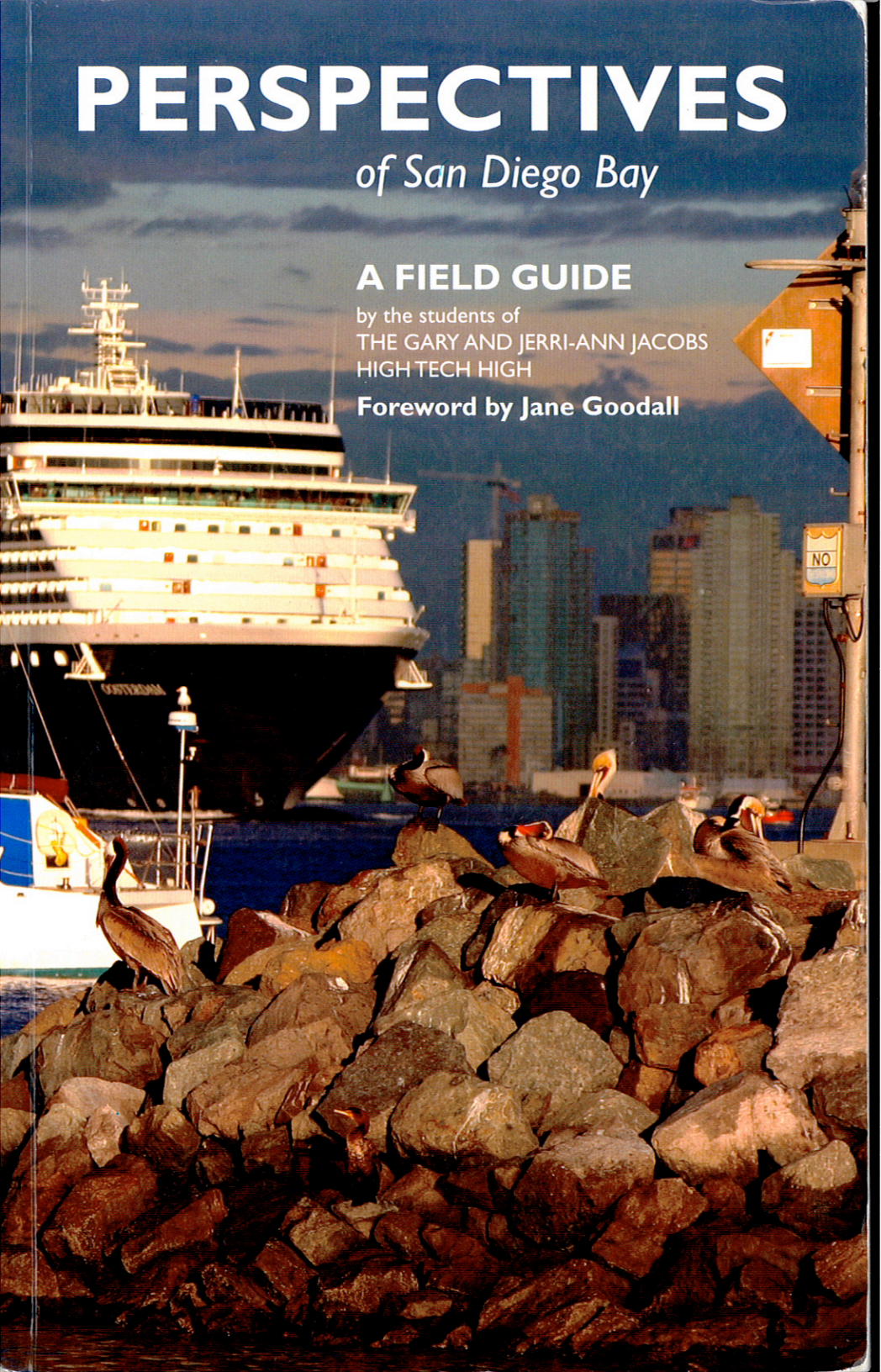
PERSPECTIVES

of San Diego Bay

A FIELD GUIDE

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

Foreword by Jane Goodall



NEREIDIDAE

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

ARTHROPODA

ARTHROPODA

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

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

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

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

STRIPED BARNACLE *Balanus amphitrite*

Class: *Maxillopoda* | **Order**: *Thoracica* | **Family:** *Balanidae*
Morphology: Small, conical. 15cm in diameter, white with purple or brown stripes running along their shell. Have terga; two pairs of plates surround mouth barnacle. Have labrum, lip-like extension anterior to the mouth.

