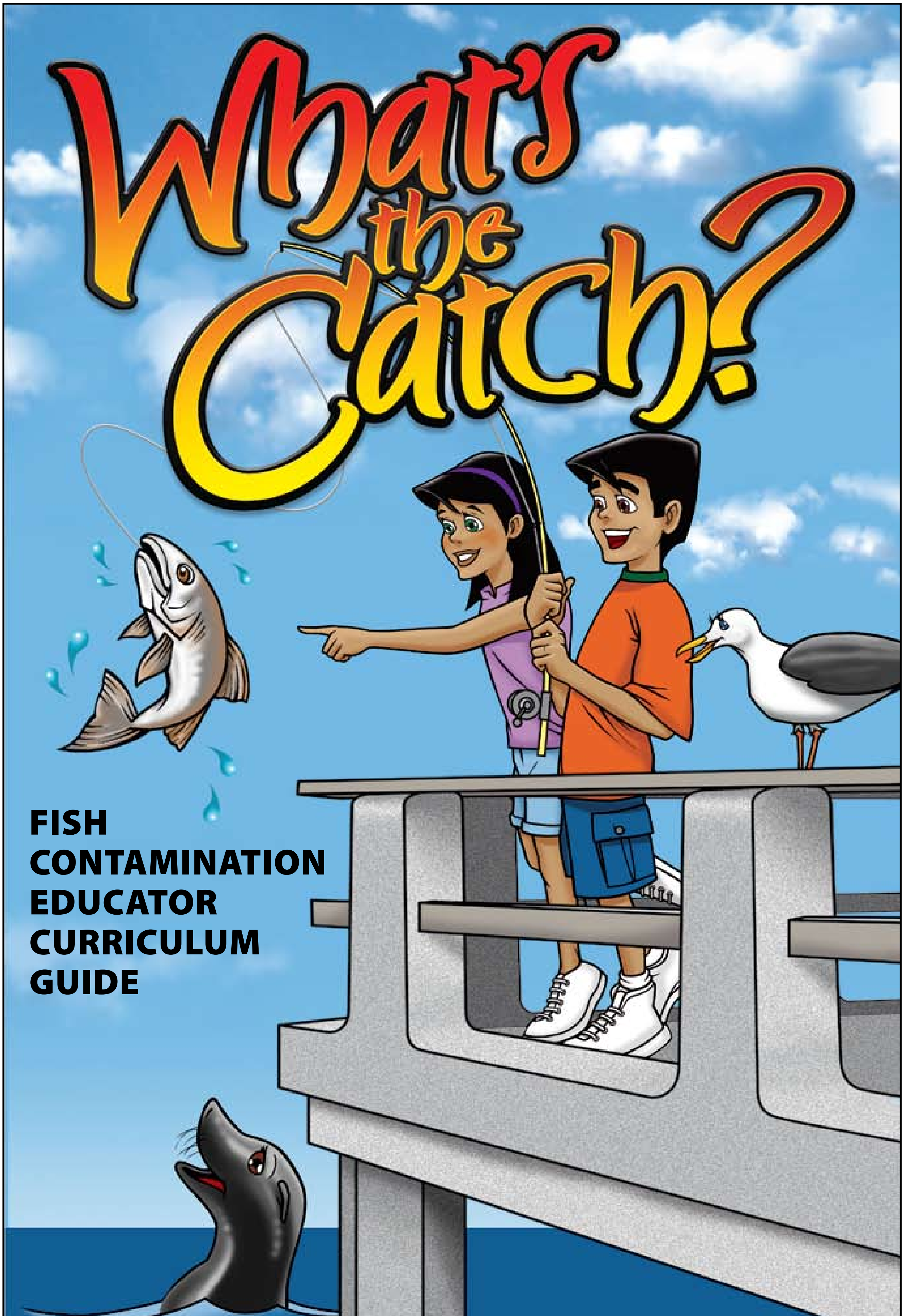


FISH CONTAMINATION EDUCATOR CURRICULUM GUIDE

Cabrillo Marine Aquarium

Sea Grant
University of Southern California

MSRP, Cabrillo Marine Aquarium and USC Sea Grant

present

What's the Catch?

Montrose Settlements Restoration Program (MSRP) is a group of six government resource agencies restoring natural resources that have been harmed by DDTs and PCBs in the Southern California Marine Environment.

MSRP is working on projects to restore wholesome fishing in Southern California. For more information see our website at www.darcnw.noaa.gov/montrose.htm

FISH CONTAMINATION EDUCATOR CURRICULUM GUIDE

Fish Contamination Educator Curriculum Guide

Updated January 15, 2009

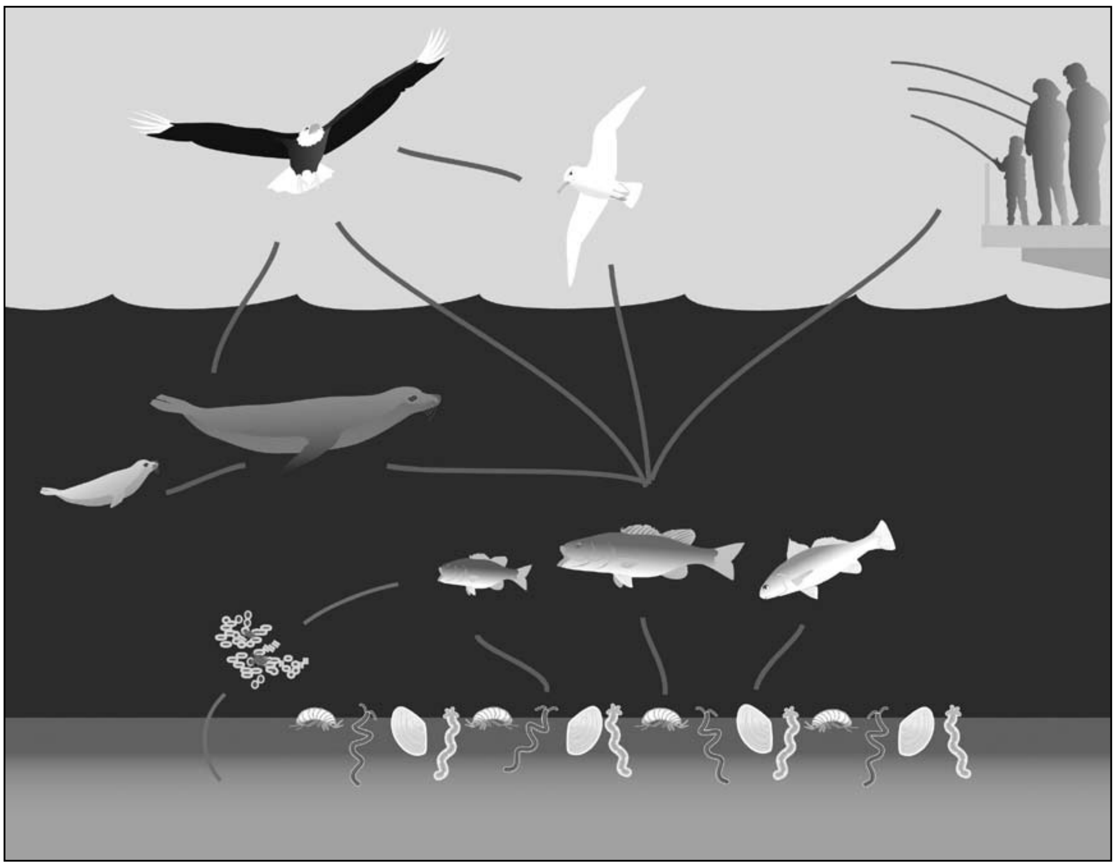
Introduction: What's the Catch? Safe Seafood Practices

As we prepare students for the future, we must help them to understand their choices or decisions, including the food that they select and how they spend their free time has important consequences. Fishing is both recreational and, for many, a good source of inexpensive protein. It is free to fish from piers, while fishing along the shore or from boats requires a license for anglers over 15 years of age.

Our ocean has been heavily impacted as our nation has grown and industry has expanded. Residents must be aware of the risks now associated with consuming some types of seafood. The lessons in this guide help students to understand the kinds of impacts that have occurred to the ocean environment before there were regulations to protect the ocean. They will gain an understanding of the risks of fish contamination that are affecting us even today and how to reduce those risks for themselves and their families.

These lessons are associated with the *What's the Catch?* comic book and are aligned with the CA Science and Social Science standards, National Science Standards, Ocean Literacy Principles and Education in the Environment Initiative Concepts for 4th-8th grades. The Palos Verdes Shelf Montrose Superfund site continues to impact the food web and thus the large number of anglers and their families. As we educate the generation who will make decisions for the future, we can hope to help them understand the importance of considering the consequences of their actions.

A Path of Contaminant Transfer in the Marine Ecosystem



Highest Trophic Level – Top Predators
- people
- marine mammals
- eagles

Intermediate Trophic Level – Water Column Feeders
- seabass
- kelp bass
- gulls

Bottom Feeders
- white croakers
- skates and rays

Sediment Dwellers
- clams
- crabs
- worms

John Cubit/NOAA

bioaccumulation – the buildup of chemical substances in the cells or tissues of an organism.

What's the Catch? Safe Seafood Practices

Curriculum Alignment

National Science Standards: 4th C, E, F, 5th – 8th C, D, F

CA Science Standards: 4th 2a,b, 3a,b, 5c, 5th 1a,f, 2c, 4a,
6th 2a-c, 5a-c,e, 6b, 7th 5a,b, 8th 1b, 2e

CA History/Social Science Standards: 4th 4.1.1, 4.6 & 7,
6th – 8th Analysis Skills, 8.12.1, 5

Ocean Literacy Principles: 6b,e,g, 7c

Education in the Environment Principles and Concepts: Ib,c, IIa,c, IIIa,c, IVa – c, Vb

Objectives

Students will be able to:

- read the *What's the Catch?* comic book and demonstrate understanding of the causes and impacts of fish contamination by answering comprehension questions
- demonstrate understanding of reading maps and identifying watersheds
- demonstrate understanding of how chemicals move through the food web
- identify which fish are safe to eat and the reasons for concern
- explain ways to reduce their risk in consuming seafood

Background

Prior to the Clean Water Act regulations many types of chemicals entered the ocean environment through ocean dumping and the watershed. The Pacific Ocean is at the base of the Los Angeles Basin watersheds. The sewage treatment plants discharge treated wastewater into Santa Monica and San Pedro Bays. From the 1940s through the 1970s Montrose Chemical Company in Torrance, CA produced the pesticide DDT (dichorodiphenyltrichloro-ethane.) The company dumped millions of pounds of the excess chemical into the sewage treatment system, where it flowed through the cleaning process. Water that is used in Torrance is treated at the L.A. County Sanitation treatment plant and that which is not recycled is discharged about 1.5 miles from shore off of White Point on the Palos Verdes Peninsula. In the 1940s-1970s the water only received primary treatment so there were large amounts of particles as well as treated water released through the discharge pipes. The sediment where the discharge occurs is composed of fine particulates. In addition, large amounts of the chemical were dumped into the storm drains that lead into the Dominguez Channel and flow straight into Los Angeles Harbor. Other companies dumped PCBs (polychlorinated biphenyls) that were used in industrial processing and electronics manufacturing. These contaminants have resulted in the EPA Superfund Cleanup Site. The Sanitation District stopped the dumping of the chemicals into the sewage treatment system in the early 1970s and the production of these chemicals were banned in the United States in the late 1970s when it was found that they were dangerous to wildlife. The chemicals continue to be present in the sediment and cause problems in the marine food web.

Why are these chemicals a problem? DDT and PCBs do not break down easily, staying in the environment for decades. They were discharged and settled into sediment where they are still present in high amounts Worms, shrimp and other animals move and feed in the contaminated sediment and get DDT and PCBs in their bodies. These benthic (bottom dwelling) animals are eaten by larger bottom feeders and as they consume them the larger bottom feeders accumulate the DDT and PCBs, a process known as bioaccumulation. As the contamination moves up through the food web, increasing in amount in the larger consumers as it builds up with each meal, the result is known as biomagnification.

DDT was the cause for a tremendous decline in the bald eagle, peregrine falcon and California brown pelican populations in Southern California. Over time, birds accumulated the DDT through the food web. When they went to brood their eggs, the DDT inhibited the absorption of calcium and the eggshells weren't strong enough to protect the developing chicks. The birds were unable to reproduce and the populations declined. (See the Restoring Natural Resources section to find out how the birds are doing now!)

