of the world. Centuries later, as thousands of new creatures were discovered around the world, a man named Carolus Linnaeus published a means to classify new organism and called it "Systema Naturae" in 1735. This system laid the foundations for modern scientific classification.

Modern classification organizes every living creature into multiple hierarchal categories. Here is an example of the classification of humans (*Homo sapiens*):

Kingdom: *Animalia*. The kingdom is the highest order of classification. There are 5 major kingdoms which include *animalia*, *plantae*, *monera* (bacteria), *fungi*, and *protista* (protozoans and algae).

Phylum: *Chordata.* The phylum is a large group of organisms that share similar evolutionary traits. Common animal phyla include chordatata (animals with backbones), mollusca (snails), arthropododa (insects), and echinodermata (sea urchins).

Class: *Mammalia.* The class is a grouping of organisms that share major physiological similarities. For example, all mammals are warm blooded, give live birth, and breathe air with lungs.

Order: *Primates.* The order is a smaller group of organisms that share a few physiological similarities. Other primates include humans, apes, monkeys, and chimpanzees.

Family: *Hominidae.* The family represents closely related organisms separated by very few evolutionary and physiological differences. Others in the *Hominidae* family include extinct upright, bipedal primates such as Australopithecus, and *Homo erectus*.

Genus: *Homo.* The genus is the first part of the scientific name of any creature and represents morphologically similar organisms. Others in the homo genus include *Homo erectus*, and *Homo sapiens*

Species: *H. sapiens.* The species is a group of related organisms that share a distinctive form and can produce viable offspring with each other. The *H. sapiens* are more commonly called humans.

When organisms are given scientific names, they are identified by genus then species. For example, in *Homo sapiens*, the first word is the genus and the second is the species. This naming convention is constant throughout the scientific community. The naming of the genus and species is almost always in Latin, the language of science. The Latin words used to describe genus and species usually have translations related to the physiological aspects, appearance, or geographic location of an organism. The words *Homo sapiens* mean "knowing man," a tribute to the higher intelligence of the upright walking primates more commonly known as humans.

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 advance class of living molluscs 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 like 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 snail, and the tube snail. The other kinds of Gastropods found in the bay have been 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. There 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 squids and octopus. They are the most intelligent, and the fastest swimming aquatic invertebrates. They have external shells called the nautilus, and internal hard shells like the 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 have 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 found in the San Diego Bay is the mossy chiton.

FILE LIMPET

Lottia limatula

Class *Gastropoda* | **Order** *Archaeogastropoda* | **Family** *Acmaeidae*

Morphology: Made of a fleshy mantle that secretes calcareous shell. Bilaterally symmetric (if cut in half, both halves would be similar).
Communication: Does not communicate.
Range: Enjoys staying in the cold waters of Atlantic and Pacific Ocean.
Feeding: Herbivores, or plant eaters, during the day. Eat marine vegetation and marine algae. Able to do this using their radula, a tongue like organ with thousands of tiny denticles.
Locomotion: Moves around during the day by rippling its muscle of the foot in a wave-like form. Returns every night to the same exact place as it presides. Nobody knows why or how they do this.
Reproduction: Have separate sexes. Reproduction occurs in the winter. Spawning of olive-green eggs occurs in January, February, April and October.
Etymology: *unknown*
Other: Have a head with a mouth. Has two long tentacles with a black eye at each end

ROUGH LIMPET

Lottia scabra

Class *Gastropoda* | **Order** *Archaeogastrocpoda* | **Family** *Acmaeidae*
Morphology: Characterized by a rough oval shell in the shape of a cone. One fourth the width, the shell has ribs and a scalloped margin. Shell is greenish brown. Rough Limpets, in comparison to File Limpets, have larger ridges that stand out about one mm.
Range: Oregon to southern Baja
Feeding: Eat diatoms from rocks using iron-based teeth. Leave dents in the rocks where they feed for the micro-plants.
Locomotion: Move using a foot muscle under the shell. Usually move when in search for more food. Can stay on the same rock for over twenty years.
Reproduction: Lay eggs. Have different genders but no interest in mating. Use a mechanism called broadcast spawning. Broadcast spawning is the mechanism in which males and females release large amounts of gametes into the ocean. These gametes mix and create offspring.
Etymology: *Lottia scabra* (L. *Lottia* unknown, L. *scabra* Rough surface, scabs)

BUBBLE SNAIL

Bulla Gouldiana

Class *Gastropoda* | **Subclass** *Orthogastropoda* | **Order** *Cephalaspide* | **Suborder** *Bullacea*
Family *Bullidae*
Morphology: shells are mostly brownish or yellowish, round or ridged
Range: The Bubble Snail is found living on rocks in Santa Barbara, California, the Gulf of California and Morro Bay, California south of Ecuador.

Feeding: tend to feed on algae. They eat particles of brush and scrapes from the surfaces of rocks and seaweed.
Locomotion: inch their way along the ocean floor using their two pairs of feelers to find their way. Gastropods crawl using a large, muscular foot that they have. The muscles in the foot wave in a rippling motion that causes the snail to move forward.
Reproduction: Bubble Snails court from 15 minutes to six hours before they have sex, touching with tentacles, as well as biting on the lip and genitals. Bubbles Snails reproduce by releasing embryo masses. They lay yellow jelly-like eggs on seaweed growing on the mud, sea lettuce, or sea spaghetti. Some reproduce asexually.
Etymology: *Bulla gouldiana* (L. *Bulla* Bubble; L. *gouldiana* Goulds)

SLIPPER SNAIL

Crucibulum spinosum

Class: *Mollusca* | **Order**: *Neotaenioglossa* | **Family**: *Calyptraeidae*

Morphology: distinct tan-colored shell with small reddish-brown spots on its surface, and a straight or only slightly convex edge on the internal shelf; 3 to 5 cm across; the underside of the shell has a shelf like deck which forms a niche for the animal to with draw into. All slipper snails are born male. When they're two months old, they start changing into females. After several weeks, the change is complete—the males have become females.
Range: Canada to Florida and Texas; typically found attached to shells and stones on soft substrate around the low water mark.
Feeding: The slipper snail feeds by filtering water through its gills the gills are covered with mucous and moves the food particles to its mouth by way of its cilia.
Locomotion: Adult slipper snails lead a sedentary life, stacking themselves on the shells of other snails, with smaller ones sitting atop larger ones.
Reproduction: To reproduce, male slipper snails deposit sperm under a female's shell. Her eggs hatch into larvae that stay put until they've developed into exact miniatures of adult snails. Periodically, females lift their shells and, with their heads, push the juveniles out into the cold marine world. Newly hatched young can't cling well, so they sink to the bottom, where they scrape algae from rocks. Eventually they're able to cling to host snails, like their parents, where most become immobile—even depending on the host snail to carry them away from predators.

GRAY PERIWINKLE

Littorina planaxis

Class *Gastropoda* | **Subclass** *Prosobranchia* | **Order** *Mesogastropoda* | **Family** *Littorinidae* | **Subfamily** *Littorininae*

Morphology: 1/2—3/4" (13—19 mm) high, almost as wide. Broadly oval-shaped, narrow, body. Brownish-gray, with irregular, scattered whitish spots. Aperture is dark brown, with a white spiral band at bottom.
Range & Habitat: Charleston, Oregon, USA to Bahia Magdalena, Baja California, Mexico. Found on rocks along shoreline above high tide line. Spend most of life out of the water. Occupy highest vertical position on shore of all marine molluscan species in California.
Feeding: Microscopic algae and diatoms, but radula also scrapes pieces off larger seaweeds. Feeds by "licking" the surface of rocks. With a source of water, can live for weeks without food.
Locomotion: Has tentacles used for locomotion. Follows mucus trails laid by other snails to prevent from bumping into things.
Reproduction: Is dioecious, but sexes are indistinguishable. Fertilization occurs internally. Females lay eggs directly into the sea. Larvae are planktonic. Eggs: laid in floating capsules, round, pink, 70-84 micrometers wide, laid 700-2,000 at a time. Mating occurs mostly in spring and summer.
Etymology: *Littorina planaxis* (L. *Littoralis* of or belonging to the shore; L. *planus* level, flat; L. *axis* axle, pivot.)
Other: Commercially used for food in European countries such as France. Protect themselves by "gluing" themselves to rocks, effectively sealing the entrance to their shell and retaining moisture in dry, sunny areas.

SCALED WORM SHELL *Serpulorbis squamigerus*

Class *Gastropoda* | **Order** *Heterogastropoda* | **Family** *Architectonicacea*
Morphology: Unicellular. The distal end of the Scaled Worm Shell houses its tentacles. It has a whitish, pinkish and has a 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 attack 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 a black with yellow lines going length wise up and down the body, edges of the creatures have an orange to yellow lines extending all along edge, a series of bright blue spots also fringing 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 pushing 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 follows the slime trail that the snails leave in their wake

DORID NUDIBRANCH *Gymnodoris ceylonica*

Order: *Nudibrancha* | **Suborder**: *Doridina* | **Family**: *Gymnodorididae*

Morphology: Their mantels cover their entire dorsal surface and cover there "feet". Their retractable gills are located on the posterior area of the body. Their sensory tentacles located at the head of the animal provide visual and sensory indications, and have a partial shell that covers the top of there bodied.
Range: Found in most cool Intertidal locations around the world.
Feeding: Are known to eat soft corals, and anemones, which gives them their toxic makeup, and sometimes eat, fish eggs, worms, and sea plants.
Locomotion: Uses stands of muscles contract in order to propel its self along the oceans floors.
Communication: None
Etymology: (naked gilled partial shell) unknown
Reproduction: Nudibranchs are hermaphididic, making it much easer to find a fertile mate, after reproducing; the Nudibranchs lays a cluster of eggs next to their food source. They eggs mature from 5-50 days, in which they start life in the larval stage, eating plankton and at the mercy or the currents.

CALIFORNIA SEA HARE *Aplypsia californica*

Class: *Gastropoda* | **Order**: *Opisthobranchia* | **Family**: *Aplysiidae*
Morphology: large, soft, bulky slugs that have tiny little tentacles which somewhat resemble rabbit ears; lack a head shield which makes them different from other members of their class; usually about 5-16 inches long but some can grow up to 75 cm; weigh 30lbs on average
Range: Most of the Californian coast and parts of the Gulf of California.
Feeding: herbivorous; diet consists of red/brown seaweed
Locomotion: jet propulsion; move by water being brought into mantle cavity and squeezed out siphon.
Reproduction: hermaphroditic, generally lay eggs at the end of its life; mate in large groups; lay up to 80 million eggs

Etymology: "without a shield"; Gr. *Aplysia* – a dirty sponge; L. *californica* – of California
Other: valuable laboratory animal, used to study neurobiology in relation to learning and memory due to its less complex nervous system composed of unusually large neurons; lifetime depends on water temperature; when threatened sea hares release a dark purple fluid for defense; sea hares can only distinguish light from dark

BAY MUSSEL

Mytilus

Class: *Pelecypoda* | **Order**: *Mytiloida* | **Family**: *Mytilidae*
Morphology: Composed of two smooth, shiny, bluish-black shells with a long rounded triangular shape that are 6-10 cm long and 3-5 cm high. 3 small teeth below the beak. In the male it is a creamy white color whereas in the female it is orange.
Range: Artic Ocean to Baja California, West Coast of South America, Japan, Australia, North Atlantic often found on rocks and mussel beds at low tide.
Feeding: They feed submerged at high tide; open shells and using cilia attached to gills to propel water and food particles in mouth. Active suspension feeder on organic particulates and dissolved organic matter. *M. edulis* is a filter feeder capable of removing particles down to 2-3 µm with 80-100% efficiency.
Reproduction: Is not hermaphrodite. During the reproductive phase mantle changes in aspect according to its sex. During reproduction the males and females release their gametes in the sea. Reproductive output size and location is also influenced by temperature, food supply and tidal exposure.
Etymology: *Mytilus edulis* (L. *Mytilus* a sea mussel, L. *Edulis* means edible)

PACIFIC OYSTER

Crassostrea gigas

Class: *Bivalvia* | **Order**: *Ostreoida* | **Family**: *Ostreidae*
Morphology: Shell can grow up to 300 mm long, and have varied shapes depending on where the oyster lives. Bivalve; the lower valve is usually cupped and cemented to some hard substrate, while the upper valve or shell is flat and is used to cover and protect the animal living inside. Cupped and flat shapes are on the inner surface of the shell; outer surface is fluted/rough. Outside is chalky tan or white with purple streaks.
Locomotion: In larval stage, oysters use their flagella to swim throughout the ocean.
Range: Introduced species, originating from Japan. Appears from British Columbia to Southern California. Adults are cemented in place, cannot move.
Feeding: This organism feeds off of planktonic algae and mixed phytoplankton of *Isochrysis galbana, pavlova lutheri, Chaetoceros gracilis,* and *Tetraselmis teterathele*
Reproduction: The spawning of pacific oysters all depends on a rise in the waters temperature above eighteen degrees Celsius. When spawning takes place it occurs during the months of July and August. Eggs develop to embryos in 6 hours at 26°C, to trochophore within 12 hours, and to straight hinge larvae within 18 hours.
Etymology: *Crassostrea gigas* (*Crass* L. Thick; *Ostrea* Gk. Oyster; *Gigas* L. Giant)
Other: They develop first as males, and after a year begin to function as females.