Range: Throughout the main Hawaiian Islands, Southwestern Pacific and Indian Ocean. Also around world-wide, in warm and temperate seas.
Feeding: Barnacles have specialized paired appendages, called cirri, which they use as a scoop net, reaching out into the water and extracting food particles. When the cirri are drawn back, food is scraped off into the mouth.
Locomotion: Larvae search the substrate with their antennae. When a suitable site has been found they release a substance that fastens to the site. Barnacles live only in marine environments, and many live in intertidal regions. Spend part of their day without seawater. Net of six pairs of long legs and cirri protrudes from the cavity, sweeps through sea water to filter microscopic planktonic cells for food.
Reproduction: Hermaphrodites; cross-fertilization occurs in dense populations. Males deposit sperm into mantle cavity of adjacent functional females via a long tube. Fertilized eggs brooded in mantle cavity; several months before the free-swimming planktonic larvae released.
Etymology: *Balanus amphitrite* (L. *Balanus*, Striped; L. *Amphitrite*, barnacle).

RED GHOST SHRIMP *Callianassa californica*

Class: *Crustaceans* | **Order**: *Decapoda* | **Family**: *Callianassidae*

Morphology: Soft-bodied crustaceans that have a long and flexible abdomen. Usually have two chelipeds; males have one cheliped that is larger than the other. At the end of these chelipeds are sharp pinchers. The second leg has long seta, or hairs. Colors range from pale pink to orange. Male shrimp are approximately three inches long and females are two inches long.
Range: Found in mostly muddy areas, but can be found anywhere from muddy shores to the deep sea. They are especially common in the tropics.
Feeding: As the mud passes through digestive tract while digging, they take in organic detritus and microorganisms. Plankton and detritus also provide nutrients that are carried by the water current moving through the burrow. The nutrient is collected by pleopods. Also collect detritus using the fine hairs on its legs. When the hairs collect the food, the third maxilliped takes up the food and delivers it to the mouth.

Reproduction: Females carry young eggs under the pleopods on the abdomen. When eggs hatch, larva swim around for weeks until they settle to make burrows of their own.
Etymology: *Callianassa californiensis*; the genus *Callianassa* comes from Greek mythology and refers to one of the fifty Nereids or sea nymphs renowned for their beauty and kindness.

STRIPED SHORE CRAB

Pachygrapsus crassipes

Class: *Malacostraca* | **Order**: *Decapoda* | **Family**: *Grapsidae*
Morphology: Ranges from 3-4cm in width. Has a center body, eight legs, and two front pinchers to defend itself or gather prey. Body is encased in a hard exoskeleton. During the molt it's incredibly soft and vulnerable to predators. Able to retain water in a convenient gill chamber which allows them to stay on land for extended periods of time. Travels to water to gather food and moisten their gills.

Range: Located in Charleston, Oregon; Isla de Santa Margarita, Baja California; Korea, Japan, and the Gulf of California. Tend to live in higher tide pools or crevices.
Feeding: Feed on film from algae as well as eating dead matter, limpets, snails, hermit crabs, and sometimes isopods. Cannibalism can occur with recently molted crabs.
Locomotion: Move by walking side to side on legs. Sometimes use their claws, but usually left in the air to scare off predators. Some use pinchers to dig holes into the sand to hide.
Reproduction: Mate right after the female has molted in summer. The male turns on back and female crawls on top of it. Female later creates a cavity in the sand and lays eggs. Eggs attach to female's legs and she carries them around for several months.
Etymology: *Pachygrapsus crassipes* (Gr. *Pachy*, thick; L. *graspus*, crab; Gr. *Crassipes*, thick foot).

ROCK LOUSE

Ligia occidentalis

Class: *Crustacea* | **Order:** *Isopoda* | **Family:** *Ligiidae*
Morphology: Usually grey with orange-tipped legs. Resembles a cockroach. Separated eyes, gills, pointed legs, antennae, forked tail and a moist but rough outer shell.
Communication: A hissing type noise.

Range: Sonoma County, California to San Francisco, California and Central America.
Feeding: Scavengers and scrapers. Feeds on dead plant and animal material. Also on the algal film located on intertidal rocks.
Locomotion: It is able to scurry under different rocks at a fast moving speed.
Reproduction: Separate sexes and sexual reproduction. Spawns from spring to early summer.
Etymology: *Ligia occidentalis* (L. *Ligia*- To fall down or to go down ; L. *occidentalis*- western sky or part of the sky)
Other: Most active at night. Changes its color each morning to become darker during daylight. A terrestrial species. Must live near a water source such as a tide pool. Dips its rear end, located at the gills, into water in order to keep its breathing apparatus moist.

CHORDATA

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 from 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. 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 it. A variety of ducks may be observed around San Diego Bay from November to March. Some of the more common members include the *Anseriformes* (the waterfowl), the *Columbiformes* (doves and pigeons), the *Faconiformes/Accipitriformes* (the raptors), and the *Pelecaniformes* (the pelicans). We 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 drab 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 water 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 are excellent swimmers and swift fliers.
Reproduction: Most mallards are capable of breeding as yearlings but 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* Beak).

