Chapter 3
Some Like It Wet

Earth is home to many creatures with many different needs, from polar bears to snakes. Everything that lives on Earth lives in a *biome*. A biome is an area of land with special plants, animals, climate, and soil. There are many different biomes on Earth. A wetland is a biome, so is a redwood forest and a desert. Biomes have plants and animals that, over time, have grown together to help each other live in their homes, whether their homes are a deep, wet jungle or a dry, sunny desert. Biomes contain a number of habitats that are specific to each biome. Here we will learn more about the wetland biome, the special *adaptations* of plants and animals who live in wetlands, and the many ways wetlands have been used in the past.

Wetlands, also called marshes, are part water and part soil. Sometimes they are covered with water, and other times they look dry but still have water hidden in the soil. Wetlands are found on our coast, near lakes, ponds, rivers and streams, and in inland mountains and river valleys. They can be salt water, fresh water, or a mix of salt and fresh, called brackish water. You may even have a wetland near your home or school.

New words

biome; wetland; adaptations; species; water table; ecosystem; habitat; environment; rare, threatened, and endangered species

Wetlands are one of California's most beautiful biomes, and one of its most special. Because wetlands are the place where land meets water, they provide habitat for plants and animals that live on land and in the water. Wetlands also have important jobs. Water that rushes off land during storms is slowed down when it hits wetlands, where it stays awhile before more slowly entering the ocean or larger bodies of water. Plants and animals thrive in this calm water, and use it for breeding and as a nursery for their young. On the coast, wetlands protect low-lying areas from storm waves—they slow the waves down before they hit dry land. Wetlands provide food and shelter for birds, young fish, small bugs, and other tiny creatures.

The birds, animals, and plants that live in wetlands have special *adaptations* to live in a part dry, part wet world. They have special body types and habits that help them eat and nest in wetlands. Wetland plants and animals rely on each other—they are all part of the wetland food chain. They can't live in a place that is all wet, such as a pond, or all dry, such as a meadow. The water and soil mixture has to be just right for a wetland to be a good home for wetland *species* (plant and animal types). Wetland species have some special adaptations, such as some wetland birds' beaks are just the right length to dig for bugs and worms that live in the mud under shallow water. And bees that live in a dry habitat nearby pollinate some wetland plants. Without these bees, the plants would not survive. These adaptations make wetland species special—many of these species can live no

California Coastal Commission Area of Critical Concern: Wetlands

Relevant California Science Content Standards, Grade 3: Life Sciences 3. a.-d

Grade 3 Activities

These activities will help students learn more about the roles wetlands serve as habitats, about a salt marsh food chain, and how some birds have adapted to become very picky eaters, limiting them to the habitats in which they can survive.

Activity Goals

3.1 Wetlands at Work

Students will:

1. Understand the beneficial functions of wetlands and how they are related to the students' needs.
2. Know that wetlands are a biome with unique habitats for many plants and animals.
3. Understand that wetlands have been used over the course of California history, and are considerably changed today.

3.2 Marsh Munchers

Students will:

1. Learn about the ecological roles salt marshes play.
2. Reinforce understanding of the concept of a food web.
3. Use body movement and pantomime to simulate the feeding motions of marsh animals and identify their interconnectedness in a food web.

3.3 Fill the Bill

Students will:

1. Understand the concept of adaptation.
2. Learn how adaptation in birds can lead to limitations in what they can eat and where they can live.

place other than wetlands. In fact, wetland habitats are home to 43 percent of the federally listed endangered and threatened species.

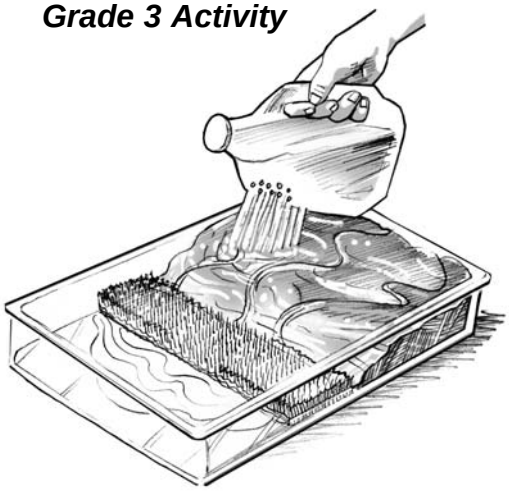
Wetlands are important places for birds that migrate with the seasons. These birds travel long distances and need a safe place to rest and pick up a bite to eat along the way. Wetlands serve this purpose.

Huge flocks of migratory birds use freshwater marshes, but their numbers have been declining because of the activities of humans. The largest remaining fresh water marshes in California are the Creighton Ranch Reserve, a relict of Tulare Lake, the San Joaquin Marsh Reserve in Orange County, and the Gray Lodge north of Sutter Buttes, the most intensively used wetlands in the Pacific Flyway. Freshwater marshes once covered the Great Central Valley, where runoff from the mountains accumulated in basins.

Today, many wetlands are near big cities that are growing fast. In the past, the value of wetlands was not well recognized, so people often filled them in with dirt to create more buildable land. As a result, a lot of wetlands were destroyed, and many of the plants and animals that depend on wetlands have become rare or endangered. A plant or animal is *rare* or *endangered* if it is in danger of becoming extinct soon. Nearly 75 percent of rare or endangered bird species rely on wetland habitats. See the concept map on page 12 to see how the many facets of wetlands relate to each other, and to us.

To protect wetland plants and animals, the state of California has created laws that limit the amount of development that can occur in wetlands. This way, wetlands can still do their many important jobs: provide homes and nurseries for specialized plants and animals, slow down water when it runs off from land, protect coastal areas from big waves, filter out sediments and contaminants, and be wonderful, peaceful places for us to enjoy.

Grade 3 Activity



Science skills

- Gathering and analyzing information
- Predicting
- Experimenting

Concepts

- Wetlands are important parts of California watersheds.
- Wetlands protect our coast.
- Wetlands slow down water runoff, filter it, and release slowly over time.
- Wetlands support life forms adapted to a part wet, part dry habitat.

California Science Content Standards

3. Life Sciences
Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:
3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.
3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organisms or other organisms, and some are beneficial.
3.d. Students know when the environment changes some plants and animals survive and reproduce; others die or move to new locations.

Activity 3.1
Wetlands at Work

Students learn what makes a wetland, and observe or create a model that demonstrates the buffering and filtering effects of wetlands.

Background

Most of California's wetlands have already disappeared from the landscape, and only now are we beginning to see the consequences and realize the importance of this previously overlooked habitat. Wetlands serve critical biological and physical functions.

Biological functions of wetlands include:

- Wetlands are a source of *high primary productivity and habitat* for year round and migrating bird and fish species.
- Wetlands have important roles in *providing for humans*; they provide recreation, flood protection, water quality maintenance, and food.
- Wetlands are *nurseries* for 75-90 percent of all the fish and shellfish harvested in America. This natural resource accounts for $111 billion dollars in sales and provides one and a half million jobs.

Physical and hydrological functions of wetlands include:

- *flood control* in low-lying areas; they act as protective natural sponges by capturing, storing, and slowly releasing water over a longer period of time.
- *storm buffers*: coastal marshes can dissipate wave energy.
- *reduce erosion*: wetland plant roots hold soil in place, reducing erosion caused by tidal action.
- *ground recharge to aquifers*: freshwater wetlands collect water.
- *improve water quality*: wetlands act as sediment sinks, effectively trapping, precipitating, and recycling waterborne constituents from run-off. Wetland plants remove small amounts of nutrients, trace metals, and other compounds and incorporate them into plant tissue. Artificial wetlands are used to treat wastewater.
- *contribute oxygen*: the highly productive wetland plants contribute oxygen to the atmosphere through photosynthesis.

This activity focuses on the physical and hydrological functions of wetlands—how wetlands work from the ground up. Because of the unique factors that create wetlands over time, a balance is created of soil, moisture, and plants. Once wetlands are permanently drained, the conditions that created such productive soils are lost, along with their benefits, and once a wetland is altered this balance is difficult to restore. Understanding the unique natural features found only in wetlands reveals why they are so important to plants and animals, including humans.

This activity is divided into two sections, *Build a Working Wetland* and *From Marsh to Marina.* Because of the length of the activities, it is advised to conduct them on different days.

California Mathematics Content Standards

Number Sense

3.2. Add and subtract simple fractions (e.g., determine that 1/8 + 3/8 is same as 1/2). (Extension #2.)

California English-Language Arts Content Standards

Writing

1.1. Create a single paragraph:
a. Develop a topic sentence.
b. Include simple supporting facts and details. (Extension #4.)

2.2. Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things, or experiences. (Extension #4.)

California History-Social Science Content Standards

3.1.1. Identify geographical features in their local region (e.g., deserts, mountains, valleys, hills, coastal areas, oceans, lakes). (Extension #3.)

3.1.2. Trace the ways in which people have used the resources of the local region and modified the physical environment (e.g., a dam constructed upstream changed a river or coastline).

Vocabulary

Runoff, flood retention, sedimentation, wetland buffer, basin, soil erosion

Objectives

Students will:

- Define and identify a wetland.
- Understand that wetlands are a biome with unique habitats for plants and animals.
- Identify the beneficial functions of wetlands to the ecosystem.
- Relate the beneficial functions of wetlands to their daily lives.