Vocabulary

advisory	**bioaccumulation**	**biomagnification**	**chemical**
contaminant	**discharge**	**DDT**	**exposure**
fillet	**food web**	**PCBs**	**sediments**
wastewater			

Materials

- maps of Los Angeles County with Santa Monica and San Pedro Bays showing the Superfund site and the Los Angeles County watersheds (http://www.waterboards.ca.gov/losangeles/images/region4.jpg)
- copies of *What's the Catch?* comic books

Procedure

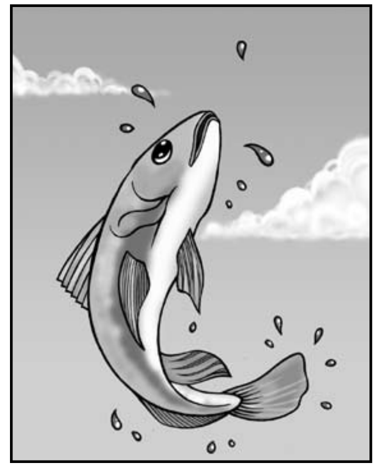
1. Review watersheds and have students talk about how the watersheds affect the ocean. (Water runs off of land carrying sediment and any trash/pollution with it in the stormwater system. The sewage treatment system removes solid waste but does not remove chemicals, including medication, before it is discharged into the ocean. Heavier particles drop to the bottom and remain in the sediment.)
2. Ask the class, "Do you think fish in the ocean might be affected by the watershed? How many students eat fish? How many like to go fishing? Do you ever wonder what the fish you eat consume to get energy? What might happen if the fish you catch to eat are in water where there is pollution? Why should you pay attention to what you eat? How can we protect the food we eat?"
3. Let's read about a problem in the water near here and see how we can eat fish and still be safe. Distribute comic books.
4. After reading discuss their questions and follow up to check for understanding with the following questions:
    1. How can you identify different fish? *(you can compare the fish to a field guide or chart, you can ask a scientist to help identify the fish)*
    2. Where is there a concern about DDT and PCB contamination in the ocean? *(off of the Palos Verdes Peninsula shelf in the Pacific Ocean, in Los Angeles and Long Beach Harbors)*
    3. Why should you limit eating fish caught in Los Angeles and Long Beach Harbors? *(because the contamination in the sediment moves through the food web and can affect the health of consumers)*
    4. What is the name of the fish from the Palos Verdes Peninsula and Los Angeles and Long Beach Harbors that you should release and not eat? *(it is known as white croaker, tom cod or kingfish)*
    5. What are three ways to reduce your risks from contaminated seafood? *(fish in areas where the water is healthy selecting fish that don't have advisories, eat only the filet cutting off skin, organs, head, etc., grill or broil the fish letting the juices drip away)*
    6. Draw a food chain showing four animals that might get contaminated if there is DDT or PCBs in the sediment. *(include worms, shrimp, bottom feeding fish, birds or larger fish or mammals that eat fish)*

7. Name three parts of a fish you shouldn't eat if it comes from a contaminated area. *(skin, head, organs)*
8. How can you find out more information about fish contamination at this site? *(CA Department of Fish and Game health advisories, www.pvsfish.org, www.darrp.noaa.gov/southwest/montrose/pdf/msrp_fs_update2004.pdf)*
9. Can it be safe to catch and eat fish? *(yes, fish provides healthy protein. It is important to know where it is okay to consume the fish you eat and the safest way to prepare fish to reduce risk. To learn about which fish you might order at a restaurant, check the website: www.mbayaq.org/cr/seafoodwatch.asp)*
10. Name two other animals besides people that might be affected by fish contamination? *(sea lions, harbor seals, California brown pelicans, dolphins, bald eagles, peregrine falcons, seabirds off the Southern California coast)*
11. How can you find out about where the safest places to fish are and which fish are safe to eat? *(use the map in the comic book, , www.pvsfish.org,, California Department of Fish and Game regulations)*
12. What can you do to protect the ocean from contamination? *(never dump chemicals down the drain or wash them down the gutter)*
13. Locate the Palos Verdes Peninsula and the contamination site on a larger map of the Southern California coastal area.

Extensions

1. Write a slogan, create a poem or draw a picture that encourages safe seafood practices.
2. Learn more about how one of the marine animals is affected by DDT *(See Restoring Natural Resources p. 27, EagleCAM, California brown pelican)*
3. Discuss products that are currently in use or being developed that might be of potential concern in 20-30 years. Brainstorm alternatives.
4. Use the USC Sea Grant Island Explorers activity looking at bioaccumulation in the bald eagle on Catalina Island *(http://www.usc.edu/org/seagrant/IELessons/Unit4/Unit4LP2Frame.Set.html)*
5. Read *Silent Spring*, by Rachel Carson, as she was one of the first to publicly identify problems from DDT.
6. Teach what you have learned to someone else.

Let's Go Fishing! How Do You Measure Up?



Curriculum Alignment

National Science Content Standards: C, F

CA Science Standards: 4th 3b, 6th 5,b & e, 7th 3e

Ocean Literacy Education Principles: 6e, 7c

Education in the Environment Principles and Concepts: II a,b,d, III c

Objectives

Students will be able to:

- correctly measure fish
- determine if a fish is legal size per California Department of Fish and Game regulations
- determine if a fish is safe to consume per California Health Department fish advisories
- explain responsible catch and release procedures

Background

Fish are an important source of protein worldwide. As the human population increases and the amount of fish being harvested increases, regulations are established to ensure fish stocks are not depleted. Regulations stipulate size limits, quantity of fish and seasons. These regulations are established based upon the size a fish reaches before it reproduces to ensure it has a chance to reproduce before being harvested. The quantity limits are established to ensure that the species isn't fished out and continues to have a chance to reproduce. These guidelines are established when populations have declined to such a degree as to cause concern. Recreational fishing regulations are adaptive and based upon the latest information about the fishery. It is important to check for updates before going fishing. Regulation and advisories website: http://www.dfg.ca.gov/marine/mapregs5.asp#advisories

Vocabulary

advisory	**bag limit**	**fork length***
regulations	**standard length (SL)***	**total length (TL)***

** see page 23 for definitions*

Materials

- spinner card to determine where the fish was caught
- large laminated cutout pictures of fish in a variety of sizes with fish facts attached on the back and a paper clip attached to the mouth area
- small fishing rod(s) or bamboo stick(s) with fishing line and magnet attached
- copy of Department of Fish and Game regulation summary sheet
- measuring tape or yardstick
- copy of fish advisory card

Procedure

1. Spread fish on "ocean floor."
2. Ask students:

   "How many have gone fishing before?"

   "How do you know if you can keep the fish you have caught?"

   "Why do you think there are regulations for the size of fish you may keep?"
3. We are going to pretend to be fishing and catch fish from this supply.
   We will check to see if what we catch is legal and safe to eat.
   a. Catch a fish and remove it from the rod. Pass fishing rod on to someone else to use.
   b. Identify your fish using ID card:
      - look at its overall shape
      - use fins to help match
      - look at color patterns and the mouth.

      Check your answer by looking at the back of the fish.
4. Use the CA Department of Fish and Game regulations to determine what the regulations are regarding the fish you caught?
5. Measure your fish to determine if it is at least minimum length.
6. Spin the location wheel to establish where you are fishing. Check the health advisories. Is this fish safe to keep?
7. Keep or release your fish based upon CDFG regulations and health guidelines. Remember, when you are fishing it is best to handle the fish with wet hands to remove the hook and lower it back into the water with a bucket if you release it.

Review

1. Was it easy to catch the fish you wanted to catch?
2. How can you determine if it is okay to keep a fish when you go fishing?
3. What else would you like to know about fishing?
4. What could you share with others you see fishing?

Use for Let's Go Fishing activity. Cut along the dotted lines. Attach to the back of the fish images before laminating.

Atherinopsis californiensis
Jacksmelt Silverside

max. size: 45 cm TL
max. age: 11 years
range: Yaquina Bay, Oregon to southwestern Baja California, Mexico

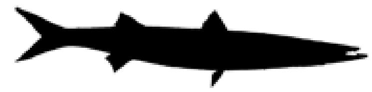
natural history: Greenish blue with silver stripes on their sides. Adults inhabit inshore areas, including bays, forming schools found to 30 m depths. Feed on plankton and small fishes. Are eaten by harbor seals, northern fur seals, pelicans, western gulls, least terns and cormorants. Spawn near the bottom in near shore habitats and eggs are attached to one another and substrate by adhesive filaments. Oviparous, with planktonic larvae that live primarily on the surface. Are not targeted by fishery; when caught are sold fresh.

Atherinops affinis
Topsmelt Silverside

max. size: 37 cm TL
max. age: 9 years
range: Vancouver Island, British Columbia, Canada to Baja California, Mexico and the Gulf of California

natural history: Green backed with silvery stripes on sides. Common in bays, estuaries, muddy and rocky areas and kelp beds from surface to 10 m depths. Form schools and adults feed on zooplankton, while juveniles feed on algae and insect larvae. They are oviparous, spawning near the bottom of near shore habitats, and eggs are attached to one another and substrate by adhesive filaments. Larvae are primarily surface dwelling plankton.

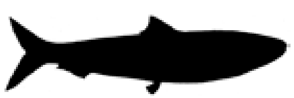
Sphyraena argentea
Pacific Barracuda



max. size: 145 cm TL
max. age: 12 years
range: Kodiak Island, Alaska to southern Baja California, Mexico; found at 0-18 m depths

natural history: Bluish-green backed with silvery sides; primarily pelagic fish with large sharp teeth and streamlined body, usually near shore or near the surface, often in small schools. Feed mainly on other fishes, sardines, anchovies, young mackerel, grunion and squid. Eaten by least terns and bald eagles. Migrates south from the California coast during autumn; may remain on the Mexican coast throughout the year. Pelagic spawners, young enter bays and harbors. Popular game fish. Utilized fresh, dried or salted and frozen; eaten broiled and baked.

Sardinops sagax
Pacific Sardine



max. size: 39.5 cm SL
max. age: 14 years
range: southeastern Alaska to Guaymas, Mexico; highly migratory, pelagic fish found from 0-200 m depths

natural history: Blue or green backed fish with silver belly and dark spots on sides. A coastal species that forms large schools. Feed mainly on planktonic crustaceans. Is eaten by fish, birds and mammals including harbor porpoise. Oviparous, with pelagic eggs and larvae. In the California region, make northward migrations early in summer and travel south again in autumn. Highly commercial baitfish, marketed fresh, frozen or canned. Utilized mainly for fishmeal; also eaten fried and broiled.

Sarda chiliensis
Pacific Bonito

max. size: 102 cm TL
max. age: 6 years
range: Alaskan coast to Cabo San Lucas, Baja California; pelagic; oceanodromous from 0-100 m

natural history: Tuna shaped with dark, slanting stripes on greenish-blue back. Large coastal schools based on size. Older individuals are encountered farther from the coast as compared to the juveniles. Females produce millions of eggs per season. Feed on a variety of small schooling fishes, squids and shrimps. This species is important to the recreational hook and line, also caught commercially by net. Eaten fresh, canned and frozen; eaten broiled and baked.

Scomber japonicus
Pacific or Chub Mackerel

max. size: 64 cm TL
max. age: 18 years
range: Alaska to Baja California, Mexico; 0-300 m depth; oceanodromous

natural history: A streamlined fish with a series of dark, wavy bars on greenish-blue back. Coastal pelagic species attracted by lights. School by size; adults stay near the bottom during the day; go to surface at night to feed on copepods and other crustaceans, krill, fishes and squid. Eaten by sea lions, northern fur seals, least terns and bald eagles. Spawn in schools. Eggs and larvae are pelagic. Highly prized both commercially and recreationally. Commercially cultured in Japan. Marketed fresh, frozen, smoked, salted and occasionally canned. Eaten fried, broiled and baked.

Atractoscion nobilis
White Seabass or Weakfish

max. size: 166 cm TL
max. age: 20 years
range: Juneau, Alaska to southern Baja California, Mexico and the Gulf of California; 0-122 m depth

natural history: Adults grayish blue to yellow. Juveniles with dark bars on sides, often in schools over rocky bottom and in kelp beds. Also found in the surf zone; young in bays and along sandy beaches. Feed on fishes, squids, mackerel and anchovies. Pelagic spawners. Prized gamefish. Hubbs-Sea World with others conducting aquaculture program to restock ocean. Excellent food fish.

Seriola lalandi
Yellowtail Amberjack

max. size: 250 cm TL
max. age: 12 years
range: British Columbia, Canada to Chile; 3-69 m depths linked with structures such as reefs, kelp, platforms; series of separate populations worldwide, migratory linked to temperature

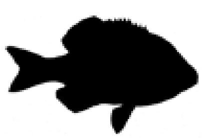
natural history: Torpedo-shaped silvery fish with yellowish sides. Pelagic and demersal species found in coastal and oceanic waters, sometimes entering estuaries They are solitary or occur in small groups. Schools of juveniles are generally found in offshore, prefer warmer water. Feed on small fish (anchovies, sardines, small mackerel, squid and crustaceans including pelagic crabs. Young eaten by least terns. Marketed fresh and salted or dried.