BUFFLEHEAD

Bucephala albeola

Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Hardly reaching 1 pound they are the smallest diving ducks. Male bufflehead have black back and white under,sides, 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, Vermont and Massachusetts.
Feeding: Aquatic insects, 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 lasts about a month. Hatchlings stay in the nest for another month.
Etymology: *Bucephala albeola* (G, *Cephala* Head; L, *Albeola* White)

GREATER SCAUP

Aythya marila

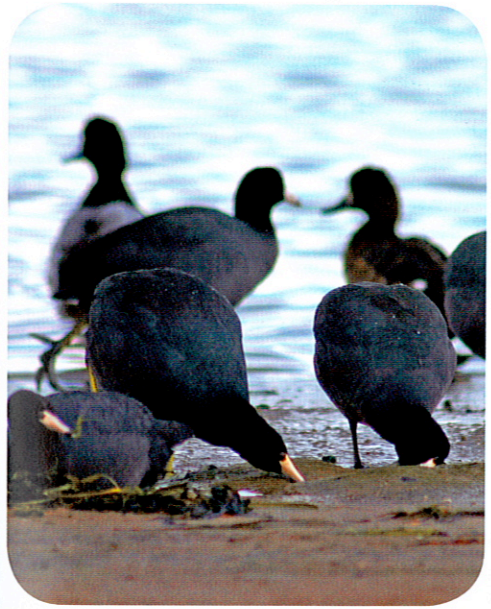
Class: *Aves* | **Order:** *Anseriformes* | **Family:** *Anatidae*
Morphology: Small compact diving duck. Length: 13 - 17 inches. Weight: 1.5 to 2.0 pounds. Yellow eyes, blue bill with small black nail at tip.
Communication: Utters a soft cooing and whistles notes in courtship. Males make a discordant "scaup" noise; females are silent.
Range: Boreal 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").

Sources:

Brown, Lloyd A. The Story of Maps. New York: Dover Publications, Inc., 1977.

Harlow, Neal. Maps of the Pueblo Lands of San Diego 1602-1874. Los Angeles: Dawson's Book Shop, 1987.

Howser, Tony. "A Scalable Skill Certification Program in GIS." Email Interview San Diego State University, San Diego Mesa College, SD City Schools, and National Science Foundation Grant. 2005.

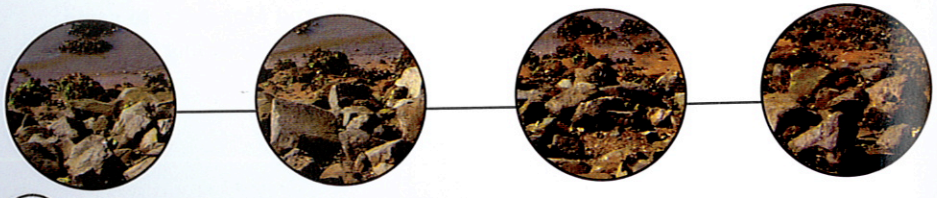
NCGIA Core Curriculum in GIS Science. Comp. Kirvan, Anthony P, et all.1997. *Department of Geography, University of Texas at Austin*, USA. 27 May 2005 <www.ncgia.ucsb.edu/education/ curricula/giscc/units/u014/u014.html>.

O'Connor, J J., and E F. Robertson. Longitude and the Académie Royale. Feb. 1997. 27 May 2005 <http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Longitude1.html>.

Photogrammetry Explained. 2005. DARTmap.com. 27 May 2005 <http://www.dartmap.com/faq_-_photogrammetry.htm>.

Strickland, Muriel. Introduction. Mapping San Diego County: An Introduction to the Holdings of the SDHS Archives Map Collection. San Diego: San Diego Historical Society. 2005.

