

# Elkhorn Slough Reserve Watershed and Wetlands Activity Guide For Teachers and Parents



Materials in this manual were developed with continued support from the following agencies:



## **PREFACE**

**Activities: All are located on the Elkhorn Slough Reserve Education website:**

<https://www.elkhornslough.org/education-program/teacher-resources/>

The goal of our efforts as educators at the Elkhorn Slough Reserve is to engage students outside on our trails and in our Visitor Center, but we understand that this is not always possible. This guide supports a teacher or parent to take the lead and utilize their closest natural place.

The materials in the Elkhorn Slough Environmental Education Activity Guide include a blend of individual and group activities that can be done at school or at home. Our intent is that students will be able to experience the wonders of nature with a hands-on, scientific focus. As well, there are opportunities to explore the human dimensions of conservation and stewardship.

Feel free to use the information in this guide in any way you see fit; assign reading of the different Introduction section, assign research using the Background resources, create your own vocabulary exercises using the Estuary Vocabulary list in the Background, explore the different habitats through an art project, or use any of our activity sheets found in this document or on our website under Teacher Resources!

We hope the material in this guide will provide support for you in your efforts to expand environmental literacy and help you engage your students from the classroom or at home.

An abundance of beauty, humor, and truths that can seem 'stranger than fiction' are out there waiting to be understood.

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**Activities: All are located on the Elkhorn Slough Reserve Education website:**

<https://www.elkhornslough.org/education-program/teacher-resources/>

## ~Section 1~

# Introduction to The Elkhorn Slough Reserve

Monterey Bay and its coastal zone are among California's most valuable natural resources. As our state's coastal wetlands continue to face challenges such as encroaching development, the preservation of these natural features becomes more critical. Although most of California's coastal marshes and wetlands have been drastically altered, several areas with significant natural attributes remain and are now protected. One of these is a relatively undisturbed example of a seasonal estuary, Elkhorn Slough, located in the central Monterey Bay area.

Elkhorn Slough is one of California's last remaining examples of an estuary. Elkhorn Slough Reserve is a State Ecological Reserve, owned and managed by the California Department of Fish and Wildlife since the 1970s. In 1979, the Elkhorn Slough Reserve was designated as a National Estuarine Research Reserve (NERR). The Reserve serves as a field laboratory where scientists can study this system and a place where students and the general public can learn about estuarine ecology in a natural setting.

The future of this and other estuaries and wetlands depends upon our young people and you. The California Department of Fish and Wildlife in partnership with the National Oceanic and Atmospheric Administration (NOAA) through the National Estuarine Research Reserve System work together to protect this unique California coastal wetland environment. As tomorrow's decision makers, young people will need a basic understanding of wetland and estuary importance, and possible outcomes that could result from loss of these fragile habitats.

The NERR (and NOAA) mission includes a commitment to K-12 and community education. The Education Program supports teachers to provide students with the experiences and knowledge they need to develop environmental literacy and to become environmentally responsible citizens in our local watersheds. The Reserve also offers a Visitor Center with interactive exhibits, over five miles of hiking trails, a microscope teaching lab, educational kits, and professional development opportunities for teachers.

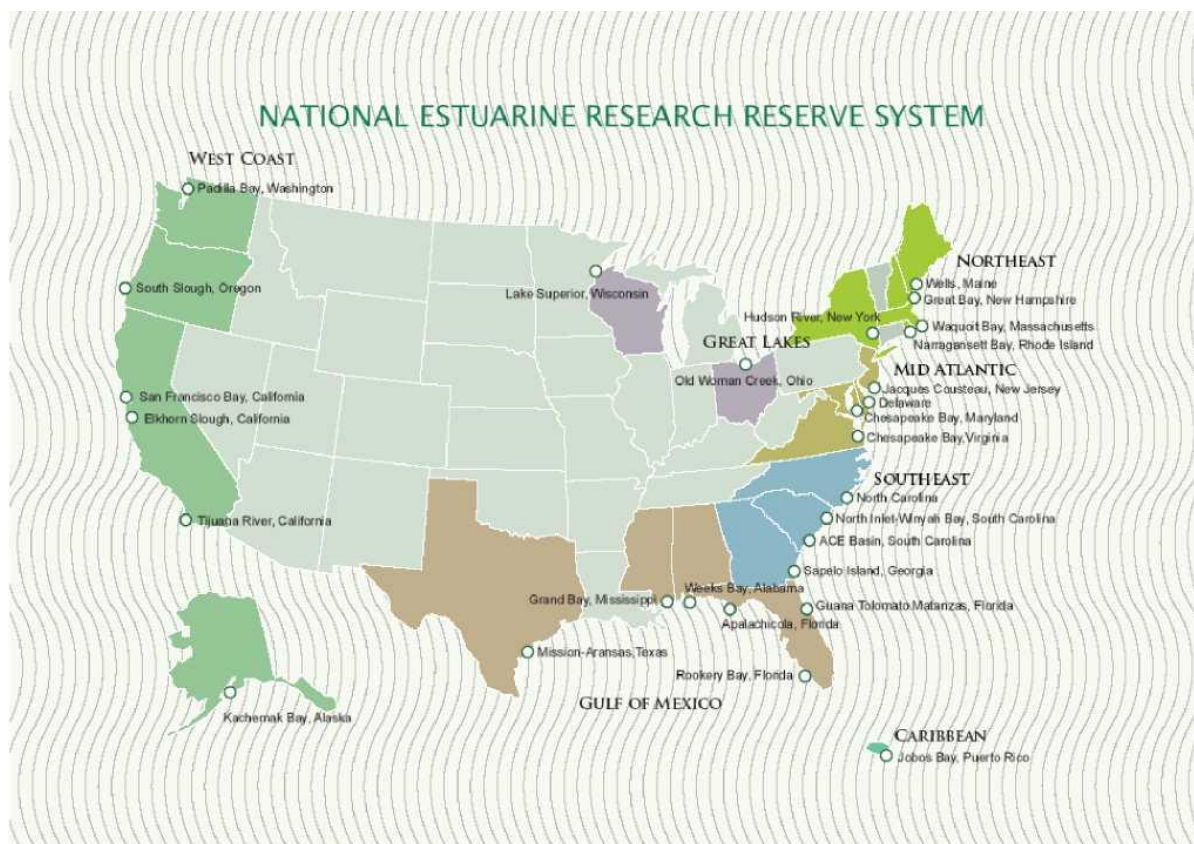
The material in this Curriculum Guide mostly focuses on the Elkhorn Slough Reserve; we hope the concepts and principles shared will result in a broader understanding and appreciation of other coastal wetlands. This knowledge could provide a vital step towards intelligent decisions in the future concerning use and misuse of estuaries and other wetlands.

The Elkhorn Slough Reserve (**Reserve**) protects over 1700 acres of mudflats, coastal marsh, and upland habitats. The Reserve is owned and managed by the California Department of Fish and Wildlife and operated in cooperation with the National Oceanic & Atmospheric Administration (NOAA). The Elkhorn Slough Foundation (ESF) is a non-profit land trust located on the Reserve site.

# The National Estuarine Research Reserve System

Established by the Coastal Zone Management Act of 1972, the National Estuarine Research Reserve system is a partnership program between the National Oceanic and Atmospheric Administration and the coastal states. The reserve system is a network of 28 areas representing different biogeographic regions of the United States that are protected for long-term research, water-quality monitoring, education and coastal stewardship.

Reserve staff work with local communities and regional groups to address natural resource management issues, such as water quality, habitat restoration and invasive species. Through integrated research and education, the reserves help communities develop strategies to deal successfully with these coastal resource issues. Reserves provide adult audiences with training on estuarine issues of concern in their local communities. They offer field classes for K-12 students and support teachers through professional development programs in marine education. Reserves also provide long-term water quality monitoring as well as opportunities for both scientists and graduate students to conduct research in a "living laboratory".



## A California Estuary

Elkhorn Slough is a seasonal estuary and a tidal embayment. During rains, freshwater falls and flows into the slough from the surrounding hills and mixes with salt water carried by tides from Monterey Bay and the Pacific Ocean. These aquatic and terrestrial environments form a complex ecological community that performs many natural and vital functions. This community:

- Traps sediments eroded from the surrounding hills and farms.
- Affords protection from flooding. The slough channels run-off into the bay after heavy storms. The salt marsh acts as a buffer for storm surge.
- Provides habitat and nursery for fish. Over eighty species of fish are known to use the slough waters at some time during their life cycle. Some key commercial fisheries species such as English sole use the Reserve's waters as nursery.
- Serves as a way station for tired and hungry birds. Over 340 species of birds have been recorded in and around the slough including resident and migratory birds.
- Supports habitat (home) for numerous plants and animals - some of which are rare or endangered species.
- Provides many opportunities for recreation and wildlife viewing.

### Natural Setting

Elkhorn Slough is located midway between the coastal towns of Santa Cruz and Monterey on the Monterey Bay. Moss Landing town and Harbor is situated at the mouth of the slough. The Monterey Submarine Canyon is at a distance of one mile from shore. The submarine canyon is the largest in Western North America, over 3,000 feet deep and 25 miles from shore water depths of nearly 2 miles have been recorded. Often shared is "the canyon is so deep and wide that it could contain the Grand Canyon".

Prior to 1910, the Salinas River shared a common mouth with the slough, as well as Tembladero and Moro Cojo Sloughs. Together, they emptied into the bay north of Moss Landing at what is today Moss Landing State Beach. The mouth of the Salinas River was diverted to its present course south of Moss Landing sometime around 1910, although the precise date and cause are unknown. The Salinas River had contributed significant freshwater flows to the sloughs during rainy seasons, and its diversion presumably changed the character and ecology of these wetlands. The construction of Moss Landing Harbor in 1946, with jetties creating a permanent and deep opening to the bay, has served to increase the tidal flushing of the slough and is responsible for a range of significant changes in its ecology since that time.

For a complete synopsis of significant changes over time please refer to the shared website [www.elkhornslough.org](http://www.elkhornslough.org). Search our Tidal Wetland Project pages, as well as Research and Stewardship restoration projects.

## **Habitats**

### **Beach and Dunes**

Barrier dunes and beaches are along the western edge marking the estuary from Monterey Bay. The persistent forces of wind, waves, and tides shape this coastal habitat. Plants such as Sea Rocket, Sand Verbena, Dune Grass, and Mock Heather are among the plants that have adapted to this dynamic environment.