MOSSY CHITON

Mopalia muscosa

Class: *Polyplacophora* | **Order**: *Neoloricata* | **Family**: *Lepidochitonidae*

Morphology: Up to 2 3⁄4” in length. Eight plates colored gray or black. The girdle is covered with stiff hairs.
Range: Range between Alaska and Baja California and is found in the mid-tidal range and have a home range of only 20”.
Feeding: Stay motionless until nightfall when it then feeds on algae.
Locomotion: Uses its muscular foot to move at very slow speeds.
Reproduction: Usually gregarious during times of breeding, while the female takes in the sperms from the males in the water it also uses for respiration.
Etymology: *Mopalia muscosa* (; Italian *muscosa,* mossy)
Other: Usually stay wedged in tight spaces between rocks and usually never move. They can usually be identified by their color, skirt, and/or number of segments.

TWO-SPOTTED OCTOPUS

Octopus bimaculoides

Class: *Cephalopoda* | **Order**: *Octopoda* | **Family**: *Octopodidae*
Morphology: Has two bluish eye-like spots on head. Can grow to 30 feet long from top of heads to tip of tentacles. Four pairs of tentacles connected with webbing and hundreds of suckers on each sit below a membranous sack that contains most of its major organs.
Range: Common around most intertidal and subtidal zones of western coast of the U.S. and Baja California. Live under rocks and tight spaces where protected from predators.
Feeding: Feeds on mollusks, crustaceans, fishes. Uses tentacles and suckers to latch onto prey and drag towards their hard beaks. Inject toxins through posterior salivary glands upon bite to paralyze prey. Suckers can pry open shells to get to insides.
Locomotion: Can crawl by using tentacles as legs. Large mantle can suck in water which is forced out through siphon to act as a jet.
Reproduction: Females lay eggs under rocks from late winter until summer. The female will then devote her life if necessary to protect her eggs. Many octopi’s devotion to protecting their eggs go as far as not hunting or eating to remain close to their nest. Many times the demand of producing a nest of offspring is the last thing a female octopus does in her life.
Etymology: *Octopus bimaculoides* (Gr. *Okto*, eight; *pous*, footed; *bimaculoides*, two spotted.)

AVES

AVES: DUCKS AND GEESE

The most noticeable creatures of the San Diego Bay are perhaps those representing Class *Aves*. There are over 8 to 10 thousand living bird species in the world, and if you've ever been down by the Bay during the spring and summer months, you'd say that you've seen about that many loitering around the boardwalks and the beaches. Birds are said to have evolved from theropod dinosaurs and are seen in the wild and in many homes as domesticated pets.

Birds are bipedal, warm-blooded members of the Phylum *Chordata*, and they are characterized by being egg-laying, feathered creatures with wings and hollow bones. All possess a bony beak sans teeth, the ability to lay hard-shelled eggs, a very light but still very strong skeleton, and a high metabolic rate. They are known to exhibit many differentiations between each class and species. For example, birds have an immense range in size and can be anywhere as small as a hummingbird to as large as the ostrich or emu. Most are diurnal, but some, like owls, are nocturnal. Many migrate long distances to switch between habitats during season changes, whereas others stay in one place their entire lives, and others still are completely unable to fly anywhere anyway as it is. Eating habits also vary from species to species. Some are more inclined to eat nectar, seeds, and insects, but others prefer to dine on rodents, fish, roadkill, or even other birds.

The phylum *Aves* has an incredible number of taxonomic orders within in. While surveying the Bay, we paid particularly close attention to the *Anseriformes* (the waterfowl), the *Columbiformes* (doves and pigeons), the *Faconiformes/Accipitriformes* (the raptors), and the *Pelecaniformes* (the pelicans). We also saw representatives of some of the other classes of birds as well.

Many of the birds seen around the Bay were members of the *Anatidae* family. These birds are commonly referred to as the ducks. Ducks are mostly aquatic birds that are fairly small and usually found in both fresh and salt water. They eat a variety of different foods including fish, insects, grains, and grasses, though as tourism to San Diego increases with each passing year, the diets of ducks are slowly expanding to include leftovers from many human lunches. Ducks migrate during the fall to warmer climates, and return to their normal habitats in the spring. Ducks are an important part of their ecosystems and food webs, and also serve as an important part of many economies as their meat, eggs, feathers, and down are widely used around the world.

MALLARD

Anas platyrhincus

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: All Mallard ducks have a blue speculum on the wings in both sexes. The male or drake characteristics are the green plumage on the head and neck, and curled black feathers on its tail. He will also have a white ring around the neck, dark breast, yellow bill, and orange-red feet. The female or hen's plumage is dab brown. She has an orange bill and feet.
Communication: They range from mating, inciting, and social calls. The volume of its call will increase as nervousness and anxiety climb. The pitch will deepen as the mallard gets larger and the duration will increase. The all known "quack" is given by the female to call in her ducklings to her and it can be heard for miles.
Range: Roughly the entire world, however mainly the Northern Hemisphere. The species contains the largest breeding range of any bird on the North American Continent. The mallard may have also been the first domesticated bird springing from it many domestic breeds.
Feeding: They eat vegetation, insects, worms, gastropods and arthropods. They usually feed at the surface of the wter and don't dive all the way under.
Locomotion: Mallards like all puddle ducks can fly directly into the air without having to run and gain momentum like a diving duck. Mallards will fly in small groups of U or V formations. These groups can consist of the usual 10-20 members or several hundred. Mallards make for excellent swimmers and swift fliers.
Reproduction: Most mallards are capable of breeding as yearlings but are usually produce fertile offspring as adults. Pair bonding starts as early as October and continues throughout March. The mallard male soon leaves the hen after mating. The hen will then lay about 9 to 13 eggs in a nest on the ground nearby a body of water. The ducklings will hatch after 26 to 28 days, and then the hen will lead them to the water never to return.
Etymology: *Anas platyrhynchos* (L. *Anas* Duck; G. *Platys* broad or flat; G. *rynchos*

BUFFLEHEAD

Bucephala albeola

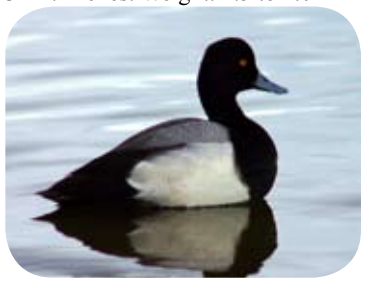
Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Hardly reaching 1 pound they are the smallest diving ducks. Male buffleheads have black back and white undersides, two tone purple and dark green on the neck and head, with a large white patch. Females have brownish backs and grayish undersides, and a black head with white patch on its cheek.

Communication: squeaks, chatters, growls, and guttural rolls; females make softer sounds.
Range: Any woodland from Alaska to Manitoba, California, Washington, Wyoming, Oregon, Montana, and Vermont and Massachusetts.
Feeding: aquatic insect, crustaceans, small fish, and some vegetation.
Locomotion: Unlike most ducks they don't need to run along the surface of the water in order to fly, and most of their flying is done fast and low.
Reproduction: Pairing occurs during spring migration. Females lay some 7 to 11 eggs, 46mm large. Color range from white to olive green. A typical nest is a tree cavity. Incubation last about a month. Hatchlings stay in the nest for another month.
Etymology: *Bucephala albeola* (G, *Cephala* Head; L, *Albeola* White)

GREATER SCAUP

Aythya marila

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Small compact diving duck. Length: 13 - 17 inches. Weight: 1.5 to 2.0 pounds. Yellow eyes, blue bill with small black nail at tip.

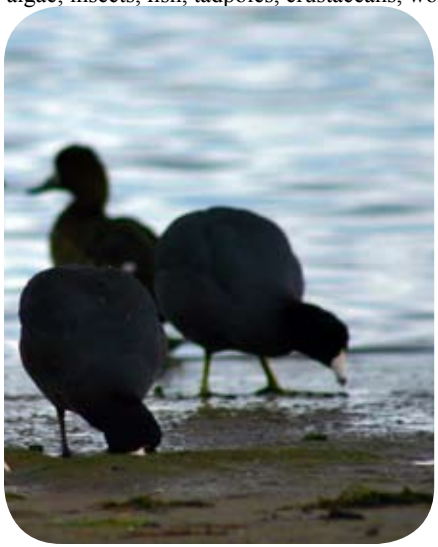


Communication: Utters a soft cooing and whistles notes in courtship. Males make a dischordant "scaup" noise; females are silent.
Range: Boral forests of Canada and wintering grounds in the Atlantic coast and the Great Lakes or migrate offshore from Alaska.
Feeding: Aquatic plants, insects, mollusks, and snails.
Locomotion: Air/Underwater movement aided with wings.
Reproduction: Nest is a hollow lined with plant matter and down, often in an open site. Female lays 8-11 olive-buff colored eggs and incubates for 24-28 days. Young are downy, leave the nest soon after hatching and fly at about 5-6 weeks.
Etymology: Perhaps from Scots *scalp, scaup*: bed of mussels (from its feeding on shellfish).

AMERICAN COOT

Fulica americana

Class: *Aves* | **Order:** *Ralliformes* | **Family:** *Rallidae*
Morphology: Slate gray head, neck, back, upperwings, breast and belly with short wings and a short tail. Very short, thick bill. White bill with dark reddish ring just before tip. White frontal shield with reddish oval near tip.
Communication: Make a wide variety of noises, from grunting to clucking, as a means of communication, between each other and to threatening predators. There are two times a coot will splash: during mating season to attract attention and to discourage predators.
Range: Migratory birds that during the summer are found in freshwater lakes and ponds of the northern United States (New York and Massachusets) and southern Canada. During winter, they head to the southern portion of the United States and are found from California to Florida.
Feeding: Mostly vegetable matter, including leaves, roots, and seeds of aquatic plants; algae; insects, fish, tadpoles, crustaceans, worms; sometimes, the eggs of other birds.



Locomotion: They float, have webbed feet for speedy, over-water locomotion, have water-proof feathers and insulating down, and some can even use their wings to propel them under water.
Reproduction: The nesting areas or ranges incorporate water, a relaxation spot, nesting cover and food. Nesting- 8-10 pinkish eggs, spotted with brown, on a shallow platform of dead leaves and stems, usually on water but anchored to a clump of reeds. Incubation lasts about 25 days.
Etymology: c.1300, *cote*, used for various water fowl (now limited to *Fulica atra* and, in North America, F. *americana*), of uncertain origin (cf. Du. *meercoet* "lake coot").
Other: Nesting- 8-10 pinkish eggs, spotted with brown, on a shallow platform of dead leaves and stems, usually on water but anchored to a clump of reeds.

BRANT

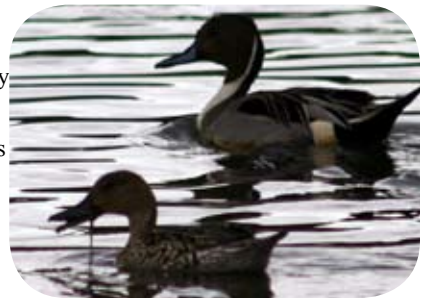
Branta bernicula

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Brants are about 60 cm long and have a short stubby bill. They have a brown/black body and pure white under tail. They have a white 'necklace' on their neck.
Communication: Quick little squawks
Range: East and West coast and their migration range from Alaska and Canada.
Feeding: As adults, they eat mostly eelgrass that can be found in the San Diego bay.
Locomotion: They fly but because they don't oil their wings, their flight is much more difficult then normal birds. They have the flap much more then normal birds and their flight path is much lower.
Reproduction: Brant females lay between 4-6 eggs on Arctic coastlines. The eggs hatch after 24 days of incubation. Once the eggs have hatched the males assumes the role of teaching the birds. At a young age the babies feed on marine invertebrates, mosquito larvae, and various plants; as they mature.
Etymology: Variant of Brent (-goose), possibly from Middle English brende, brindled
Other: In 1931, the eelgrass was killed in most habitats and the Brant was almost wiped out. Special focuses were made to bring the grass back and the bird is slowly recovering. The grass was first raised in captivity outside of Canada and Alaska by Ron Vavra of El Cajon in 1973. He did this by recreating the Artic summer with floodlights on timers.

NORTHERN PINTAIL

Anas acuta

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: One of the larger species of duck and differ vastly in coloration between sexes. Males have dark brown heads with bright white chests, grey wings and long dark brown tail feathers that come to a point, giving the species its name. Females are different shades of brown with shorter brown tail feathers.
Communication: Male makes wheezy mewing notes and a whistle. Female quacks.
Range: The pintail lives mostly on the West Coast and in the central portion of the United States and Canada and migrate to lower latitudes in winter.
Feeding: Pintails are self-sufficient and feed on small invertebrates, gradually add plant material to diet such as seeds of grasses, sedges, pondweeds, also vegetative parts.
Locomotion: Flight/Walk (immediately after birth)/Swim
Reproduction: Mating begins in April/May. Females build their nests on the ground usually in residual cover of short grasses or other vegetation, in brush, or in the open. Pintails lay from 6-12 eggs and ducklings hatch together usually at around 28 days.
Etymology: *Anas acuta* (L. *Anas* - Type genus of the *Anatidae*: freshwater ducks, L. *acuta* - Sharp or pointed)



COMMON MERGANSER

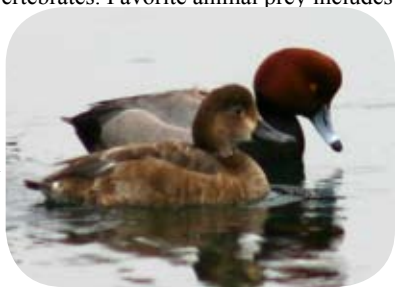
Mergus merganser

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Length is 18 inches, Wingspan 37 inches. Pointed bill and Serrated Edges. Red bill is thick with a tapered crest. Red or Black head is common. White plumage with dark bar. Alternative plumage in winter and fall months.
Communication: Males have a whistle while female squawks tend to sound like hoarse croaks.
Range: Non breeding season usually brings them to north pacific habitats. Breeds in North America from central and south-coastal. Winters from the Aleutian Islands and south-coastal Alaska east across southern Canada to Newfoundland and south to southern California and the Gulf Coast.
Feeding: Mostly fish and some invertebrates are ingested.
Reproduction: Monogamous; one mate. Nest is usually placed on existing tree crevices although they can be in various holes or crevices. Eight to eleven eggs are laid and are incubated for 28-35 days. Young stay with female for 65-85 days until fledging.
Etymology: *Mergus Merganser* (L. *Mergus* Sea Bird; L. *Merganser* "waterfowl, diver," from mergere "to dip, immerse")
Other: Due to the wing length and loading time, they must run across the water to take off. When learning to fly, they must sometimes endure a 15 m fall due to the height of nests. Parachuting or fluttering is known to occur.