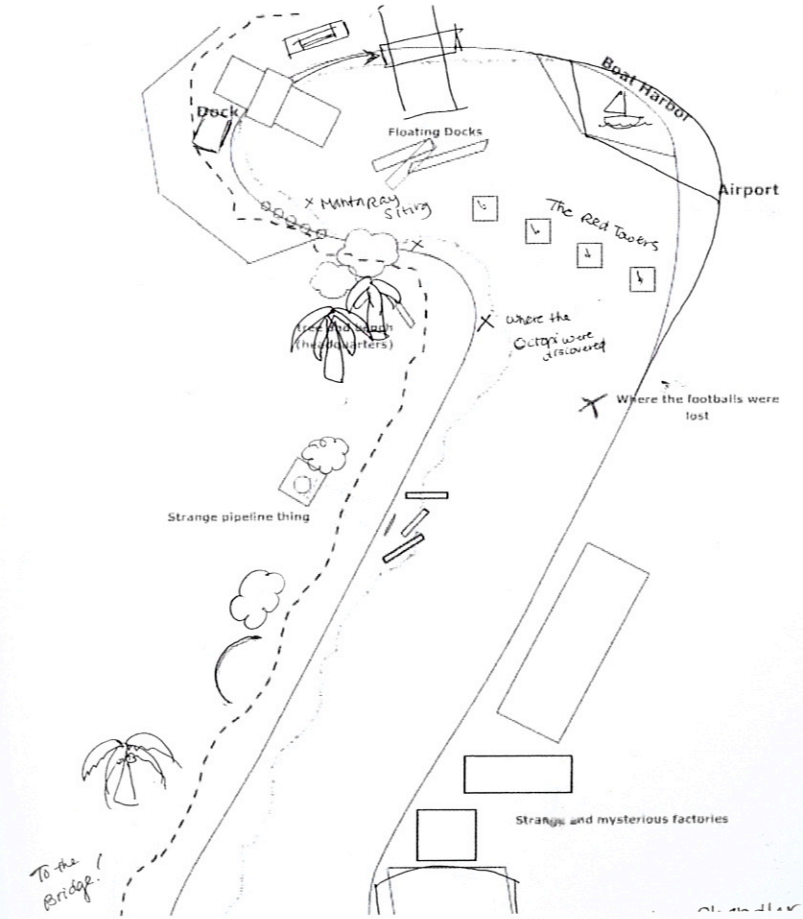
Strickland, Muriel. Personal interview. 25 May 2005.



Mapping Technique Comparison

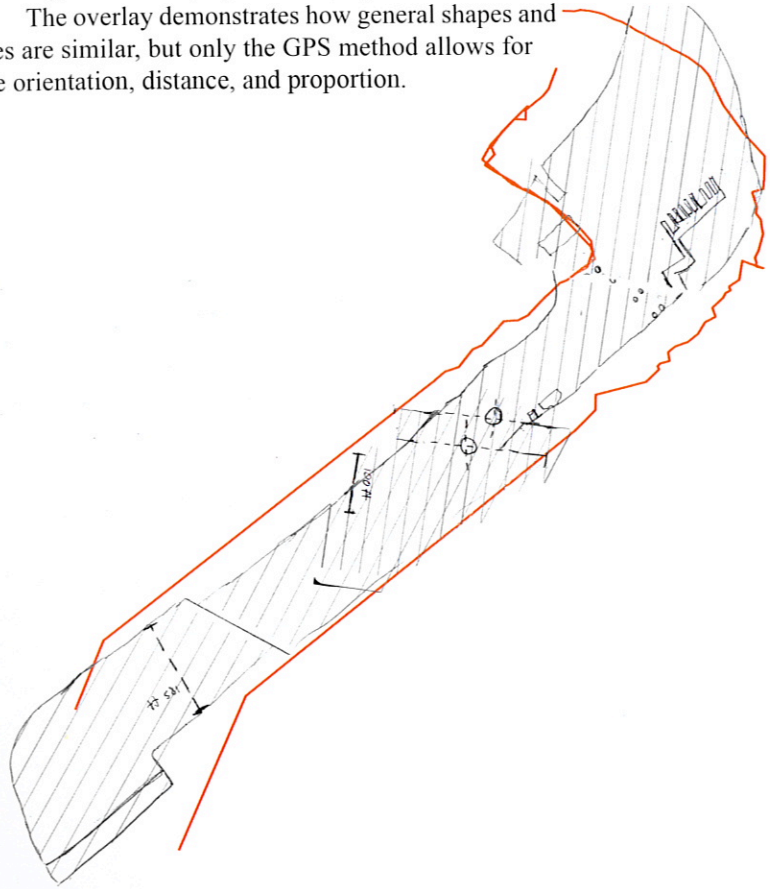
As technology has advanced, so has the ability to accurately record spatial data on maps. Below are a few examples comparing multiple techniques of mapping the same area. All of these maps are representations of the Boat Channel, an extension of the San Diego Bay.

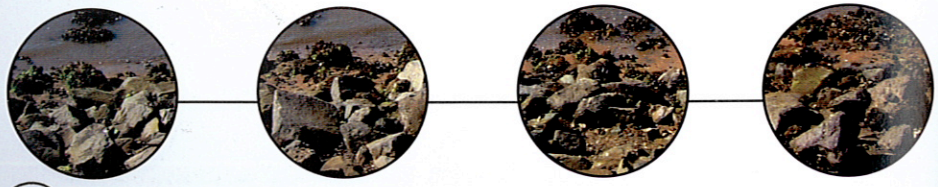
The following is a diagram that was drawn while standing on the shore using visual cues to create a representation of what the artist thought the Boat Channel looked like from above. Obvious landmarks are represented on the map with only an approximation of distance and proportion. This technique is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