### **Between the tides - Estuary - Mudflats and Marsh**

The interface between the land and water is a dynamic natural arena in the slough. This edge is continually affected by changes in the tide and by rain and run-off from the land. Pickleweed, Alkali Heath, Salt Grass, Jaumea and Salt Bush are among the terrestrial plants that have adapted to life at the very edge of this ever-changing zone. These plants provide shelter and raw materials that help fuel the estuary. Every nook and cranny of this habitat is occupied -it teems with life.

The shallow, sheltered waters of the estuary support an abundant population of tiny plants and animals called plankton. These are the foundation of the estuary food web. Many organisms burrow into the soft sediments of the slough. Numerous invertebrates inhabit the marsh and mudflats where they feed on algae and detritus.

Estuarine waters provide excellent spawning and rearing habitat for many kinds of fish that find protection from predators and an abundant supply of food. The slough is a nursery for many species of fish including the Leopard Shark, California Bat Ray, Surf Perch, Top Smelt, Flounder, English Sole and Staghorn Sculpin.

Many species of birds utilize the waters of the estuary. Egrets, Herons, and innumerable shorebirds find a rich and varied diet in the marsh and intertidal mud flats. Terns, Pelicans, Osprey, Grebes, Loons and Kingfishers are attracted by a plentiful supply of fish.

Deer, raccoons, skunks, opossums, bobcats and more also depend on the slough's resources. Harbor Seals, Sea Lions, and Sea Otters regularly utilize the slough waters for feeding and resting and to raise their young.

### **Uplands**

The uplands surrounding Elkhorn Slough form a diverse terrestrial habitat which further enhances the value of the Reserve as a sanctuary to wildlife and human visitors. Coast Live Oak, grasslands and chaparral areas each provide specific habitats. The complex web of interactions within these communities and between them is an integral part of the larger estuarine ecosystem.

Exotic plants such as thistle, hemlock and various grasses are predominant in old grazing fields. Some of these weedy species provide food and cover for wildlife. Grasshoppers, beetles, and

spiders feed in open fields. Attracted by these insects and seeds, birds come from nearby woodlands to feed. Finches, sparrows, meadowlarks, and black birds are commonly seen. Red-tail Hawks, Red Shoulder Hawks, and White-Tailed Kites, among many others, hunt for small rodents that inhabit these communities. At night the Barn Owls and Great Horned Owls hunt these rodents as well.

Oak woodlands covering the hillsides surrounding the estuary provide valuable habitat for untold numbers of wildflowers, woodland birds, and other creatures. These woodland slopes also perform several important natural functions. By retaining soil and water, woodlands prevent erosion along the estuary shoreline. Within the woodlands, essential nutrients are released from decaying plants and animal life. As these nutrients are washed toward the shoreline, estuarine waters are enriched.

Several areas on the Reserve are in the process of restoration to native plants. These projects will enhance the value of the Reserve for the wildlife that are here year-round and those who are simply passing through.

## **Cultural Stories**

Early human use of Elkhorn Slough dates back more than 10,000 years. These early people hunted Tule Elk and waterfowl, and they gathered shellfish that were abundant in slough waters. Over several thousands of years several migrations brought people into this area and a large complex society developed. Today, scattered middens or shell mounds, and other archaeological evidence indicate sites of these seasonal and permanent villages. Today, ancestors of these first peoples are still here and their stories continue.

In the 1700's the first peoples of this area were folded into the Spanish Mission system and many died from disease and conflict. By the 1800's, American settlers had established homes and farms in the surrounding uplands. Fields and orchards dotted the hills and valleys of the Elkhorn area. Hudson's Landing, in the upper northern reach of the slough, served as a port for the Watsonville area. Grain from nearby farms was shipped down the slough to Moss Landing, where it was loaded onto coastal schooners bound for San Francisco.

The Southern Pacific Railroad expanded rail service into the Watsonville-Salinas area in the 1870's. The rail bed was laid along the edge and through of the slough. Most immediately the need for coastal shipping was reduced, thus changing an industry. The railroad levee also became one of the first and fairly significant human-made embankments.

Resource use surrounding the slough has changed over the last 100 years. Today there is a dairy farm, livestock and agricultural operations as well as residential living right up to the Reserve boundaries. Moss Landing at the mouth of the slough, is home to one of the busiest fishing ports in the State and shares the lower slough with an energy power plant. A number of important scientific and educational organizations have facilities there as well. These include the Moss Landing Marine Laboratories, Monterey Bay Aquarium Research Institute and, on the eastern edge of the slough, Elkhorn Slough National Estuarine Research Reserve

## ~Section 2~

# Elkhorn Slough Reserve Activities

The Education Team has compiled a wonderful collection of activities and resources that will help teachers and parents make important environmental education connections for their students. The Reserve curriculum is broken in to three grade bands K-5, 6-8, and 9-12. A summary of the offerings is in this chapter. The actual lessons and activities are on the website in the grade band folders. Most of the offerings were adapted from Reserve curriculum and re-designed to be done at school or your own back yard.

### **For Teachers - Next Generation Science Standards**

We are excited to announce that all our activities and kits have been evaluated through the Next Generation Science Standards lens. We acknowledge the value of the NGSS in setting a bar for creating environmental education programs that encourage investigation, exploration, analysis, and engagement, and move students towards environmental literacy. This new framework is based on designing a program that allows students to continually build on and revise their knowledge and abilities over multiple years and supports the integration of such knowledge and abilities with the practices needed to engage in scientific inquiry and engineering design. As you explore this chapter you will find that we have organized our activities in grade bands (K-5, 6-8 and 9-12), and that we have provided detailed descriptions on how they align to the three dimensions of the framework:

- Scientific and engineering practices
- Crosscutting concepts that unify the study of science and engineering through common application across fields
- Core ideas in four disciplinary areas: physical sciences, life sciences, earth and space sciences, and engineering, technology applications of science

While all our activities and kits have been reviewed through the lens of GSS they are not meant to satisfy the standard, merely support. These details are listed on each activity description. Additionally, this manual does not provide guidance for how teachers use NGSS, and so we recommend visiting the website for more detailed explanations:

<http://www.nextgenscience.org/>

**Reserve Activities: All are located on the Elkhorn Slough Reserve Education website:**

**<https://www.elkhornslough.org/education-program/teacher-resources/>**

Additional resources are placed at the end of this section.





Elkhorn Slough  
National Estuarine  
Research Reserve

# Elkhorn Slough Reserve

## Slough Sleuthing – Grades K-5

**Slough Sleuthing** is all about observation; what can you see with your eyes and hear with your ears?

### Trail Walk

Slough Sleuthing - Trail walk

NGSS:

SEP: Asking questions and defining problems

DCI: LS4.D Biodiversity and humans. LS2. Ecosystems

- K-2: A range of different organisms live in different places
- 3-5: Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.
  - Ask about available resources to enrich your walk

**Activities below are located on the Elkhorn Slough Reserve Education website:**

<https://www.elkhornslough.org/education-program/teacher-resources/>

### Field Exploration

*-For Use on school yards or backyards*

One Hundred Inch Hike

Insect Shake

Observation Rings (for practicing observations)

### Activities

*-For use in Classroom or home-*

What Beaks Eat (adaptations, form and function, patterns)

Wetlands Metaphor (Language Arts activity)

Build a Wetland Model (Earth systems, using models, and human impact)



# Elkhorn Slough Reserve

## Wetland Wonders – Grades 6-8

Through the exploration of **Wetland Wonders** middle schoolers learn to ask questions and investigate the world around them.

### Trail Walk

Wetland Wonders - Trail walk

NGSS:

SEP: Engaging in argument from evidence

DCI: LS2, LS4

- 6-8: Interdependent Relationships of Ecosystems, Cycles of Matter, and Ecosystem Dynamics: Changes in biodiversity can influence humans' resources and ecosystem services they rely on.

Activities below are located on the Elkhorn Slough Reserve Education website:

<https://www.elkhornslough.org/education-program/teacher-resources/>

### Field Exploration

*-In the school yard or back yard-*

Insect Shake

Biodiversity Survey - iNaturalist or data sheets

*-For use in Classroom or home-*

What Beaks Eat

Build a Wetland

# Elkhorn Slough Reserve

## The Watershed and You – Grades 9-12



*The Slough and You* activities encourage High School students to pause and consider the human impacts they are observing around them and to discuss solutions and alternative scenarios.

### Trail Walk

Human Impacts – Trail walk

NGSS:

SEP: Engaging in Argument from Evidence

DCI: ESS3, LS2, LS4

- 9-12: Biodiversity is increased by formation of new species and reduced by extinction. Humans depend on biodiversity but also have adverse impacts on it. Sustaining biodiversity is essential to supporting life on Earth.
- Ask about available resources to enrich your walk, and human impact worksheet

**Activities below are located on the Elkhorn Slough Reserve Education website:**

<https://www.elkhornslough.org/education-program/teacher-resources/>

### Field Exploration Kits

-For use on school yards or back yards-

Biodiversity Survey – iNaturalist or data sheets

-For use in Classroom or at home-

What Beaks Eat (Data Analysis)

Build a Wetland



# Elkhorn Slough Reserve

## Exploring Nature with Your Students

**Take your kids for a walk around the block! Or out to a neighborhood park!**

Plant and animal names help us to organize our knowledge, but they don't tell us much about the way an animal moves or an oak tree fits into its environment. We learn about our world by watching quietly, listening, and being aware of our surroundings. So, to those of us unaccustomed to such exploring-please relax and enjoy the day. Listen to your adventurous spirit. Let your imagination and enthusiasm guide you. Your students will follow suit.

### **Learn with the Student**

Don't feel like you need to be a "walking encyclopedia" of facts to lead a good field trip. How you react to something speaks so loudly that often people don't hear what you are saying. Be an enthusiastic facilitator rather than a boring lecturer. Most students will tune us out after two or three minutes of speaking, anyway. Don't be afraid to say, "I don't know, but let's find out."

### **Reinforce Discovery**

When a student points out or brings you a snail, insect, or flower, this is the most important thing in the world to him or her. Respond with enthusiasm to the discovery and call the group together if possible to share the find. After examining it, be sure to replace it. Enthusiasm is a greater catalyst than knowing a bunch of names.