Activity 3.1a
Build a Working Wetland

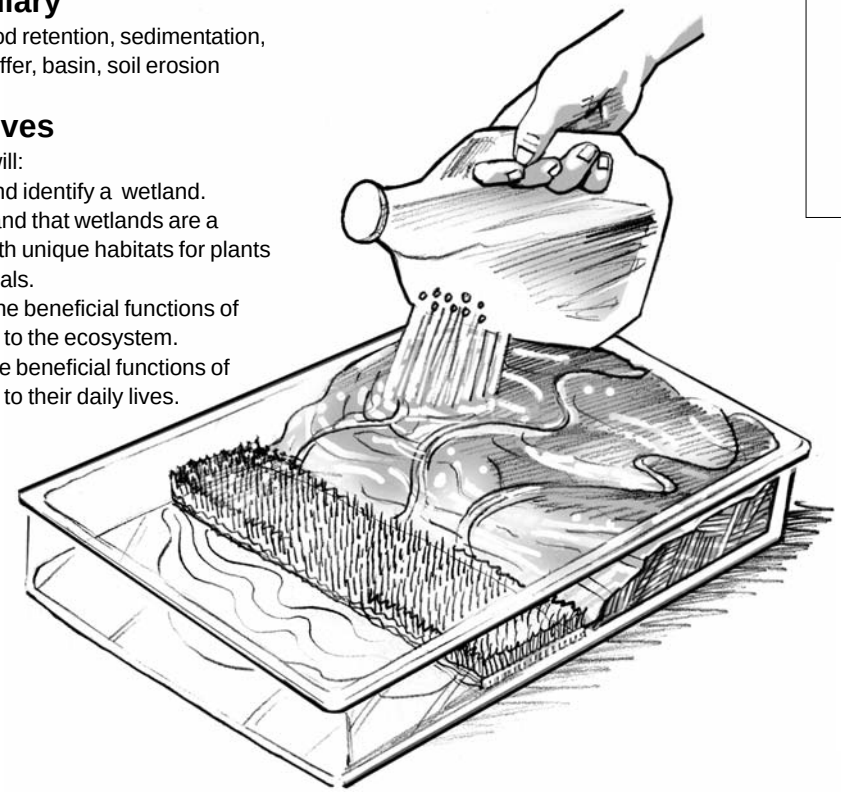
Note: this activity may be completed as a teacher-led demonstration or a small group hands-on activity (small group activity, 2-4 students per model, is recommended). Adjust instructions to meet either case.

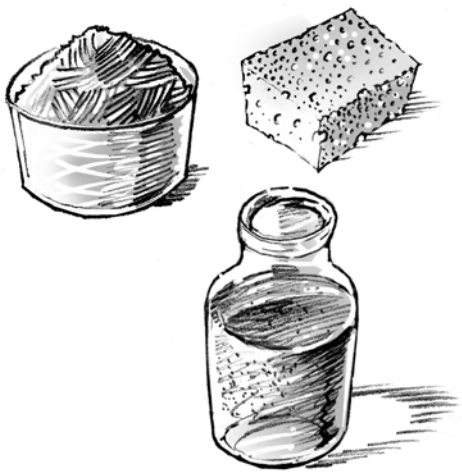
1. Ask students what they know about wetlands. What is a wetland? Have they ever been to one? Are they large or small? How can you tell if someplace is a wetland? Students will learn what a wetland is and why wetlands are special places. *Wetlands have unique qualities: part wet, part dry; shallow basins that collect water. Wetlands perform important functions: filtering pollutants and sediments from runoff, reducing flood damage, and preventing soil erosion. Wetlands provide a special habitat for plants and animals adapted to a part wet, part dry environment.* Project the concept map (see "Wetlands at Work" worksheet) on an overhead projector and discuss with students.

2. Create a wetland model or provide materials for students to create their own. Discuss its features (*sprinkling can is rain, clay is watershed, carpeting or sponge is wetland, and catch basin is water body or ocean at end of the watershed*). The model will demonstrate these functions. **PREDICT**. If we make it "rain" on the watershed before we put in the wetland, what do you think will happen to the rainwater? (*Rain runs downhill and pools up at the lowest end.)*

Make a Wetland Model

1. Spread layer of modeling clay in half the pan to represent land. Leave other half empty to represent lake or ocean.
2. Shape clay in pan to gradually slope down to water. Smooth along sides of pan to seal edges. Make meandering streams in clay that lead to water.
3. Cut indoor-outdoor carpet, sponge, or florist's foam to fill the space across the pan along the edge of the clay. This represents a wetland buffer between dry land and open water. This must fit well—the model won't work if there are large spaces under the wetland or between it and the sides of the pan.





Time to complete

Activity 3.1a: 90 minutes if students make models in small group activity; 50 minutes for teacher-led demonstration.
Activity 3.1b: 50 minutes or less.

Mode of instruction

Classroom demonstration or independent group work with classroom discussion.

Materials

1. Photocopy of "Wetlands at Work" and "From Marsh to Marina" worksheets, one for each student. Overhead transparency of "Wetlands at Work."
2. Overhead projector
3. For each model (Activity 3.1a):
   - Modeling clay
   - Long shallow pan: a 13" x 9" baking pan, or a roller paint pan
   - Scraps of indoor/outdoor carpeting, florist's "Oasis" foam, or sponges
   - One-half gallon plastic milk jug w/lid
   - Cup of soil
   - Jar of muddy water

Preparation

Teach this as an alternation between teacher-led discussion and demonstration, or, if students make their own wetlands, as a discussion with activity completed by groups.

Outline

Before class

1. Review background information.
2. Photocopy two worksheets and overhead transparency.
3. If teaching this as a demonstration, make the wetland model.
4. If students are making the model, assemble materials.
5. Make the milk jug sprinkler.
6. If doing extensions, check section for materials to decorate models.

During class

1. Discuss the usefulness of models.
2. Review with students; list characteristics of a wetland on board.
3. Hand out "Wetlands at Work" worksheet.
4. Conduct demonstration or lead students in small group activity.
5. Students complete worksheet, whole class discussion on responses.
6. Pass out "From Marsh to Marina."
7. Students complete worksheet, whole class discussion on results.

3. Fit the piece of carpeting or sponge into the wetland area, and sprinkle some "rain" on the land. **Compare results to prediction.** Students observe and describe what is happening. (*Some of the water is slowed down by the wetland carpeting.*) Excess runoff slowly flows into the body of water. Point out the wetland absorbed some of the water (pick up the wetland and squeeze some water out to prove it).

4. **PREDICT:** What do you think will happen if the wetland is removed? (*The water will not be absorbed; it will flow more quickly into the body of water.*) Remove the carpeting and pour out water. Pour the same amount of water on model at the same spot and rate as before.
Compare results to prediction. Have students note differences. *(The water should fill the body of water much more quickly and may eventually overflow and flood the land that is no longer protected by the wetland. Most wetlands are shallow basins that collect water and slow its rate of flow and retain water for a time. This slowing process reduces flooding and soil erosion.)*
PREDICT: If a wetland is filled in and houses are built on the fill, what might happen to the houses during a severe rainstorm? Why? (*They might be flooded because the wetland will not be there to absorb and slow the rush of water from higher ground.*)

5. Pour the water from the last demonstration out of the model, squeeze out and replace the piece of carpeting. Explain this demonstration will be just like the first, except soil will cover the clay.
PREDICT: What do you think will happen to the bare soil when it rains? (*The rain should pick up and carry some, but not all, of the sediment over the land and into the body of water, representing topsoil erosion.)*

6. Spread soil over the clay and make it rain, or pour muddy water from jar onto the land. This water represents polluted runoff and sediment from the watershed.
Compare results with prediction. Compare the water that ends up in the body of water with the water in the jar. What do you think happened? Discuss results. *(Soil particles trapped by carpeting, which made water in catch basin much clearer than the muddy water in the jar. The "uphill" side of the wetland should be coated with trapped sediment.)*

7. Remove carpeting, pour out basin, and try experiment again. What happens without the wetland in place? Ask: Why did all the dirt particles end up in the body of water this time? (*The thick mat of plant roots traps silt and filters out pollutants as the carpet or sponge did in the model. Silt and pollutants end up in lakes, rivers, and other waters.*)

3.1.a. Results and reflection

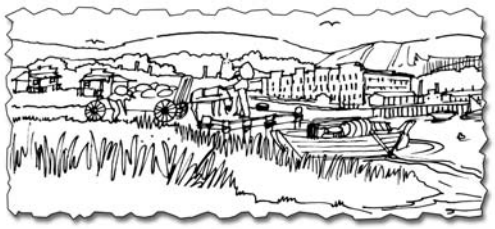
Students write their answers on the "Wetlands at Work" worksheet.
1. What happens where there is no wetland? (*Silt and pollution rushes into the body of water.*)
2. How might muddy water affect fish? (*It is harder for them to see and breathe with clogged gills, could lead to their death.)*
3. How might the muddy water affect other animals and plants? (*Settling sediment smothers bottom dwelling animals who filter feed, blocks sunlight*

needed for plant growth, lowers visibility of animals who fish, introduces toxins and eliminates food sources, disrupts food chain)
4. How might all of this affect students' lives? (*Decrease in natural resources and food sources; decline in quality of drinking water [freshwater wetlands only]; impacts on recreation such as swimming and fishing; change in how things look; changes in economy from fewer harvestable species.*)

Activity 3.1b
From Marsh to Marina

Salt marshes can be great places to make a living! Native Americans living along the coasts knew this—so did the earliest European settlers. This activity gets students to think about how people have used (and abused) salt marshes over the years.
(From Marsh to Marina was adapted from *NatureScope: Wading into Wetlands*, National Wildlife Federation. Learning Triangle Press, 1997. Reproduced with permission of The McGraw-Hill Companies.)