BIOGEOGRAPHY

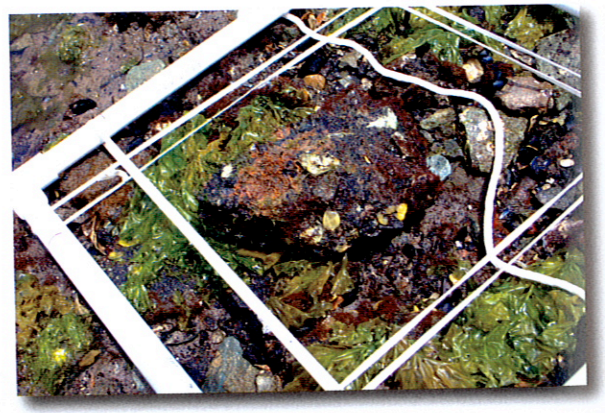
Introduction

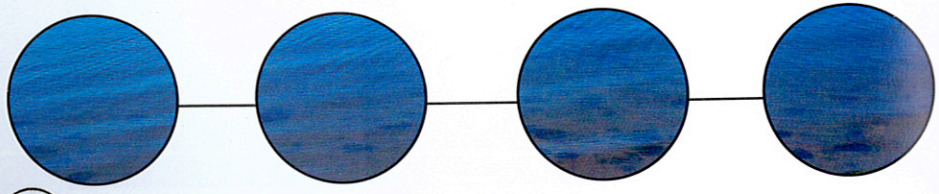
One of the main aspects of this guide was a study in species abundance and diversity across northern San Diego Bay, from the Coronado Bridge to the mouth of the Bay. As humans and nature continue to clash, as artificial replaces natural, this guide provides insight into the spectrum of intertidal creatures that have survived throughout the Bay. In order to assess the living creatures, various sites were surveyed across the coastline of the Bay. Harbors, inlets, channels, and beaches were a few of the places that the survey teams looked through in their search for life.

Sections of shoreline were laid with transects to observe, quantify, and classify the creatures at certain tide heights. The goal of this study was not only to compare life across the bay, but also to describe the changes in habitats at different tide heights of the intertidal zones. Once the creatures had been counted and archived, geography and cartography was needed to display and make sense of the vast amounts of data that had been collected over a three-month period.

It was predicted that the species abundance and diversity would differ by location due to several factors. The causative variables may include the distance from the ocean (mouth of the bay, enclosed harbor compared with open channel), and the differences in human activity at the site.

The biodiversity study of this field guide called for a need to accurately plot species distribution across the bay using our own form of biogeography. In order to give this data spatial meaning, Geographic Information Systems (GIS) were used to place the data throughout San Diego. Satellite photography, coastal surveys, and GPS data collected by the survey teams were combined to generate maps showing species distribution throughout the bay. With the help of modern GPS technology, the survey teams were able to place the data extremely accurately.





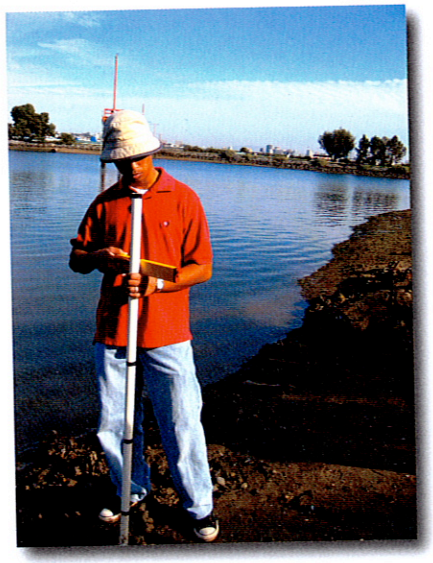
Methods of Data Collection

To quantify the species at a given location, we had to have a system by which we would measure them. The first step was to create a grid by which we could count and quantify the creatures within the grid. A 0.5 meter by 0.5 meter square frame made of PVC pipe made the outline of our grid. Due to the sheer size of a 0.25 meter^2 square, only the corners of the 0.25 meter^2 plot were used. By stringing line across our plot, four 10 cm by 10 cm square, were made at each of the four corners of the 0.25 meter^2 plot.

The next step was to know where to place the plot in order to count the creatures at the different tidal heights along the beach. To begin, a tide chart from SIO was used to find the exact time at which the low and high tide would be at a 0 foot tide height. A pole was then placed in the ground to mark the 0 foot spot. Once we knew where the 0 foot mark was, five ropes were laid perpendicular to the water line approximately 2 meters apart from each other to create transect lines on the shore. Along each transect line at the 0 foot tide mark a plot was placed on the ground.

Next was to observe the creatures underneath each plot. Only the 10 cm by 10 cm squares at the 4 corners of the plots were used to observe what was inside

them. For each of the 10 cm by 10 cm squares, the composition of the ground (rock or sand), and the type and number of a particular species were recorded. Once each of the four corners had been recorded, the plot was moved.