REDHEADED DUCK

Aythya americana

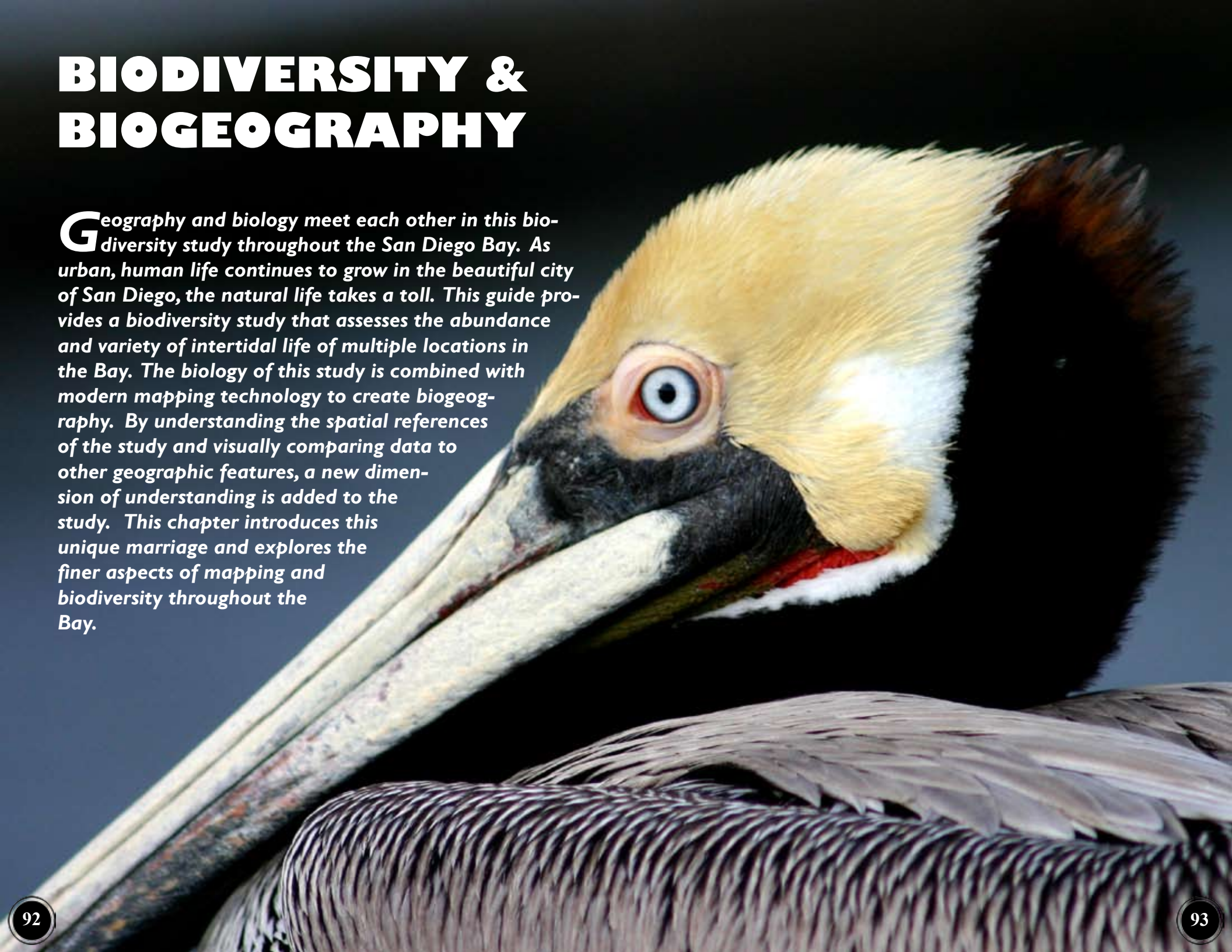
Order: *Anseriformes* | **Family:** *Anatidae* | **Genus:** *Aythya*
Morphology: 50cm long and 770 grams for males and 680 grams for females. Males have a white crown, blue and black tipped bill, light brown breasts, and speckled gray face and neck. Females have a slightly darker crown, pale breasts, and a green speculum which is bordered with black**.**
Communication: Communication is vocal. One of the loudest of diving ducks. When taking off, females let out a loud squawk while males tend to have more of a purr when speaking to each other.
Range: Inhabit in California, and parts of the great lakes. Breeding is in Alaska, Central Canada, and Northern United States. During the winter, they can be seen in Southern United States, and Mexico. Known for commonly traveling.
Feeding: Eats mainly aquatic vegetation and invertebrates. Favorite animal prey includes snails, crustaceans, and insects. Ducklings eat the same foods as adults.
Locomotion: Can fly as well as swim.
Reproduction: Sexually. They have mating rituals which are also characteristic of the other Aythya species. Females use inciting calls and perform next stretching. The males then perform the "kinked-neck call" which is similar to a very long slow head throw. Other mating rituals include the "turn the back of the head" display and the "preen behind the wing" display.
Etymology: *Aythya americana.* (L. *Aythya* diving duck species; L. *Americana* America)



Other: Because Redheads eat small, hard food items, they accidentally eat lead bullets mistaking them for food. Large numbers of Redheads die from lead poisoning each year, particularly in Canada, where lead shots have not been particularly banned. In the 1960's and 1970's they had to be protected because of fear of endangerment due to over hunting. A complete ban was imposed from 1960 to 1963. Only small quotas have been allowed since then.

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.



GEOGRAPHY

History of Mapping:

Mapping the San Diego Bay

From its birth, map making has been secretive. Maps have been used in wars, highly important intelligence, or traveling to locations filled with treasures and trade. Cartography, the discipline of map-making, holds many mysteries and intrigues. Although the study of cartography unravels a fascinating journey through history's mathematical and philosophical discoveries first hand accounts (from the individuals involved in the cartographic endeavor) are scanty and even less common are the actual maps, charts, and original globes, which are involved in the progression of cartography. The secretive nature of map-making includes stories of sea captains carrying important maps that shipwrecked their boats before allowing pirates to take maps that lead to hidden treasures. Today map-making still remains secretive. As technology grows in complexity many everyday map users do not have the rudimentary skills to properly use or enjoy these. Just as in the past many people today cannot take advantage of the wonderful world of maps. (Brown 1977)

Like many technical sciences, map making was originally the product of curiosity. It came along as a result of the human wish to depict the environment. The first known maps come from the Babylonians who are believed to have been making maps before 6000 B.C.E. Artifacts recovered from this ancient civilization show depictions of earth as a flat disk. Erroneous ideas about earth's shape brought fundamental questions of geometry and mathematics to ascertain the shape of the earth. (O'Connor, JJ and EF Robertson, 2005)

The first sketches (i.e. maps) made it evident to map creators, as well as users that accuracy was essential. However, there was no scientific knowledge upon where a foundation could be established and before going farther one needed to be established. Hitherto, the heavy reliance primarily on the sun turned into an emphasis, eventually expanding to understanding the entirety of celestial bodies and its relationship to earth. As a result, the first milestone came when earth was proven to be a sphere. In the history of cartography, there are three prominent figures that scientifically proved the earth was spherical. (Brown 1977)

In Greece, three mathematicians and philosophers clarified the mystery of earth's shape and by doing so they helped advance the techniques of cartography. The first was Pythagoras, in 500 B.C. E., Pythagoras hypothesized that the







Earth was round after observing the height of stars and how ships appeared on the horizon. He noticed that the top of the masts appear first, then the sails and finally the hulls. The second most influential Greek, Aristotle, in 300 B.C. E., noticed lunar eclipses. He logically deducted that the earth must be a sphere since it casts a rounded shadow on the moon. Lastly, in about 150 A.D., Ptolemy, a mathematician, geographer and astronomer, created an eight-volume work called Geographia that showed many maps of the world. Ptolemy was the first to implement lines of latitude on maps. These are imaginary lines that helped describe the location of a point on Earth. The lines start at the Equator at 0o and go to up to the North Pole (90o N) and down the South Pole (90o S). (Brown 1977)

During the Middle Ages the work of Ptolemy was lost, subsequently the progress of cartography stopped as Europe fell into the Dark Ages. Ptolemy's work was not accurate—his measurement of earth's circumference was too small, nevertheless Ptolemy had the right concepts. His geographic speculation was the key to unlocking the next step in the puzzle. During the Middle Ages, maps became largely decoratively, even religious symbols, and most cartographers started depicting Jerusalem as the center of the world. The influence of the church was oppressive. For about twelve hundred years it was considered sinful to probe the mysteries of the universe and the explanations set forth by the church in regard earth and the heavens were not to be questioned. Maps were produced under the church and to a large degree these were awe inspiring, yet vague enough to quench the curiosity of the common observer. To defy the church could result in severe consequences, and as a result only heretics and those brave enough to bear these consequences proceeded with their geographic speculation. (O'Connor, JJ and EF Robertson 2005)

As Europe awoke from the Dark Ages, math and science flourished, and with this a revived interest in cartography led to the next stepping-stone in being able to produce an accurate map of earth. Countries (especially Spain and Portugal) were heavily investing in expeditions to the New World, and logically they wanted a return in their investments. Navigation was the key. Unfortunately, navigation was difficult because at the time there was no system to tell location at sea, so of those that ventured to sea many never came back. With plane coordinate geometry, accredited to Renee Descartes, in the 1600's, earth's geometry system gradually came into realization. (Brown 1977)

With Descartes development of plane coordinate geometry, an abstract frame of reference for flat surfaces was created. Any point's position could be indicated with regards the horizontal (x) axis and the vertical (y) axis. In this manner, the position of any point could easily be plotted in the Cartesian plane and the position of any point relative to another can be shown. After cartographers and

geographers established the spherical nature of earth, concepts from the Cartesian coordinate geometry quickly became useful. It was incorporated into earth's geometry system, nonetheless the challenge proved greater with the geometry of sphere. (O'Connor, JJ and EF Robertson 2005)

Map Making in San Diego Bay

The complexity of cartography stretches beyond just map prints; it incorporates three fields all of which are equally important in the final product. These three components of map-making are: the techniques and tools used to survey, the medium of print, and the style of the map. A shortcoming in any field leads to a distortion in the final print. (Brown 1977)

Changes in instruments and techniques throughout time have been evident. In mapping San Diego, there were various changes in map technology. It is important to note, that while the mapping of San Diego Bay was done with reasonable frequency, there was a lag in technology when compared to the modes that were being employed in the East Coast and Europe. (Strickland 2005)

Since the Spanish first arrived in the Port of San Diego, a rich history of San Diego Bay mapping has accumulated. Despite the lost of a few maps here and there, the history of San Diego Bay is well kept. Cabrillo, the first European visitor to San Diego in 1542, left no evidence of maps from his expedition to the port. Sixty-two years after Cabrillo, the first extant map of San Diego Bay dates from Vizcaino's expedition in 1602. This map is a rough sketch, understood to be synonymous with San Diego Bay at the time. The techniques employed here uses minimal scientific knowledge or technology. (If there were any instruments used perhaps the artist used an astrolabe to estimate angles he did not take the time to survey in the field.) The sketch does not include latitude and longitude and there is no evidence any attempt was made. The direction north and south are probably based upon wind direction. (Strickland 2005)