Girella nigricans
Opaleye

max. size: 66 cm TL
max. age: 10 years
range: San Francisco, California to southern Baja California, Mexico

natural history: Oval bluish-gray perch shaped fish with 1-3 whitish spots on side near dorsal fin. Young are intertidal species with homing behavior, adults found near or over rocks and in kelp beds up to about 30 m depth. Feed mainly on seaweed and occasionally invertebrates. Form dense schools in spring in kelp beds. Pelagic spawner. Breathe air when out of water. Eaten by eagles, sea lions and cormorants. Considered an important game fish and may incidentally be caught in commercial fishing activities. Marketed fresh.

Embiotoca jacksoni
Black Perch



max. size: 39 cm TL
max. age: 10 years
range: Fort Bragg in northern California to central Baja California, Mexico, including Guadalupe Island

natural history: High variation in coloring. Chiefly live in rocky areas near kelp, occasionally over sand bottom of coastal bays and around piers and pilings. Occur from intertidal areas to 46 m depths, typically within 1m of the bottom. Eat invertebrates including amphipods, crabs, brittle stars and worms, often sorting through bites in mouth and spitting out substrate. Are eaten by harbor seals and cormorants. Usually form small groups. Viviparous. Popular sport fish.

Paralabrax clathratus
Kelp Bass or Calico Bass

max. size: 72 cm TL
max. age: 34 years
range: Columbia River, Washington to southern Baja California, Mexico

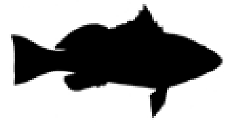
natural history: Gray-brown or olive on backs and sides with pale blotches. Found in or near kelp beds, shallow water and to 50 m. Found throughout water column. Large specimens usually occur in deeper water. Juveniles feed on benthic invertebrates (especially crustaceans); adults feed on fishes and cephalopods. Both juveniles and adults may feed on plankton when abundant. Pelagic spawners. Excellent food fish and an important game fish, also caught with troll lines.

Amphistichus argenteus
Barred Surfperch

max. size: 43 cm TL
max. age: 9 years
range: Bodega Bay, California to north central Baja California, Mexico

natural history: Silvery fish with 8-10 yellow or rust colored bars on their sides. Mostly found in surf of sand beaches, but reported from trawl catches at depths up to 73 m. Also occur near rocks, pilings and other sources of cover and food. Usually form small groups. Also caught from piers and skiffs. Feed preferably on sand crabs but also eat clams and other invertebrates. Viviparous. Caught hook and line.

Paralabrax nebulifer
Barred Sand Bass



max. size: 67 cm TL
max. age: 31 years
range: Santa Cruz, California to Magdalena Bay, Baja California and Acapulco, Mexico

natural history: Greenish-gray with light patches on sides. Usually found on sand bottom among or near rocks from shallow areas to about 183 m depth, but usually at less than 30 m. Juveniles feed on benthic invertebrates (crabs, bivalves and mysids); adults prey on fishes (especially midshipman) and also on crustaceans. Pelagic spawners; eggs and larva are pelagic. Important game fish.

Umbrina roncador
Yellowfin Drum or Yellowfin Croaker

max. size 56 cm TL
max. age: 15 years
range: Point Conception, California to the Gulf of California, Mexico; found at 0-45 m depths

natural history: Shiny bluish-gray green back with light belly. Barbel found on chin. Found in shallow sandy areas, often in surf zones, bays and tidal sloughs. Nocturnal feeders on fishes, crustaceans, marine worms and bivalves. Often caught by surf fishers. Pelagic spawners.

Seriphus politus
Queen Croaker or Queenfish

max. size: 30 cm TL
max. age: 12 years
range: Yaquina Bay, Oregon to southern Baja California, Mexico; 1-21 m depths

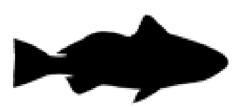
natural history: Bluish-tan back with light belly and yellow fins and large mouth. Occur inshore, often over sandy bottoms. Commonly schooling in bays and tidal sloughs, around pilings. Move into deeper water at night. Feed on small shrimps, marine worms and fishes. Eaten by sea lions, least terns and cormorants. Pelagic spawners. Larva feed on plankton.

Sebastes caurinus
Copper Rockfish

max. size: 58 cm TL
max. age: 55 years
range: Kenai Peninsula, Gulf of Alaska to central Baja California, Mexico; 30-183 m depths; prefer colder water

natural history: Pinkish orange-red to brownish with patches of white or yellow. Abundant in shallow, protected bays and inlets, among rocks and kelp beds; also found around pilings and jetties or under floats. Juveniles found in loose aggregations in shallow, weedy bays during summer. Mainly a benthic feeder on octopi, shrimp, fish and small crabs. Viviparous, with planktonic larvae. Sold mainly whole and as fresh fillets; excellent for fish chips or for pan-frying as fillets.

Genyonemus lineatus
White Croaker



max. size: 41 cm TL
max. age: 15 years
range: Barkley Sound in British Columbia, Canada to southern Baja California, Mexico; rare north of California, USA

natural history: Silvery fish with slightly yellow backs. Usually a small black spot where pectoral fin meets the body, small barbels on chin. Found over sandy bottoms to depths of 183 m and in harbors. Young feed on plankton. Adults feed nocturnally on polychaetes, amphipods, small shrimps, crabs and mollusks. Eaten by halibut, barred sandbass, sea lions, seals, cormorants, least terns and gulls. Oviparous, multiple pelagic spawner. High levels of DDT in areas with contamination. Check advisories before consuming.

Roncador stearnsii
Spotfin Croaker

max. size: 70 cm TL
max. age: 15 years
range: Point Conception, California to southern Baja California, Mexico

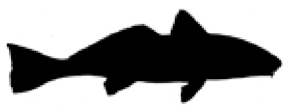
natural history: Bluish-gray back with white belly, obvious black spot at base of pectoral fin. Found along sandy shores and bays, mostly in shallow surf zones to 15 m depth. Often found near rocks and entrances to bays. Usually form small groups, but aggregate for spawning. Pelagic spawners. Feed on invertebrates, such as marine worms, clams, crabs and small crustaceans. Popular sport fish, illegal to sell commercially.

Cheilotrema saturnum
Black Croaker

max. size: 45 cm TL
max. age: 20 years
range: Point Conception, California to Baja California, Mexico

natural history: Perch-shaped croaker with blackish-purplish to brownish back and silvery belly. Common species found near the bottom, often in caves and crevices of exposed coasts and open bays to depths of 46 m. Feed on crabs and shrimp. Young found in large schools.

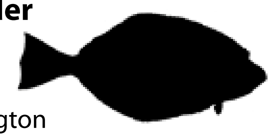
Menticirrhus undulatus
California Corbina or Kingcroaker



max. size: 71 cm TL
max. age: 8 years
range: Point Conception, California to Peru

natural history: Long, thin croaker with grayish-blue back and white below; short chin barbel and large pectoral fins. Occur along sandy shores and in bays, usually in sandy surfs of exposed outer coast, very shallow nearshore to 27 m. Found in small groups; larger fish are solitary. Feed on sand crabs, other small crustaceans, clams and worms. Pelagic spawning begins in July. Young eat small crustaceans such as amphipods. Good fish to eat. Common in markets.

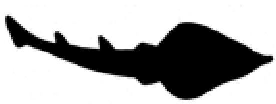
Paralichthys californicus
California Halibut or Flounder



max. size: 152 cm TL
max. age: 30 years
range: Quillayute River, Washington to southern Baja California, Mexico

natural history: Brown to blackish on eyed side, white on alternate side with high arched lateral line and large mouth. Can be left or right eyed. Lives on sandy bottoms, common beyond surf line; also in bays and estuaries. Found near shore to 183 m depth. Feed on fishes and squids. Important sport and commercial fish. Caught by nets. Marketed fresh and frozen. Oviparous, adults migrate to shallower waters to spawn. Young depend upon wetlands. Feed on fishes (white croaker, anchovies, sardines and walleye), octopi and squid. Very sharp teeth, known to bite when handled. Eaten by sea lions, angel sharks and electric rays.

Rhinobatos productus
Shovelnose Guitarfish



max. size: 119 cm TL
max. age: 16 years
range: San Francisco, California to the Gulf of California

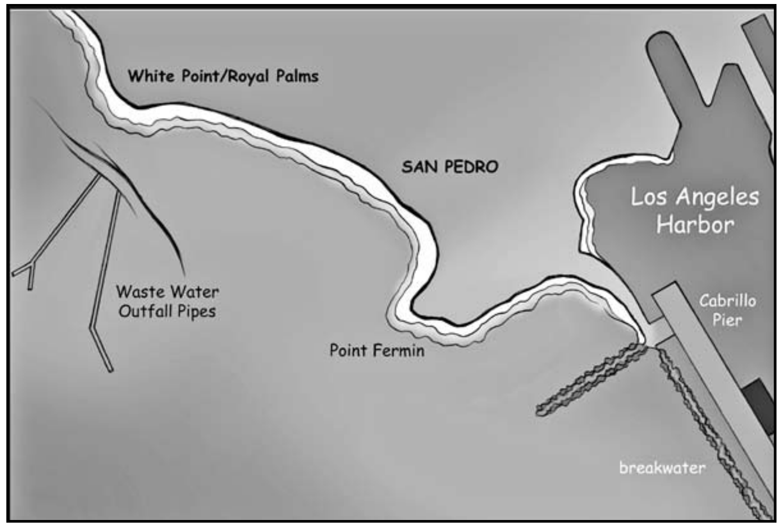
natural history: Light brown on top and white on bottom, spade shaped ray. Found on sand or mud bottoms of bays, sea grass beds, estuaries and near rocky reefs 1-91 m. Nomadic and gregarious. Found singly or in aggregations. Burrows in sand during the day, feed on crabs, shrimp, worms, clams and small fishes (shiner perch and mudsuckers). Ovoviviparous, with 6 to 28 pups in a litter. Often caught in gill nets and on piers.

Scorpaena guttata
California Scorpionfish

max. size: 43 cm TL
max. age: 21 years
range: Santa Cruz, California to Punta Abreojos, Baja California, Mexico.

natural history: Spiny red to brown mottled thick bodied fish with large sharp fins. Usually occurs near the bottom in rocky areas of bays and along shore, especially in caves and crevices. Found to depths of 200 m. Venomous spines in the dorsal, anal and pelvic fins. Spawn in summer and eggs imbedded on walls. Crabs primary food of juveniles and adults; also eat fishes, octopi and shrimps. Nocturnal. Important commercial and sport fish.

Where Did it Happen? Latitude and Longitude



Curriculum Alignment

National Science Standards:
4th C, E, F, 5th - 8th D, E, F, G

CA Science Standards:
4th 3b, 5c, 6th 2a-c

CA History/Social Science Standards:
4th 4.1.1, 4.6

Ocean Literacy Principles:
6b,e,g, 7c

Education in the Environment Principles and Concepts: IVa - c, Vb

Objectives

Students will be able to:

- locate lines of latitude and longitude on a map
- diagram a watershed
- explain topography found off the Palos Verdes Peninsula using a map
- explain some of the challenges faced when dealing with an ocean superfund site

Background

The Joint Water Pollution Control Plant (JWPCP), in Carson, opened in 1928. The Two six mile long tunnels connecting the plant to ocean outfalls at White Point were constructed under the Palos Verdes Peninsula in 1937 and 1958. The treated waste water is discharged through ocean outfalls at 60 m depths of water at 2.4 km from shore. The continental shelf is narrow and drops into a steep canyon, which is why the effluent is discharged close to shore. The plant currently serves about 3.5 million customers, daily treating approximately 320 million gallons of incoming wastewater, which is processed to a secondary treatment level. The treated water has a higher salt content and is not readily reusable.

Historically, water only received primary treatment. In addition to chemicals flowing through the treatment process and into the ocean, fine particles flushed into the ocean as part of the treated wastewater stream. Particles accumulated on top of one another burying prior discharge. When dumping of DDTs stopped, the discharged particles covered the contaminants already in the sediment. The improvement in water quality, with secondary treatment at JWPCP, has reduced the accumulation of sediments building up on top of the contaminated sediment.

The sediment at the discharge site continues to be composed of fine particulates. The benthic (bottom) currents run northwest. Moving fine particles and exposing contaminated sediments. The surface, wind driven currents tend to run southeast along the shoreline. Decreased deposition of sediment particles combined with ocean currents has resulted in the spreading of some of the contaminated sediments. Burrowing organisms also cause some movement of sediments.