To address the intertidal zonation at each site we used a novel method to precisely find the location of the -1', 0', +1', +2', +3', and +4' tide heights. From the marker pole that was placed at the 0' tide height, one foot was measured up from the bottom of the pole. At that point, a laser attached to a bubble level was leveled and then shot until it hit somewhere on the transect line +1 up the slope from the previous survey mark. The point where the leveled laser hit the transect line was the +1 foot tide height location.

The plots were then moved up the transect line and everything was surveyed once again at the +1 foot tide height mark. This method alleviated the necessity to wait for the tides to come in and out. The process was repeated until all of the tide heights along the transect line were surveyed (from -1' or 0' to +5'). Once this happened, the transect line was picked up and in a leap-frog fashion was placed another 2 meters down the beach.

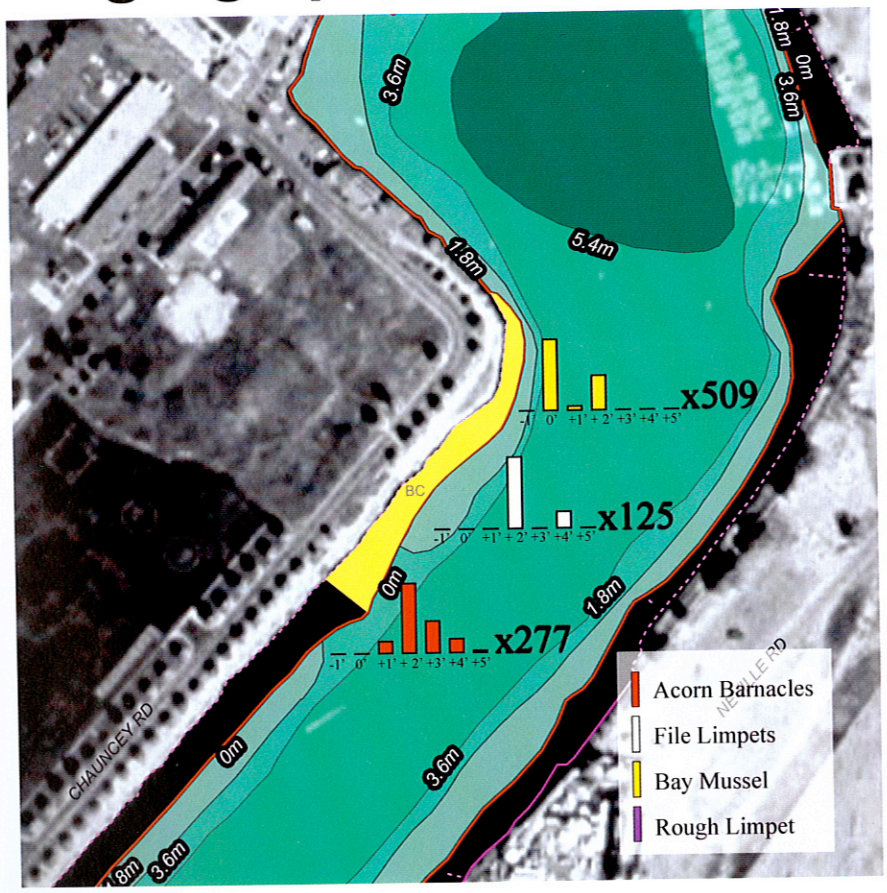
When the transect line was placed down again, all of the steps repeated until a substantial portion of a particular beach had been surveyed. Each site included 15 to 30 transects.

While the survey data of the living creatures was being collected, the geographic portion of the survey had to also be created. For each of the sites that were surveyed, GPS units were used to mark the boundaries of a particular survey site. These were obtained by collecting the GPS coordinates for each of the corners of the area being surveyed and then plotting out the area on a computer.

Once we had a polygonal plot of the survey area, the location could be then geo-referenced to satellite imagery and other survey plots to generate the maps that showed the distribution of species across San Diego Bay.