### **Use Questioning Skills**

Discussion is better than lecture at encouraging participation. Open-ended, stimulating questions encourage thinking. "Why is this animal living here?" "What would you need to live here?" "Does this animal have anything that helps it live here?" These are examples of questions that promote thinking and group interaction.

### **Label Last**

We are a culture of labelers. Often, once we know the names of something we turn off our attention, put it in a neat little box and search for something else to label. Names are good to know; so is information on what something is, where it lives, and what it does.

### **Ouch! Ouch! Ouch!**

Be the voice of the plants and animals when students, in their eagerness, get careless. Impart an environmental ethic without a negative tirade or embarrassing the youthful explorer.

### **Planning the Outdoor Trip**

It is important for us as leaders and teachers to have a plan for an outdoor activity just as we would for one in the classroom. Do you want to write? Collect plankton? Go on a 100" Hike? Complete the South Marsh Loop Trail? These are valuable activities. However, please let the plan be a flexible guide. Is there a teachable moment? Please use it! Let go of the plan and focus the students' attention on what they are noticing. They'll remember it.

## ~Section 3~

# Background Material and Additional Resources

### Estuary Education – National Estuarine Research Reserves

This suite of estuary education resources help educators bring [estuarine science](#) into the classroom through hands-on learning, experiments, fieldwork, and data explorations. These specially designed lessons, activities, [data explorations](#), animations and videos can be used independently or as a supplement to existing curricula and can be adapted to meet any grade level

<https://coast.noaa.gov/estuaries/curriculum/>

### Elkhorn Slough Reserve

Educational resources for teachers and parents to use in the classroom or at home focused on the habitats, plants, and animals in the Elkhorn Slough watershed.

<https://www.elkhornslough.org/education-program/teacher-resources/>

**Elkhorn Slough Reserve – Slough Life:** Explore the plants and animals of the Elkhorn Slough Reserve. Great resources for reports and science projects.

<https://www.elkhornslough.org/slough-life/>

**Elkhorn Slough Live Otter WebCam:** What are the otters doing? Check the live video feed!

<http://www.elkhornslough.org/ottercam/>

**Citizen Scientist Otter Monitoring:** Be a citizen Scientist and join the monitoring team! Use these data sheets while on the Otter Cam to help us learn more about the Elkhorn Slough otters, [this file](#).

**Save the Estuary:** Play the game! <http://games.noaa.gov/oscar/>

Climate Kids: Grades 4-6. NASA's Eyes on Earth hosts engaging on-line interactive games, activities, images, video, and content.

<http://climatekids.nasa.gov/>

### Tepapa New Zealand Museum

<https://www.tepapa.govt.nz/learn/for-educators> Build A Squid Project. Interactive activity.

Students! Learn about squid, build a squid and track your squid over the course of time.

<http://squid.tepapa.govt.nz/build-a-squid/interactive>

**Games at Planet Arcade:** This arcade is a portal to games and interactive activities focused on ocean and air themes. <http://games.noaa.gov/>



# ELKHORN SLOUGH RESERVE WORD SEARCH

Name \_\_\_\_\_

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K S C H W M D X P R D R  
R S A O G U A W W E T E  
A H R L M U N L E Z D S  
H M L U I A O W C W N E  
S R A Y E N E L O L V R  
T A R C I L I E S W E V  
G I O F K I S T Q S L E  
K R D C M T S B Y J U A  
W Q I E U C I F I C A P  
A P L A N K T O N R B R  
H E R O N D R I B A U J  
C Y X H O T N B Y B U A

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## Word Bank

BIRD	CLAM	CRAB	ESTUARY	PLANKTON
MUD	TIDE	WORM	PACIFIC	PICKLEWEED
OWL	RAY	SHARK	HERON	SALINITY
OCEAN	HAWK	RESERVE		SLOUGH



# Sopa de Letras para Elkhorn Slough Reserve

Name \_\_\_\_\_

N P N Á L I V A G E S O  
 G O I A L M E J A E A C  
 T A T C U A F V S B L I  
 I O V C K B G T A N I F  
 B N E I N L U N M Y N Í  
 U A K V O A E Q A N I C  
 R S P D R T L W R F D A  
 Ó U O I M A A P E L A P  
 N G O C É A N O A E D F  
 C A R P I N T E R O D Z  
 O J E R G N A C W H P G  
 P E L Í C A N O H Ú B Y

## PALABRA DEL BANCO

ALMEJA	TIBURÓN	CANGREJO	ESTUARIO
GAVILÁN	PLANCTON	LODO	MAREA
GUSANO	PACÍFICO	OCEÁNO	SLOUGH
	FANGAL	PICKLEWEED	BÚHO
PELÍCANO	GAVIOTA	CARPINTERO	SALINIDAD



# Insect Safari

## In your backyard!



Name \_\_\_\_\_

### I saw an insect that lives...

- under a rock
- on a plant
- in the water

### I saw an insect that eats...

- plant matter
- animal matter

### I saw an insect that moves by...

- Walking
- Climbing
- Swimming
- Flying

### I saw an insect that is mostly colored...

- Green
- Brown
- Black

**Draw a picture of an insect you saw today!**





# Elkhorn Slough Reserve

## More Teacher/ Parent Resources

- An estuary glossary for Elkhorn Slough
- English /Spanish wetlands vocabulary
- Identifying habitats a Elkhorn Slough
- Locating habitats at Elkhorn Slough
- Cool facts about Elkhorn Slough
- Climate change resources for teachers
- Marine and estuary education resources for teachers
- Marine and estuary education resources for students
- Some basic ecological concepts
- The education and environment initiative
- Ticks and tick-borne diseases in California
- Sudden oak death
- Amphibian chytridiomycosis
- California oak moths at Elkhorn Slough Reserve
- Ten things to know about butterflies at Elkhorn Slough
- Habitat preference of Elkhorn Slough butterflies
- Acorn woodpeckers
- Fishes of Elkhorn Slough

# An Estuary Glossary for Elkhorn Slough

**adaptation**- a physical or behavioral feature of a plant or animal that helps it to meet its survival needs.

**algae** - non-flowering plants without roots that include seaweeds and phytoplankton.

**anoxic**- water that is depleted of dissolved oxygen.

**autotrophic**- describes an organism that makes organic material (e.g. carbohydrates) from inorganic material; a primary producer; includes plants, phytoplankton, and some bacteria.

**benthos, benthic**- Bottom dwelling; non-planktonic; attached to or resting on the substrate.

**biodiversity** - Refers to the variety and variability among living organisms and the ecological complexes in which they occur.

**biota** - The animals, plants, and microbes that live in a particular location.

**brackish** - mixture of fresh and saltwater typically found in estuarine areas; water that is saline but not as salty as seawater.

**carnivore**- an animal that eats other animals.

**consumer**- an organism that eats plants or animals to obtain energy.

**decomposer**- organisms such as bacteria and fungi that feed on and break down dead plant or animal matter, making organic nutrients available to the ecosystem.

**diatom**- One of the large groups of phytoplankton. They are mostly single-cell plants and have cell walls made of silica (SiO<sub>2</sub>), or what you might call a “glass house”.

**dinoflagellate**- Another large group of phytoplankton. The name comes from the Greek language. “Dinos” means to whirl or spin, and “flagellum” means to have a whip-like tail. Under a microscope we can see them spinning.

**detritivore**- an animal that obtains nutrients by consuming detritus (plant and animal parts as well as fecal matter). Worms are important detritivores in Elkhorn Slough, aiding decomposition.

**dissolved oxygen (DO)** - the amount of free oxygen dissolved in water. DO is required by organisms for respiration in water. DO levels in estuaries widely fluctuate in response from natural and human influences.

**diurnal**- refers to activity during the day. For example, a Red Tail Hawk is a diurnal bird.

**ecology** - the study of the relationships of living things to one another and to their environment.

**ecosystem** - an interactive system of a biological community and its non-living environment.

**ecotone**- the transition zone between communities, such as between uplands and wetlands; transitional areas can be rich in flora and fauna, with elements from adjoining communities.

**endangered species** - a plant or animal that is in immediate danger of becoming extinct and needs protection to survive.

**erosion** - The process where soil and other matter are worn away by rain, stream currents, tidal currents, waves, and wind.

**estuary** - A partially closed coastal body of water where freshwater and saltwater mix; Elkhorn Slough is a seasonal estuary due to the seasonality of rainfall and runoff. Also, in some situations there are freshwater estuaries where lake and river water mix.

**exoskeleton**- hard, shell-like covering of some invertebrates.

**food chain**- energy follows a single path from producer to consumer (e.g. grass, vole, owl).

**food web**- A complex weaving of food chains where energy is transferred to all different trophic levels including bacteria and other decomposers.

**habitat** - the place and its surroundings in which a plant or animal normally lives and includes all the resources an organism needs for survival such as food, water and shelter.

**halophyte**- a plant that grows where it is affected by salinity in the root area or by salt spray.

**haulout**- an area on the shore where marine mammals rest.

**herbivore** - an animal that eats plants.

**holoplankton**- Zooplankton that spend their entire lives as plankton, such as the copepod.

**heterotrophic**- an organism that obtains its organic matter from the environment (usually from autotrophs); a consumer.

**hypoxia** - a condition of low oxygen in the water. This forces fish to either swim away or die and can suffocate plants in the water.

**intertidal**- the area between extreme high and low tide levels. Alternate wetting and drying of this area by the tide cycles creates unique and challenging environmental conditions and habitats.

**invertebrate**- an animal that does not have a backbone or spinal column (e.g. snails, worms, insects, and crabs).

**meroplankton**- Zooplankton that complete only a part of their lives as plankton. They then develop into such animals as fish, crabs, barnacles, sea stars and sea anemones.

**migration**- seasonal movement of animals from one place to another.

**mudflat**- nonvegetated wetlands on the edge of the saltwater subject to periodic flooding and minor wave action; provides habitat for invertebrates, fish, and shorebirds.

**National Estuarine Research Reserve**- a network of 28 protected areas established for long-term research, education and coastal stewardship authorized as part of the Coastal Zone Management (CZM) Act of 1972. Elkhorn Slough NERR is part of this system.

**neap tide**- tides with the smallest height difference between high tide and low tide, usually occurring during the moon's quarters; compare with spring tide.