The Vizcaino Map

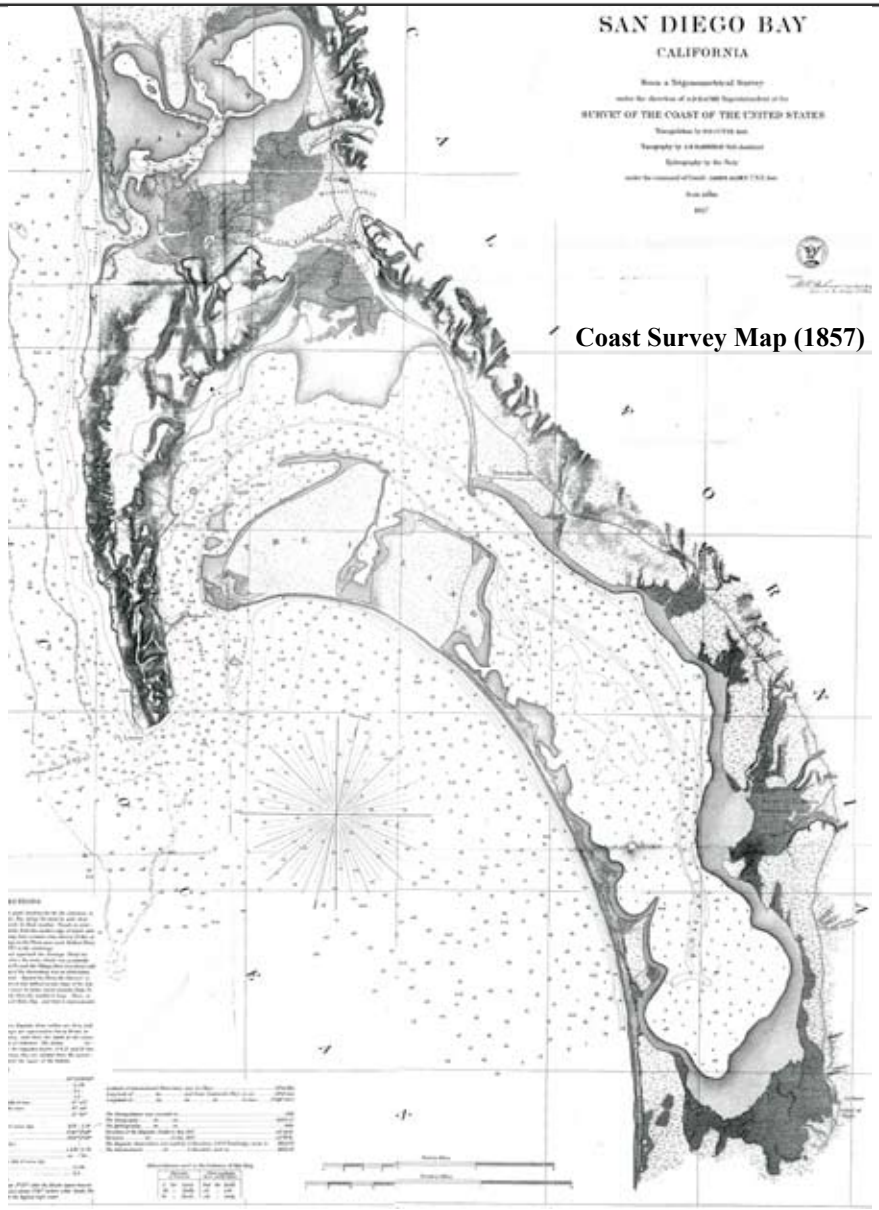






The next map of San Diego Bay which demonstrates a change in technique is known as the Pantoja Map. In 1782, Juan Pantoja mapped the San Diego Bay and its surroundings giving history its first detailed map of the area. In a seven-week field survey, Pantoja, a cartographer and geographer on his way to Monterrey Bay, made a refined version of what is still considered a sketch. One can speculate that Pantoja used more sophisticated tools such as an astrolabe to measure angles and basic techniques of triangulation. By 1789 derivatives of the Pantoja map appeared in England and France. (Harlow 1987)

The Pantoja Map



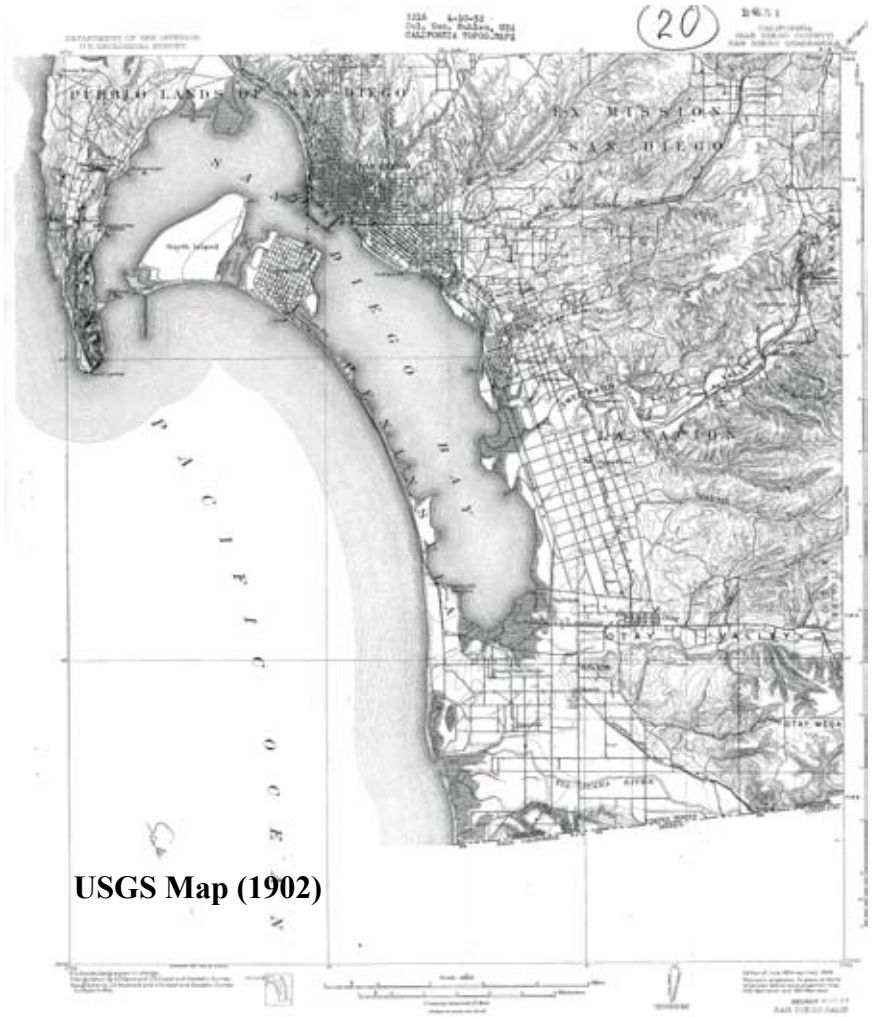
Coast Survey Map (1857)

The Pantoja map remained the quasi-official map of San Diego till 1848. With the Treaty of Guadalupe Hidalgo, settling Mexican-American territory disputes, San Diego officially became American territory and new maps were drawn of San Diego. Thus in 1857, with San Diego Bay now a part of the United States state of the art maps were needed. Using triangulation and new map printing techniques the U.S. Coast Survey mapped San Diego Bay. The map was used for navigational purposes and includes details such as linear scales in statute and nautical miles. There are latitude and longitude figures in margins. At lower left, sailing direction and notes on courses and bearings, soundings, and tides are included. (Harlow 1987)

By the late 1880's mapping techniques and surveying methods had changed. US Geodetic Surveys (USGS) were now being conducted. A geodetic survey is one in which ellipsoidal earth figures are used (exact latitude and longitude lines compensating for flattening at the poles). In 1902, the US Geodetic Survey (USGS) published a complete map of San Diego, whereas in the past maps focused primarily in the Bay, this map covered the entirety of the city. This USGS Topographic Map Series are based on interlocking latitude and longitude grids. The grid quadrangles in such maps are not themselves complete wholes, but together form a single map. Each grid, however, allows for individual handleable size map sheets and each grid square can individually be revised. (Strickland 2005)

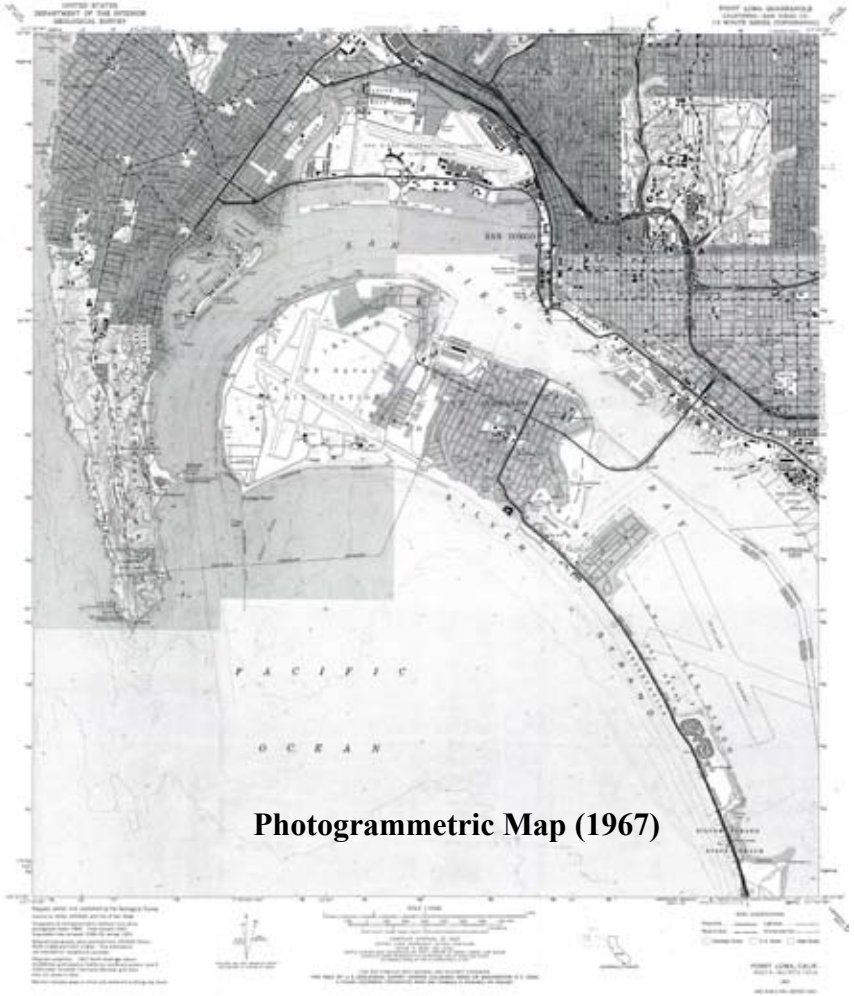
The next map of San Diego Bay, which demonstrates a change in technique, dates to 1967. To create this map a method known as photogrammetry was used. Photogrammetry is an aerial remote sensing technique, the latest innovation at the time. In photogrammetry, a high-resolution aerial camera uses global satellite navigation technology to place a camera over the designated photo block. In 1967, the technique was not as advanced as it is today, however, photogrammetry did allow for some advances. To this day, most maps are created using photogrammetric methods. (US Geodetic Map 1967)

One other advance made at this time was the cartographers ability to apply accurate scales to their maps. By using scaled photographs, cartographers could then transfer this scaled information directly to their maps. ("DART" 2005)



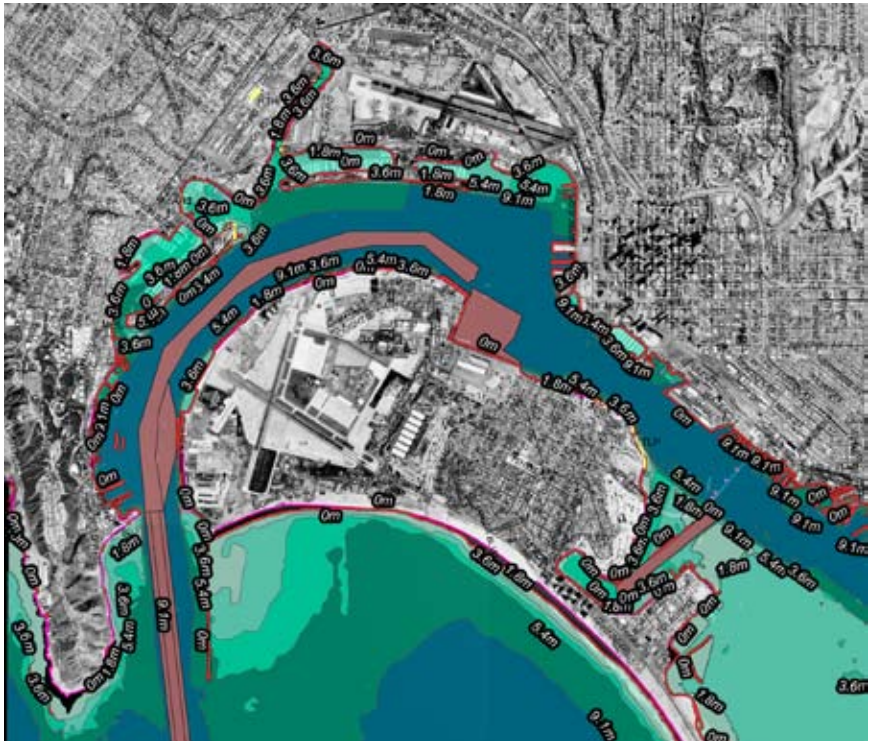
USGS Map (1902)



Photogrammetric Map (1967)



The Future of Cartography: Geographic Information Systems

Until the arrival of Geographic information Systems (GIS) maps were generally done to depict location for navigational purposes. With GIS Technology, all of that was to change. Cartography moved beyond the general to the thematic. Now maps and other GIS depiction could provide information beyond that found in classic maps.