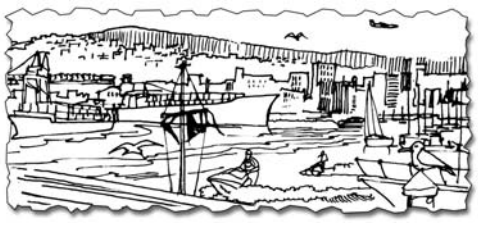
1. Pass out "From Marsh to Marina" worksheet and a blank piece of paper. Explain that the pictures represent ways people used salt marshes through time. You may want to let the students color the pictures. Have students cut out the pictures and try to arrange them in order, from top to bottom, from past to present.



2. When everyone has finished, go over the answers. Students glue pictures in correct order, and label the time period of each picture:

Picture 1: 1600	Picture 4: 1950
Picture 2: 1700	Picture 5: 2000
Picture 3: 1850	

3. Use the following information to talk about each picture:
Picture 1. Native Americans were the first people to use the resources of California's salt marshes. In the West, the Miwok, Chumash, and Ohlone tribes depended on the salt marshes along the Pacific Coast. The Native Americans found game in salt marshes—especially in the fall, when huge flocks of ducks and geese migrated through. Native Americans gathered oysters, clams, and other shellfish in the tidal creeks of salt marshes; built special fish traps out of brush; and scooped trapped fish into buckets.
Pictures 2. Many Europeans settled near salt marshes during the 1700s and 1800s. Living near the marsh wasn't an easy life. Europeans were unaccustomed to the mosquitos and other biting insects. Cattle would occasionally have to be destroyed when they sank too far down into the marsh mud to be rescued. But there were advantages to marsh living, too. There was plenty of food, and the vast fields of salt marsh hay made good grazing grounds.



Picture 3. By the late 1800s, many salt marshes in North America were settled. People began to have a big impact on the ecology of the land. Have the students compare this situation with that depicted in Pictures 1 and 2. When there were few people, the marsh could easily recover from their impacts, but with more people, the damage is more serious and long-lasting. Students may name the ways they see that the people are affecting the marsh.
Pictures 4 and 5. By the 1950s, people had drastically changed many original salt marshes. Few people recognized the marshes' importance in their natural state. To turn them into "useful" places, they filled them in

and built airports, houses, and buildings. Students may determine how the wildlife in Picture 1 and Picture 5 differ (*fewer species in picture 5; shorebirds, deer, and other salt marsh animals gone; few places for birds*).

Results and Reflections

Students describe what could happen to water, sediments, homes, and wildlife when wetlands are destroyed. This can be accomplished either by writing a simple paragraph, or creating an illustration of a wetland that has been filled, drained, or paved over, and subsequent effects on plants, animals, and humans.

Conclusions

Wetlands are important parts of the watershed and the natural landscape. They provide beneficial services such as filtering sediment out of water, and slowing down the rate at which the water enters larger bodies of water, as well as providing habitat for many native species. Wetlands have been used for many purposes throughout history, but are now vanishing. Without wetlands, plants and animals that depend on this unique environment will disappear.

Extensions and applications

1. Have students landscape the models with plants and animals attached with toothpicks. Use an assortment of materials. Some ideas:
   - Cotton swabs for cat tails. Paint sticks green and cotton brown, or paint toothpicks green and stick bits of brown clay to the tops.
   - Long pine needles for reeds. Make trees by gluing pieces of green sponge onto twigs. Dried flower heads make nice trees.
   - Photocopy, cut, and color wetland creatures from page 19 and glue them onto toothpicks.
2. Almost all of California's wetlands have been filled. Only 10 percent remain. Demonstrate with 10 blocks: take 9 away, what is left represents how many wetlands remain. Only 1/10 remain. What fraction has been filled?" i.e. 10/10 – 1/10 = ?
3. Students may identify a wetland in the local area (see Appendix B) and relate information to their community.
4. Have students write a paragraph, containing a topic sentence and at least three supporting sentences, to describe their experience if they were a wetland plant. What would they see, hear, smell and feel?
5. Have students read a book about a wetland plant or animal (such as an egret, pickleweed, or leopard shark) and complete a book report.

ANSWER KEY
1-C, 2-A, 3-E, 4-B, 5-D

Adapted from

Wetland in a Pan, from *WOW! The Wonders of Wetlands* is used with permission from Environmental Concern Inc. For further information contact Environmental Concern Inc. at (410) 745-9620 or visit *www.wetland.org*

From Marsh to Marina, from *NatureScope: Wading into Wetlands*, National Wildlife Federation. Learning Triangle Press, 1997. Reproduced with permission of The McGraw-Hill Companies.

Wetlands at Work

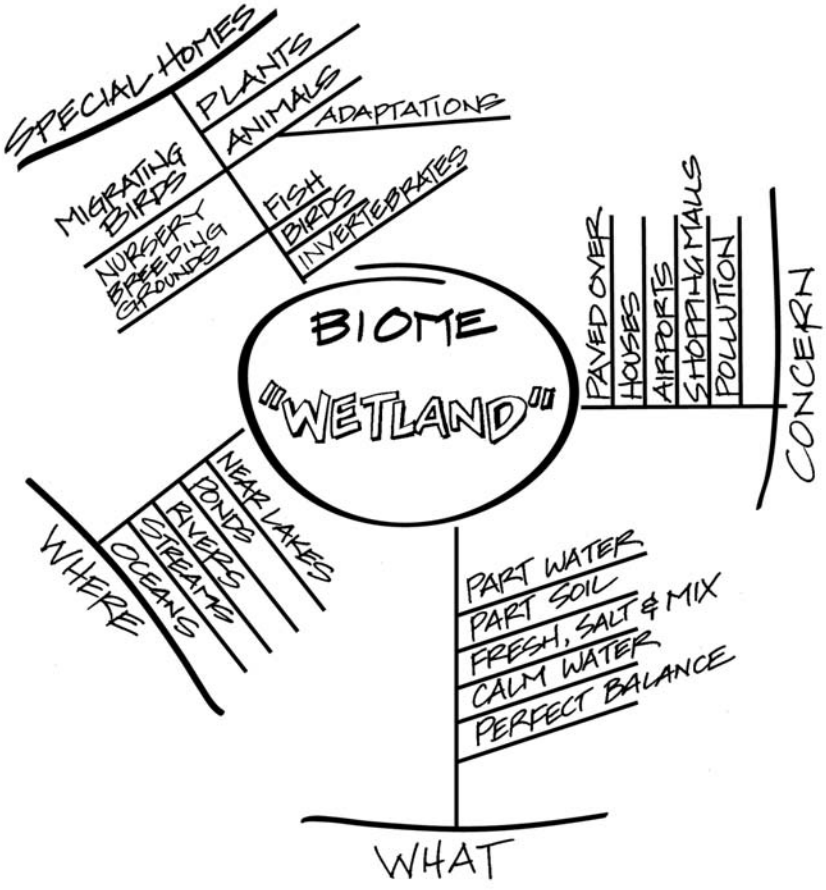
Answer these questions after your teacher has shown the wetland model.

1. What happens where there is no wetland?

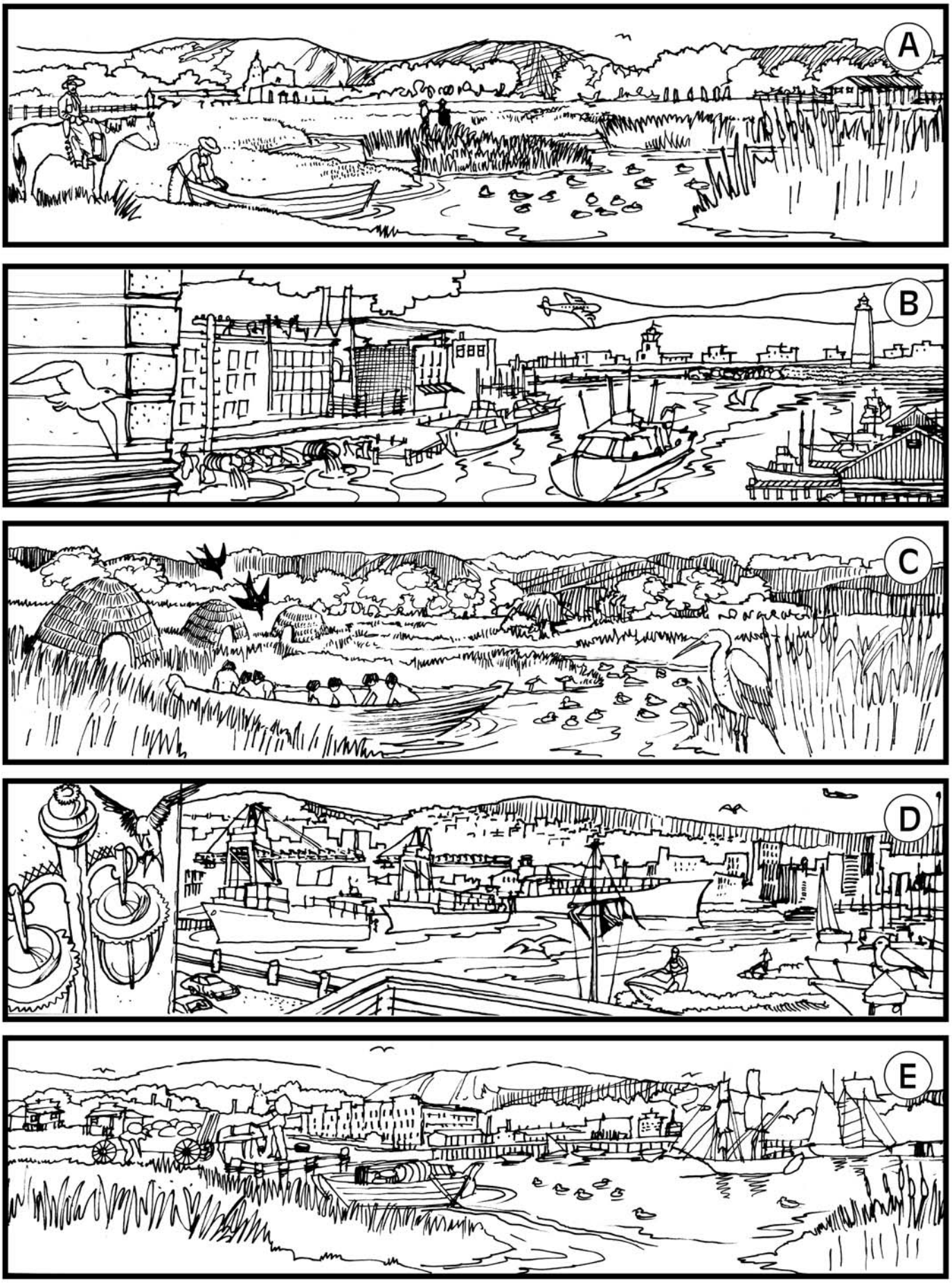
2. Can fish live in muddy water or water with pollution in it? Can they see, or breathe?