**nekton**- all aquatic animals that can swim through the water against currents, including marine mammals, fish, squid and some crustaceans.

**niche**- the ecological role of an organism in a community especially in regard to food consumption.

**nocturnal**- animals that are active during the night.

**nonpoint source** - refers to pollution that enters estuaries from many places, such as when rainwater washes over parking lots, lawns, or farms and brings pollutants from all these sources.

**nutrient cycle**- natural processes that recycle nutrients in various forms from the environment, to organisms and then back to the environment; also called the biogeochemical cycle.

**omnivore**- an animal that eat plants and animals.

**pathogens** - disease-causing microorganisms such as viruses, fungi, and bacteria.

**photosynthesis**- the process by which plants convert light energy into chemical energy (such as sugars) using carbon dioxide, water, and minerals; primary production.

**phytoplankton**- microscopic photosynthesizing organisms that drift with the currents; microalgae including diatoms and dinoflagellates.

**plankton**- free-floating organisms drifting in water, unable to swim against currents; name derived from the Greek word *planktos* meaning 'wanderer' or 'drifter'.

**plankton bloom** – a rapid increase in the population of phytoplankton or zooplankton in an aquatic system. Blooms often color the water green, red or brown, depending on the species.

**producer**- organisms that use photosynthesis; terrestrial and aquatic plants.

**salinity** - a measure of the salt concentration of water; higher salinity means more dissolved salts; salinity of open ocean water is in the range 32-37 parts per thousand, averaging 35ppt.

**salt marsh**- a tidal wetland that is periodically covered by salt water and is dominated by halophytes.

**scavenger**- an animal that feeds on dead plants or dead animals.

**sea level rise**- long-term increases in mean sea level; currently refers to sea level changes due to the greenhouse effect and associated global warming.

**sediment** - mud, sand, silt, clay, shell debris, and other particles that settle on the bottom of rivers, lakes, estuaries, and oceans.

**spring tides**- tides with the greatest range between highs and lows, usually occurring near the full moon and new moon; compare with neap tide.

**slough**- a narrow, winding waterway, salty or fresh, edged with marshy or muddy ground.

**tidal creek**- channels containing salt or brackish water that flow with tidal changes.

**tidal erosion**- the process by which tidal flows erode banks and channel beds; sometimes called tidal scour. (also: tidal scour)

**tides** - the rise and fall of ocean waters produced by the gravitational influence of the moon and sun combined with the rotation of the earth.

**turbidity**- the measurement of water clarity; clarity is affected by sediment and plankton concentrations in the water.

**uplands**- lands lying above the reaches of the highest high tides.

**upwelling**- upward movement of water that usually occurs near the coasts due to winds driving surface water offshore, bringing nutrients from the depths of the ocean to the surface.

**vertebrate**- an animal that has a backbone or spinal column.

**watershed** - the area of land that drains into a particular body of water. The Elkhorn Slough watershed comprises 45,000 acres.

**wetland**- land areas that are seasonally or permanently waterlogged, including lakes, rivers, estuaries, and freshwater marshes and contain plants that can live in or around water.

**zooplankton**- animal plankton; many are microscopic but also include larger animals such as jellyfish. Some, such as copepods, remain plankton for entire life cycle, while others, such as crabs, are planktonic only during larval stages. Many have some power of locomotion, especially in terms of vertical migration, and use this to avoid predators or to increase their chances of finding food.

# English/Spanish Wetlands Vocabulary

beak – pico

prey – víctima

burrow – madriguera

predator – animal de rapiña

channel – canal

protect – proteger

endangered – en peligro

uplands – tierras altas

estuary – estero, estuario

wetlands – humedales

habitat – hábitat

slough – estero

marsh – marisma, pantano

mudflats – bancos de lodo

salt marsh – marisma del mar

tide – marea

migrate – migrar

sand – arena

Monterey Bay – Bahía de Monteréy

Owl pellet – bolita de Lechuza

species – especie

tracks – huellas

## Animals/Algunos Animáles

Barn Owl – Lechuza de Campanario

bird of prey – un ave rapáz

Great Egret – Garza Blanca

Snowy Egret – Garza de Dedos Dorados

Great Blue Heron – Garzón Cenizo

hawk – gavián

snake – culebra

gopher – tuza

raccoon – mapache

fox – zorro

plankton – plancton

crab – cangrejo

gull – gaviota

duck – pato

tern – charrán

pelican – pelícano

Woodpecker – carpenter

shorebirds – aves playeras

rat – rata

mouse – ratón

skunk- zorrillo

diatom - diatomea



# Cool Facts about Elkhorn Slough

**Elkhorn Slough is home to the second largest remaining salt marsh left in the state of California**, exceeded only by the expanse of marshes in eastern San Francisco Bay. These areas are made all the more precious by the fact that we have lost more than 90% of the wetlands in California.

**From the familiar and majestic mountain lions that roam the ridge tops** of the Elkhorn Slough watershed, to the peculiar and comical skeleton shrimp that cling to fronds of eel grass in the waters of the estuary, the Elkhorn Slough watershed is truly home to a variety of species.

**Conservation scientists have studied the habitats of the world and identified 25 areas of the greatest biological diversity**, (having the most numbers of different types of species.) The Elkhorn Slough watershed is right smack in the middle of one of these “biodiversity hotspots”. It even has a cool name, the California Floristic Province, and is right up there with the tropical rainforests of South America and the unique island habitats of Madagascar. (Conservation International website, [www.conservation.org](http://www.conservation.org))

**There are more than 100 different kinds of fish that make Elkhorn Slough their home** for at least some part of their life cycle. The estuary is a nursery ground for many species of fish that come into the slough from the open ocean seeking shelter and food for their young. The Leopard Shark (*Triakis semifasciata*) is an example, with the females swimming into the shallow waters of the tidal marshes and mudflats to give live birth to their young “pups”.

**There is a peculiar species of fish that lives in Elkhorn Slough** known as the “Longjaw Mudsucker”, (*Gillichthys mirabilis*). In order to survive in the ever-changing environment of the estuary it can tolerate temperatures ranging from the frigid waters of Monterey Bay (54 °F) to the warm waters of isolated tidal pools in the upper ends of the slough (95 °F). It is able to live in fresh water from streams entering the slough, or tidal pools that become 2 ½ times saltier than ocean water due to evaporation. And if other organisms in the pool of water use up all the oxygen, the Mudsucker can swim to the surface, gulp a bubble of air and absorb oxygen through tiny blood vessels in its throat. This is one tough little critter....

**Related to seahorses, the Bay Pipefish** (*Syngnathus leptorhynchus*) lives in the eel grass and sea lettuce beds of Elkhorn Slough. Reaching a length of 30 cm., this long, thin fish is uniquely capable of looking like a stick in the mud, often positioning itself standing straight up on its tail. Like sea horses, the female will deposit over 200 eggs in a brood pouch on the underside of the male. The male will incubate the eggs for up to two weeks, and then release the young to fend for themselves.

**Another interesting and talented little fish that visits the slough every year** to raise its young is the Plainfin Midshipman, *Porichthys notatus*. In the spring the males migrate from the deeper waters offshore and will dig out nests under rocks in the intertidal zone. To attract the females to their nests the males will produce a very loud hum, one of the few fish in the world that can sing! The females are attracted to the best vocalists, lay their eggs on the underside of the rocks and depart. The males stay in the nest, guarding the eggs until they hatch. (For photos of the fish and to hear a recording of its hum go to:

<http://www.dosits.org/audio/fishes/plainfinmidshipman/>

**View a 7-minute video:** <http://www.elkhornslough.org/sloughlife/fish/plainfin-midshipman.htm>

**The wetlands of Elkhorn Slough are an important rest stop for birds that migrate** along the coasts of North and South America on what is known as the “Pacific Flyway.” Each year millions of birds representing over 350 species make the journey north to nesting grounds where there is a tremendous amount of food for their young during the brief Arctic spring and summer. They return to southern climates to avoid the harsh winters. One such species is the Red-necked Phalarope (*Phalaropus lobatus*), among the world’s smallest seabirds. It can be seen feeding in the shallow waters of Elkhorn Slough in the fall. This is a brief stop-over on their journey to wintering areas off the coast of Ecuador and Peru, an annual round trip journey of over 12,000 miles, (19,300 km)!

**Over 60 species of mammals have been found in the Elkhorn Slough watershed**, including Mountain Lions and Sea Lions, long-tailed weasels and a marine weasel known as the Sea Otter, and over 12 different types of bats!

**At least 20 different reptiles are found in the watershed**, including the Western Pond Turtle, which is listed by the federal government and by the State of California as a species of special concern.

**There are over 10 different types of amphibians found here**, including the endangered Santa Cruz Long-toed Salamander and the threatened California Red-legged Frog. Both are known to be reproducing in fresh water ponds in the Elkhorn Slough watershed.

**More than 550 species of marine invertebrates that have been identified in the Elkhorn Slough**, and probably many times this still to be discovered, since these spineless critters include numerous miniscule and even microscopic animals.

**Much of the story of Elkhorn Slough is happening in the mud.** It has been estimated that on average, a bucket of mud from the slough, about 1 cubic foot contains:

500 billion bacteria

500 million diatoms (microscopic plant-like organisms)

50,000 protozoans (microscopic single-celled animals)

50,000 worms

5,000 crustaceans (critters with hard exoskeletons, including crabs, shrimp)

40 clams

# Identifying Habitats at Elkhorn Slough

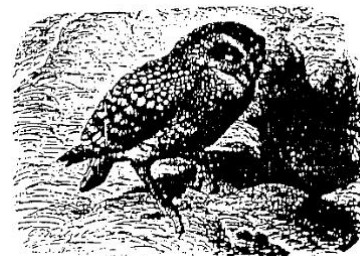
The following table lists each habitat along with its distinguishing features, such as physical characteristics or the species you might typically see there.