Unlike, ancient methods of navigation, which were done with such tools as a sextant, today, satellites and radio signals, are the primary source for recording location via global positioning systems. Geographic information systems are computer application tools used to store, analyze and display data that have a spatial component in order to aid in visualization and decision-making. Not only does

GIS give us the location it also employs software that allow us to see statistically both quantity and quality of desired components. (Howser 2005)

It is estimated that 80% of all data have some kind of spatial configuration. For example, data from a list of addresses, or a series of Caribbean plantations, or even the locations of a particular invertebrate can be located and configured in a map complete with representation of their quantity and qualities. Today we have questions such as, where should the City of San Diego assign more police officers with a limiter labor pool and budget. This decision is made easier by mapping the types of crime, the times that they occur, and the number of incidents on GIS map. Where is the next earthquake likely to occur? By using a GIS map layers of historical earthquakes, faults, seismic plate boundaries, scientist can conduct risk analysis. The potential of GIS spans to all disciplines and application is not only incredible, but tremendously useful.

Obtaining data is the costliest and most time consuming process of creating a GIS map. There are many pre-made datasets from groups and organization such as the US Geological Survey and various governmental entities such as the City of San Diego. Most GIS users use existing datasets and convert them to a format that GIS can manipulate and depict. However, when new and important questions are asked, many times new and uncollected data is required. During the course of the completion of the Field Guide we have attempted to collect new data regarding the distribution of intertidal species in SD Bay. Collecting new GIS data is very costly and time consuming. We have nevertheless found the effort worthwhile, as we hope the Field Guide will demonstrate this.

Conclusion

As discussed in this paper, in the past, maps were held in secret for the sheer power of their important information. The very techniques of mapmakers were held in check by the power of the state. In addition, the scientific, mathematical, and philosophical approaches were not always correct. At times, hundreds of years elapsed before the combined efforts of many resulted in a scientific or mathematical advance. Cartography despite the odds against it has nevertheless progressed through the centuries. Today, the world of maps is not so secretive, but it does remain somewhat inaccessible. The complexity of the technologies, which it employs and the complexity of the science and math (GIS techniques included) puts maps, at times, beyond the general public understanding. With the arrival of the internet, the popular Google search engine and Mapquest, to name a few, maps and their widespread use may be coming out of their hiding places to be enjoyed by all. (Brown 1977)

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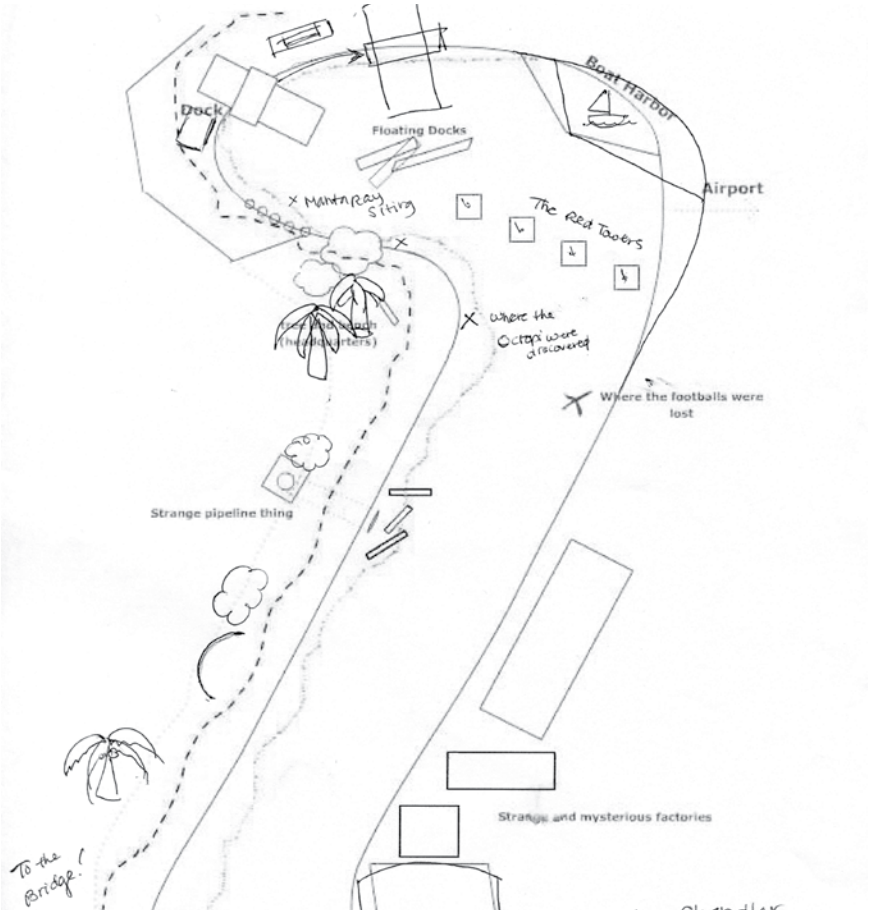
Mapping Technique Comparison:

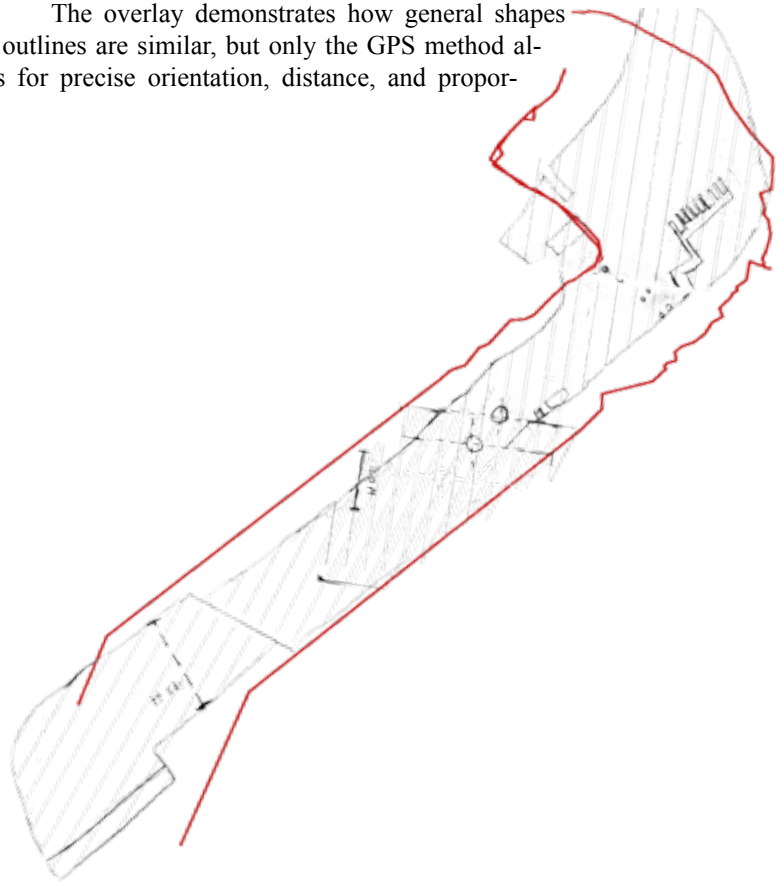
As technology has advanced, so has the ability to accurately record spatial data on maps. Below are a few examples comparing multiple techniques of mapping the same area. All of these maps are representations of the Boat Channel, an extension of the San Diego Bay.

The following is a diagram that was drawn while standing on the shore using visual cues to create a representation of what the artist thought the Boat Channel looked like from above. Obvious landmarks are represented on the map with only a approximation of distance and proportion. This technique is an example of some of the most primitive forms of surveying.



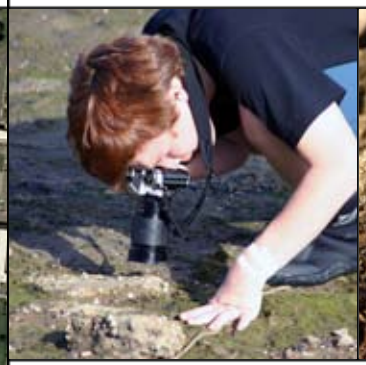
This next map compares the difference between eyesight and precise placement with Global Positioning System (GPS) technology. The black lines are another artist's rendering of what he believes the end of the boat channel looks like. The red lines were created using GPS surveying. In order to generate the red line, a survey team recorded their latitude and longitude every few yards using the Garmin Etrex® GPS system. Once enough data points had been collected, the points were plotted and then a line was traced through them. This method allows for accuracy limited only by the accuracy of the GPS signals.

The overlay demonstrates how general shapes and outlines are similar, but only the GPS method allows for precise orientation, distance, and proportion



With high resolution aerial and satellite photography, the next comparison can be seen. This image is high resolution aerial photography with the GPS generated survey lines overlaid on top of it. The accuracy of the image is only limited to the resolution of the pixels. In this case, each pixel is approximately 12 inches in the real world. The GPS line (the white line on the image) which looked so accurate in the previous image has many places where the line appears jagged and not on the proper path. When the GPS survey points were collected, the survey team attempted to follow the coastline exactly. The error in the plotted GPS line represents the amount of error in standard, commercially available GPS systems which can be anywhere between 15 to 30 feet.

BOAT CHANNEL



Hundreds of years ago, the San Diego River used to flow though this small inlet as it dumped into the Pacific. You would never guess that by its modern appearance. Its location between the international airport, the old Naval Training Center, and a former dumpsite has turned this dredged and artificial channel into what it is today. Yet there is still life clinging to the rocks and in the shadows of the intertidal zones. Even in the heart of human civilization, natural life still exists.

History of the Boat Channel:

The Boat Channel's existence has produced many controversies over the years. Currently, there is a conflict over who holds responsibility for its clean up between the City of San Diego and the Navy. The Navy once used the area known as the Naval Training Center (NTC), which included the Boat Channel as a training facility. Recently, however, the Navy transferred the ownership to the City as part of the Clinton-era military closings. The City's new redevelopment project for NTC called for a public park along the Boat Channel's shoreline. However, the City does not want the financial liability for the Boat Channel's clean up due to the cost. ("Boat Channel | Navel Training Center" 2005)

The Boat Channel contains sediment with high levels of lead, copper, zinc, and DDT, which are a banned pesticides. Navy records show that there are around fifty to sixty areas of the NTC that have been poisoned. Though this amount of toxins is normal for large military base, it is not normal for the residence or public parks within a city's limits. (McNab 2005) (Fact Sheet NO. 5 1996)

The Boat Channel was labeled a polluted area by the City. The air quality in the Boat Channel area also has come into question by the City. The end of the Boat Channel has released benzene and vinyl chloride hundreds of times the legal limit into the air. The soil around the Boat Channel also came into question when a recent discovery of a large toxic burn dump near the grounds of High Tech High School was discovered. Sites within NTC were used as late as the seventies for burning garbage disposal. After these landfill sites served their purpose, they were capped with soil trapping in the toxins left behind. These toxins included

infectious wastes, paint wastes and thinners, and cancerous metals. Although, the military base was blamed for this, there have been no measures to clean up the environmental hazards. (McNab 2005) (Fact Sheet NO. 5 1996)

On March 18, 2004, the San Diego City Manager's Office finally took action by recommending that the City take steps to depollute the Boat Channel at NTC. Jim Madaffer, a chairman of the Council's Natural Resources and Culture Committee, told City staff members to conduct more detailed research in order to make another proposal to the City about the Boat Channel. What may happen remains to be seen. The responsibility for carrying out the clean up is debated between the Navy and the City. No one wants to take the responsibility. It seems as though development will be at a halt until someone picks up the bill for the cleaning of the Boat Channel. (Powell 2004)

Uses:

When traveling to sunny Southern California, there is no better place to bring the family than the majestic decaying shores of the San Diego Boat Channel. Located directly underneath the eternally operating Lindberg airfield's flight path, it is sometimes a calm and tranquil piece of nature to enjoy. Once used as a draining point for the runoff and a training site for a bustling Navy Training Center, it is now a disease ridden body of water.

Do not let its putrid smell fool you. There are dozens of things for the whole family to enjoy. You and the kids can take a swim to the floating docks, but be sure to have your tetanus and hepatitis shots. While enjoying a wonderful nature hike along a forgotten trail, do watch out for broken glass and barbed wire. Better yet, integrate the family's sunbathing activities on the broken slabs of sharp concrete walls of the Boat Channel with the identification of different vermin that live along and among those slabs. Whatever you choose to do, we urge you to take a day to visit San Diego's most valued natural treasure—the Boat Channel.

Location:

The San Diego Boat Channel is located near the old Naval Training Center (NTC), just off of Rosecrans Street. It extends northward from the San Diego Bay and jutting away from the Bay's waters at the Spanish Landing. To the west of the Channel is the massive redevelopment of Liberty Station and to the east is Camp Nimitz and the San Diego International Airport. The Boat Channel was created from marshlands. In 1922, when the soil was dredged from the Boat Channel marshland, the Navy reclaimed the material to build the NTC. In 1923, NTC construction began on 135 acres of highland and 142 acres of tideland, donated by the City of San Diego and San Diego Chamber of Commerce to the Navy.

During the construction period, the shoreline of the San Diego Bay extended further inland than it is currently. The area near the Spanish Landing at the North Athletic Area and Camp Farragut was entirely underwater. In 1939, a construction plan was authorized to make further improvements of the Boat Channel, which was to be deepened and 130 acres of filled land were added to the eastern boundaries of the NTC. Today, the average depth of the Boat Channel is 12-15 feet. The deepest is 27 feet at its lowest point. When dredging ended, the Boat Channel had become a carved out "L" shaped from the marshlands. Though construction for the Boat Channel is completed, development around continues to this day.

Description and Feeling:

To get to the Boat Channel, we had to hike through the old section of the Naval Training Center. As we looked around, a sense of desolation and abandonment came over us. Seeing all the broken glass and empty buildings almost made us want to turn back. But the end was near and water was in sight.