3. Can other plants and animals live in the muddy or polluted water?

4. Here are words that tell why wetlands are special. Draw a picture of a special wetland.



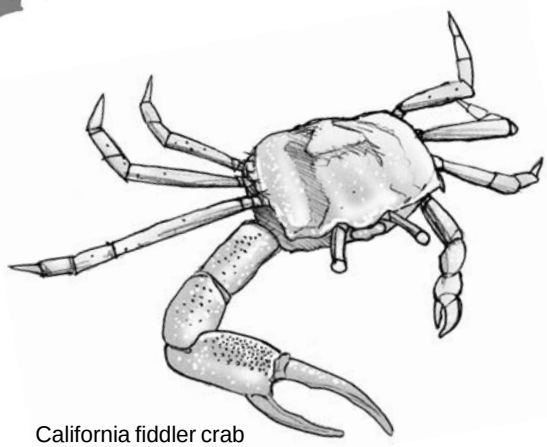
From Marsh to Marina



Grade 3 Activity

Activity 3.2
Marsh Munchers

Are you a predator or the prey in the salt marsh? Students play this game and become part of the food web—they eat and are eaten!



California fiddler crab
Uca crenulata

Science skills

- Organizing
- Inferring
- Predicting
- Communicating
- Graphing

Concepts

- Plants and animals that live in wetlands have special relationships to each other and to their part-wet part-dry environment.
- Salt marshes are a type of wetland.
- Salt marshes provide habitats for both fresh and salt water species.
- Salt marshes are one of the most productive ecosystems on Earth.
- A food chain is a series of plants and animals that pass matter and energy through the chain by eating one another.
- A food web is one or more overlapping food chains; organisms at one trophic level eat different foods, including other species at their same and lower trophic levels.

Background

A salt marsh is an important ecosystem found between a land mass and the ocean. Fresh water and salt water come together to form a unique habitat for wildlife. The constantly changing mixture of fresh and salt water provides food and shelter for species from both habitats. Activity 3.1 focused on the physical components; this activity focuses on the living components of the salt marsh ecosystem.

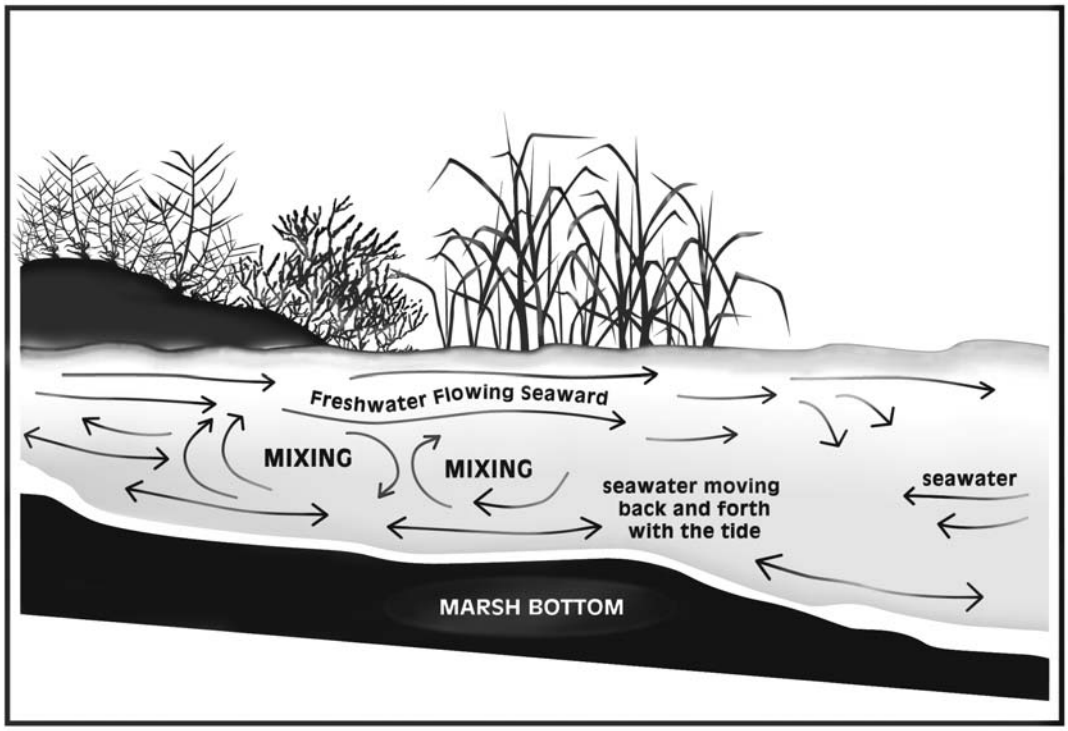
Salt marshes are one of the most productive ecosystems on Earth—they are five times more productive than a field of wheat! The main producer for this ecosystem is salt marsh grass, which grows and thrives in nutrient-rich waters of estuaries where salt water from the ocean mixes with freshwater from land drainage. Salt marsh grass is constantly producing new growth. Bacteria promote the decay of the marsh grass, which in turn produces *detritus*. Detritus is dead and decaying plant or animal matter. Fiddler crabs, snails, small shrimp, and fish feed on decomposed marsh grasses. Oysters and clams filter detritus and tiny living plants from the water, then become food themselves for crabs, birds, and fish. Many marine organisms and commercially valuable fish species, including flounder, salmon, and striped bass, depend at some point in their lives on salt marsh ecosystems.

In Elkhorn Slough, one of California's last remaining large wetlands, college students conduct research to find out just how rich this environment is. They have found some astounding numbers! In a standard coffee can core, the following numbers are typical:

- 100-1000 organisms/core (a big range because organisms are patchy)
- 10-20 species/core

This is just invertebrates: if you included diatoms, bacteria, protozoans, etc. of course the numbers would be **orders of magnitude** higher. The coffee cans are about seven inches in diameter, and cores are taken to a depth of seven inches.

Many resident and migratory birds are dependent on salt marshes for food and nesting. Ospreys, sandpipers, and the heron family feed along marsh creeks during the spring and summer, while ducks and northern harriers can be seen in the winter months. Raccoons, shrews, and mice wander through the marsh in search of food, and deer, grasshoppers, and geese feed on the grasses. Marshes also provide critical services (e.g., trapping sediments and nutrients from runoff so that waters in bays and along the coast are clean and clear), as well as being exciting places to see lots of wildlife such as birds, fish, and invertebrates.



Salt Marsh Mixing

California Science Content Standards

3. Life Sciences

Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organisms or other organisms, and some are beneficial.

3.d. Students know when the environment changes some plants and animals survive and reproduce; others die or move to new locations.

Activity

This simulation introduces how a salt marsh food web works. First you will discuss what students know about salt marshes. Then you play a game that illustrates how a salt marsh food web works.

1. Lead a classroom discussion about salt marshes. What do you know about salt marshes? Where do we find salt marshes? (*Along coasts or bays, in protected areas where fresh water meets salt water. Salt marshes have special birds and animals that live there, dependent on the part wet, part dry habitat. Salt marshes are very productive. Because of human impacts, there are few salt marshes left in California.*) Draw the above diagram on the board or project on an overhead projector, and discuss the characteristics of a salt marsh. Note how sea water flows in with the tide, and freshwater flows over it, with some mixing in between. Explain that salt marshes are very rich and productive areas for animals and plants to inhabit because of all the nutrients brought to the marsh by creeks and rivers, and because they are shallow and receive lots of sunlight for plants to grow. Salt marsh inhabitants must be able to live in both fresh and salt water. **Ask**: Do you know of any animals that live in a salt marsh? (*Birds, small mammals, fish, and invertebrates such as snails and oysters.*) Discuss the ways in which salt water mixes with fresh water.