Habitat	Distinguishing Feature or Typical Species
Salt Water Channel	Slough waters with significant tidal flow.
Salt Pond	Saltwater areas artificially protected from tidal flow by levees
Freshwater Ponds	Upland areas that collect freshwater
Freshwater Creeks	Flowing freshwater
Mud Surface	“Benthic epifauna” such as crabs
Mud Subsurface	“Benthic infauna” such as Fat Innkeeper Worm
Salt Marsh	Pickleweed
Freshwater Marsh Swale	Cattails
Woodland	Upland areas principally vegetated by trees: oak, eucalyptus, or, in the case of riparian, willow
Chaparrel	Upland areas principally vegetated by chaparral plants such as California sagebrush, coyote brush, or manzanita. A specific and rare chaparral habitat, Coastal Maritime Chaparrel, is unique to California’s Central Coast. Here it occurs on ridges and south-facing slopes and is typified by three different species of manzanita.
Grassland	Upland area where more than 50% of plant cover is grass, as opposed to shrubs and trees.
Dredge Island	An artificial habitat formed by depositing dredge materials in the slough channel, forming a suspiciously rectangular “island.”

# Locating Habitats at Elkhorn Slough

The following table summarizes where each habitat can best be seen in ESNERR, either from the Reserve trails or the visitor center exhibits. A few habitats are included because visitors often ask about them, even though they can't be seen on or from the Reserve.

HABITAT	WHERE BEST SEEN ON OR FROM RESERVE
<b>Saltwater Channel</b>	The rate of tidal flow varies with distance from the mouth of the slough. The fastest flowing water is in the main channel, best viewed from the west side of Hummingbird Island (the old Empire Gun Club site). The South Marsh Trail footbridge gives a good view of a secondary channel
<b>Salt Pond</b>	Viewing access in State Wildlife Area on Hwy 1 just north of the slough.
<b>Freshwater Ponds</b>	Cattail Swale on South Marsh Trail. Private property at Moonglow Dairy is a freshwater pond much visited by birders (but this is private property and visitors need to respect).
<b>Freshwater Creek</b>	Carneros Creek is the seasonal freshwater source that makes Elkhorn Slough a seasonal estuary. The creek is northwest of Porter Marsh but not visible from Elkhorn Road nor in the ESNERR.
<b>Mud Surface</b>	Boardwalk on Long Valley Loop Trail , the Boardwalk on South Marsh Loop
<b>Mud Subsurface</b>	Visitor Center display: "Mud Column Habitat"
<b>Salt Marsh</b>	Long Valley Loop and South Marsh Loop boardwalks
<b>Freshwater Marsh</b>	Margins of Cattail Swale, low areas along Long Valley Loop
<b>Woodland</b>	Visible throughout Reserve. The South Marsh Trail passes through all three types of woodland: oak, eucalyptus, and riparian. Long Valley provides the best example of oak woodland.
<b>Chaparral</b>	Sage scrub chaparral is seen throughout the Reserve. Coastal Maritime Chaparral is not seen on the Reserve but on ESF-protected lands, notably Brothers Ranch.
<b>Grassland</b>	Visible throughout the Reserve
<b>Dredge Island</b>	View from South Marsh Trail



## Eight Basic Ecological Concepts

### ❖ **Everything has a home**

We call these homes habitats, ranges, and ecological niches. Everything that affects a living organism is its environment. Ecology (from the Greek word “oikos” which means house) is the study of the common home of all life – the earth.

### ❖ **Every organism is adapted for survival in its habitat**

Adaptations are specific features that aid an organism in meeting its survival needs.

### ❖ **Every living thing is becoming something else**

Plants and animals evolve, changing over time as environmental conditions change. Abrupt environmental change can result in extinction. When things die, they are broken down, decomposed, recycled and used by other living things.

### ❖ **Every living thing eats and is eaten by something else**

Three categories of life forms are in the basic food cycle of life: producers, consumers, and decomposers.

### ❖ **Everything depends on something else**

Interaction and interdependence occur among living things and their environment. A change in one strand of the food cycle affects the entire web. Nothing exists in isolation.

### ❖ **There are six basic necessities for life: food, water, respiration (i.e. O<sub>2</sub>-CO<sub>2</sub>), reproduction, shelter, and space**

These necessities are found in the atmosphere, the hydrosphere, and the lithosphere. The biosphere is that part of the planet where these zones collectively support life on earth.

### ❖ **Diversity is essential for life**

Many similarities and differences occur among living and non-living things. This variation is essential for maintaining a healthy community and ensuring that plants and animals survive and reproduce in spite of changing situations.

### ❖ **Humans are animals capable of consciously changing the balance of nature**

We are rational, thinking beings that have changed and continue to alter the environment of the entire earth in many profound ways. As such, we have a responsibility to all living things, both in the present and the future.

## Climate Change Resources for Teachers

**This list includes resources for learning and teaching about local and global climate change issues.**

**NOAA's Data in the Classroom** teaching modules can be found here:

<https://dataintheclassroom.noaa.gov/>

**The coastal acidification animation** is here:

<https://oceanacidification.noaa.gov/WhatWeDo/EducationOutreach.aspx#14963>

**Global Climate Change- NASA's Eyes on the Earth:** This is a superb resource for anyone interested in climate change. This science-based site includes interactive visualization tools, data and analysis, and links to research. <http://climate.nasa.gov/>

**Climate Kids: NASA's Eyes on the Earth – Grades 4-6.** Eyes on Earth. This site hosts engaging on-line interactive games, activities, images, video, and content. <http://climatekids.nasa.gov/>

**EPA's Climate Change Kids Site-** Learn the basics, see the impacts, think like a scientist, be part of the solution, and take a climate change expedition.

<http://www.epa.gov/climatechange/kids/index.html>

**How We Know What We Know About Our Changing Climate: Scientists and Kids Explore Global Warming.** This site provides a “non-scary, action-oriented, and inspiring look at how scientists do their work, what they are discovering about global warming, and how kids are already learning about this through Citizen Science. Kids can make a difference!”

<http://www.howweknowclimatechange.com/>

**Coastal Adaptation to Sea Level Rise.** This is a publication by Nature Conservancy on communicating about climate change. There are several nice graphics on projected sea level rise for metropolitan areas on the East

Coast. [http://www.elkhornslough.org/tidalwetland/downloads/110912\\_Newkirk.pdf](http://www.elkhornslough.org/tidalwetland/downloads/110912_Newkirk.pdf)

**Global Warming and the Greenhouse Effect- GEMS, grades 6-8, Lawrence Hall of Science, UC Berkeley.**

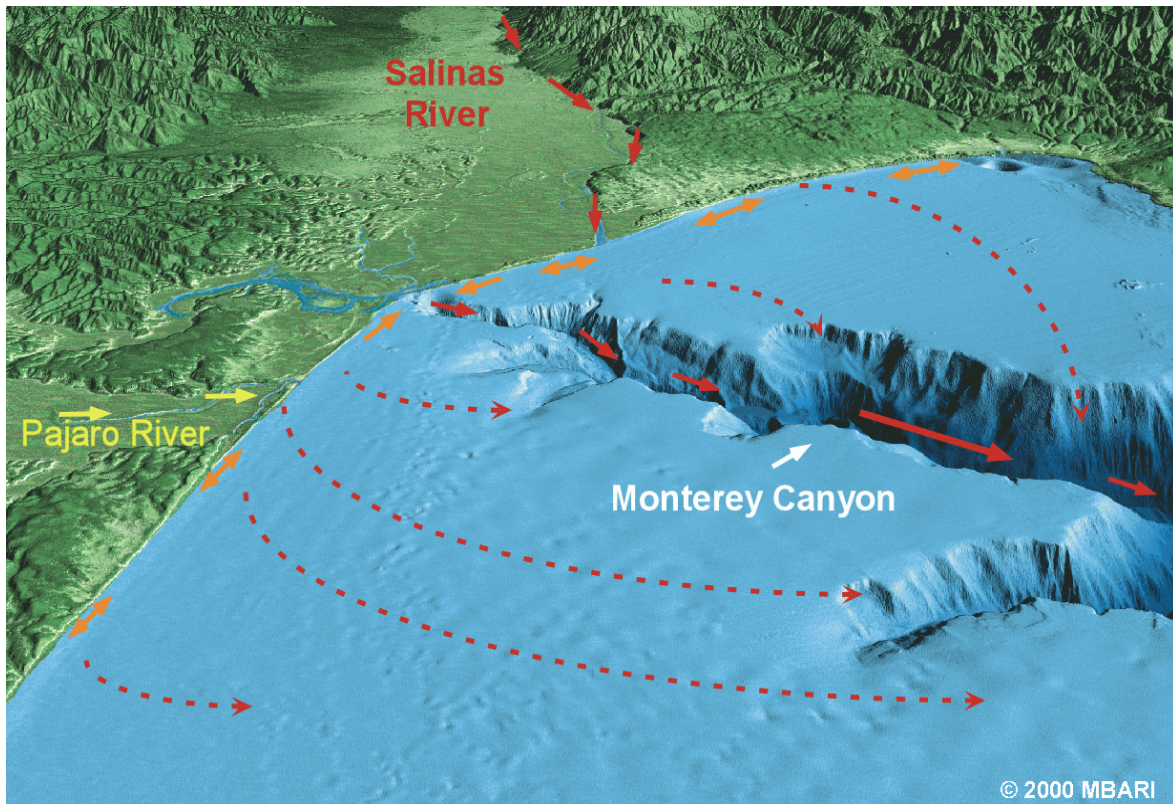
This guide's hands-on activities and experiments help students see environmental problems from different points of view. Students play simulation games and hold a “world conference” on global warming. <http://www.lhsgems.org/index.html>

**The Digital Library for Earth System Education (DLESE) – Grades 6-12**

Inquiry-based exploration of evidence for periodic melting of ice and resulting sea level rise. Students learn/demonstrate understanding of impact of sea level change on flora, fauna, and human society.

Lesson plans and resource links are included. <http://www.teachingboxes.org/seaLevel/index.jsp>

## Monterey Bay Submarine Canyon



Submarine canyons are considered to be a major conduit for sediment transport from the continent into the deep sea. However, little is known about the transport processes that occur within canyons and the rate in which sediments are transported down canyons. The canyon processes group at MBARI is interested in determining processes by which submarine canyons are excavated. We have begun to systematically characterize the sedimentary materials that move along the floor of the canyon system from their continental source to their final destination on the abyssal plane of the Pacific Ocean.



# The Education and Environment Initiative (EEI)

Naturalist John Muir captured the vital importance of education about the environment when he said, "Tug on anything at all and you'll find it connected to everything else in the universe." Imagine the possibilities if that understanding began as early as Kindergarten and continued through high school. With the Education and the Environment Initiative (EEI) Curriculum, that vision is well on the way to becoming a reality.