Vocabulary

latitude lines – imaginary lines on the earth's surface. They run east and west around the globe and tell you your distance north or south of the Equator

longitude lines – imaginary lines on the earth's surface that run from pole to pole around the globe and tell you your distance east or west from the Prime Meridian (longitudinal line running through Greenwich, England is 0°).

Materials

- maps of Palos Verdes Superfund site
- access to Google Earth or latitude and longitude coordinates
- writing instruments

Procedure

1. Look at the Palos Verdes Shelf Map. What do you notice about the area?
2. How deep is the water where the discharge from the wastewater outfall is located? *(the lines showing topography depths are shown in meters)*
3. Montrose Chemical was located at 20201 S. Normandie Ave., Torrance, CA 90502 at 33°50'56.59" N and 118°17'58.08" W. Use Google Earth to find the latitude and longitude. Plot it on your map.
4. L.A. County Sanitation is located at 24501 Figueroa Street, Carson, CA 90745 at 33°48'09.29" N and 118°17'01.53" W. Draw the plant on your map.
5. Draw arrows to show the flow of contaminants through the treatment plant and onto the continental shelf at the outfall pipes. The contaminants are fairly heavy and were deposited in the bottom sediments. They were covered by additional particles through the years. As the discharge became cleaner, less particulates were deposited and the currents removed some of the particles covering the contaminated sediment.
6. Typically, the benthic currents, those running along the bottom, flow northwest, and the surface currents flow southeast in this area. Where would you collect samples to determine if the contamination has spread and where the contamination lies? *(you could sample beyond the outer boundaries in set increments until you found no contaminated sediment or track as the levels of contamination decreased.)* Which way would you expect the contaminants to flow? *(because they are heavier sediments they would most likely be more influenced by the benthic currents)*
7. Why would you expect it to be difficult to determine how much contamination is in the sediment further from shore? *(there is a significant increase in the slope, a submarine canyon, where the sediments sink much deeper and are harder to collect)*
8. Other contaminants emptied into Los Angeles Harbor through storm drains into the Dominguez Channel. Would you expect the plant in Torrance or the harbor to be at a lower elevation? Why? *(as people build along the coast they try to protect the property and build above sea level so that it won't be damaged by the ocean)*
9. What type of water flow or other influence would you expect to cause the contamination to spread into the harbor? *(watershed runoff could carry it as well as tidal movement; burrowing animals cause it to move)*

Extension

Look up and identify the watershed in your area. Find out where it empties and find out if there are concerns about water quality.

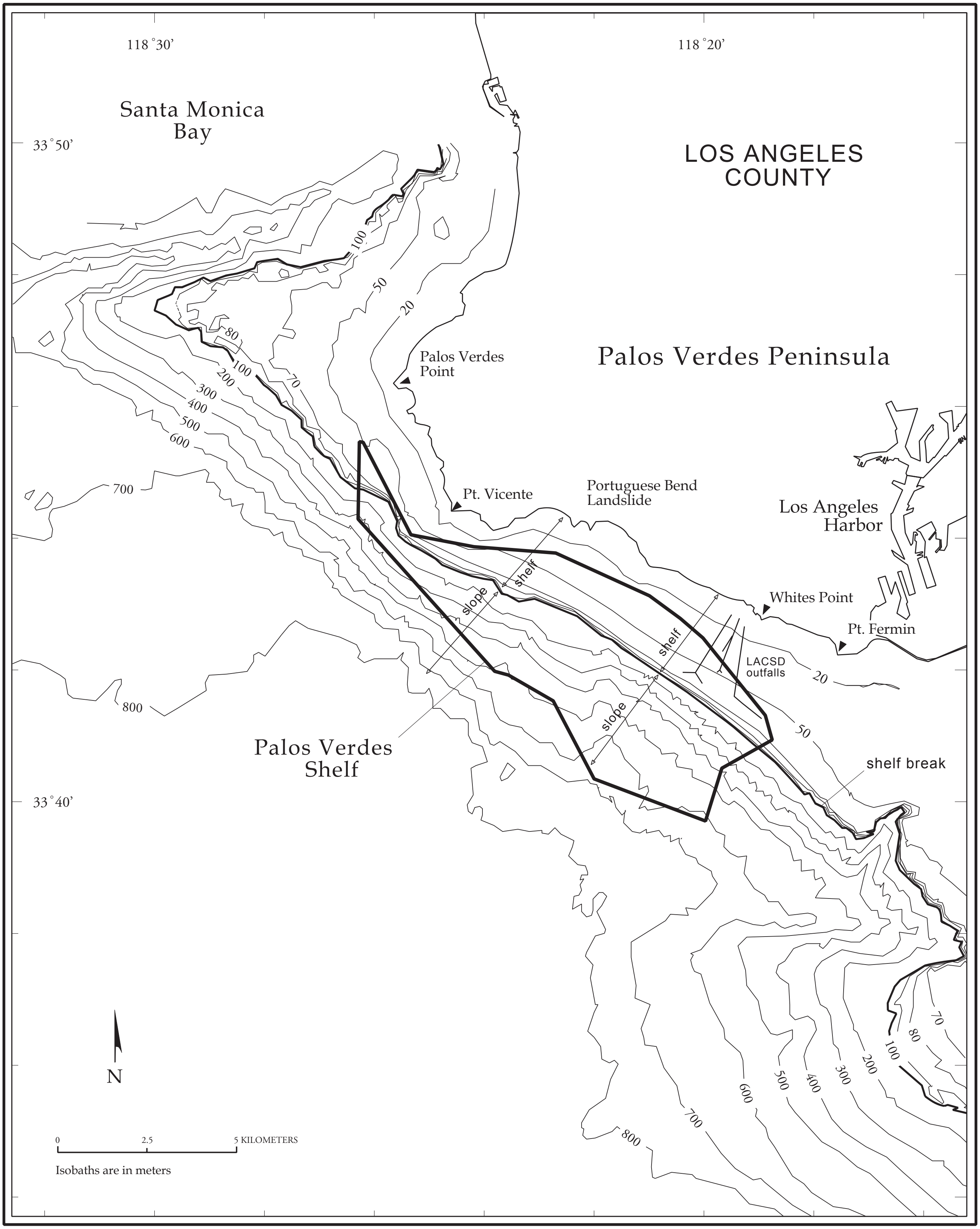
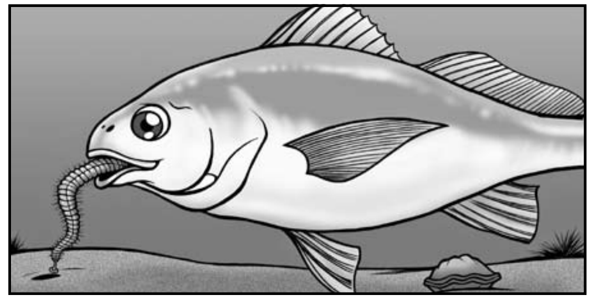


Figure 1. Palos Verdes Shelf Location Map



Surviving On the Soup of the Sea: Food Webs and Bioaccumulation

Curriculum Alignment

National Science Standards: C, F, G

CA Science Standards: 4th 2,b,c, 3a,b, 5.c; 5th 2a-c, 6th 2a-c,5c; 7th 2a,b, 3a, 5a-e 8th 5a

CA History/Social Science Standards: 4th 4.7, 8th 6.1, 12.1

Ocean Literacy Principles: 5d, 6e, 7c

Education in the Environment Principles and Concepts: I b,c, IIa,c, IIIa,c IV a-c,Vb

Objectives

Students will be able to:

- diagram a food web, discuss predator-prey relationships
- use vocabulary words
- observe how organisms at the base of the food web affect higher level predators
- discuss bioaccumulation

Background

There are many different food chains that interact to form complex food webs in the near shore coastal environments. These food webs reflect that predators have a variety of food sources and how energy is passed from one organism or group of organisms to another. The complexity in food webs helps to ensure survival in nature even if one source becomes scarce. The web may break down when too many sources decrease or disappear.

Many food webs begin with photosynthetic producers that get their energy from sunlight. Primary consumers (worms, snails, copepods, fish fry) feed upon producers and/or detritus. They are eaten by secondary consumers that are predators (small fish, crabs, etc) and the food web continues with predators feeding upon prey until top consumers or top predators are reached. A simple food chain might include diatoms that conduct photosynthesis to produce energy. That energy is consumed when the diatom is eaten by a copepod, which is then eaten by fish fry, which in turn is eaten by a small fish, which is then consumed by medium fish, which is finally eaten by a bird. When one organism is consumed, the energy is transferred to the next level. However, with each transfer energy is lost in the process of digestion. Many more organisms are required to support a top predator. When organisms die, microbes play a critical role in decomposition, providing nutrients for plant and algal growth.

When chemicals or toxins are introduced into the food web, they can be passed through to each predator in turn, resulting in higher levels of contamination in the top predators as they accumulate those toxins in their tissues. The evidence of bioaccumulation is shown with high levels of contaminants in beluga whales, bald eagles and white sharks.

Vocabulary

adaptation	**bioaccumulation**	**chemical**	**consumer**	**contamination**	**ecosystem**
food chain	**food web**	**predator**	**prey**	**producer**	**detritus**

Materials

- sample food webs, one card for each organism in the web, ball of yarn
- paper, pencils, scissors for each student or student team
- list of organisms that live in the harbor or bay on sandy bottoms

Food Web Introduction Activity

How do different types of organisms in one ecosystem interact with one another?
(symbiosis, predation, competition for space or food)

1. Organisms need energy to survive. Show an example of a food web.
2. Pass out organism cards to each student. Have students get in a circle and pass a ball of yarn, unwinding the yarn webbing as it moves from prey to predator. If it reaches top predators without reaching all of the students return to decomposers/nutrients and continue until all participants have been connected.
3. What if there is a fisherman that catches all of the small fish, topsmelt and sardines? *(They are no longer a food source for the larger fish so the larger fish will have to leave the area to feed.)* What happens when the small fish are no longer eating all the plankton? *(In addition, the topsmelt and sardines are no longer eating plankton, and that can result in an increase in plankton. Excessive plankton can result in loss of oxygen if they use up the nutrients and then die, dropping to the bottom to decompose.)* What happens to the number of predators who need food? *(They decline.)* Have them let go of their connection to demonstrate the impact.
4. Discuss human influences that can impact food webs creating an imbalance in an ecosystem.

Extension

To check for understanding, have students draw a basic food chain and then expand it to draw a food web. To review food webs more completely, see www.usc.edu/org/seagrant/Education/IELessons/Unit3/Lesson5/U3L5CO.html.

Contamination in the Web Activity

Begin with a discussion to engage students in thinking about the variety of predator/prey relationships.

1. Do all animals eat prey that is smaller than themselves? *(not necessarily, some are selective, some eat carrion)*
2. What features or adaptations determine a predator's food selection? *(availability, ease in catching, ease in ingesting, i.e., claws, beak, proboscis)*
3. Generate a list of organisms that make up food webs in the sandy shore/harbor environment.
4. Have students draw a circle, square, triangle and diamond on their paper. Cut out each of the shapes.
5. Write consumer on the square, detritivore on the triangle, producer on the circle and secondary consumers on the diamond.
6. Place shapes in sequential order, one on top of another to show the feeding sequence. Once you all agree on the order, spread the shapes in a sequential row and draw arrows to show the movement of energy through the food chain.
7. Together go through the list of organisms in the food web cards and mark whether they are producers, detritivores, carnivores or secondary consumers.
8. Have students share food chains from the bay that they can identify.
9. Once they are comfortable recognizing the role of the different organism in the harbor food web, ask students to respond to the following scenarios by selecting one of their shapes and then explaining how it would be affected:
   - A new increase in fishing is allowed and fishermen catch all of the larger fish. *(primary consumers will increase because they are not being preyed upon – their predators are all being fished out)*
   - The pelicans and least terns are injured by an oil spill. *(sardines and anchovies increase in number; detritivores increase as microbes break down birds that have died)*

- The runoff from fall rains dump large amounts of "fertilizer" into the ocean causing a plankton bloom. *(tremendous growth increasing the total phytoplankton population; consumers increase as they have more food)*
- Toxins that were dumped in the bottom of the harbor seep into the sand. *(detritivores consume them and become contaminated and the consumers that eat the detritivores suffer from bioaccumilation, secondary consumers suffer from biomagnification)*
- The area receives a designation as a marine protected area and commercial fishing is no longer allowed. *(the size of top consumers increases)*
- The harbor is dredged causing tiny sand to cloud the water. *(producers decrease producing food with less sunlight available, so less food available to the foodweb)*