The sense of security was soon destroyed, when we stumbled past an old broken down pier. After seeing the pier and the old beaten seats along the trail, our hopes for a pleasant beach experience were lost. As energy drained out of our systems, complaints began to rise in everyone's mind. Thoughts of how uneventful and dreadful the day was going to be ran through our minds.

Knowing that first impressions are not always right, we tried to make the best of our situation. One of us even took a swim and came out happy, though he smelled like sewage. We were able to see creatures that some of us have only seen on the Discovery Channel, such as shorebirds, octopi, crabs, and all sorts of invertebrates. With the day coming to an end, we realized that a beach does not need white sand to be considered beautiful. If there was ever a place to break the norm and release the inner child, it was the Boat Channel.

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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.

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.

By Merlin Gunn-Cicero

Broken Links

Transform, transcribe, and translate
The antiparallel polar chains of humanity's makeup turn actions into reactions
The spectrum of my truth serum
Bumps upon my scandal
I cast my feet and hands into the sea
Let my head lie by the dry sand
Wither away wither away
I have barely made a scratch
"will I be remembered?" echoes in the far distant
From where my reality came, I care not about remembrance
Living on
Wither away, wither away

-Khoa Tran

The Boat Channel

Boat Channel, currents flowing,
Lights on water, shining, glowing.
Boats wait anxiously at the channel's docks,
Rocking, floating, bells ringing with the clocks.
Their decks are dry and warm, their hulls are pearly white,
Sea salt hangs in the air,
Oh, the Boat Channel, what a sight.

People come and people go, laughing and talking,
Do they wished they owned a priceless piece?
In quiet ripples, the water breaks against the silent sea walls.
Shore rocks standing like a mighty fortress.
The heron hunts and the seagull gives its call.
Boat channel, currents flowing,
Lights on water, shining, glowing.

-Ben Lewis

Biology of The Boat Channel:

Octopus Garden

The average octopus is said to be extremely intelligent, they choose their own habitats to keep themselves away from predators. Why are there so many octopi at the San Diego Boat Channel? An octopus can choose their own habitat to live in. You can see abundant octopi habitats at the Boat Channel. Since the Boat Channel is filled with plenty of harmful chemicals and sewage drains, it is unlikely for this place to be a tourist spot for visitors that happen to stroll along. Therefore, few humans are around to disturb or fish this amazing creature.

Octopi reside in rocky areas throughout the Boat Channel shoreline. They establish dens in rocky areas or caves, and smaller individuals may dig dens in sand-shell substrates. The Boat Channel is filled with many octopus dens which are mainly located on the shore of the bay and sand. The reason for this is because they are camouflaged which allows them to hide from predators. The octopus' predators include seals, sea lions, sea otters, dogfish, lingcod, flatfish and larger octopi. These predators are not located around the Boat Channel allowing the octopi to thrive. An octopus can escape from its predators by shooting a jet water through its body to create a burst of speed.

Under water they can crawl along the bottom of the sea floor by using their tentacles as legs as they slither through crevices under rocks. There are many rocky areas in the Boat Channel where the octopus dens can be easily seen.

An octopus den mainly looks like a hole surrounded by a ring of rocks 3-4” in diameter. An octopus lives in this habitat to keep away from predators. The Boat Channel is a safe haven for octopi to live because it is a sheltered place with very few visitors that stroll by.

Interactions of The Boat Channel

San Diego Wetlands

Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is often covered by shallow water during some parts of the year. Wetlands can be categorized according to specific habitat and type of vegetation. Saltwater and brackish water marshes, which are usually located in coastal areas, are located in wetlands. Also, there are freshwater wetlands, which are primarily in the inland areas of California and then there’s the freshwater forested and scrub wetlands, which are commonly referred to as riparian habitat.

The South San Diego Bay Unit was the dream of San Diego’s environmental community for over 20 years. With 97% of bay habitat in San Diego lost to development and the remainder much degraded over time because of commercial activities, this refuge will be managed to ensure that the bay’s thousands of shorebirds and waterfowl migrating along the Pacific Flyway as well as its resident species will survive into the next century. Despite the dredging and filling of natural areas, many species of birds continue to frequent the Mission Bay area in the natural vegetation of the San Diego Flood Control Channel between Interstate 5 and the Pacific Ocean. A frontage road and bicycle paths offer prime viewing of this 200-acre preserve from both sides of the channel.

Wetlands are recognized as a very important ecosystem with functions and values such as biological diversity. This is when wetlands provide important habitat for diverse communities of plants and animals, including over 50 percent of the federally listed threatened or endangered species. Then there are waterfowl

habitats. Wetlands provide the principal habitat for migratory waterfowl. There are fisheries where wetlands provide direct spawning and rearing habitats and food supply that supports both freshwater and marine fisheries. Flood control is also included where flood flows are detained reducing the size of its destruction. Water quality plays a role in wetlands. This absorbs and filters pollutants that could otherwise degrade ground water or the water quality of rivers, lakes, and estuaries. Also wetlands provide recreation such as fishing, hunting and outdoor recreation.

Although there are many values that wetlands serve to improve the environment, there are also controversies that follow. The issue of hunting is very important. There are duck clubs that own many wetlands for people to shoot and kill birds. However, the duck hunters support and own the majority of the wetland habitat in California. Wetlands used to be seen as a breeding ground for disease-carrying mosquitoes. This is also a major factor in the flaws of wetlands. There is also a vast amount of endangered species that inhabit the waters of San Diego. But there are ways being experimented to try and prevent this issue.

Bird Habitat: San Diego Boat Channel

The Boat Channel provides refuge for many species of waterfowl. This is partly because of the fact that San Diego Bay, specifically the Boat Channel used to be a natural wetland before the introduction of the industrialization. It is instinctual for many birds to flock to wetlands to seek suitable refuge during the migration and mating periods during a bird’s lifespan. Even though the Boat Channel is no longer considered a natural wetland it still provides much of the same accommodations as one.

The Boat Channel is partly isolated from human activities due to its obscure location in the San Diego Bay. This region supports some of the highest bird diversity in the northern section of San Diego Bay. The lack of human interaction is perfect for the development of the bird's life. It allows the birds an unadulterated habitat to raise their young and occupy during the migratory seasons. All the required necessities are there, from habitat to feeding and the birds must not be affected by the few negatives, human interaction and planes. It is amazing that so many birds find peace here directly underneath the take off flight path. It is

likely so many birds flock to the Boat Channels because the advantages outweigh the negatives so that the birds no longer pay heed to them.

Dolphin Mine Training

The Marine Mammal Program of the Navy began in 1959. The Navy was very interested in studying the hydrodynamics of dolphins. The initial benefit would be to improve torpedo, submarine, and ship design, however, the Navy soon discovered that dolphins have other resourceful qualities.

There are several Marine Mammal Systems for dolphin training used by the military. The MK4 system is used to find mines that are tethered to the ocean floor. The MK7 system is used to find mines that are on the ocean floor or buried in sediment. The dolphins also clear a path for human divers and equipment in this system. The MK8 system uses the dolphins and their trainers to find safe passages for troops to land.

Dolphins are utilized for this dangerous work because of their echolocation capabilities. Their radar sensors are more accurate than the Navy's technology, which makes locating mines easier. Dolphins are also able to make numerous deep dives without the side effects a human diver would suffer as well as being a good alternative when a diving mission is too dangerous for a human to complete.

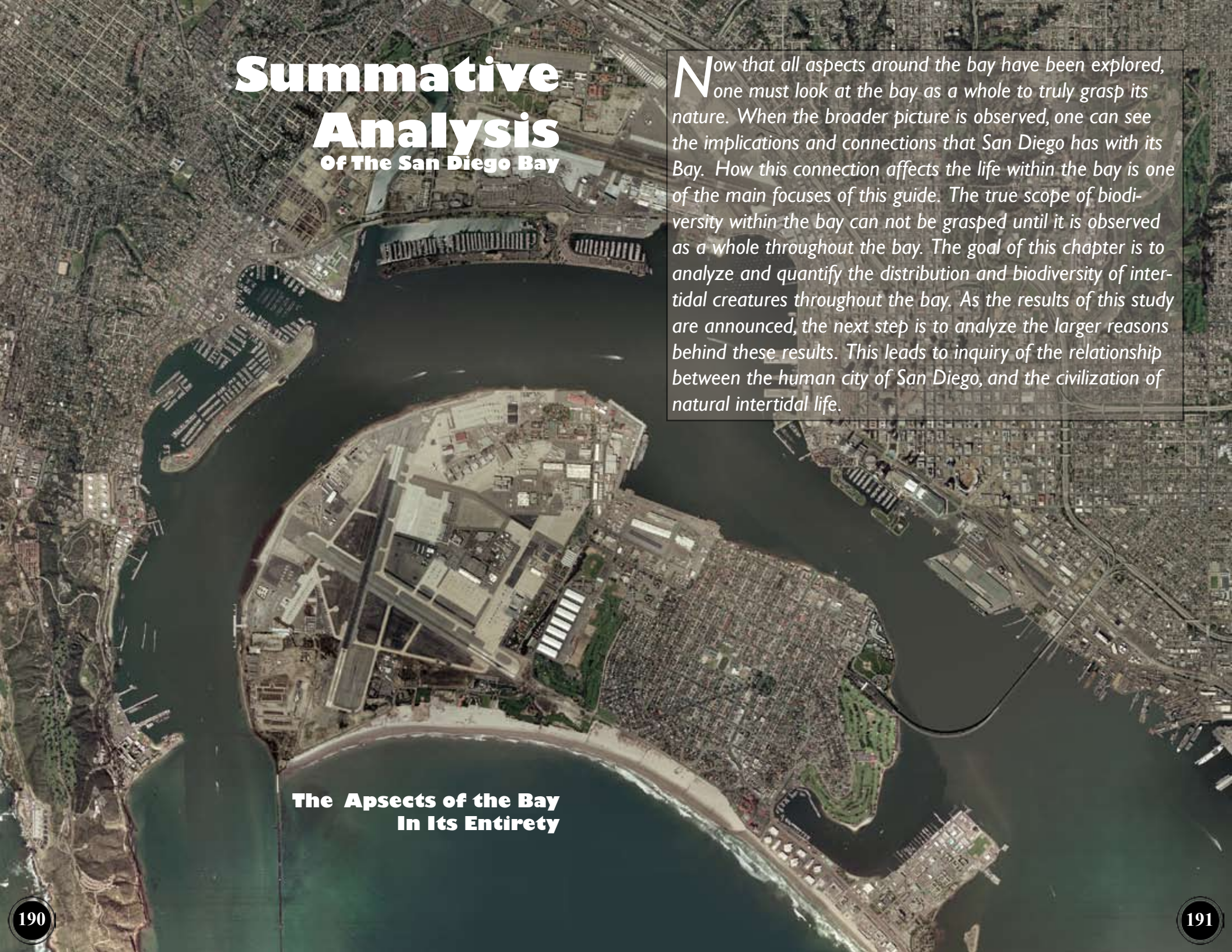
Dolphins are trained primarily by hand signals and positive reinforcement. If a dolphin performs a maneuver correctly, he will get a reward, such as fish or a whistle. A game or toy can also serve as a reward. There is also a clicker method that is effective for training dolphins. The clicker functions as a reward for the dolphin. A click will only be given when a trick or command is completed correctly.

Part of the dolphin mine training is happening in San Diego. The Navy utilizes Shelter Island and the Boat Channel for their dolphin training. The dolphins live in areas of the bay that are sectioned off for their use. These are convenient locations because of the proximity to Fort Rosecrans and MCRD.

Summative Analysis

Of The San Diego Bay

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.



The Apsects of the Bay In Its Entirety

BIODIVERSITY ANALYSIS

One of the main purposes of this guide was to assess the biodiversity of common intertidal creatures around San Diego bay in hopes of drawing conclusions based upon our findings. In order to determine biodiversity, the creatures had to be surveyed and counted at various locations scattered throughout the bay. The presence of certain creatures and their numbers at certain tide heights can, when compared on multiple factors, give indications on features such as the natural health of the bay. The exact procedures of this study were discussed in the Biodiversity and Biogeography chapter of this book.

In order to present meaningful data to the reader, five of the most common intertidal creatures were selected to display results.