The goal of EEI is to increase environmental literacy for California K-12 students by teaching Science and History-Social Science academic content standards to mastery within an environmental context.

Field-tested in Kindergarten to 12th grade classrooms from San Diego to California's North Coast, the 85 EEI Curriculum units cover selected academic content standards in both Science and History-Social Science. Each EEI Curriculum unit is designed to teach one or more standards to mastery.

The State Board of Education (SBE) unanimously approved all 85 EEI Curriculum units and they are now available for use in California's classrooms.

From the EEI website at: <http://www.calepa.ca.gov/Education/EEI/About.htm>

For example:

## 5.3.a. **Earth's Water**

[Teacher's Edition](#), [Supporting Materials](#), [Word Wall Cards](#), [Dictionary](#),

Poster: [Glaciers on Earth](#), Presentation: [Managing California's Water](#), NGS

Map: [Political](#)

# The California Oak Moth at Elkhorn Slough Reserve



BY SUSIE FORK

October 2002

The California oak moth (*Phryganidia californica*) is a native moth of coastal California and the Sierra Nevada foothills. The tannish brown adults (body length 14–20mm) are commonly seen in the late afternoons from spring through fall as they hover around Coastal Live Oak and other oaks in the genus *Quercus* that serve as host plant for the larvae. In the Monterey Bay area, these moths are on the wing from approximately June through November. Females lay whitish eggs in clusters on twigs and leaves; the eggs turn reddish or brownish as hatching approaches. Young larvae skeletonize the leaf surface, while mature larvae consume entire portions of the leaf. The mature larvae are 20–30mm long and are olive green with black and yellow longitudinal lines along the back and sides and have a reddish head. The pupae are white or yellow with black markings and are found hanging from bark, leaves, and branches.



The life-cycle of the oak moth includes two and occasionally three generations per year. In most of California there are usually two broods per year -- a long-lived winter generation and a short-lived summer cycle. The first set of eggs hatch in late fall, and the small caterpillars overwinter on the undersides of oak leaves. Mature larvae are found from May to June, and adults emerge June to July. The eggs of summer adults hatch soon after, and the cycle is completed with the emergence of adults in early fall.



Periodic outbreaks occur approximately every 5 – 10 years, and in the most extreme cases lead to severe oak defoliation of some trees. During these outbreaks caterpillars are often seen suspended from cobwebby strands (perhaps using the silk as a lifeline or to anchor to twigs while consuming the underlying leaf platform). Healthy oaks appear to recover from these periodic defoliation events, but oaks that are simultaneously subjected to other stresses of drought, soil compaction, fungal infections (e.g. Sudden Oak Death Syndrome), and bacterial infections may be more seriously affected by oak moth defoliation. Biochemical and physiological defenses of oaks help to resist insect attack. This resistance, however, may vary between individuals of the same species and might explain why neighboring trees exhibit widely varying amounts of defoliation. Other potential factors which may indirectly affect susceptibility include the age and condition of an oak (whether it is diseased or drought-stressed) as well as human impacts (e.g. pruning, damage to roots associated with construction or vehicle traffic, altered drainage patterns, and so on).



Predators of the California Oakmoth include birds, spiders, true bugs, lacewing larvae, and ground beetles. These moths are also parasitized by several small wasps and are susceptible to certain insect-specific fungal infections. So, although the oak moths can periodically wreak havoc on certain trees, oaks and oak moths have been coevolving for a long time and can be viewed as one of the many conspicuous insects of the Reserve.

## Insects at the Elkhorn Slough Reserve

A simple way to gain an appreciation of the significance of insects is to view these creatures in context of the entire animal kingdom: 95 percent of all animal species on Earth are insects. More than one million insects have been identified to the species level, and at least ten million more species remain to be identified.

Insects, like many other invertebrates, belong to the phylum Arthropoda, a group that includes such diverse animals as crustaceans, spiders, millipedes, and centipedes. Every arthropod has a segmented body with paired jointed appendages, bilateral symmetry, and a chitinous exoskeleton. Within this phylum are several classes, including the class Insecta, which comprises all of the insects. All insects have two antennae, a body composed of three segments (head, thorax, and abdomen), six jointed legs, and an exoskeleton.



A grasshopper perches on the blossom of a native flower, Farewell-to-spring.

The arthropods that are not insects include millipedes, centipedes, arachnids (spiders and ticks), and crustaceans (crabs, shrimp, sow bugs). These other invertebrates differ from insects, for example, by having more body segments or appendages.

The class Insecta is subdivided into 32 orders, and members of each order share a suite of characteristics. The largest order, in terms of the number of species, is Coleoptera (beetles), which includes 500,000 species. One in four animals on Earth is a beetle, attesting to the prevalence of this group. Other conspicuous orders include Hymenoptera (bees, ants, and wasps), Diptera (flies), and Lepidoptera (butterflies and moths). The highly social termites (order Isoptera) and ants, that form huge colonies, each contribute an astounding 10 percent of the total animal biomass!

We know this California **Long-horned Beetle** is a male because of its "saw-blade" antennae.

Insects make a living in many ways. As herbivores, insects eat more plants than any other animal on Earth. Many are predators and parasites of other insects or of vertebrates (animals with backbones). Insects are also a huge source of prey for other animals. As decomposers and detritivores, insects provide clean-up services by recycling dead plants and animals. Insects are abundant in most habitats, including in terrestrial, freshwater, and brackish water environments and can be found in extreme environments such as hot, dry deserts or well above timberline at high elevation. Interestingly, only a few insects have colonized the marine environment.



Elkhorn Slough hosts a diverse assemblage of insects. Brackish pools teem with water boatman and fly larvae, while adult brine flies swarm above the water surface. Cattail Swale is home to a variety of aquatic insects, including dragonfly and damselfly nymphs, as well as many diving beetles. In the upland habitat one might come across the brightly colored, furry velvet ant (actually a wingless wasp) scurrying along the ground in search of her prey, the offspring of a solitary bee. If you're lucky, you might even glimpse a large black wasp – the tarantula hawk – flying low over open grassy areas in search of its tarantula prey.

The predatory Bumblebee Robber Fly has evolved to look like a bumblebee, perhaps to give its victims (typically, honeybees) a false sense of security, perhaps to escape predation itself.



Insects you are more likely to see here include the spittlebug (nymphs of small, drab insects called "froghoppers") living hidden in the middle of protective globs of foam, and the big black shiny stink beetle lumbering along in open dry areas.

These are just a few of the many insects that await discovery by an observant visitor to the slough. There is definitely more than meets the eye to be discovered here, and the slough will richly reward those willing to stop and take a closer look.

## Ceanothus Silk Moth

Susie Fork has organized the existing ESNERR insect collection, and has greatly augmented it with specimens she has collected. Over 200 insect species in 10 orders are now known from the Reserve.



Three orders account for a majority of the collection: the moths (Lepidoptera) with greater than 50 species found at the slough and the beetles (Coleoptera) and flies (Diptera) with greater than 20 species in each order.

Visit the Elkhorn Slough website to download a summary report characterizing the reserves's insect fauna and a list of insect families.

# Ten Things to Know About Butterflies at the Elkhorn Slough Reserve

Butterflies undergo complex metamorphosis (Egg-Caterpillar-Chrysalis-Butterfly). A young butterfly (caterpillar) is nothing like an adult butterfly. Advantage: You'll never hear a butterfly say, "These kids are eating me out of house and home."

Butterflies are not very picky about which flowers they nectar on, but caterpillars often can eat only one or a few closely related host plants. Why? Plants benefit from having many butterflies visiting and pollinating their flowers. Plants do not benefit from being eaten, so they produce toxins. Caterpillars specialize in dealing with the *toxins* of one type of plant, at the cost of being unable to deal with the toxins of others.

There are 4 butterfly food groups (caterpillars chew, butterflies only drink):

-Fat: They don't eat fat, but use "baby fat" left over from their caterpillar days.

-Sugar: Obtained from flowers *in* the form of nectar.

-Salt: Obtained from mud. Butterflies also drink water.

-Protein: Obtained from animals, in the form of scat or carrion.

Butterfly species are few enough in number and distinct enough in appearance to allow you to know all of them in an area. There are about 17+ species at Elkhorn Slough.

The clearest way to differentiate butterflies from moths is to look at their antennae. Butterfly antennae are slender with clubbed tips. Moth antennae are either slender or feather-like, with no enlargement at the tips. Butterflies fly only by day; some moths fly by day. Some butterflies are drab; some moths are brightly colored.

Butterfly predators include birds, lizards, yellowjackets, and crab spiders. Caterpillar parasites include various wasps and tachinid flies, both of which lay their eggs in or on the caterpillar. When the eggs hatch the larvae eat the caterpillar from the inside out.

No butterfly lives more than one year; most live only a few days or weeks as adults. The time of year that butterfly adults are around (flight period) is a function

of which life stage overwinters, how many broods occur in a year, the life history of the host plant, etc.

Butterflies use many methods to find each other for mating. Understanding their bag of tricks will help you find butterflies and explain a lot of the behaviors you observe.

Butterflies need our help. They are threatened by pesticides, habitat loss (often the loss of host plant habitat), and exotic plants. Native plant gardens help. Join a July 4<sup>th</sup> butterfly count. Share your knowledge and enthusiasm with others.

It is not necessary to collect butterflies to see them up close, enjoy them, and learn from them. Close-focus binoculars can bring you face-to-face with butterflies.

~~Paul Johnson April 2000



## Habitat Preferences of Elkhorn Slough Butterflies

PICKLEWEED and SALTGRASS	Pygmy Blue Sandhill Skipper
GRASSLANDS	Anise Swallowtail California Ringlet Cabbage Butterfly Buckeye
DISTURBED AREAS/ GRASSLANDS	West Coast Lady American Lady Gray Hairstreak Fiery Skipper Common Checkered Skipper
WOODLAND and RIPARIAN CORRIDORS	Tiger Swallowtail Mourning Cloak Lorquin's Admiral Sylvan Skipper Umber Skipper
OAK WOODLAND	California Sister
EXPECTED TO BE ANYWHERE	Monarch Red Admiral Painted Lady Common Sulphur Acmon Blue

# Acorn Woodpecker *Melanerpes formicivorus*



[http://www.elkhornslough.org/sloughlife/birds/acorn\\_woodpecker.htm](http://www.elkhornslough.org/sloughlife/birds/acorn_woodpecker.htm)

## Habitat at the Reserve

Oak, pine and riparian woodland habitats and common year round.