2. Discuss the importance of detritus in salt marshes. Salt marshes produce lots of *detritus* (dead or decaying plants and animals). Detritus plays an important part in the salt marsh food web. Producers are the first level in a food web; plants are producers that create food from sunlight. Salt marsh grasses are very abundant and constantly grow and die to become detritus. Bacteria and fungi are decomposers. They break down detritus. Salt marshes produce a lot of food, and plants and animals grow and die to create more detritus. Snails and worms eat detritus,

California Mathematics Content Standards

Number Sense

2.1. Find the sum or difference of two whole numbers between 0 and 10,000. (Extension #1.)

2.4. Solve simple problems involving multiplication of multi-digit numbers by one-digit numbers (3,671 x 3 = __). (Extension #1.)

California English-Language Arts Content Standards

Reading Comprehension

2.7. Follow simple multiple-step written instructions (e.g., how to assemble a product or play a board game.) *Standard achieved if game instructions are distributed to students.*

Objectives

Students will:

- Understand that salt marsh plants and animals are adapted to the special part wet, part dry, and part saltwater, part freshwater environment.
- Describe the difference between a food chain and a food web.
- Describe some of the components of a food web and how it works.
- Identify some of the components of a salt marsh food web.
- Act as predator or prey in simulated salt marsh food web.
- Identify the interconnectedness of plants and animals in the salt marsh food web.

Time to complete

60 minutes

Mode of instruction

Teacher-led whole class discussion, followed by game where students use body movement and pantomime to simulate feeding motions of marsh animals.

and many of the larger animals eat snails and worms. Grasses, detritus, and bacteria aren't big and flashy like hawks and raccoons, but without them, the salt marsh food chain would collapse!

3. Discuss food webs. What do you know about food webs? (*A food web is a way to describe how the living parts of an ecosystem relate. Bigger animals eat smaller animals. There are predators and prey that eat and are eaten. Food webs describe who eats whom.)* Display the "Wetland Food Web" diagram on an overhead projector, or draw it on the classroom board. Plants and animals can be arranged in levels of who eats whom, named "trophic levels." Have students help decide who eats whom in the salt marsh food web. **Discuss**: In any food web, there are producers (mostly plants) and consumers. By growing and being eaten, producers create food for consumers to eat. Food webs also contain predators and prey—predators capture prey for food, and prey are eaten by predators.

Pre-game instructions

1. The class will pretend to be animals in a salt marsh. Each animal plays an important role in the food web. In this game, all animals are consumers. The producers, plants, and bacteria that support the detritus-eaters (prey) are not a part of this game (plants and bacteria do not provide much action in an action-oriented game). *This is a simulation; in real life, these animals play several roles in the food web.*
2. Give one envelope to each student. Explain that their identities are a secret. Each envelope contains the identity and feeding behavior of one animal that lives in a salt marsh. The only way others will know what kind of animal they are is by the way they feed. When students receive their envelopes, explain that some students will be detritus-eaters and others will be predators who eat the detritus-eaters (prey).
3. Have students open their envelopes and see what animal they are and what feeding behavior they use. Students may need help with this stage. Remind them to keep their identities a secret, but help them learn to pantomime their feeding behavior. **Note: if your students may have difficulty with this activity (i.e. predators not being able to recognize prey by feeding behavior), make name tags to hang around students' necks: shrimp, fish, snail, oyster, crab.**
4. Discuss what predators eat. Make this table on the board without the *x*'s. Fill in the table as you discuss who eats whom.

Salt Marsh Food Web: Who's Eating Whom?

	Human	Shore Crab	Raccoon	Green Sturgeon	Egret
Juvenile fish			x	x	x
Shrimp	x	x	x	x	
Snail	x	x			
Oyster	x	x			
Fiddler crab			x		x

5. Explain rules of the game.
   a. Each student represents a detritus-eater or a predator.
   b. Each detritus-eater has four food tokens, representing five marsh animals of the same species (five snails, five oysters, five fish...).

Materials

1. Timer
2. Construction paper: white, green, yellow, blue, and red
3. Predator cards (master provided)
4. Detritus-eater food tokens (master provided)
5. One envelope per student
6. Overhead transparency of "Wetland Food Web" and "Marsh Mixing" (page 15)
7. Overhead projector

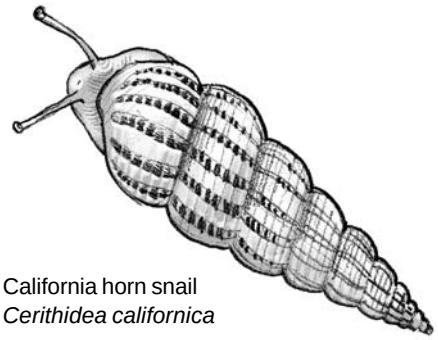
Prepare and Place in Envelopes
(One envelope per student. Envelope includes either predator card or detritus-eater food tokens. Photocopy food tokens onto colored construction paper. Adjust numbers for your classroom.)

Predator Cards (white paper)

1 raccoon	1 each
1 shore crab	1 each
1 green sturgeon	1 each
1 egret	1 each
1 person	1 each

Detritus-Eater Food Tokens
(use colored paper or have students color tokens)

- 5 fiddler crabs: 4 red tokens each (20 total)
- 5 snails: 4 blue tokens each (20 total)
- 5 oysters: 4 yellow tokens each (20 total)
- 5 juvenile fish: 4 green tokens each (20 total)
- 5 shrimps: 4 white tokens each (20 total)



California horn snail
Cerithidea californica

c. Detritus-eaters and predators must pantomime their feeding behavior throughout the activity. Detritus-eaters show their feeding styles from stationary squat positions; predators will walk and display their behavior.
d. Predators tag detritus-eaters by tapping them on the shoulder.
e. The detritus-eater must give a food token to an appropriate predator (see table) when tagged.
f. Each predator must acquire eight food tokens from appropriate prey within the time period to stay alive. The time period represents one tidal cycle (low to high and back to low tide). Terrestrial predators can only feed when the tide goes out, and marine predators can only feed when the tide comes in. Therefore, all predators are limited by a time constraint within which they must acquire enough food.
g. Each predator can only acquire one token from each detritus-eater.
h. Detritus-eaters keep feeding while they still have tokens. When they run out of tokens, they sit quietly in place decomposing in the salt marsh.

Note: Depending upon time constraints, play the game a number of times so students have the opportunity to be both predator and prey.

Playing the game

1. Get settled where the game will be held. All students should have their envelopes with them. **Predict**: Ask students what they think will happen in this game. Will all the predators be able to collect enough food to survive? How will the predators know which prey is appropriate to eat? (*By the behavior of the detritus-eaters—the predators know by experience what they are looking for, what tastes good and is relatively easy to catch. Again, if this is too difficult, make name tags for detritus eaters.*) Will they run out of prey? (*No, in a healthy salt marsh, there are more prey than predators. In an unhealthy habitat, perhaps one into which humans have either developed or dumped polluted water and trash, the food web breaks down, with less food for all.)*
2. Set the boundaries of the game (a circle drawn on the pavement outdoors, a boundary set by stationary objects [from that tree to this fence], or a very large string circle indoors). Tell students there will be a set time limit.
3. Have all the detritus-eaters spread out within the boundaries or the playing field and start pantomiming their feeding behavior. Remind detritus-eaters to be sure to distribute themselves throughout the area, not to clump up in one area. This makes them more difficult to catch.
4. Predators begin to pantomime their feeding behaviors, and you start the timer. Tell predators to capture their prey (tap on shoulder, one token only from each detritus-eater) and place their tokens in their envelope. Call time when appropriate (after *some* predators have acquired eight food tokens—time may vary, but do not allow enough time for all predators to get eight tokens.)
5. Students hold onto their envelopes for discussion.

Results and reflection

1. Back in the classroom, discuss results. Have predators empty their envelopes onto their desks. **Ask**: Did every predator get eight food

Preparation

Choose a location to do the game, a **large** playing area inside or outside. Have rainy day indoor site planned (cafeteria, multi-use room). Designed for 25 students; can be adapted for smaller or larger groups.

Vocabulary

Salt marsh, adapt, prey, predator, producers, consumers, food web, fresh water, salt water, tides, decompose, detritus, food chain, trophic level, ecosystem

Outline

Before class

1. Create transparency of marsh mixing diagram and "Wetland Food Web."
2. Photocopy predator cards onto white construction paper. Cut.
3. Cut 20 detritus-eater food tokens of each color from colored construction paper. *See materials list for instructions.*
4. Photocopy food web and salt marsh mixing diagrams onto overhead transparencies (or draw them on the board).
5. Place colored construction paper food tokens and predator cards into the appropriate envelopes.

During class

1. Ask what students know about salt marshes and food webs. Display "Marsh Mixing" overhead transparency and discuss the fresh water/salt water mixing dynamics and effects on organisms.
2. Discuss the nature of the simulation and what students are modeling.
3. Explain rules of the game. Demonstrate feeding behaviors.
4. Play the game.
5. Discuss results. Did everyone get enough food to survive?
6. Repeat game if students are unclear on the concepts.
7. Return to class and discuss the "Wetland Food Web" overhead transparency.

tokens during the time period? Why, when there is so much food out there, do all animals not get their fill? (*Some, like people, are more mobile and selective about what foods they eat in the marsh because they can get food in other habitats. Others, like shore crabs, green sturgeons, and egrets, are more selective in what they can eat. Only the raccoon eats almost all the detritus-eaters in the salt marsh.*) What happens to all of the detritus-eaters who don't get eaten? (*They die and decompose, creating more detritus for detritus-eaters to eat.*)

2. Fill in the connecting arrows on the "Wetland Food Web" in one of three ways: display on overhead projector, draw it on the board, or have students cut out the animal illustrations to arrange on their desks. Discuss and show the connections between all the animals in the salt marsh food web. Don't forget the detritus—you may illustrate it by little dots sprinkled over the food web by each detritus-eater.