Review

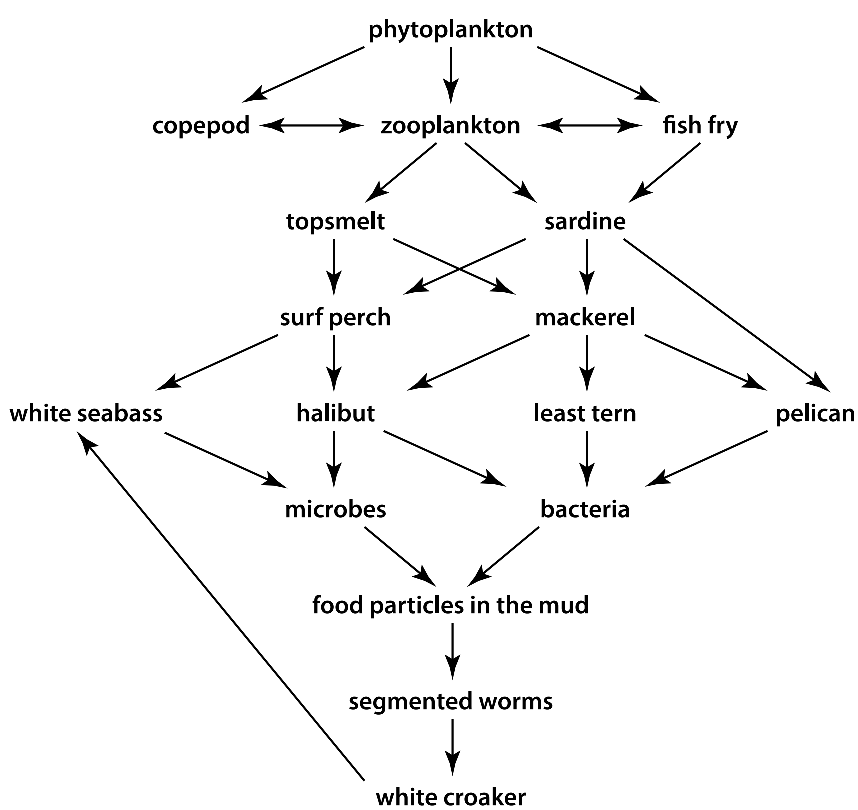
Which of the animals are at risk of contamination from pollutants that enter the food chain through the mud or sand? *(bottom feeders and those linked through the food web)*

How many worms does a bottom-feeding fish need to eat to survive? *(depending on the size of the fish and other food available it could eat several worms a day.)*

What happens to the fish if it only eats worms that have pollution in their bodies? *(the toxins or pollution can bioaccumilate in the fish's body resulting in the fish having much higher levels of pollution; each amount of pollution or toxin adds up)*

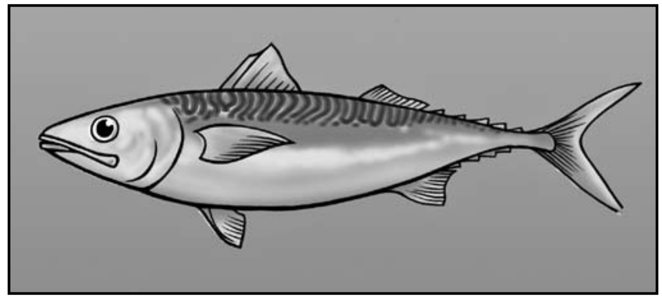
Why don't all of the fish get pollution from the harbor? *(not all of the fish eat contaminated food; the filter-feeders are eating plankton that would not likely be exposed to the contamination in the mud/sand)*

Food Web



phytoplankton	**pelican**
topsmelt	**halibut**
bacteria	**sardine**
least tern	**mackerel**
shrimp	**surf perch**
copepod	**fish fry**
zooplankton	**white seabass**
white croaker	**particles in the mud nutrients**
microbes (decomposition)	**segmented worm (polychete)**

Fintastic Fish



Curriculum Alignment

National Science Standards: A, C

CA Science Standards: 4th 3a,b, 6b,f; 5th 2a-d, g, 3a,6a;
6th 5c; 7th 2a,b,3a,5a-c,g,j

Ocean Literacy Principles: 5d-f, 6b,e,g, 7c

Education in the Environment Principles and Concepts: I a,c, IV

Objectives

Students will be able to:

- identify the internal and external anatomy of a fish and compare the systems and structures to those of a human
- use appropriate vocabulary
- follow sequential steps in completing a dissection and record observations
- share observations and compare and contrast their observations

Background

Fish are finned vertebrates that use gills to respire in the water. Fish are found in both fresh and saltwater. There are three classes of fish: jawless fishes (lampreys and hagfish), cartilaginous fishes (sharks and rays) and bony fishes (have calcified skeleton such as mackerel, perch, opah, etc.). With over 29,000 species, bony fish are the most abundant grouping. Most fish species are marine. The first primitive fish were alive over 500 million years ago. Fish are critical in the ocean food chain and have adaptations and characteristics essential to their survival within their own ecosystem.

Vocabulary

(see fish morphology page)

Materials

- images of fish (photos from magazines, internet, travel brochures, etc.)
- fish anatomy label cards
- fish diagram
- human anatomy diagram
- double-sided removable tape to hold cards on diagram
- dissection supplies per pair of students: internal anatomy diagrams, sharp/narrow bladed scissors, tweezers, defrosted whole fish wrapped in newspaper
- gloves
- paper towels
- trash bags

Procedure

1. Let students know that they will be learning about the form and function of the anatomy of a fish. They will be able to look at organ systems and see how they function. The external anatomy of a fish is different from a human, as fish must survive in water and humans live primarily on land. Note the similarities between human and fish internal anatomy. This activity will help students know how fish survive and how people use different parts of a fish. **Remind students that as scientists they are expected to be respectful of nature and recognize they are doing this lesson to learn first-hand about organ systems.**

   Alternatives for students who choose not to dissect include:
   a. build a fish from materials creating a key for the different materials used and label each of the systems
   b. virtual dissections *(both of these activities complement dissections as well)*

2. Ask students: What are some of the challenges that animals face if they live in the ocean? *(movement of currents, predators, pollution, getting lost, etc.)* Which sensory and locomotive structures enable fish to survive? *(fins, lateral line, vision, smell, chemoreception, etc.)* What adaptations animals have for survival in the ocean environment? *(some have specialized appendages such as fins, some respire in the water with gills and some use a swim bladder to stay buoyant, etc.)* Can you think of any structures or systems that are unique to fish? *(lateral line, swim bladder, otolith (ear bone) to help determine location)*

3. Fish have many different body shapes and forms depending upon where and how they live. Have students look at the images of different types of fish and explain which fish is likely the fastest *(Fusiform or streamlined body shapes are efficient for moving through the water. Fast moving fish tend to have a torpedo shaped body. Examples include tuna, mackerel, sardine, trout and smelt.)* Fish that are laterally compressed (flattened from side to side) include perch, garibaldi, opaleye and half moon. They are slower moving and tend to maneuver more in covered areas such as kelp or under piers. Flat fish such as halibut are laterally compressed as well and live buried in the sand, swimming up to catch unsuspecting prey. Bottom dwelling fish tend to be flattened with a more rounded body shape. They are often slow moving and survive by camouflage. They include scorpion fish, cabezon and rockfish. Some have barbels *(whisker-like appendages)* such as corbina and croaker.

4. Pass out one identification external anatomy label to each student, and have them match their label to the parts of the fish diagram that is in front of the class. Discuss what is important about each structure and how it helps the fish to survive.

5. Ask students: How do they think fish stay afloat? *(swim bladder)* What organs/parts do they expect to find in the fish? What other questions do they have about how fish survive? How might the dissection help answer these questions? How might they pursue their other questions?

6. Review lab safety guidelines: stay in seats; fish and its parts must remain on the table; scissors are to be used carefully, etc.

7. Pass out fish. Have students find the external anatomy on their fish with their partner. Review the external anatomy of the fish and discuss how it helps the fish move efficiently.

8. Lift the operculum to examine the gill arches and gill rakers. *(used to capture food)* Ask students why the gills are filled with blood. *(used to move oxygen into blood which circulates oxygen through body)*

9. Note the mouth has two openings, one exiting after water moves over the gills *(through the operculum)* and a second for food to move to the stomach. What purpose do they think the tongue serves? *(used to help trap prey)* How about the nostrils? *(to help find prey and avoid predation)* From observing the teeth on the fish, what types of food do you think it eats? Are they big enough to take bites or just to hold onto prey?

10. Open the fish by inserting the scissors at the anal opening and cutting shallowly through the belly toward the head. Cut between the pelvic fins and stop below the gill covering (operculum) and turn the scissors to cut through into the gill cavity. Go back to the start of the first cut and insert scissors deeply to cut through the muscle to the dorsal fin. Open the flap of skin and muscle to reveal the internal organs.
11. Use the internal anatomy diagram (p. 26) to identify organs and organ systems before cutting to remove. The heart and liver are found below the gills. The stomach is attached to the pyloric caeca, intestine and anus. Have students identify the parts of the digestive system (mouth to anus.) The swim bladder is silvery to transparent and found along the spine. On both sides of the spine are the kidneys, which are dark, reddish-black in color. If the fish is mature you may find ovaries with orangish-colored eggs and blood vessels or cream-colored testes that can be used to identify if the fish is a female or male.
12. Draw your observations and list the organs you find. Have students compare and explain how organs are similar or different from humans.

Organ	In fish	In humans
Gills - for breathing		
Heart - circulation of blood		
Liver - filters and cleans blood		
Pyloric caeca - produces digestive juices		
Gonads - produces eggs or sperm		
Stomach - digests food		
Intestines - digestion/movement of wastes		
Kidneys - produces urine		
Anus - exit for solid wastes		

Evaluation

Have students summarize their observations about the fish dissection. What are the similarities and differences with the human's and fish's organ systems? Which of their questions were they able to answer after completing the dissection? How might they determine if their answers can be generalized to other fish?

Fish Morphology - Body Structures

1. **anal fin** - found on the anterior side of fish, used to maintain stability

barbel - slender tactile process or fleshy projection located around the head on some fish

2. **caudal fin** or tail fin - used for sustained swimming or bursts of high-speed forward swimming; can be used to determine the general speed the fish swims

3. **caudal peduncle** - section of body between the vent and the caudal fin, supports the caudal fin

4. **dorsal fin(s)** – used to keep the fish upright, like a keel in a boat; some fish, such as eels, have extended fins that run the entire length of their body and use them for swimming; fins also used for stabilizing fish

5. **eyes** - used for vision; fish with larger eyes rely more upon sight, and help to capture all available light

6. **finlets** - small fins, generally behind the dorsal and anal fins

7. **fork length** - length from front tip of the longest jaw to the center of the fork in the caudal fin

8. **lateral line** - runs the length of the body from operculum to caudal fin; composed of a series of small canals with pressure-sensitive receptors; used for sensing motion in the water, including sound waves moving through the water

9. **mandible** - the largest and strongest bone of the face; is the lower jaw and holds the lower teeth in place

10. **mouth** - the opening through which food and water enter; size, shape and position vary considerably and can be used to determine prey

11. **nostrils (nares)** - used to detect scent; most fish have two pairs

12. **operculum** - bony flap that covers gill cavity; water exits through the operculum after passing over the gills

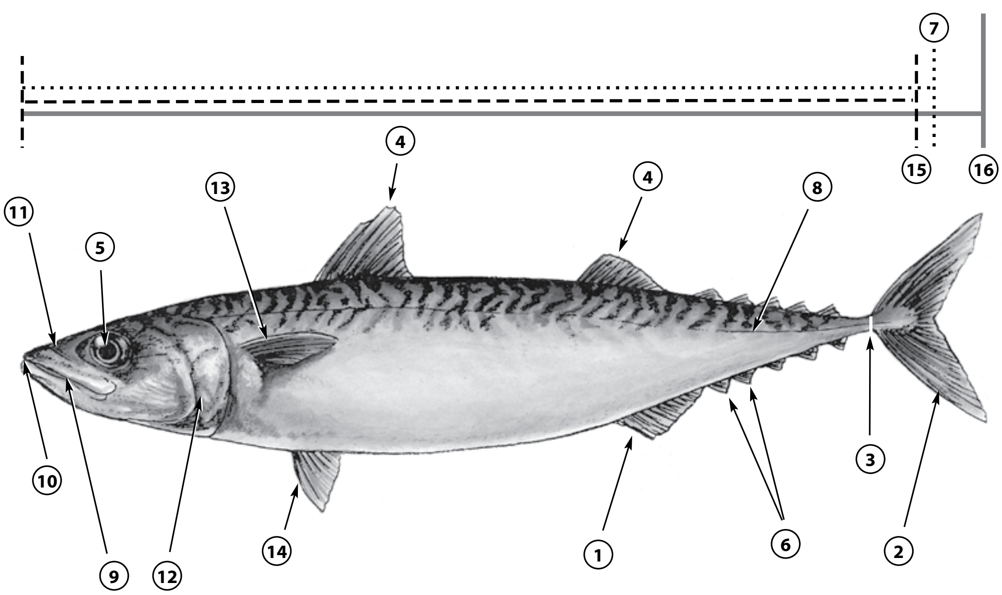
13. **pectoral fins** and (14) **pelvic fins** – used to steer up and down, turn left or right, to stop and, in some cases, back up or hover; some fish use them for swimming in quick bursts

pre-operculum - the large membrane bone lying in front of and parallel to the opercle

scales - small rigid plates that grow out of an animal's skin to provide protection; not all fish have scales