Acorn Barnacle

Bay Mussel

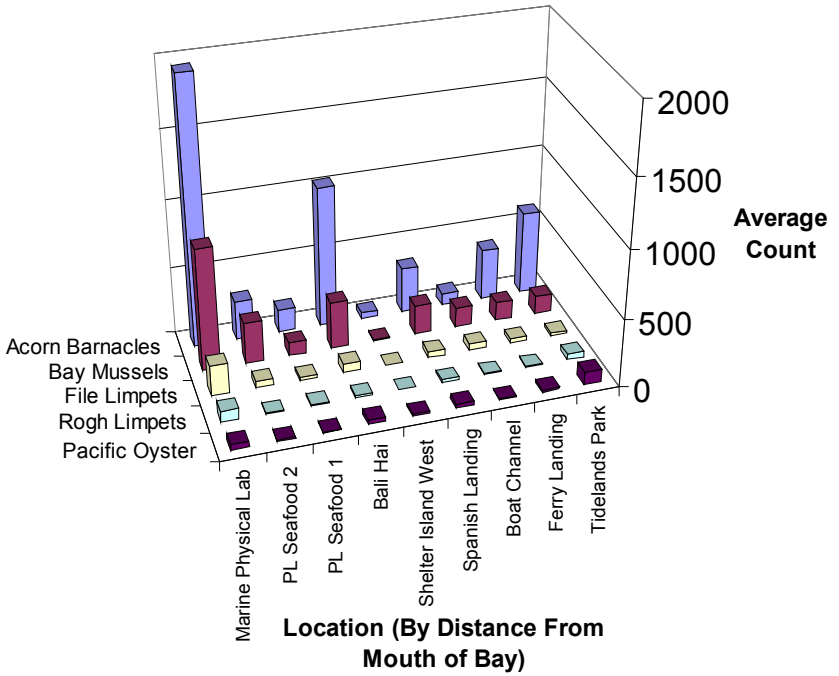
File Limpet

Rough Limpet

Pacific Oyster

There were 9 survey sites at 6 different locations. One was at the Marine Physical Lab at the Nimitz Scripps Institute; another two at Point Loma Seafood and a site further in the America's Cup Harbor. There were two sites at the tip of shelter island. Shelter Island West was on the northwestern site of the island facing the harbor while Bali Hai was on the northeastern side of the island facing the bay right next to the Bali Hai restaurant. Another site was at the Spanish Landing underneath the Harbor Drive bridge at the mouth of the boat channel. The following site was at the northern end of the boat channel located just west of the San Diego International Airport. The final two sites were on Coronado Island. One was near the ferry landing and the other was at Tidelands park near the Coronado bridge.

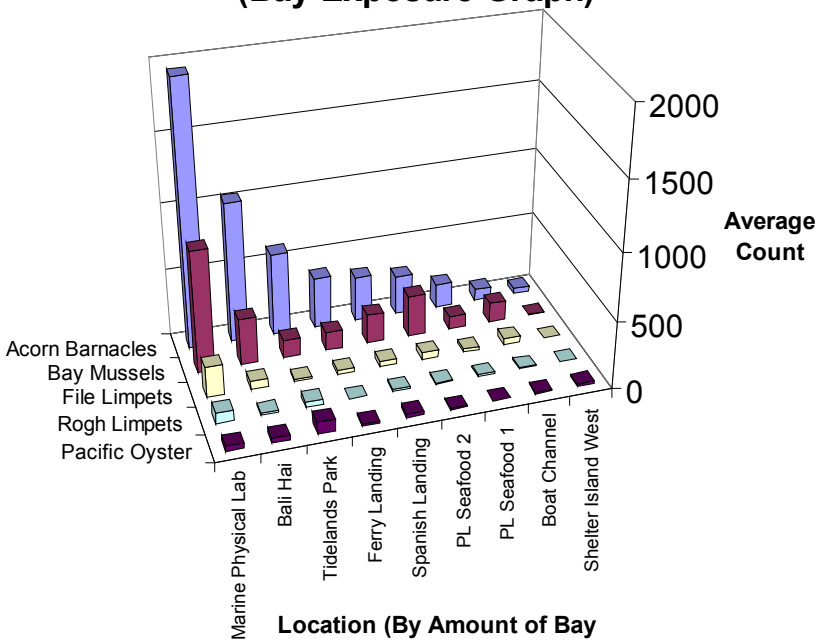
Average Creature Count Per Species Per Location



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 from closest to the mouth of San Diego bay to the furthest into the bay. Going in on the z-axis are the 5 common species that were used to assess the bay. Going up and down on the y-axis is the average number of creatures found for the particular site and species.

The most average abundant species and site are the Acorn Barnacles at the Marine Physical Lab at the Scripps Institute. As the locations become further away from the mouth of the bay, it appears that the average count decreases slightly; however, the data is very sporadic with extreme highs and extreme lows next to eachother.

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 by the amount of average exposure to the bay. The other axis are the same as they were in the previous graph.

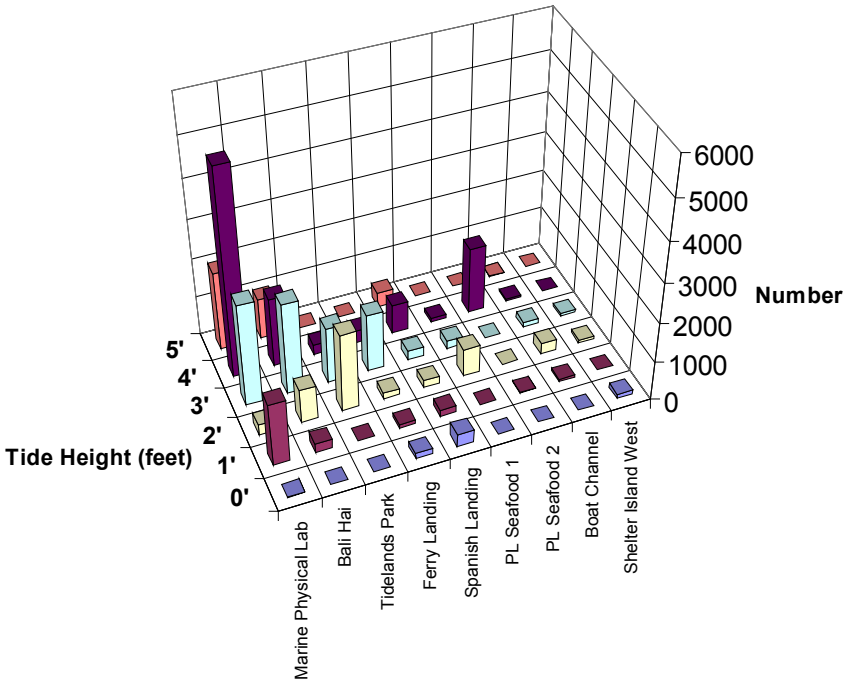
This graph shows a direct correlation with the amount of bay exposure with the average number of creatures living in the location. The furthest left bars represent data taken at the Marine Physical Lab. This location is on a beach that is not hindered by any sort of harbor or breakwater. Similar conditions 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.

ANALYSIS OF ABUNDANCE PER SPECIES

Acorn Barnacle:

The graph below shows the abundance for the acorn barnacle across various sites and at increasing heights above the mean 0 foot tide. It is most abundant at the +4' tide height and at the Marine Physical Lab.

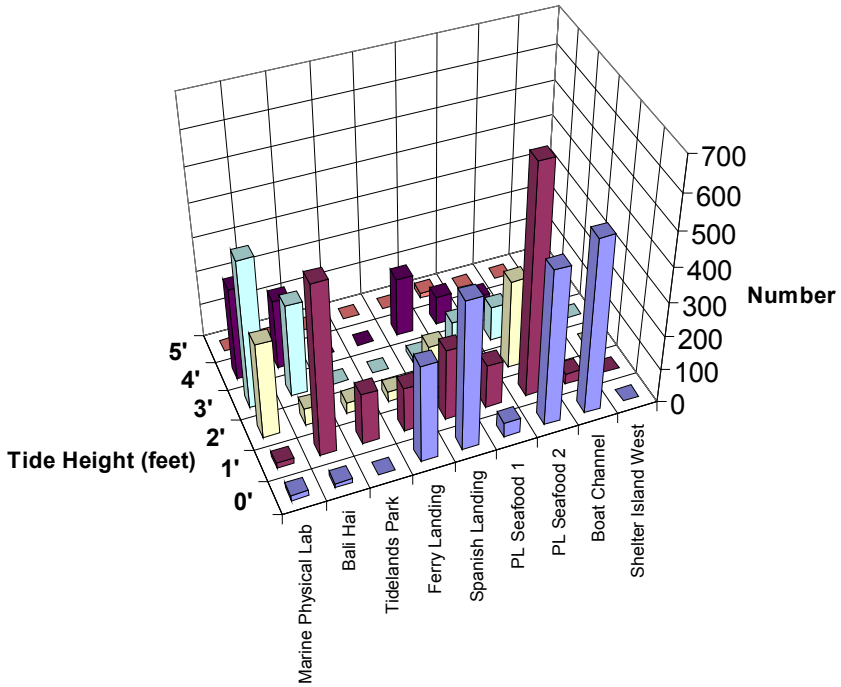
Tide Height and Abundance Across San Diego Bay for Acorn Barnacle



Bay Mussel:

While the barnacles may have the most in numbers, the bay mussel has the greatest biodiversity. The unusual aspect about this data is the noticeable shift towards the right of the graph of the data which represents less exposure to the bay. It seems that the mussels can survive and flourish in locations around +1 foot tide height in harsher conditions.

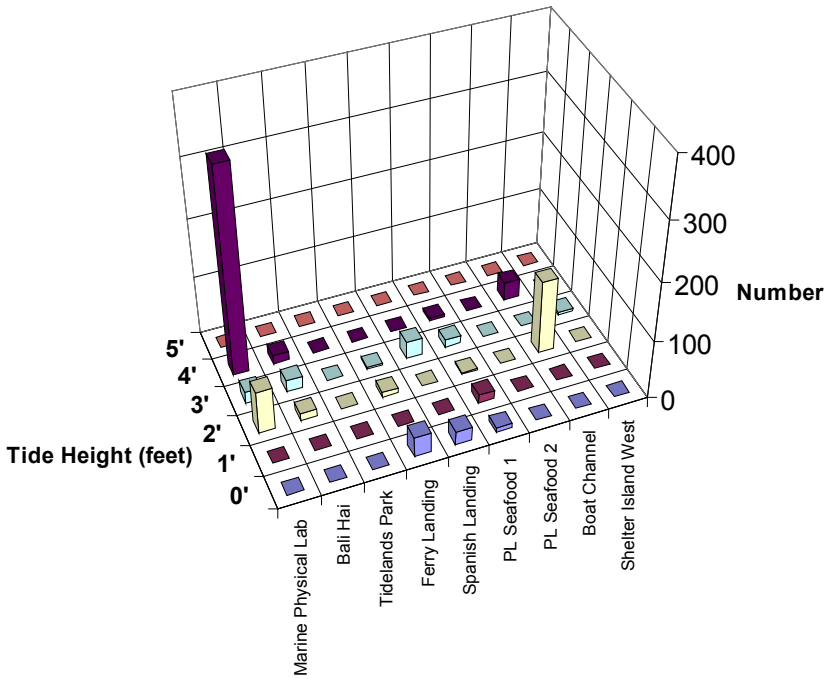
Tide Height and Abundance Across San Diego Bay for Bay Mussel



File Limpet:

A large number of file limpets were found 4 feet above mean 0ft tide at the Marine Physical Lab. Apart from that location, the distribution seems to be relatively random with a few spikes around the tide heights of 2, 3, and 4 foot. This may indicate that the file limpet does not need large quantities of water in order to survive, but can live in many different conditions.

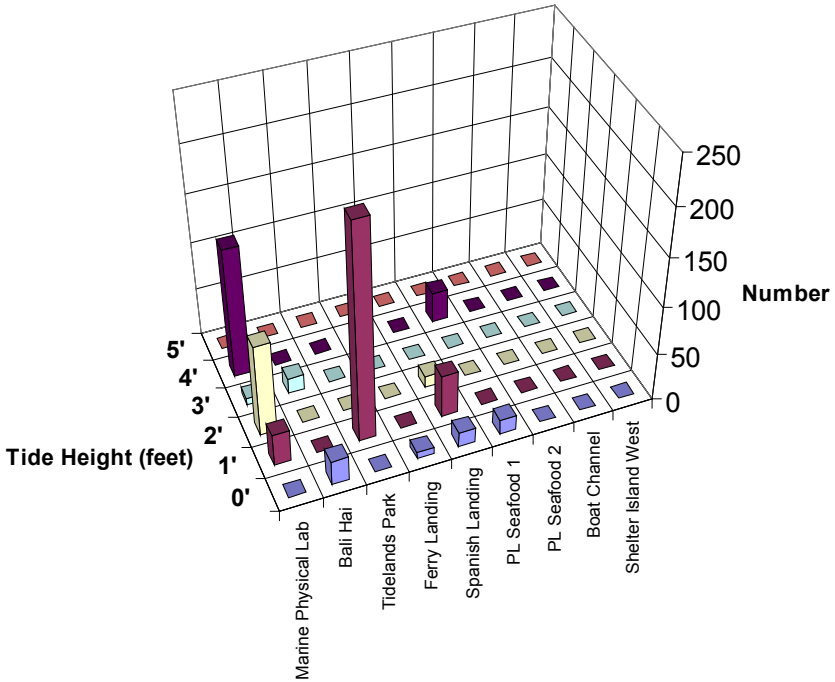
Tide Height and Abundance Across San Diego Bay for File Limpet



Rough Limpet:

Large quantities of rough limpets were found in Tidelands Park at the +1 foot tide height. Strangely enough, the very few of the similar File limpet were found at this location and tide height. The random nature of the data suggests that like the file limpet, this creature survives in a variety of conditions and is very tolerable to the amount of water exposure it receives.