3. What would happen to the salt marsh animals if the salt marsh was filled in with dirt and an airplane runway built on it? Or, if it was dredged and made into a harbor? (*Some of the predators, like people, egrets, and raccoons would leave and find food in other nearby habitats. For some predators, the other habitat would not be as easy for them and they would have to work harder to find the right food. Others dependent on salt marsh conditions, like the fiddler crab, oyster, and juvenile fish, would not survive.)*

Conclusions

Plants and animals that live in a habitat are related to each other by what they eat. Salt marshes are a very rich and productive habitat that support a wide variety of animals that depend upon special conditions to survive, including a part wet, part dry environment, and a daily exchange of fresh water and salt water. It is important to protect remaining salt marshes so plants and animals have a home.

Extensions and applications

1. Determine how much food was available to predators. Guide students in computing the number of food tokens available by multiplying the number of detritus-eaters by five. Then, as a class, create a bar chart showing how many food tokens each predator collected. What was the total number of tokens collected? How many tokens were left uneaten, to decompose in the marsh?

2. Have students paint a mural of the salt marsh food web, with accurate drawings of each animal. Draw in the grasses and detritus. With yarn, connect each animal with what it eats.

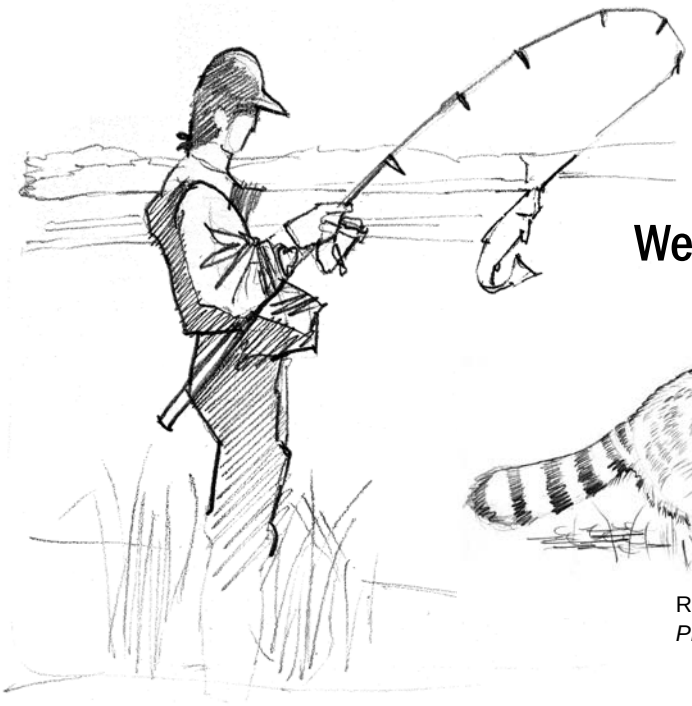
3. Research and locate a salt marsh near to you (see Appendix B). Arrange a field trip to the salt marsh, and locate some of the plants, animals, and birds in the salt marsh food web.

Adapted from

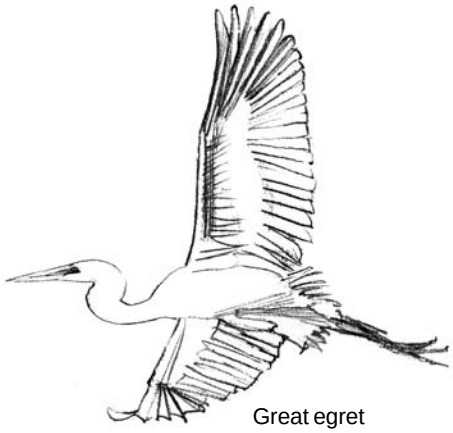
Additional References

Appendix B. Wetlands of California
ceres.ca.gov/wetlands/geo_info/so_cal/so_cal_wetland_index.html
eureka.regis.berkeley.edu/ncccwis/

Wetland Food Web

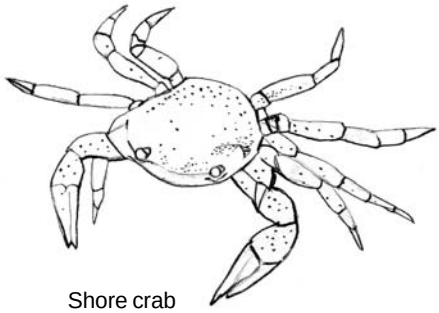


Human
Homo sapiens sapiens

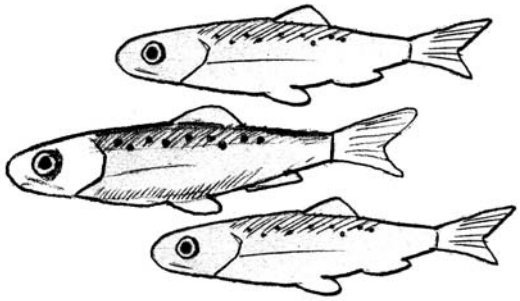


Great egret
Casmerodius albus

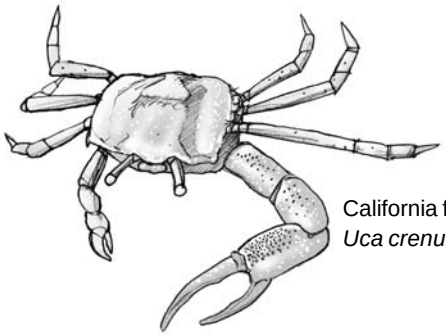
Raccoon
Procyon lotor



Shore crab
Pachygrapsus crassipes

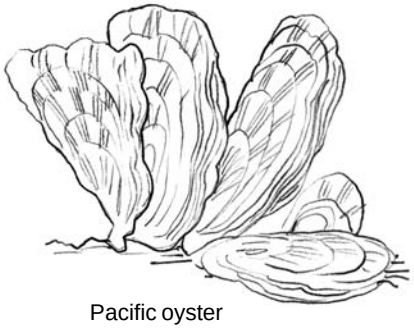


Juvenile fish
Oncorhynchus spp

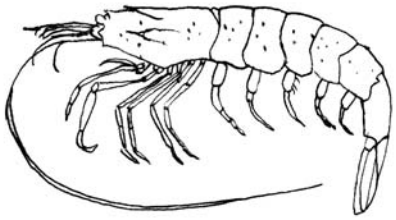


California fiddler crab
Uca crenulata

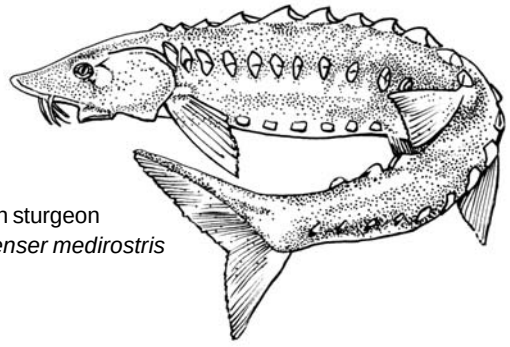
California horn snail
Cerithidea californica



Pacific oyster
Crassastrea gigas



Bay shrimp
Crangon franciscorum

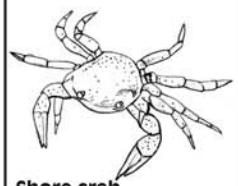


Green sturgeon
Acipenser medirostris

Master for Marsh Munchers

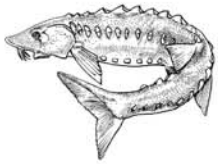
Predator Cards

Person fishing.
Walk forward holding fishing pole and casting line. *Tag prey by touching shoulder.*

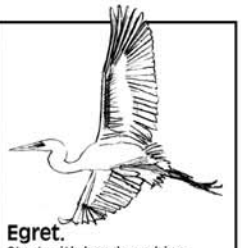


Shore crab.
Walk sideways, waving arms like claws. *Tag prey by touching shoulder.*

Raccoon.
Walk forward washing hands. *Tag prey by touching shoulder.*

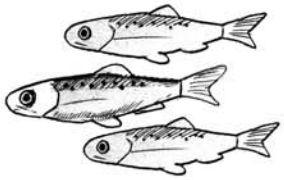


Green sturgeon.
Walk with hands held forward and together, like a mouth. *Tag prey by touching shoulder.*

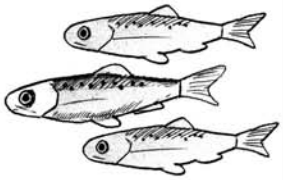


Egret.
Strut with hands on hips, elbows like wings. *Tag prey by touching shoulder.*

Detritus-Eater Food Tokens



Juvenile fish. Gulp down detritus in water or on bottom. *Pucker lips and make sucking noises while feeding.*



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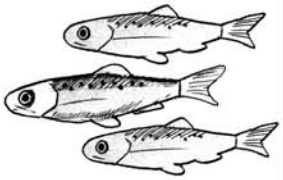

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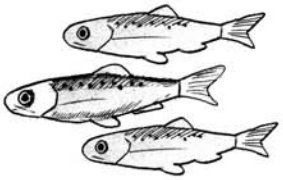