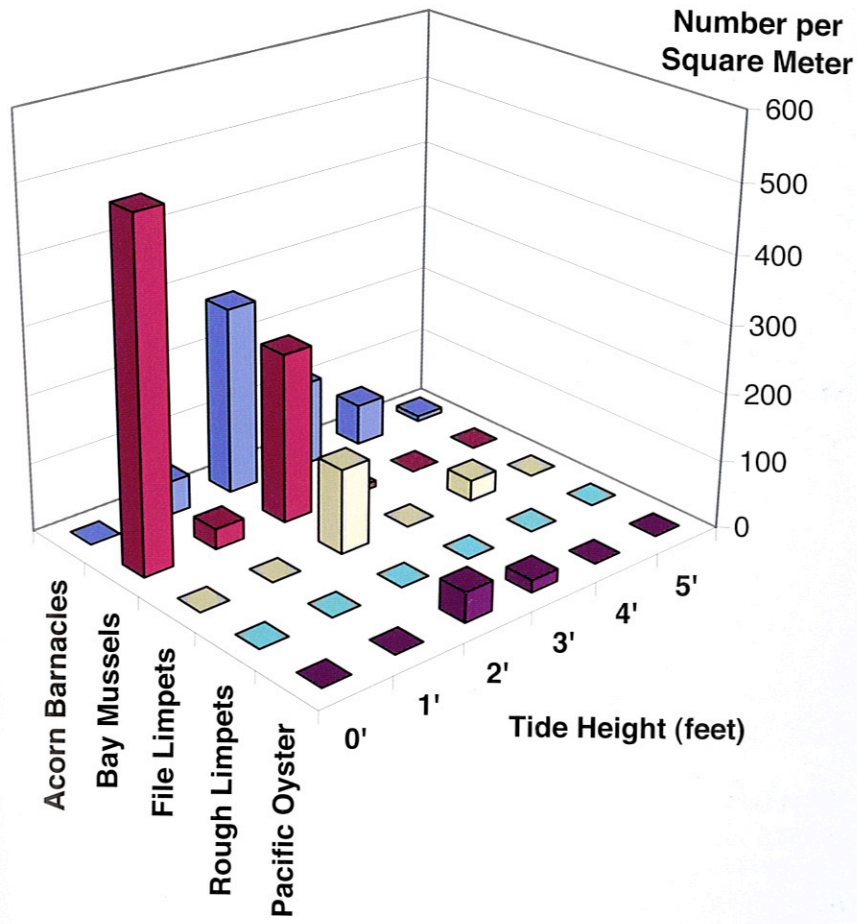
There was one instance in which we had access to a system called a differential GPS. While normal GPS units have an accuracy of approximately 20 feet, a differential GPS has accuracy to within 8 inches. After collecting data and using algorithms that correct for atmospheric interference, extremely accurate survey results can be collected. At the Coronado survey locations, we were able to use this system to map out the locations of the individual plots; a feat nearly impossible with normal GPS units.

Biogeography



The above map displays a portion of the Boat Channel where the biodiversity survey was conducted. The area in yellow is the approximate extent of the survey transects. The flat bar graphs on the image above represent the abundance of the four most common species arranged by tide heights. The bar on the far left is the abundance of creatures at a -1 foot tide height while the bar on the far right is the abundance at a +5 foot tide height. The highest count per creature was set as the 100% mark and the other bars were scaled to match that. As a result, the graphs are not proportionate to each other. A scale factor is immediately to the right of the graph. For example, a scale of x227 means that the maximum value of that one graph is a count of 227 creatures per square meter.

Tide Height and Species Distribution at The Boat Channel

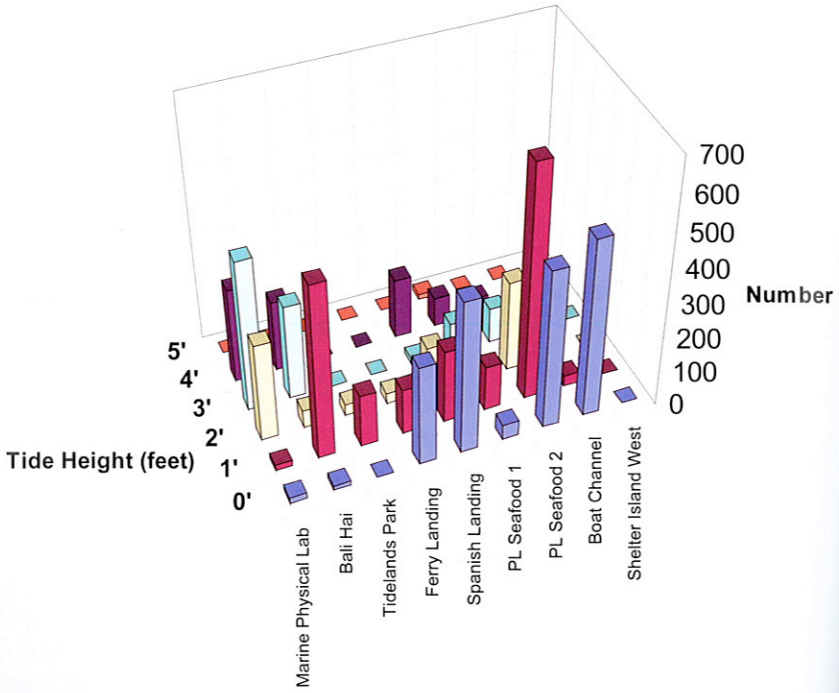


The above 3D graph represents the abundance of a certain species at a certain tide height. In the Boat Channel, acorn barnacles and mussels are the most common and appear in the lower tidal elevations from 0 feet to 3 feet. There were also an unusually large number of file limpets found at the 2 foot tide height. No rough limpets were found at this site.

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.