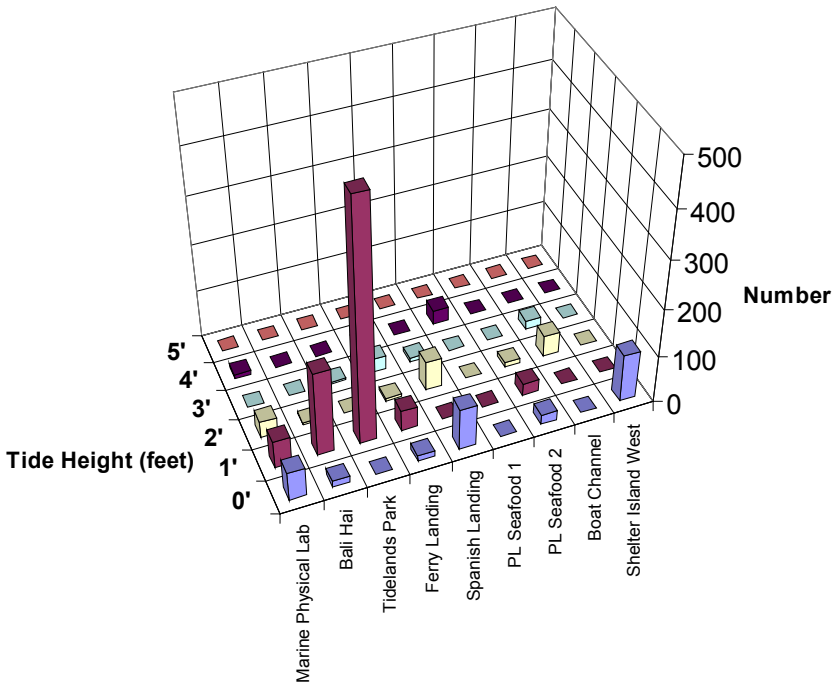
Tide Height and Abundance Across San Diego Bay for Rough Limpet

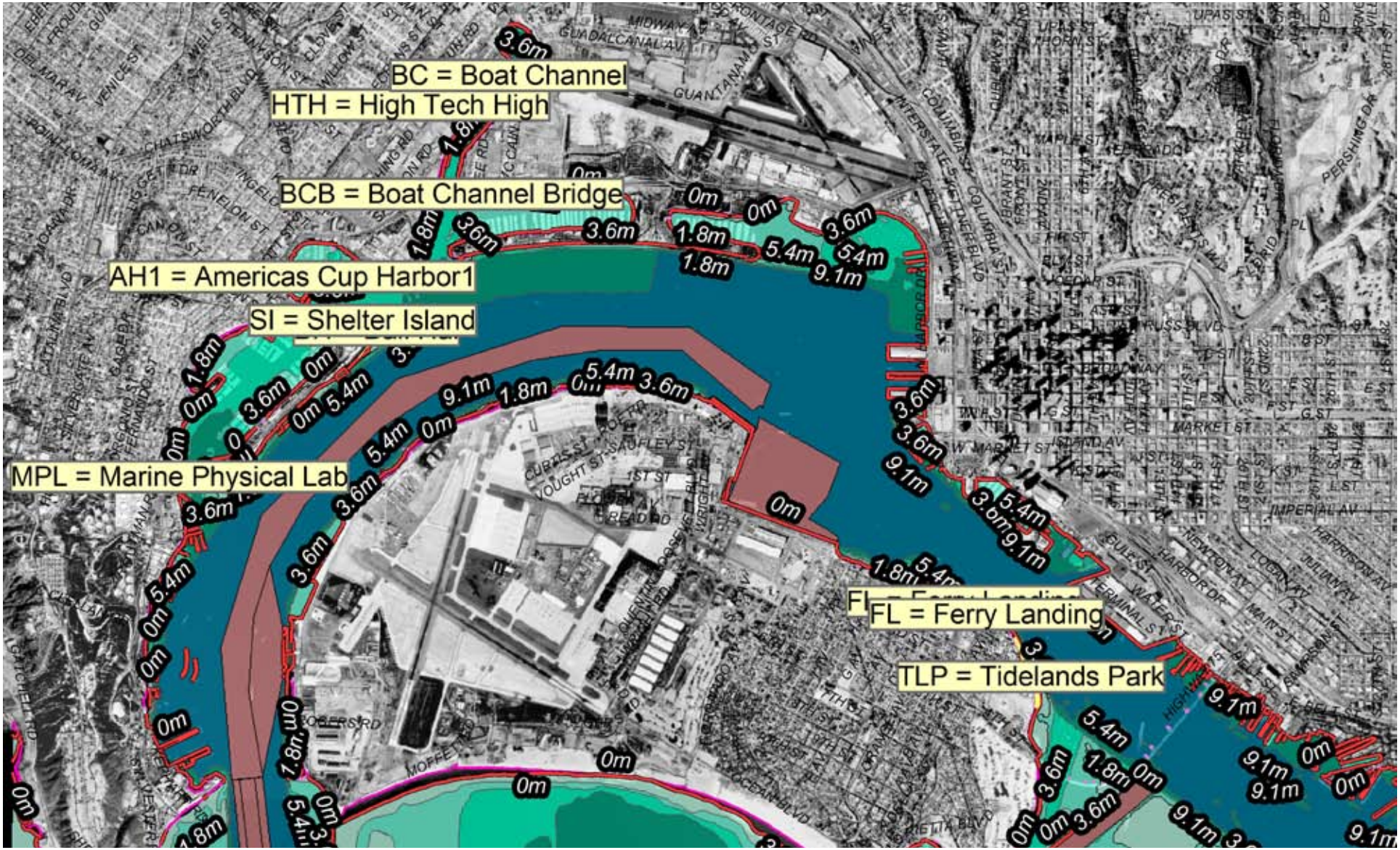


Pacific Oyster:

The Oyster was primarily found in lower tide heights such as +0', +1', and +2' tide heights. This indicates that the oyster needs to be covered by water often to survive. The extreme lack of data for the higher tide heights also indicates that oysters are not very tolerable to water level changes and require the constant flow of the ocean for food and air.

Tide Height and Abundance Across San Diego Bay for Pacific Oyster




BC = Boat Channel
HTH = High Tech High
BCB = Boat Channel Bridge
AH1 = Americas Cup Harbor1
SI = Shelter Island
MPL = Marine Physical Lab
FL = Ferry Landing
TLP = Tidelands Park

BIODIVERSITY MATRIX

Species / Location:	Boat Channel	Bali Hai	Shelter Island West	Point Loma Seafood 1	Point Loma Seafood 2	Coronado: Tidelands Park	Coronado: Ferry Landing	Marine Physical Lab	Spanish Landing
Acorn Barnacle	X	X	X	X	X	X	X	X	X
Bay Mussel	X	X		X	X	X	X	X	
File Limpet	X	X	X	X			X	X	
Rough Limpet		X		X		X	X	X	
Pacific Oyster	X	X	X	X		X	X	X	X
Gray Periwinkle	X	X		X	X				
Bubble Snail				X			X	X	
Serpulorbis	X	X							
Slipper snail							X		
Shore Crab	X	X		X	X	X	X	X	
Rock Louse				X				X	
Tunicate		X		X			X	X	
Keratose Sponge									
Byrozoan	X								
Sea anemone (lg. solitary)							X		
Sea anemone (sm. colonial)						X			

This table is a checklist of creatures found at different sites. The rows are the 16 most common intertidal species while the columns represent the different sties around the bay. An "X" means that a particular specimen was found at that particular site. This document allows a reader to see which locations around the bay have a large amount of biodiversity. For example, the Ferry Landing at Coronado Island has the highest biodiversity with 10 different species identified. Conversely, the Boat Channel Bridge near the Spanish Landing has only 2 types of identified species. This can also show which species are the most prevalent. For example, the Acorn Barnacle is present at all locations.

Glossary

Asexual reproduction: Reproduction without eggs and sperm (e.g. bacteria are asexual as they multiply by dividing).

Biarticulate: Consisting of two articles or segments.

Bivalve: A mollusk whose body is enclosed by a pair of hard shells.

Calcareous: Contains calcium carbonate.

Carnivore: An animal that eats other animals.

Carotenoid: Any of a group of red, orange, and yellow accessory pigments (coloring matter) of plants or algae.

Caudal: Pertaining to the tail.

Chelipeds: Whole appendage bearing chela (claw or pincer).

Cilia: Hair-like organelles extending from the membrane of many eukaryotic (containing a nucleus and other membrane-bound organelles) cells; often function in locomotion.

Cirri: Small, flexible appendages present on some invertebrates, including barnacles and annelids.

Coalesce: To fuse, blend, merge, unite, or cause to grow together.

Copepods: Any of a large subclass (Copepoda) of usually minute freshwater and marine crustaceans that form an important element of the plankton in the marine environment and in some fresh waters.

Cortex: The outer layer of the cerebrum (brain), densely packed with nerve cells.

Detritus: Particles from decaying plants and animals.

Diatom: Unicellular algae capable of photosynthesis and characterized by producing a thin outer shell made of silica (glass).

Dioecious: Having the organs of the sexes upon distinct individuals.

Discordant: A twin pair (or set of individuals) in which one member exhibits a certain trait and the other does not; belonging to divergent species.

Distal: Farthest from the body.

Dorsal: Refers to the back of an organism, as in the dorsal fin of a shark.

Echolocation: The process by which an animal locates itself with respect to other animals and objects by emitting sound waves and sensing the pattern of the reflected sound waves.

Elongated: Made or grown longer; having notably more length than width; being long and slender.

Esophagus: Portion of the gut between the mouth and stomach in the anterior neck.

Exoskeleton: An external skeleton or supportive covering of an animal, as for example, the shell coverings of a crustacean, the calcium carbonate secretions of stony corals, or the bony plates of an armadillo.

Flagella: Long hair-like organelles at the surface of the cell with capacity for movement.

Foliose: Leaf-like; bearing leaves.

Follicle: A small anatomical sac, cavity, or deep narrow-mouthed depression (e.g. a hair follicle).

Gamete: Mature male or female reproductive cell (sperm or ovum) with a haploid set of chromosomes.

Gestation: The process, also known as pregnancy, by which a mammalian female carries a live offspring from conception until it develops to the point (birth) where the offspring is capable of living outside the womb.

Girdle (chiton): The outer rim or leathery border of chitons.

Gonads: Primary sex organs; ovaries in the female and testes in the male.

Gregarious: Tending to form a group with others of the same kind.

Haploid: A single set of chromosomes (half the full set of genetic material), present in the egg and sperm cells of animals and in the egg and pollen cells of plants.

Herbivore: A plant-eating animal.

Hermaphrodite: An animal or plant having both male female reproductive organs.

Intertidal: The zone between high and low tide.

Isopod: Any of a large order of sessile-eyed crustaceans with the body composed of seven free thoracic segments, each bearing a similar pair of legs.

Larvae: The young and immature form of an animal, which must change to become an adult.

Locomotion: The ability or power to move.

Mantle: A protective layer of epidermis in mollusks or brachiopods that secretes a substance forming the shell.

Membrane: A pliable sheet of tissue that covers or lines or connects organs or cells of animals.

Monogamous: The condition in which a single male and female form a prolonged and more or less exclusive breeding relationship.

Monomorphic: An organism whose sex cannot be determined by just looking at them.

Mottled: Any material that contains spots of different colors or shades.

Mysids: Group of small, shrimp-like crustaceans characterized by possessing a ventral brood pouch.

Neuron: The main actors in the brain, neurons are cells that issue and receive electrical signals to and from other parts of the body.

Nymph: A larva of an insect with incomplete metamorphosis.

Organelle: A subcellular structure having a specialized function for example the mitochondrion, the chloroplast, or the spindle apparatus.

Ostracods: Small mobile marine with right and left valves for shells and an indistinctly segmented body.

Ovaries: Female sex organs.

Palp: A lateral appendage of the lower jaw or the maxilliped (a paired appendage on the posterior and ventral edge of the cephalon (the head, or anteriormost body unit)).

Papillose: Covered with fleshy, nipple-like projections on an animal's mantle.

Paragnath: One of the two lobes which form the metastome (lower lip) of Crustacea; One of the small, horny, toothlike jaws of certain annelids.

Pectoral: Of, pertaining to, situated, or occurring in or on the chest.

Peristomium: The first segment of the earthworm's body; contains the mouth.

Phytoplankton: Minute free-floating aquatic plants.

Planktonic: Free-floating; drifting, rather than swimming.

Plumage: The feathers of a bird.

Polychaetes: A class of marine worms and their free-swimming larvae.

Polymorphic: A species having many different forms.

Proboscis: An elongated appendage of a living organism. The most common usage is to refer to the tubular feeding and sucking organ of certain invertebrates like insects, worms and mollusks.

Prostomium: The lobe of skin that projects out in front of the peristomium (first body segment). It is located above the mouth, and there are three different formations.

Radula: A flexible tongue-like organ in some molluscs that consists of rows of horny teeth on the surface.

Raucous: Unpleasantly loud and harsh.

Regurgitate: To bring undigested or partially digested food up from the stomach to the mouth, as some birds and animals do to feed their young.

Reticulation: A pattern formed by obliquely (slanting or sidelong direction or position) intersecting threads or linear ridges of ornament (Surface sculpture standing out in relief on shell surface).

Scavenger: An animal that eats the dead remains and wastes of other animals and plants.

Sculpin: An ugly little fish found in trout streams that trout love to eat.

Sessile: Organisms that remain attached to a substrate.

Substrate: The material making up the base upon which an organism lives or to which it is attached.

Subtidal: Below the level of the lowest tide.

Syrinx: The "voice box" in the throat near where the bronchial tubes and the trachea join. In song birds, the syrinx is the organ that makes singing possible.

Terga: The back, or back plates of an animal.

Transverse: Lying or being across, or in a crosswise direction.

Tremolo: The quick repetition of a note; the alternation between two notes as rapidly as possible.

Trochophore: A small, free-swimming, larval stage of some aquatic invertebrates such as mussels and clams; trochophores swim using cilia, rather than flagella or some other method.

Unicellular: Single-celled.

Valve: One of the two halves of the shell of a bivalve mollusk.

Vertebrae: The bones of the spinal column.

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