**Did you know...** Woodpeckers have the longest tongues of all birds.

The Acorn Woodpecker is a medium-sized, clown-faced woodpecker with a black back, white belly, red crown, and white eyes. Males have red head with white foreheads, while females have a black patch separating the red from the white.

Here at the Slough the Acorn Woodpecker can often be found tending to their granary trees. These acorn granaries are usually made in dead tree trunks or trees with thick bark such as the Reserve's Monterey Pines. These birds are very social and will work together in large colonies to tend and defend their stash.

They eat a variety of foods including nectar from trees, insects, flowers, a variety flying insects, and acorns of course.

Woodpeckers have many specialized adaptations. Their tail has stiff feathers, so that it can be used to help stabilize them while perched on trees. They have the longest tongues amongst birds. These protractile (like in chameleons) tongues, are sticky and covered by spiky hairs at the tip for piercing insects like a skewer. Their heads are specially-adapted to withstand the high impact of banging on wood all day. The beak of the woodpecker grows continuously as it wears down. Their bills can hit a tree with speeds exceeding 1,000 times the force of gravity, this is about 100 times higher than the acceleration experienced by an astronaut during the launch of a spaceship. The brain of a woodpecker can withstand the shock of all this due to its skull's large cranial surface (which distributes the shock evenly) and stiff neck muscles which do not allow the twist of its neck.

## Fishes of Elkhorn Slough

Of the more than 100 fish species that spend all or part of their lives in Elkhorn Slough, a mere dozen or so illustrate the remarkably diverse adaptations that allow them to live in a home where temperature, salinity, and depth fluctuate daily and seasonally. These are very challenging conditions, and not many fish manage to survive in them.

### SHARKS, SKATES, and RAYS (ELASMOBRANCHS)

This group of fish has a flexible skeleton made of cartilage. Lacking a rigid bony framework, their thick skin has to function as the place where muscles attach. When the tail arches, it pulls on the tough, elastic skin which draws back like a rubber band and aids movement. Their outer skin is covered with tooth-like denticles, giving it the abrasive quality of sandpaper for which it was once used.

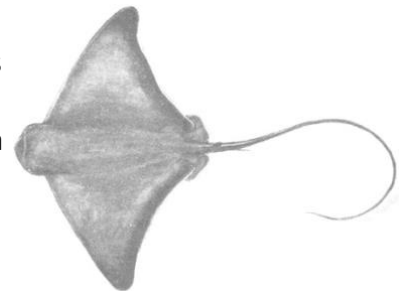
#### LEOPARD SHARK *Triakis semifasciata*

Named for dark bars or spots on its long grey body, leopards are more abundant mid-to late-summer when they give birth in the slough's protected waters. Preying on fat innkeeper worms, crabs, clams, and shrimp may not bespeak "apex predator" but the fare is hearty enough to produce a buff 5- or 6-footer.



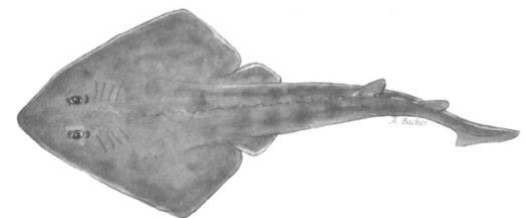
#### BAT RAY *Myliobatis californica*

Bat Rays glide through the water nosing crustaceans with blunt teeth fused into hard plates that crush the exoskeletons to get at soft tissue within. Bat Rays are shy and well-behaved, a good thing because their barbed tails can deliver a painful thwack if annoyed.



#### SHOVEL-NOSED GUITARFISH *Rhinobatos productus*

Inside the mouth of a shovel-nosed guitarfish, are rows of small, rounded teeth resembling corn-on-the-cob. The top row crushes the hard outer shells of crustaceans and mollusks, exposing the soft tissue inside. All this munching and crunching of shells plus the mouthfuls of sand that get scooped up with dinner wear down those pearly whites. Not to worry; rows of new shovel-nosed guitarfish teeth migrate upward to replace worn ones as if on a conveyor-belt.



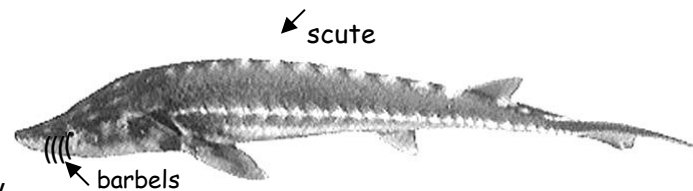
## BONY FISHES (OSTEICHTHYANS)

Fishes that have bony skeletons began with a cartilage framework (as did yours). As these young fish develop, mineral deposition turns the cartilage hard and dense, providing a robust place for muscles to attach. Bone is heavier than cartilage so a bony fish needs a mechanism that enables it to move up and down in the water column. A sinking fish has limited prospects.

A nifty swim bladder filled with air or oil is the boss adaptation that allows bony fish to manage the weight of mineral-dense bones and a heftier physique. By regulating swim bladder contents, the fish is able to move up and down in the water column. A few innovative fishes use swim bladders to enhance their social lives. More about that later...

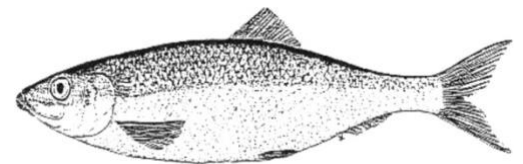
### GREEN STURGEON *Acipenser medirostris*

What a pity the slow-growing (up to seven feet), long-lived (up to 60 years), truly green sturgeon rarely checks in at the slough. Its visage would surely create a stir: in addition to its size and color, it has a snout, an overbite, five rows of thick, bony plates called scutes, and whisker-like barbels under its chin. Barbels are tactile organs that help fish forage in murky water. The sturgeon is believed to be on a branch of fish ancestors that ventured onto land to become amphibians. A vestige of cartilage remains in its vertebrae.



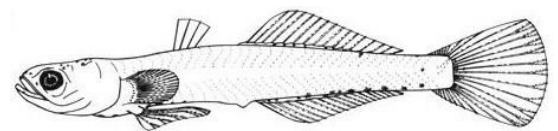
### PACIFIC HERRING *Clupea harengus pallsii*

Abundant in spring/summer, especially as juveniles, herring school near the surface where they are important forage food for other fish, birds, and harbor seals. Herring scarf down zooplankton (crustaceans) and small fishes.



### ARROW GOBY *Clevelandia ios*

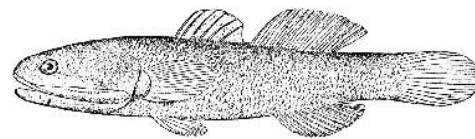
This little fish shares a burrow with the Fat Innkeeper Worm. From there, it ambushes passing prey. By turns collaborative and opportunistic, an arrow goby positions bulky food items near the useful claws of a fellow burrow-resident crab to be torn apart. Everyone benefits: manageable chunks for the goby, bits for the crab, and suspended particles for filter-feeders and others that prefer soup. On the other hand, gobies *eat the eggs and young of their host!*



LONGJAW MUDSUCKER *Gillichthys mirabilis*

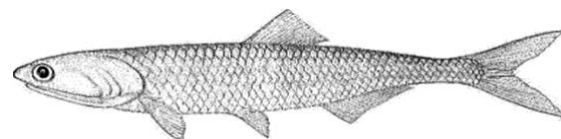
No great surprise: the longjaw mudsucker boasts a really long upper jaw and burrows in mud. Its modest appearance belies Herculean talents.

Stranded and exposed at low tide, it can wriggle across a mudflat to find water while gulping and holding air in its throat so oxygen can be absorbed into its bloodstream, all the while tolerating wide swings of salinity ranging from fresh to 2 1/2 times that of ocean water *and* surviving temperatures from 48° to 95° F. A reality show can't be far off.



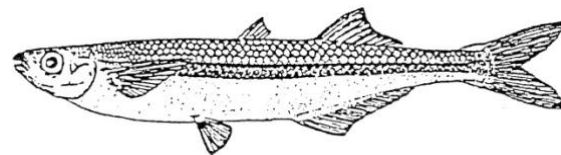
NORTHERN ANCHOVY *Engraulis mordax*

Live, unsalted anchovies visit the slough in spring and summer to dine on plankton, and are important forage food for birds and fish. While commercially important for bait, the anchovy stars in Caesar salads, Worcestershire sauce, and some pizzas.



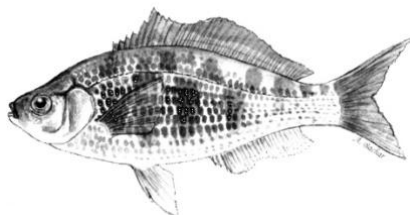
TOPSMELT *Atherinops affinis*

A single topsmelt might slide by unnoticed, but a school of them flashes and dazzles when sunlight reflects off their silvery sides and bellies. They are, in fact, members of the Silversides Family. Algae and insect-larvae eaters, topsmelt, like anchovies, are food for everybody else – except for the pizza part.

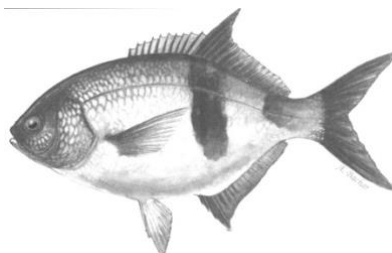


SURF PERCHES

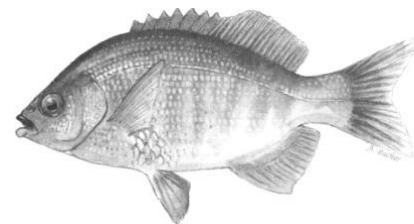
Through no fault of their own, the surf perch's burden is to so perfectly fit the image next to the word "fish." There is no cachet in being a generic anything. Despite their lack of pizzazz and celebrity, surf perch are important to commercial and recreational fishers, and that is worth something. The scientific names for each of the three species mentioned here reference the fact that they give birth to live young. Sad to say, the Black Perch isn't even black.