15. **standard length** - the distance from the anterior tip of the snout to the base of the tail; does not include the caudal fin

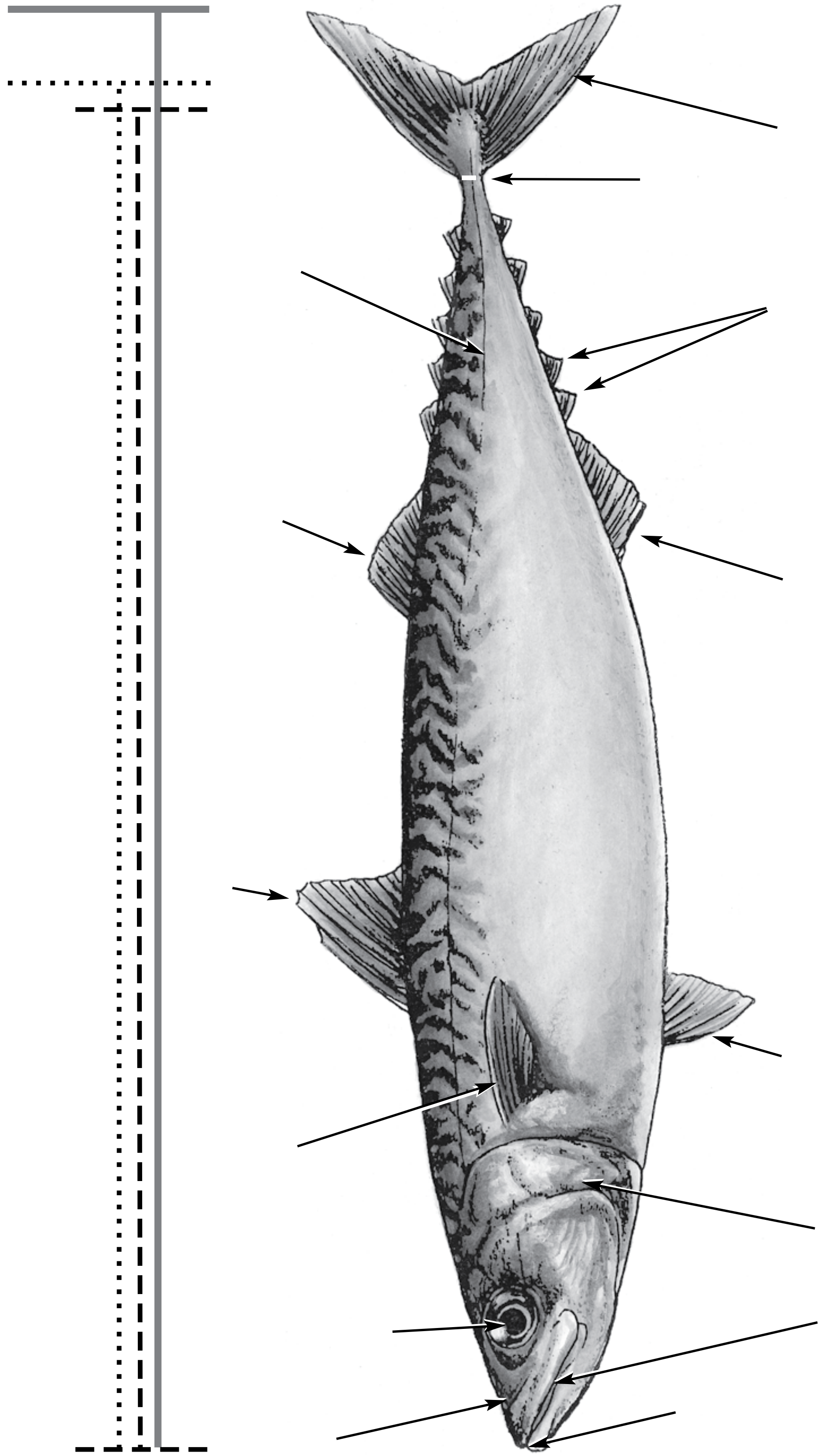
16. **total length** - the distance from the anterior tip of the snout to the posterior edge of the caudal fin

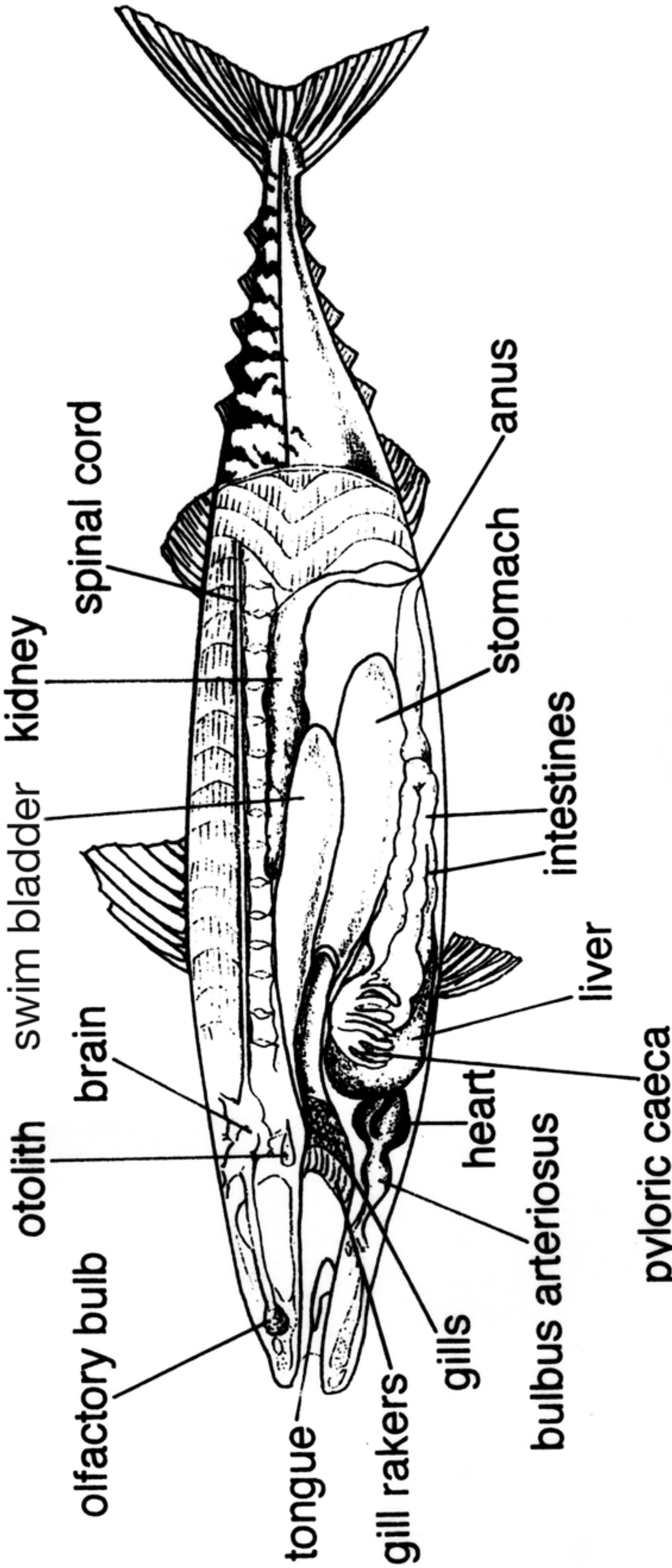


caudal peduncle	**lateral line**
pectoral fin	**second dorsal fin**
mouth	**operculum**
first dorsal fin	**total length**
eye	**nostril**
anal fin	**scales**
fork length	**standard length**
pelvic fin	**finlets**
mandible	**caudal fin**

External Anatomy

Pacific Mackerel
Scomber japonicus





Pacific Mackerel
Scomber japonicus
Internal Anatomy

Restoring Natural Resources Harmed by DDT and PCBs

How do things get restored?

To restore marine life scientists first have to support the claim that harm was done to the marine ecosystem and then they decide how to bring back marine life and habitats. Restoring animal populations and habitats can be complicated and very expensive. The money for restoration comes from lawsuits against the companies that polluted or from a trust fund that has been established from taxing chemical and petroleum industries. For the case against the Montrose Chemical Company in Torrance, CA and other companies that released DDT and PCBs, the U.S. government and the State of California filed a lawsuit. The lawsuit started in 1990 and was not settled until 2001, more than ten years later.

What is the cost of restoration?

Montrose and the other factories that were polluting were forced to pay $140 million dollars for the restoration of natural resources and the clean up of the contaminated site where DDTs and PCBs were dumped. Approximately fifty percent of this money was allocated for restoration and the other half of the settlement went to the Environmental Protection Agency (EPA) for cleanup. For more information on the cleanup efforts visit the EPAs website at www.epa.gov and search for "Palos Verdes Shelf."

The funds for restoration went to a group of natural resource trustees who then formed the Montrose Settlements Restoration Program (MSRP). MSRP trustees are comprised of representatives from six different Federal and State agencies. The agencies are:

- National Oceanic and Atmospheric Administration
- United States Fish and Wildlife Service
- National Park Service
- California Department of Fish and Game
- California Department of Parks and Recreation
- California State Land Commission

What is in a restoration plan?

After MSRP was formed, the next step was to put together a restoration plan. While the lawsuit was pending, scientists discovered that bald eagles, peregrine falcons, seabirds, fishing, and fish habitat were all harmed by the DDT and PCBs released into the ocean. MSRP talked with experts, managers, scientists, and the public to find out how to restore these natural resources. A plan that included all of the comments and ideas from these groups was put together and is available for anyone to read. Many types of restoration have already taken place. (for more details, see the MSRP website, http://www.montroserestoration.gov)

Bald Eagle Restoration

Bald eagle head.
Lee Emery, USFWS

Restoring Bald Eagles to the Channel Islands

By the early 1960s, bald eagles had disappeared from the Channel Islands due to human impacts, primarily from the introduction of DDT and other contaminants into the environment. DDT causes the eggs of bald eagles to become thin making them very fragile. Now, over 40 years later, levels of DDT continue to cause reproductive problems for the bald eagles reintroduced onto Catalina Island. Because of the continuing problems, and because the eagles have not naturally recolonized all of the California Channel Islands, MSRP reintroduced bald eagles in the Northern Channel Islands. From 2002 to 2006, 62 bald eagle juveniles were released on Santa Cruz Island. The birds have moved between the Channel Islands and have crossed the Santa Barbara Channel to the mainland. The eagles came from populations in Alaska and some were raised by the San Francisco Zoo before being released in southern California.

Successful Breeding on the Channel Islands!

In 2006, two nests were discovered on Santa Cruz Island. Each nest had one eagle chick that fledged from its nest. This milestone represented the first time in 50 years that bald eagles successfully reproduced on the Channel Islands without human assistance. In 2007, only one nest was successful on Santa Cruz Island. However, on Catalina Island, four eggs hatched naturally in two nests. This was the first time in over 50 years that bald eagles on Catalina Island successfully had hatched eggs! In 2008, more nests were successful at hatching naturally on Catalina Island than on the Northern Channel Islands. It appears that the bald eagles are spreading out among the different islands. In 2008, a new nest was established on Santa Rosa Island by eagles released as part of this restoration program.

Monitoring the Eagles

Biologists watch the eagles to see where they are nesting and how many eggs hatch during their breeding season (which takes place during winter and spring each year.) Once the young eagles leave the nest many of them don't survive their first year. Biologists attach a tracking device to the eagles that helps them track the eagles once they leave the nest. Some of the eagles travel as far as British Columbia from the Channel Islands. Biologists also recapture the released eagles in order to collect blood and feather samples to look for contaminants in the eagles.

Santa Cruz Island EagleCAM

With the successful hatching of a chick on Santa Cruz Island, MSRP worked closely with the Ventura County Office of Education, the Institute for Wildlife Studies, and the National Park Service to set up the Santa Cruz Island EagleCAM, a solar-powered camera that broadcasts live images of the nest via internet to classrooms and households accross the world. Bald eagle enthusiasts can now share their observations with each other and the biologists.