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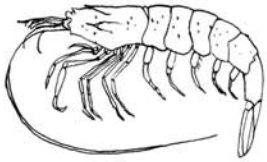
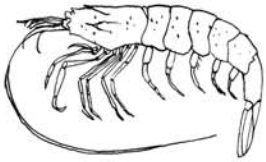


Bay shrimp.
Stir up mud and detritus with legs, lift particles to mouth. *Make stirring motions with arms.*



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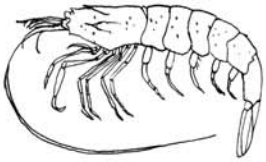

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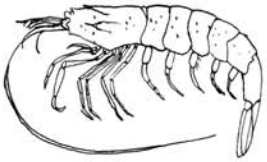

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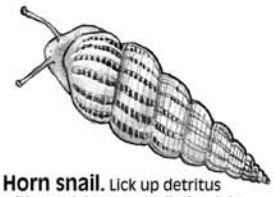
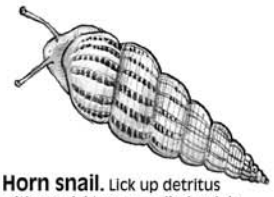


Horn snail. Lick up detritus with special tongue called radula. *Make licking motion with one hand as radula near mouth.*



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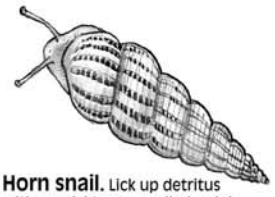

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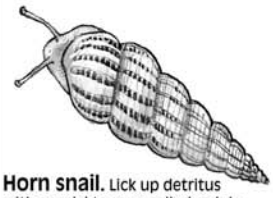

Horn snail. Lick up detritus with special tongue called radula. *Make licking motion with one hand as radula near mouth.*

Pacific oyster. Filter detritus from water with gills. *Wave arms back and forth in air.*

Pacific oyster. Filter detritus from water with gills. *Wave arms back and forth in air.*

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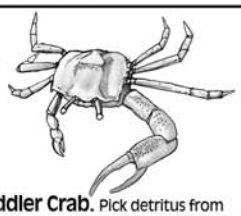
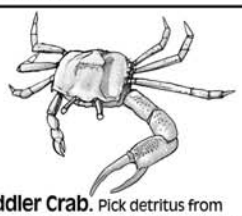


Fiddler Crab. Pick detritus from sand with one or two claws. *Pick object from ground with thumb and first finger acting as claw.*



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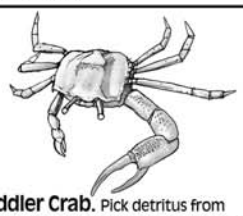

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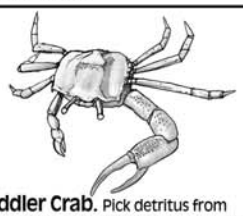


Fiddler Crab. Pick detritus from sand with one or two claws. *Pick object from ground with thumb and first finger acting as claw.*

Activity 3.3
The Perfect Beak

Find the beak to match the food! Students learn how birds' beaks and tongues are adapted to best take advantage of their favorite food.

Science skills

- Observing
- Predicting
- Experimenting
- Gathering and analyzing information
- Graphing data

Concepts

- Habitats provide food for animals.
- Over many years plants and animals establish a balance in their habitat.
- Plants and animals have adaptations that improve their survival in their natural habitat.
- Adaptations affect the way animals look, where they live, and how and what they eat.
- When the environment changes, habitats are altered so they no longer can support the plants and animals that depend upon them.
- To protect and preserve California's native species, their habitats must be kept intact.

Background

It would be impossible for a hummingbird to gobble up a mouse, or for a hawk to slurp up some nectar from a flower. Each type of bird has a special beak and tongue adapted to eating certain foods. Birds use their beaks as tools to collect and prepare food for eating. Students will find out which beaks are best for tearing, scooping, cracking, and picking, and they will try to find out which tools go with which types of "food." Discuss with students different bird beaks and how beaks help birds survive:
Hummingbirds have long hollow beaks they use to probe flowers for nectar. The beak protects the tongue that slurps up the nectar. The tongue is so long, it is curled up inside the beak, and uncurls out to feed.
Curlews, godwits, kiwis, and American avocets, which are shore birds, have long, strong beaks they use to probe for worms, crustaceans, and other small creatures in mud, sand, and water.
Cardinals, sparrows, jays, and finches have very short, conical beaks that are very strong and can break open tough seeds.
Brown pelicans and spoonbills have long, flattened or pouchlike beaks that they use to scoop up fish and other aquatic creatures.
Eurasian wigeons and some ducks have bills that act like strainers to filter tiny plants and animals from the water.
Warblers and flycatchers have small, sharp, pointed beaks for picking insects from leaves, logs, and twigs.

Activity

(The Perfect Beak was adapted from: Fill the Bill, from *NatureScope: Birds, Birds, Birds*, National Wildlife Federation. Learning Triangle Press, 1999. Reproduced with permission of The McGraw-Hill Companies.)

Setting up activity stations

1. Set up six different stations, each with a special type of "food" that fits one of the six different types of beaks. At each station there are three different tools—one that fits the food at the station, and two that don't fit. Make a standup sign for each station (fold 8 ½" x 11" paper into a tent) that tells what type of food is represented. For example, have a sign that says "nectar in a flower" at Station #1. (*The "*" below identifies the tool that best fits the food at the station.*)

Station #1: Water in thin vase for nectar in a flower. (hummingbirds)
Tools: eyedropper or straw*
envelope or small fishnet
large scoop or slotted spoon

Station #2: Large saucepan filled with dry oatmeal, with grapes on the bottom to represent worms buried in the mud or use fake rubber worms instead of grapes. (curlews, godwits, kiwis, and avocets)
Tools: chopsticks*
nutcracker or pliers
strainer

California Science Content Standards

3. Life Sciences

Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3.d. Students know when the environment changes some plants and animals survive and reproduce; others die or move to new locations.

Objectives

Students will:

- Link adaptation to feeding and survival in birds.
- Describe why there is such variety in bird beaks.
- Identify why birds are dependent on specific foods and habitats.
- Understand the connection between individual species and their habitat.

Time to complete

50-60 minutes

Mode of instruction

Hands-on small group activity

Materials

1. "The Perfect Beak" worksheet
2. Two eyedroppers or straws (if using straws, collect 2 straws per student; students should not share straws)
3. Three pairs of chopsticks
4. Three nutcrackers or pliers
5. Two large scoops or slotted spoons
6. Two strainers
7. Two heavy envelopes or small fishnets
8. Two forceps or tweezers
9. Two tongs
10. Small log or thick, short stick
11. Raw rice and puffed rice
12. Two aquariums or large containers, bowls will do
13. Grapes or fake worms
14. Dry oatmeal
15. Tall, thin vase
16. Large saucepan
17. Walnuts or other nuts in shell (4-6)
18. Styrofoam chunks

Station #3: Whole walnuts or other nuts to represent seeds with hard coverings. (sparrows, cardinals, jays, and finches)

Tools: nutcracker or pliers*
tongs
chopsticks

Station #4: Styrofoam chunks floating in an aquarium filled with water to represent fish and other aquatic animals. (spoonbills and brown pelicans)

Tools: large scoop or slotted spoon*
eyedropper or straws
chopsticks

Station #5: Puffed rice in an aquarium filled with water to represent tiny aquatic plants and animals. (Eurasian wigeons and some other ducks)

Tools: strainer*
forceps or tweezers
tongs

Station #6: Rice spread on a log to represent caterpillars and other insects. (warblers)

Tools: forceps or tweezers*
envelope or small fishnet
nutcracker or pliers

Activity Stations

1. **Ask:** What do you know about beaks? What are they used for? Are they all the same? Why would birds have so many different shapes of beaks? From ducks to pelicans, here they will learn about adaptations, how plants and animals change over time to survive in their habitat.
2. Explain that the students will go to each activity station as a small group. There will be three different tools at each station, each of which represents a different type of bird beak function. They must decide which "beak" (tool) would most efficiently get the food at each station. Students decide by trying out different tools. They can discuss their results with others in their group, but will record their own choices on "The Perfect Beak" worksheet. Tell students to pick up the food with a tool, but not to eat it! Set a time limit for how long students stay at each station. Students must leave the station as they found it (allow time for cleaning up).
3. Hand out a copy of the "The Perfect Beak" worksheet to each student and explain how to complete it. At each station, they will take turns trying the tools with the food. Once they choose the best tool, they write the name of the tool on their worksheet. On the worksheet are pictures of different birds and their beaks. On the line under each picture, they write the number of the station that represents the correct beak. For example, they write "1" for hummingbird, as the nectar at station 1 is the hummer's food.
4. Divide the class into six teams; start each team at a different station.
5. After teams have rotated through all stations, they return to their desks for a group discussion. **Ask**: Why do you think birds have so many types of beaks? (*Birds are adapted to their habitats, and in each habitat there is only a certain type and amount of food available. Birds have adapted to feeding*

Preparation

Begin collecting materials one week before class. Lead a whole group discussion on beak types as introduction to activity. Have students complete worksheets as they rotate through the stations. Follow activity with whole group discussion, create a table that compares results, and discuss long-term implications of impacts on habitats.