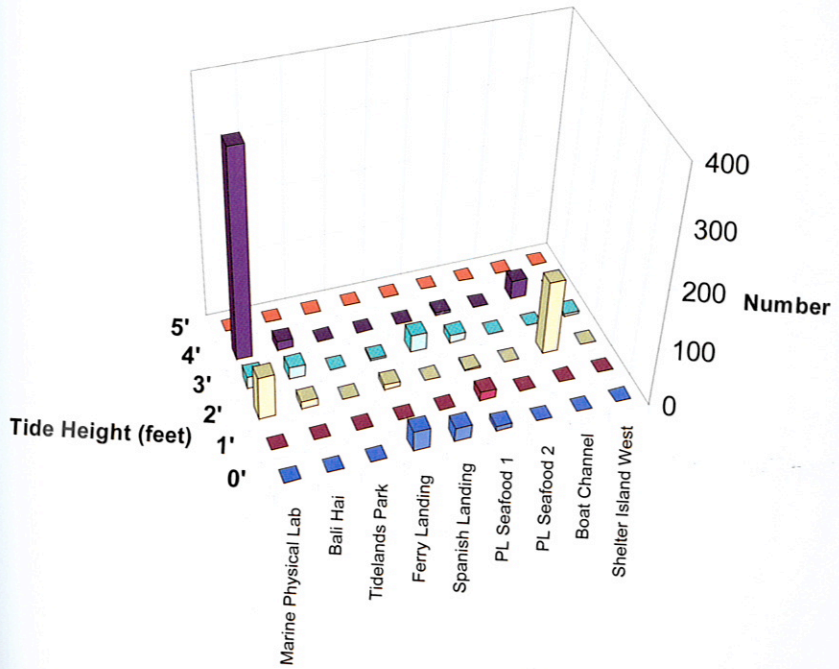
Tide Height and Abundance Across San Diego Bay for Bay Mussel

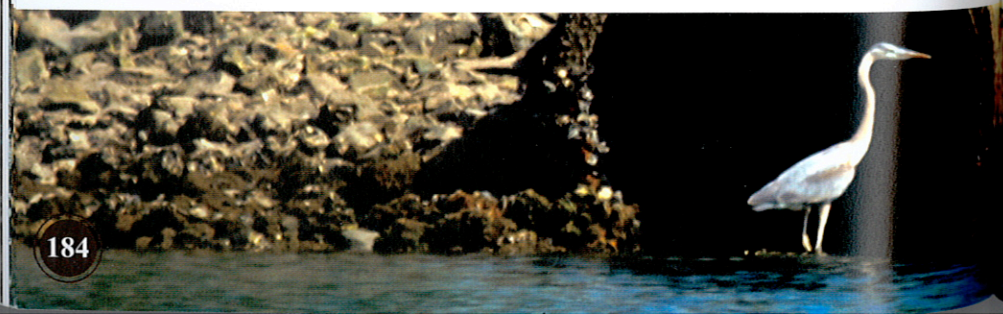


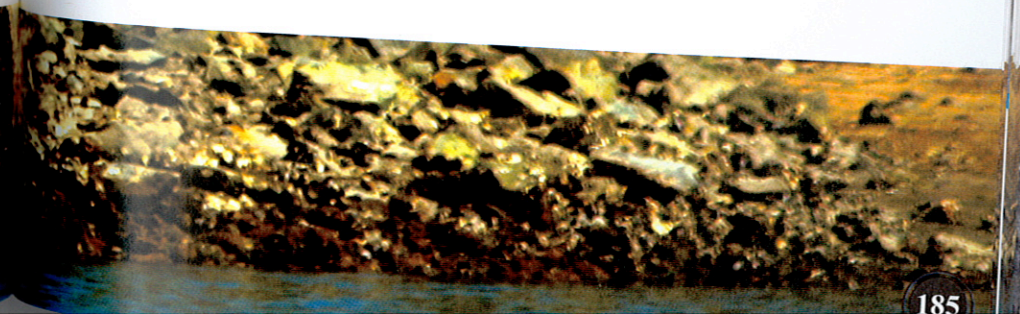
File Limpet

A large number of file limpets were found 4 feet above mean 0 ft 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







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—George B. Schaller, Wildlife Conservation Society, New York

The students of the Gary and Jerri-Ann Jacobs High Tech High School are pleased to present this exploration into the many facets of the San Diego Bay. Merging cartography, humanities, biology, and art, we have created a comprehensive guide that not only explains concepts and creatures, but also draws connections among the possibilities that exist within San Diego's waters. *Perspectives* is more than just a field guide; it is a way to see the Bay from all angles and a means to fully pay tribute to a web of interconnectivity revealed through research and reflection.

Along with a detailed guide to the intertidal creatures found around the Bay, we outline the impact of humanity on the Bay, through a series of biodiversity research studies and original works of creative writing. Poetry and nature reflections provide a parallel between the science and the spirit of the Bay, while state-of-the-art mapping techniques and GPS navigation bring deeper meaning to each location.

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