The Ventura County Office of Education maintains an informational website and discussion board with updates on the bald eagles. Biologists from the Institute for Wildlife Studies provide weekly updates on the bald eagles. Visit the EagleCam at http://chil.vcoe.org/eagle_cam.htm and the eagle discussion board at http://z7invisionfree.com/CHIL_EagleCAM/index.php.

Bald eagles inside hack tower just after release.
Milena Viljoen, MSRP

Fishing and Fish Habitat Restoration

Restoring Fishing

The release of PCBs and DDTs into the southern California marine ecosystem has increased risks associated with consuming fish, especially in areas close the Palos Verdes shelf. The state of California and other local organizations responded by posting signs and creating brochures to warn people about eating fish from some fishing sites, including several fishing piers. Some anglers stopped going to these piers because they were afraid to eat the fish they catch. Other people continued eating fish. Therefore, one of the restoration goals is to increase the ability for anglers to safely consume fish that they catch.

Surfperch with kelp.
David Witting, MSRP

Providing Public Information

Not all fish species in California are highly contaminated with DDTs and PCBs and are consequently safe to consume in moderate quantities. One way of restoring the ability of anglers to safely consume fish is to educate them about which fish are safer to eat and how to cook the fish to avoid harmful chemicals. In addition to the "What's the Catch" comic book another MSRP educational tool is a fish identification card. Anglers can take this waterproof card fishing with them to help them identify the fish they catch. There are also safe cooking methods on the back of the card. Future projects to support public education include installing a fish cam, developing permanent exhibits, educating local fishing groups, and supporting outreach projects that educate children and families. (Visit the Fish Contamination Education Collaborative website at http://www.pvsfish.org to learn more about what the EPA is doing to educate the public about fish contamination.)

Artificial Reefs

While educating anglers about fish that are safe to consume is an important component of increasing their ability to safely consume fish, it may be of limited benefit to anglers that fish from piers that are surrounded by habitats that primarily attract the most contaminated fish. To address this, a second restoration approach is to use artificial reefs to diversify the habitats around piers, attracting fish that have less contamination. The white croaker, a fish species that has high levels of DDTs and PCBs, is a bottom-feeder and eats marine life that lives in muddy sediments. These sediments have the highest concentrations of DDTs and PCBs. Fish that live on rocky reefs do not have as much contamination because they tend to feed on marine life that lives on or above the rocky areas which have much lower concentrations of DDTs and PCBs than soft sediments. Building artificial reefs near piers that are mostly soft-bottom will attract reef fish that are safe to eat in moderate quantities. Several locations are being considered for these artificial reef projects at this time. This process requires biologists to study the area to determine if the reef will be successful in attracting reef fish species.

Restoring Fish Habitat

Most of the DDTs and PCBs remain in the sediments on the ocean bottom near the Palos Verdes Shelf where these chemicals were released. This area is now unable to produce clean fish the way it did before the chemicals were released. Given the fact that these injured habitats are likely to persist for many years, MSRP is funding projects that restore or enhance fish habitats in areas or habitat types that are not affected by the DDTs and PCBs. These projects will increase production of fish in areas that are not contaminated. Habitats that MSRP is now supporting for restoration include rocky reefs, wetlands and Marine Protected Areas. By restoring important fish habitat this also benefits the fishing community because there will be more fish available when these areas are healthier.

Wetlands

Wetlands provide a safe habitat for young fish before they venture into the open ocean as adults. Wetlands have plenty of food and shelter that is necessary for several species of sport fish during their first year of life. Over 90% of wetlands in Southern California have been lost to coastal development. Two wetland restoration projects are being supported by MSRP along the Southern California coast. One of which will help restore 140 acres of coastal wetland habitat in Huntington Beach.

Marine Protected Areas

Marine Protected Areas (MPAs) are similar to National Parks in the United States where wildlife and habitat is preserved and protected. As with National Parks, MPAs vary in the degree to which they protect wildlife and habitats. In 1999, the California State legislature passed the Marine Life Protecting Act (MLPA, http://www.dfg.ca.gov/mlpa/), which directs the state to design and manage a network of MPAs in order to, among other things, protect marine life and habitats, marine ecosystems, and marine natural heritage, as well as improve recreational, educational and study opportunities provided by marine ecosystems that are subject to minimal human disturbance. The first network of Marine reserves that were established under this act is in waters surrounding the four northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) and one of the in the southern Channel Islands (Santa Barbara). This marine reserve is also known as the Channel Islands National Marine Sanctuary (CINMS, www.channelislands.noaa.gov). MSRP is providing support for the Channel Islands Marine Reserves to study the effectiveness of the MPAs in protecting marine life and increasing fish abundance.

Peregrine Falcon Restoration

Peregrine falcon flying.
Craig Koppie, USFWS

Monitor the Recovery of Peregrine Falcons on the Channel Islands

Peregrine falcons were also found to be harmed by DDT in the marine environment. They prey on seabirds that feed on fish which have these chemicals in them. Falcons were also found to lay thin shelled eggs that break easily due to DDT contamination. MSRP is monitoring the falcons that nest on the Channel Islands to see if they can recover naturally in southern California. Biologists are also collecting peregrine falcon eggs to monitor for levels of DDT and PCBs in them.

In February 2007, biologists from the Santa Cruz Predatory Bird Research Group completed their first comprehensive monitoring effort. Biologists spent many weeks conducting aerial and ground surveys of the islands. In April 2007, for the first time in over 50 years, biologists discovered a pair of peregrine falcon chicks and an unhatched egg on Santa Barbara Island. Approximately 3 weeks later, biologists attached small metal tags on both legs of each chick. The tags will allow the biologists to identify the chicks individually and track them into adulthood.

Seabird Restoration

California Channel Islands

Studies that were done during the lawsuit against Montrose and other factories showed that seabird eggshells were also thinning because of DDT. MSRP decided to fund seabird restoration projects throughout southern California and Mexico. Seabirds are still impacted by DDT even though they nest far from the contaminated site. Contamination in the marine environment can be widespread and does not stop at borders. Below are short descriptions of the restoration that is being done for each island and an update on what has been done so far.

Santa Cruz Island

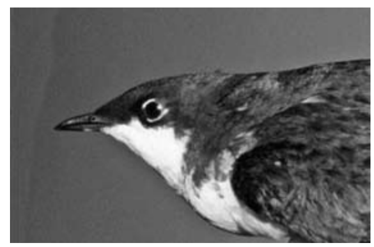
The goal of the restoration efforts focused on Scorpion rock, Orizaba rock, and within sea caves surrounding Santa Cruz Island is to restore seabird habitat by removing non-native vegetation, installing artificial nesting boxes, and reducing human disturbance.

Biologists are conducting surveys of the Cassin's auklets and the ashy storm-petrel populations at Scorpion and Orizaba rocks and in the sea caves off Santa Cruz Island. Seabirds use Scorpion and Orizaba rocks to nest because they are free of predators. Seabirds nest on the ground, and can easily be preyed upon by other animals. Biologists removed non-native plants that made it difficult for birds to nest and planted ones that were originally on the rock and are better for nesting seabirds.

Biologists placed 50 artificial nest sites on Orizaba rock and Cavern Point Cove caves. The artificial nests provide more secure places for seabirds to nest. Recordings of ashy storm-petrels calls were placed on Orizaba to attract these seabirds to the rock. If seabirds think there are other birds already on the rock, they are more likely to nest in that area. Biologists will continue to monitor these areas to see if seabirds are returning.

Santa Barbara Island

The main objectives of this habitat restoration effort is to benefit Cassin's auklets and Xantus's murrelets by removing non-native vegetation and reducing human disturbance.



Adult Xantus's murrelet.
Jennifer Boyce, MSRP

Biologists will conduct surveys of Xantus's murrelets to quantify the population and identify nesting areas on the island. Biologists will also conduct an assessment of the status of Cassin's auklets on Santa Barbara Island, involving collecting historical data from the literature and conducting visual surveys.

A small planting effort of native plants was completed and most of the plants have survived. More planting of native plants has taken place in other nesting areas of both Cassin's auklets and Xantus's murrelets. Biologists will also use recordings of Cassin's auklets to attract these seabirds to the island in the future.

San Nicolas Island

The goal for this restoration project is to protect western gull and Brandt's cormorant colonies on U.S. Navy–owned San Nicolas Island by removing feral cats. In addition to seabirds, San Nicolas Island supports a large number of endemic species, including at least 20 plant species, 25 invertebrates, one reptile, three birds, and two mammals.

Baja California Pacific Islands (Coronado and Todos Santos Islands)

Nesting cormorant.
Roy Lowe, USFWS

Restoration will include using social attraction techniques (including decoys and vocalizations), improving nesting opportunities with artificial nests, shielding lights, and reducing human disturbance. The seabirds that will benefit from restoration on these islands are Brandt's cormorants, double-crested cormorants, California brown pelicans, western gulls, Cassin's auklets, ashy storm-petrels, and Xantus's murrelets.

Restoration In Action

Curriculum Alignment

National Science Standards: 4th C-G, 5th – 8th C-G

CA Science Standards: 4th 2b, 3a,b, 5th 2a, c, 3a,b,4a-d, 6th 4d, 5a-e, 7th 1f, 2b,3a,e,5a,c,6d,h

CA History/Social Science Standards: 4th 1.1, 1.5, 4.6

CA Language Arts Written Language: 4th 1.2,1.3,1.7,1.8,2.3b, 5th 1.1,1.2,1.4,2.3c, 6th 1.1-3, 2.3, 7th 1.1,1.4,2.3b, 8th 1.2,1.5,2.3b

Listening/Speaking: 4th 1.2,1.2,1.7,2.1,2.2, 5th 1.1, 1.2, 2.1, 2.2, 6th 1.1,1.4,1.5,2.1,2.2,2.5, 7th 1.1,1.4,1.5,2.3, 8th 1.3,1.4,1.5,2.3

Ocean Literacy Principles: 5, 6e,g

Education in the Environment Principles and Concepts: I, II, IIIc, IV

Objectives

Students will be able to:

- locate restoration sites on a map using latitude and longitude
- make daily journal recordings of nest observations from the EagleCAM (http://chil.vcoe.org/eagle_cam.htm)

Background

NOAA as one of the Montrose Settlement Restoration Program's trustees and has taken on the responsibility to restore the damage done to natural resources from the Montrose chemical contamination. http://www.darrp.noaa.gov/southwest/montrose/msrphome.html

Because present estimates indicate that DDT and PCBs will continue to contaminate marine resources and birds in Southern California for future generations and a substantial amount of DDT probably will remain in the sediments and life of the Palos Verdes Shelf for decades, these projects will aim to reverse some of the damages.

These efforts have already led to successes. The bald eagle project has resulted in new chicks, and angler education has helped the public better understand the issues and make wise choices for their own health, Huntington Beach and Bolsa Chica wetlands are being enhanced with settlement funds and other projects will continue to be implemented and monitored.

Vocabulary

EagleCAM	**endangered species**	**fledge**	**reintroduction**
restoration	**seabird**	**wetland**	

Materials

- Internet access for the EagleCAM
- writing instruments

Procedure

1. One of the best ways to understand how organisms survive in nature is to observe them in their natural habitat. This can be done using a live feed EagleCAM or nest camera where students have an opportunity to observe (watch and hear) and then record their observations.
2. Have students write a paragraph about what they anticipate seeing in the eagle nest, including what challenges the eagles will have at being successful prior to the beginning of the nesting season *(early January)*.
3. Assign a student or team of students to watch the EagleCAM each day, record observations and share an update report with the rest of the class. An observation sheet may include:

date	**start time to end time**	**name of observer(s)**
weather	**description of nest**	**description of egg(s)**
behavior of eagle(s)	**other animals in the area**	**other observations**

4. Written observations can be accompanied by pictures. The science journal can be completed by each student or by the class as a group. As the students work they will likely develop questions that can be recorded and then researched. The answers can then be included in the science journal.
5. At the end of the nesting season have the students write the story of the nesting year and compare their early writing to their final story as evidence of their learning.

Extensions

1. Look up and map the locations where the restoration work is occurring.
2. Investigate common questions and answers by checking http://chil.vcoe.org/eagle_faq.htm
3. Measure and build a model eagle nest. The nest structure at Santa Cruz Island is as follows: circumference = 4.25 meters; diameter at widest point = 1.9 meters; diameter at narrowest point = 1.3 meters; nest material depth max/min = 0.7/0.4 meters. What materials are the nest built from?
4. Observe how an eggshell thins when the calcium in the shell is reduced. Have the students feel the egg then place the egg in a jar, cover the egg with vinegar and let it sit for a few days. Remove the egg and carefully feel it again. Continue until the calcium is reduced leaving only the thin membrane covering for the egg. What challenges would a developing egg face without a hard protective shell?
5. Find out what the feeding range is for a bald eagle. Plot on a map the circumference of the area the eagle might travel in search of food using Santa Cruz Island as your center point.