Outline

Before class:

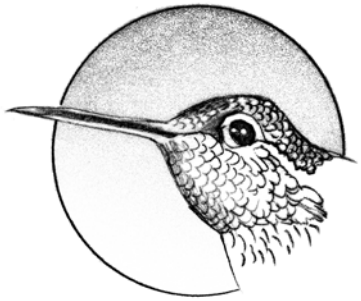
1. Assemble materials the week before the activity day. Have students sign up to bring in materials. Put a large list on the wall, and check off materials as students bring them.
2. Make one copy per student of "The Perfect Beak" worksheet.
3. Day of class: Before students arrive, set up stations with signs and materials.

During class:

1. Lead general group discussion about characteristics of birds (where they live, what they eat, what they look like).
2. Discuss how to fill out the worksheet. Complete small group activity: rotate through activity stations with worksheets. Students record observations.
3. Reassemble as whole group. Create a table on the board and compare results of worksheets. Lead a group discussion on: beak adaptations in general, pros and cons of specialized beak adaptations, and dependence of birds on specific foods.

Answer Key

Station 1: Anna's hummingbird
Station 2: Long-billed curlew
Station 3: Cardinal
Station 4: Brown pelican
Station 5: Eurasian wigeon
Station 6: Hermit warbler



Anna's hummingbird
Calypte anna

in their habitat efficiently to survive.) **Ask**: How can specialized beaks help some birds stay alive? (*A bird with a specialized beak can often eat a type of food that no other bird can eat, such as a hummingbird able to get nectar at the base of a long, narrow flower, or the jay's very sharp, hard beak that can crack nuts*.) **Ask**: How might a specialized beak hurt a bird? (*If a bird's habitat changes and its food is no longer available, the bird might die because it can't eat anything else. Some birds, such as crows and gulls, have versatile beaks. Crows can eat fruits, nuts, berries, dead animals, and even fish and small rodents. This is one reason why crows are found in many habitats.)*

Results and reflection

1. Students fill out worksheet.
2. Students answer this question on the back of their worksheets or in their journals: "If I were a bird, I would have a _____ beak and I would eat _____. I would live_____."
3. Make a data table on the board and discuss the student's worksheet answers (bird names across top, type of food down the side). **Or,** have students make the data tables themselves on the other side of their worksheets. Did everyone come to the same conclusions? Were there some foods that could be eaten by more than one bird beak?
4. Students explain what would happen to their bird if its habitat changed. Students choose the reason for the change (natural or human-created), and write their answers on back of the worksheet.

Conclusions

All living things have adapted over time to live in their natural habitat. Plants and animals have evolved together to meet survival needs of their species. Adaptations enable them to survive in specific habitats. Bird beaks are one example of how an animal has become adapted to a specific condition of a habitat: it is dependent upon the foods of that habitat. Some birds have very narrow food requirements; some can only eat nectar, others only eat hard-shelled nuts. When habitats are changed and birds' preferred food is no longer available, species dependent on that habitat may not survive.

Extensions and applications

1. Conduct research into other examples of adaptations in California's plant and animal communities.
2. Discuss other types of adaptations in birds. (*Long legs for wading, big wings for gliding, sharp eyes for seeing small rodents, bird songs for mating, feathers for lightness and warmth, bright colors for mating and camouflage.*) Hand out worksheet "Divers and Dabblers" and have students draw the two body types and describe how their adaptations assist them in obtaining food.

Adapted from

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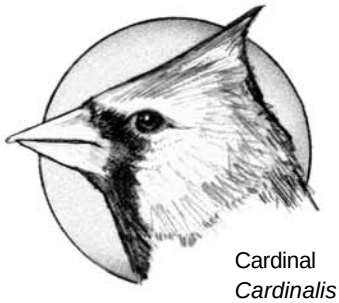
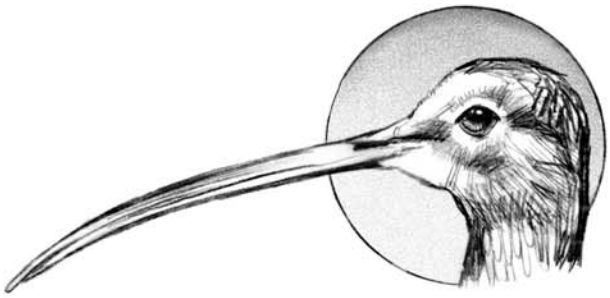
Additional References

Schoenherr, A.A., 1995. *A Natural History of California.* University of California Press, Berkeley.

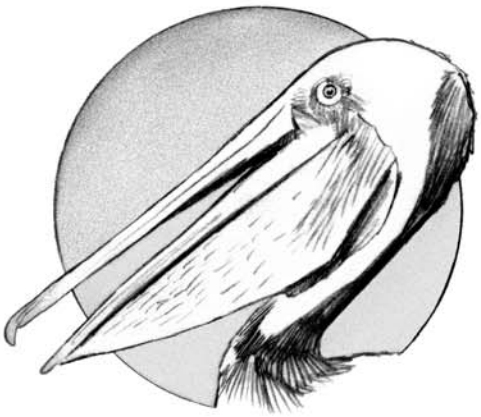
The Perfect Beak



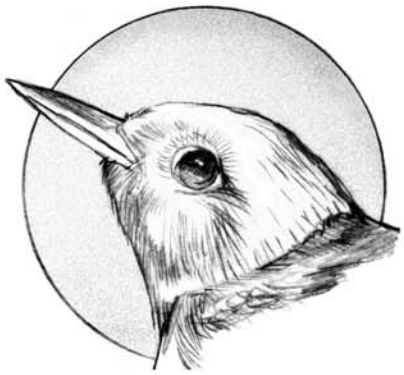
Cardinal
Cardinalis cardinalis



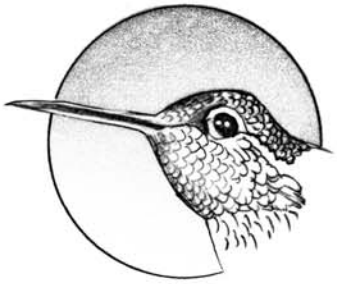
Long-billed curlew
Numenius americanus



Brown pelican
Pelicanus occidentalis



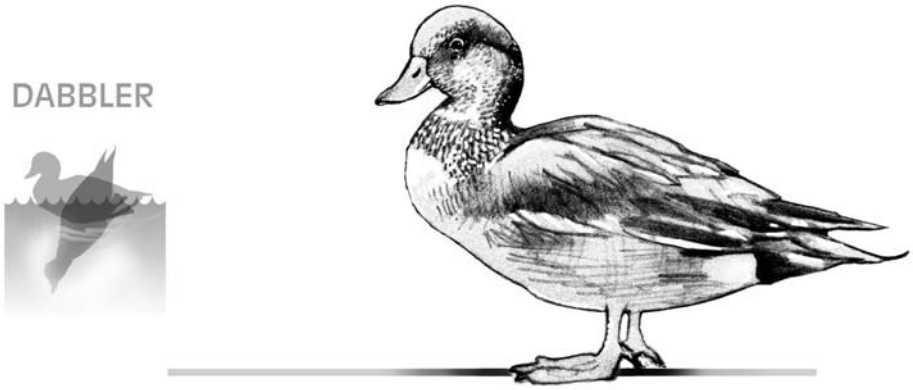
Hermit warbler
Dendroica occidentalis



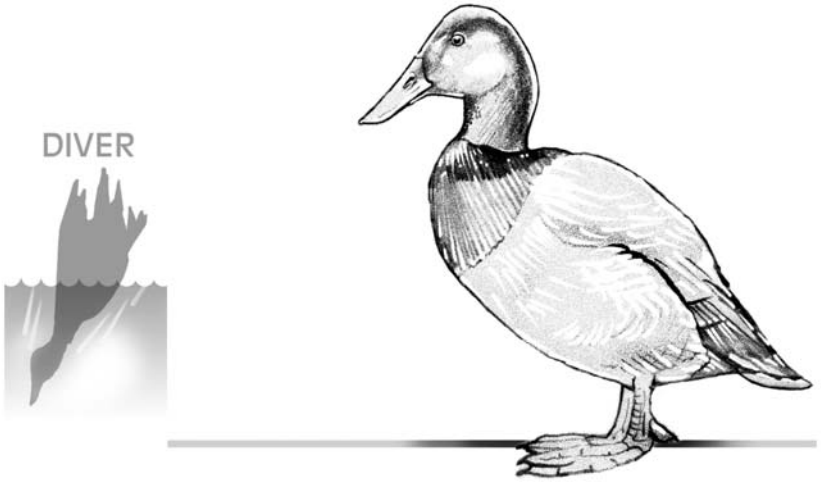
Anna's hummingbird
Calypte anna

Eurasian wigeon
Anas penelope

Station	Best Tool
1	
2	
3	
4	
5	
6	



American wigeon
Anas americana



Canvasback
Aythya valisineria

Divers and Dabblers

Beaks are pretty specialized, but they aren't the only bird body part where we can see adaptations working. Body type and flying habits are a few more ways that birds have adapted to their habitat. Let's look at ducks.

There are two basic kinds of ducks: dabblers and divers. Dabblers consume algae, detritus, and snails. Most dabblers feed by inflating air sacs and tipping tail-up to reach the bottom, and some walk out on the mud. Divers spend most of their time on the water, diving to feed on fishes, crustaceans and aquatic larvae. Divers are good swimmers but awkward on land. Dabblers differ from diving ducks in their ability to become airborne; they can spring directly into the air. Diving ducks have to run along the surface of the water to reach sufficient speed to fly.

How is a diver's body adapted to what and how it feeds, and how is this different from a dabbler? Draw the two birds and describe how their body types help them get their food.

Eurasian wigeon
Anas penelope

Notes