Shiner Perch  
*Cymatogaster aggregata*



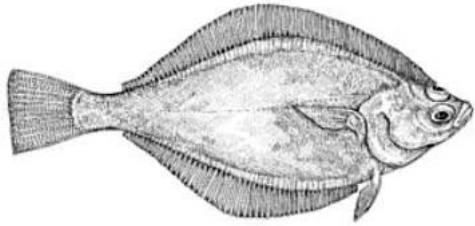
Pile Perch  
*Damalichthys vacca*



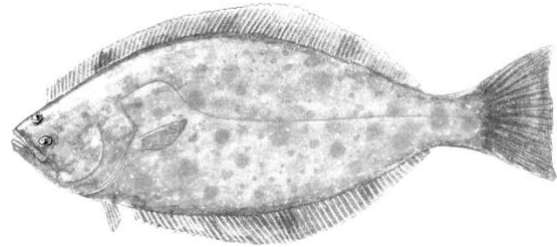
Black Perch  
*Embiotoca Jackson*

## FISHES THAT GIVE NEW MEANING TO “EL OJO”

Bottom-dwellers that keep a low profile by lying on one side have had to overcome hugely limited vision. At birth, the eyes are on opposite sides of the head. Then, depending on the species, either right or left eye begins to migrate so both eyes end up on the up or dorsal side, though they NEVER <sup>QUITE</sup> LINE <sup>UP</sup>. Very Picasso. No sleek athletes in this group; their flat pancake shape suits a low-lying, benthic lifestyle, with only their raised eyes protruding above the sand.



*Pleuronectes vetulus*



English Sole  
California Halibut *Paralichthys californicus*

## UTTERLY DISTINCTIVE FISHES

### BAY PIPEFISH *Syngnathus leptorhynchus*

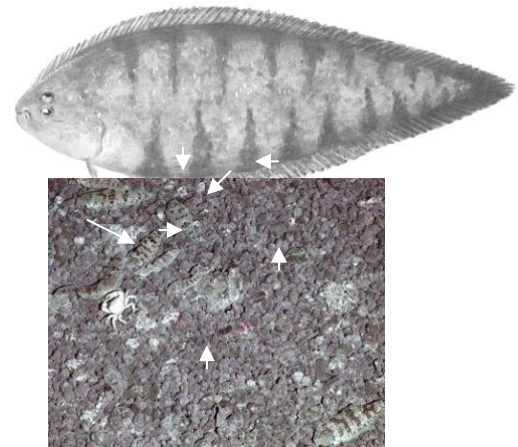
Ancestral cousins of seahorses, had Bay



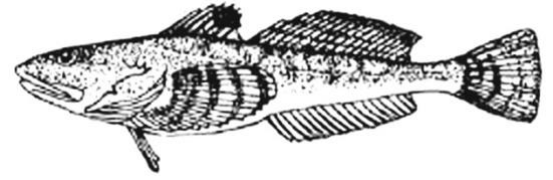
Pipefish not evolved in nature, surely Disney would have drawn them. The long, toothless, tubular mouth sucks up yummy plankton. With a greenish body and straight tail, an upright pipefish sways and blends in among blades of native eelgrass. Pipefish make-do where flappy leaves of sea lettuce have replaced eelgrass beds, though to less artful effect. Females deposit eggs in the male’s brood pouch, leaving him “in a family way.” Nutrients pass from his body to the developing young through the pouch lining.

### CALIFORNIA TONGUEFISH *Symphurus atricauda*

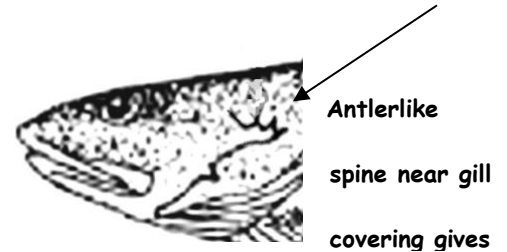
This flatfish is well-named. In addition to its eponymous shape and hue, the tonguefish is covered with slippery slime and hemmed with a unified fin (no tail). The underside is white. Hmm, how might a white belly be an advantage? NOAA helpfully posts a photo (our arrows) of tonguefish in a natural habitat of clumpy sediment. Snuffled into the fine sediment of soft mud, they are even harder to spot and almost impossible to pick up. Lying low by day, they become active at night. Can you find others? The crab doesn't count, but it helps with perspective.



**PACIFIC STAGHORN SCULPIN** *Leptocottus armatus*  
Named for the antler-like spines on the gill cover, the sculpin is a mud-colored bottom-dweller that feeds on whatever it comes upon: shrimps, worms, crustaceans, and clam siphons. They emit a low-pitched humming sound if threatened, which is felt as a vibration when held.



Sculpins can grow to 12 inches and are a frequent buffet item for Great Blue Herons, as you might notice in the Visitor Center mud exhibit. Sculpin are sometimes stranded on mudflats when the tide goes out. To survive, they gulp air and burrow until the water returns. Spines on the gill-cover can cause nasty cuts if the fish is held in the hand.



Antlerlike  
spine near gill  
covering gives

**CABEZON** *Scorpaenichthys marmoratus*  
Showy cabezon, found mostly near the slough mouth, are larger, more voracious, and colorful than other sculpins. Brown, red, or olive-green and darkly mottled on the outside, their flesh is often tinted blue (though it turns white when cooked); some researchers speculate that ingestion of copper compounds in their shellfish diet is responsible for the bluish tinge.



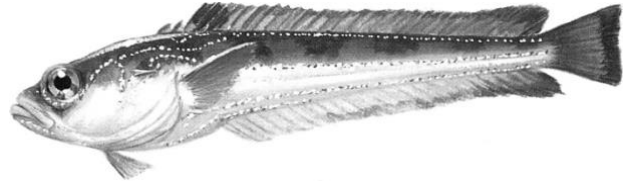
Ravenous feeders, cabezon prey on crab, fish, chiton, octopus, and tasty abalone. Some marine biologists think the element of surprise must play a role in the cabezon's success at dislodging mollusks that attach firmly to rocks.

As with other rockfish, cabezon parents are dutiful protectors of their nests; however, situating nests on top of shallow, rocky outcroppings can result in exposure to predators at low tide. Given such monumental risk, it may be fortuitous that cabezon eggs (roe) are poisonous to many mammals (including humans) and birds.

Toxic eggs go a long way to discourage snacking raccoons and other hungry passers-by when parents are indisposed.

PLAINFIN MIDSHIPMAN *Porichthys notatus*

Imagine a fish arrayed with 600 or more glowing photophores along its sides and belly that produce enough blue-green light for you to read this page in the dark. Add to the light trick, the ability to hum so ardently that people living on Sausalito houseboats cannot sleep between 8 PM and sunrise each summer, and you have the plainfin midshipman. By repurposing their swim bladders, amorous midshipmen produce a variety of croaks and hums (intrusive to human ears at 40 decibels when 1,000 midshipmen congregate). One harbor master described the serenade as, "... a loud and audible mechanical raspy hum like an electric razor. It sounds like 'mzmzmzmzmzmzmzmzmzmzm.'"



Most of the year the midshipman lives in deep water, but each summer the fish journeys into the slough's shallow, protected waters to reproduce. After the female lays eggs and departs, the male hunkers down to guard his progeny until all have hatched. Through warming days, rising salinity, and exposing low tides the male remains at his post, surviving by gulping air (which is absorbed through the lining of his throat) until the incoming tide re-wets and refreshes. Intertidal fishes such as the midshipman can also absorb oxygen directly through their skin. As for the exposed egg mass, researchers tell us that as long as the eggs do not desiccate too much, occasional exposure to the air's higher temperature and oxygen levels actually hastens egg development. Once all young have emerged and separated from their yolk sacs, the midshipman quietly decamps for deeper waters until next summer. \* *Check out the video on our website:* <http://www.elkhornslough.org/plainfin-midshipman/>

ONESPOT FRINGEHEAD *Neoclinus uninotatus*

Absolutely ferocious, the fringehead is like a humorless Oscar the Grouch. Attracted to enclosed, dark places, the fringehead occupies discarded bottles, cans, abandoned shells, and similar real estate when it isn't insinuating itself into cracks or crevices.



Whether highly territorial or just plain cranky, a fringehead attacks all comers. Its close cousin is the Sarcastic Fringehead. No joke.

*Please do yourself a favor by checking into Dr. Milton Love's two definitive texts: Probably More Than You Want To Know About The Fishes Of The Pacific Coast and Certainly More Than You Want To Know About The Fishes Of The Pacific Coast.*

Available directly from Really Big Press, Santa Barbara.

*Who knew that learning about fish species could be wildly entertaining?*

Dr. Love is a well-respected marine biologist at the Marine Science Institute, University of California, Santa Barbara.



## For more information

Caspian Tern

[http://www.elkhornslough.org/sloughlife/birds/caspian\\_tern.htm](http://www.elkhornslough.org/sloughlife/birds/caspian_tern.htm)

Top Smelt

<http://www.elkhornslough.org/sloughlife/fish/topsmelt.htm>

Ghost Shrimp

[http://www.elkhornslough.org/sloughlife/inverts/ghost\\_shrimp.htm](http://www.elkhornslough.org/sloughlife/inverts/ghost_shrimp.htm)

Brown Pelican

[http://www.elkhornslough.org/sloughlife/birds/brown\\_pelican.htm](http://www.elkhornslough.org/sloughlife/birds/brown_pelican.htm)

Moon Snail

<http://www.elkhornslough.org/sloughlife/inverts/moonsnail.htm>

Leopard Shark

[http://www.elkhornslough.org/sloughlife/fish/leopard\\_shark.htm](http://www.elkhornslough.org/sloughlife/fish/leopard_shark.htm)

Fat Innkeeper Worm

<http://www.elkhornslough.org/sloughlife/inverts/fatinkeeperworm.htm>

Harbor seals

[http://www.elkhornslough.org/sloughlife/mammals/harbor\\_seal.htm](http://www.elkhornslough.org/sloughlife/mammals/harbor_seal.htm)

Sea Otter

[http://www.elkhornslough.org/sloughlife/mammals/sea\\_otter.htm](http://www.elkhornslough.org/sloughlife/mammals/sea_otter.htm)

Elkhorn Slough NERR

<http://www.nerrs.noaa.gov/Reserve.aspx?ResID=ELK>

Plankton

<http://estuaries.noaa.gov/Teachers/plankton.aspx>