Vocabulary

adaptation – a device, mechanism or organism that changes to better succeed in the environment in which it is found

advisory – guidelines or recommended restrictions to ensure protection

anal fin – fin located on fish's underside behind the pelvic fins, used for stability

bag limit – number of fish allowed to be caught and kept by an individual on a daily basis

bioaccumulation – the buildup of chemical substances in the cells or tissues of an organism

biomagnification – the accumulation and amplification of chemical substances at each succeeding trophic level

carnivore – an organism that eats animals

caudal fin – tail fin, most fish use for forward movement

commercial fisheries – fish caught with the intent to sell

consumer – an organism that ingests other organism to get energy

contaminant – an impurity; any material of an extraneous nature associated with a chemical, a pharmaceutical preparation, a physiologic principle or an infectious agent that is not in its natural environment, and therefore foreign to the new environment

contamination – the process of polluting

current – a tidal or non-tidal continuous movement of ocean water in a certain direction

decomposer – organism that gets energy from dead plants and animal matter, breaking it down further to nutrients used by photosynthetic organisms

degrade – conversion of a chemical compound to one less complex, as by splitting off one or more groups of atoms

DFG, California Department of Fish and Game – responsible to manage wildlife and natural habitats of California

detritus – waste from organisms and decaying plants, algae and animals; **(-ivore)** – feeds on detritus

DDT, dichlorodiphenyltrichloroethane – an organochlorine insecticide used to control mosquitoes and other insects; DDT is very toxic, very persistent in the environment and bioaccumulates in many animals to a large degree

dichotomous key – classification tool used to identify and organize a collection of objects or organisms

discharge – release of a substance

dorsal fin – large fin or fins on a fish's back (connected or separate) used for stability when swimming

EagleCAM – camera placed at the nest of a bald eagle to record images of the nest for remote observation

ecosystem – a community of organisms interacting with one another and the physical environment

effluent – a discharge of pollutants into the environment, partially or completely treated or in its natural state; generally used in regard to discharges into waters

endangered species – under the Endangered Species Act (ESA) an endangered species is one that is in danger of extinction throughout all or a significant portion of its range; Endangered Species Act (ESA), passed by Congress in 1966, establishes a federal program to protect species whose survival is threatened by habitat destruction, overutilization, disease, etc.

EPA, Environmental Protection Agency – the mission of the Environmental Protection Agency is to protect human health and the environment; since 1970, the EPA has been working for a cleaner, healthier environment for the American people

exposure – vulnerability to the elements or to contaminants

fillet – section of muscle cut from the bone

fin – organ of locomotion and balance in fishes and some other aquatic animals; in fishes, fins are of two types: paired (pectoral and pelvic fins) and unpaired or median (dorsal, anal and caudal fins and finlets)

fish – finned vertebrate that uses gills to breathe in the water

fishery closure area – a fishing area which is closed or restricted by a government entity. Such closure prohibits fishing for commercial, recreational, or subsistence purposes

fledge – to acquire the necessary feathers for flight to be able to leave the nest

food chain – a linear succession of organisms in an ecological community that shows the progressive exchange of energy

food web – all the interactions of predator and prey, along with the flow of nutrients into and out of the ecosystem; these interactions connect the various members of an ecosystem and describe how energy is converted and passed from one organism to another

fry – newly hatched young after the yolk sac has been fully absorbed and the fish swims freely in search for food

habitat – an area that provides life requirements such as food, water, shelter and space for that particular organism to survive

herbivore – an organism that eats plants or algae

ichthyology – the scientific study of fishes; **(-ist)** – scientist who studies fish

immune system – a system that provides the organism with a defense against infection

larval fish – stage in fish's life cycle just after hatching from an egg where fish lives off of yolk sac

lateral line – a series of sensory pores along the head and sides of fish and some amphibians by which water currents, vibrations and pressure changes are detected

microbes – microscopic living organisms including bacteria, plankton, fungi, viruses and protozoa

mitigation – the act of making less severe or intense; measures taken to reduce adverse impacts on the environment

NOAA, National Oceanographic and Atmospheric Administration – a federal agency within the U.S. Department of Commerce that is dedicated to predicting and protecting the environment; NOAA's overall mission is to understand and predict changes in the Earth's environment, protect life and property, provide decision makers with reliable scientific information, conserve and manage the nation's living marine and coastal resources to meet our nation's economic, social and environmental needs, and foster global environmental stewardship

non-point source pollution – a pollution source without a single point of origin or outlet. It occurs when rainfall, snowmelt or irrigation runs over land or through the ground, picks up pollutants and deposits them into rivers, lakes and coastal waters or introduces them into ground water. Common nonpoint sources are agriculture, forestry, mining, construction, dams, channels, land disposal, saltwater intrusion and city streets

omnivore – an organism that eats seaweeds/plants and animals

operculum – bony plate protecting gill covering

otoliths – inner ear stones found in most bony fish used to detect changes in body position

oviparous – animals that hatch from eggs

ovoviviparous – reproduction whereby fertilized eggs are incubated within the parent's body and are released; hatched examples include some sharks, seahorses and surfperch

PCBs, polychlorinated biphenyls – any of a family of industrial compounds produced by chlorination of biphenyl, noted primarily as an environmental pollutant that accumulates in animal tissue with resultant pathogenic effects including neural impacts and possible increase risks of some types of cancer

pectoral fins – side fins used mainly for direction or steering, sometimes used for forward and backward swimming

pelvic fins – paired fins located on the belly of a fish or under the pectoral fins

pelagic – organisms found in open ocean waters

point source pollution – origin of a pollutant discharge from a definable point, such as an effluent from the end of a pipe

population – individual organisms of the same species living in a particular area

predator – an organism that catches and eats animals for food

prey – an organism that is caught and eaten by others for food

primary treatment – most of the solids sink, are removed and pumped to the digesters. Other wastes are skimmed from the surface. The liquid is then pumped to the secondary treatment system for further treatment.

producer – organism that makes its own food through chemosynthesis or photosynthesis

protected species – species that are protected by federal legislation such as the Endangered Species Act, Marine Mammal Protection Act and Migratory Bird Treaty Act, etc.

recreational fishing – fishing for personal consumption or recreation

regulations – legal restrictions to ensure species protection

rehabilitation – the recovery of specific ecosystem components in a degraded ecosystem or habitat

reintroduction – placing an organism back in its former habitat after it was eliminated from the area

restoration – to bring back to or recover the health of an organism or environment

scales – a flattened rigid plate forming part of the body covering of many animals

school – a social group of fishes, usually of the same species, which tends to orient and move in the same direction

seabird – a bird that is typically found in coastal waters and open ocean ecosystems (pelican, cormorant, murres, petrels, etc.)

secondary treatment – in covered, oxygen rich aeration tanks, bacteria in oxygen rich aeration tanks consume most of the remaining solids in the waste water. The bacteria and solids are separated from the wastewater in clarifiers. It is thickened and then sent to the anaerobic digesters. The treated wastewater is then sent to the tertiary treatment process.

sediments – soil, sand and minerals washed from land into water, usually after rain, that pile up in reservoirs, rivers, harbors and coastal areas destroying habitats and clouding the water so that sunlight cannot reach aquatic plants

spawn – to produce or deposit eggs; the eggs of aquatic animals; the mass of eggs deposited by fishes; to give forth young in large numbers

species – a category of taxonomic classification ranking after a genus and consisting of organisms capable of interbreeding

storm water – water that accumulates on land as a result of storms, and can include runoff from urban areas such as roads and roofs

superfund – the federal government's program to clean up the nation's uncontrolled hazardous waste sites

superfund site – a site where toxic wastes have been dumped and the Environmental Protection Agency has designated them to be cleaned up

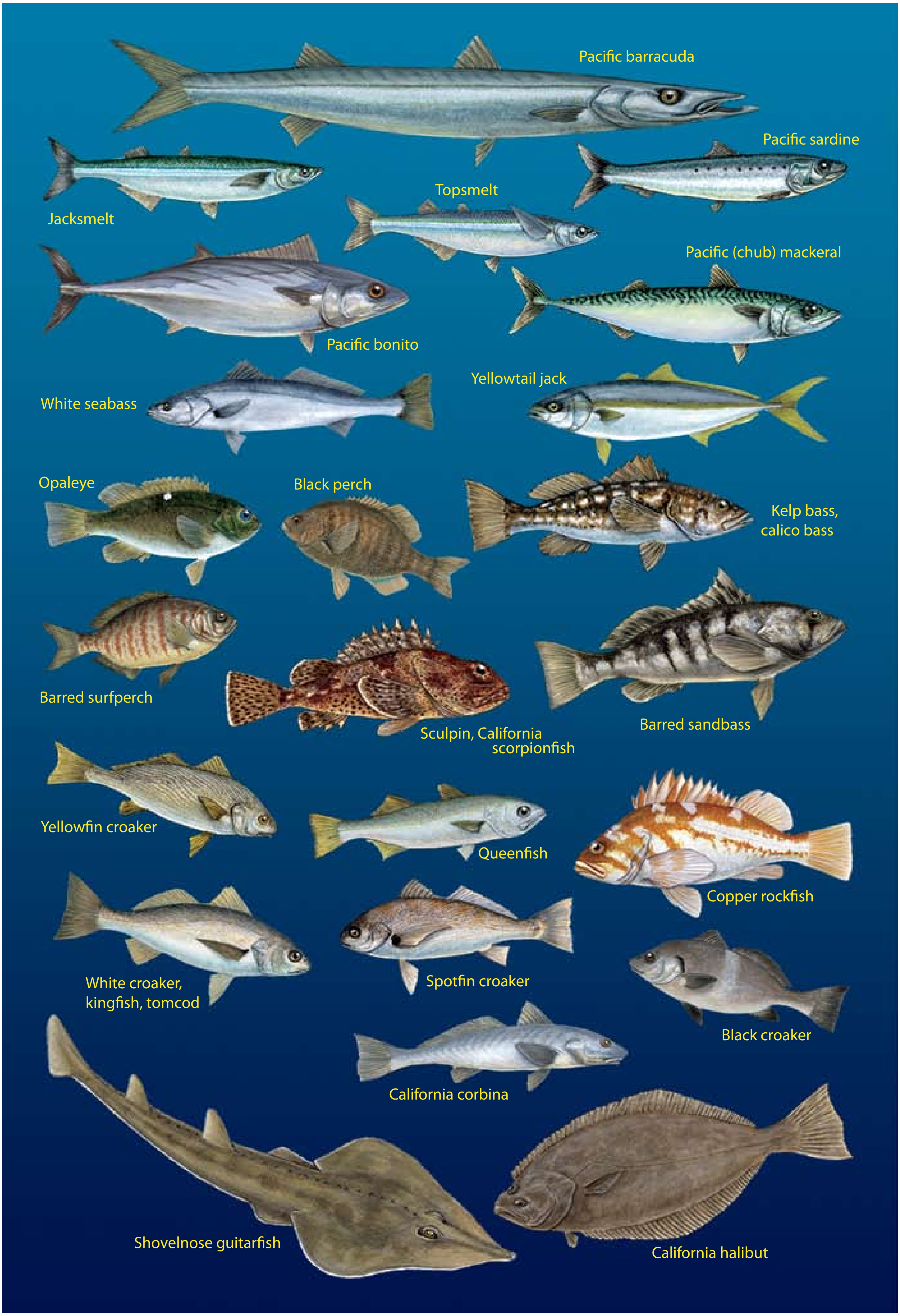
viviparous – produces live young; gives birth to live young

wastewater – a mixture of water and dissolved or suspended solids carrying wastes from homes, businesses and industries

wastewater treatment plant – a facility containing a series of tanks, screens, filters and other processes by which pollutants are removed from wastewater

watershed – an area of land that drains down slope to the lowest point; the water moves through a network of subterranean and surface drainage pathways which converge into streams and rivers, eventually reaching an estuary and finally the ocean; because water moves downstream, any activity that affects the water quality, quantity or rate of movement at one location can affect locations downstream to the ocean

wetland – an area that is a transition between terrestrial and aquatic environments that is covered with water for at least part of the year; may serve as an important nursery as well as biologically productive resource for surrounding ecosystems


Pacific barracuda
Pacific sardine
Jacksmelt
Topsmelt
Pacific (chub) mackeral
Pacific bonito
White seabass
Yellowtail jack
Opaleye
Black perch
Kelp bass,
calico bass
Barred surfperch
Sculpin, California
scorpionfish
Barred sandbass
Yellowfin croaker
Queenfish
Copper rockfish
White croaker,
kingfish, tomcod
Spotfin croaker
Black croaker
California corbina
Shovelnose guitarfish
California halibut