SALTWATER WETLANDS

Stretching along much of the world's coastlines are ribbons of life—productive and important communities of plants and animals that flourish between the open waters of the oceans and the dry lands beyond. These communities, the saltwater wetlands, take several different forms. In the tropics, for example, they're mangrove swamps: thick stands of mangrove trees and the host of organisms that live among their tangled roots and branches. But north and south of the tropics, in the temperate zones, mangrove swamps give way to the open, grassy wetlands called salt marshes. Both of these major kinds of saltwater wetlands support rich networks of life adapted to dynamic, often unpredictable, environments.

IN TUNE WITH THE TIDES

Mangrove swamps and salt marshes are different in a lot of ways—mainly because they occur in different climates. But they're alike in that they're both subjected to some of the same kinds of conditions, day in and day out. These conditions are dictated by a powerful force: the oceans' tides.

Daily Ups and Downs: Twice each day along most of the world's coasts, the tide rises and falls. What this daily fluctuation in the water level means to saltwater wetlands is that they're exposed to a continually changing environment. For part of the day mangrove swamps and salt marshes are flooded, and many of the plants and animals that live in them become partially or completely covered with water. Then, as the tide gradually retreats, the plants and animals become exposed to air.

It's not just the water level that changes, though. So does the temperature of the wetland—each time the tide comes and goes. (In warm seasons water tends to be cooler than air or land, and in cool seasons it's often warmer.) Rising and falling tides also bring increases and decreases in the salt content, or *salinity,* of a coastal wetland. (For some examples of how certain salt marsh and mangrove swamp plants and animals have adapted to their habitats, see "Amazing Mangroves" on page 22 and "Changing with the Tide" on page 27.)

Molding Marshes; Shaping Swamps: Changes in a saltwater wetland aren't limited to the tides' ups and downs and the increases and decreases in temperature and salinity that they bring. Over time, the whole wetland changes—shifting, shrinking, or expanding depending on factors such as weather patterns and climatic changes. For example, a single violent storm can wash away part of a wetland or create areas where new wetlands can take hold. (Sediment washed up on shores can make fertile ground for wetland plants.) Gradual changes in the sea level can also affect wetlands. As the sea level rises, a new wetland can form where, say, a forest once stood. And as the sea level falls, fields, forests, and other "dry" habitats can eventually develop in a former wetland.

SALTWATER WETLANDS UP CLOSE

Here's a closer look at salt marshes and mangrove swamps, starting with the most abundant and widely distributed of the two.

SALT MARSHES

Seaside "Prairies": In a way, salt marshes are the prairies of the coasts. A sea of grasses characterizes these wetlands, which in the United States are most extensive between the coasts of southern Massachusetts and northern Florida. But these

saltwater "prairies" have a different look from, for example, the prairies of the American Midwest. One reason for this is that they're intersected here and there by *tidal creeks*—saltwater creeks that rise and fall with the tides.

A Dirty Build-Up: Salt marshes are a common feature of the world's coasts, but they don't occur along just any type of shore. The inner reaches of coves, inlets, estuaries, and bays make some of the best sites for salt marshes, since they're protected from the full force of the pounding surf. Sediment brought in on the tides and nutrient-rich silt carried in by rivers can settle in these calmer areas, giving marsh plants an ideal place to sprout, grow, and spread. Once they've gotten started, the plants trap even more sediments and silt among their roots and around their stems. And when they die, their leaves, stems, and roots become part of the sediment too, making the soil richer for future generations of plants.

Impressive Producers: Grasses are the most common plants in many salt marshes, and usually only one or two grass species dominate the scene. These grasses are often members of the tough, productive group known as the spartinas.

Spartina grasses are the bread and butter of many salt marshes. These grasses are incredible producers, creating as much or more food per acre than most carefully cultivated and heavily fertilized agricultural fields of the same size. All of the animals in a spartina salt marsh depend on this "generous" food source, either directly or indirectly. (In western salt marshes, pickelweeds, spike grasses, and certain other plants are often more abundant than spartina.)

Webs of Life: The bacteria of a salt marsh contribute a lot to the marsh plants' ability to feed so many. Through the process of decomposition, they break down the dead stems and leaves of spartina and other plants into a form that other animals can use. (Only certain insects, crabs, and a few other animals can digest the tough plants in their original form.) This decomposed vegetation, along with tiny bits of animal remains and other "scraps," is known collectively as *detritus*. Salt marsh algae grow on detritus, and crabs, fish, mussels, clams, and many other animals feed on these enriched bits of food. The detritus eaters eventually become food for birds and other marsh predators. (Detritus also "feeds" the plants of a salt marsh.)

Tiny as they are, these detritus particles can be important far beyond the boundaries of the salt marsh. Some detritus washes out to sea on the tides where, either directly or indirectly, it may feed ocean animals.

The Smaller the Better: Because of all the food salt marshes have to offer, they support a lot of life—more than most forests, oceans, prairies, and other types of habitats of equal size. But many salt marsh organisms are small or even microscopic. Salt marsh mud, for example, is alive with billions of bacteria and other tiny organisms. And insects, snails, mussels, crabs, and others live in and around the mud, within the tidal creeks, or among the marsh grasses and other plants.

Not many larger animals make the salt marsh their permanent home, though. Some animals, such as raccoons, foxes, and minks, use the marshes as hunting grounds. And big browsers such as deer often come into the marshes too, to feed on the grasses and other plants.

Migrating birds and the young of certain species of animals are two other groups of salt marsh "part-timers." For more about how they use salt marshes and other wetlands, see "Migration Vacations" and "Natural Nurseries" on page 4.

(continued next page)

cattle egret

Credit: HoodedWarbler/Wikimedia

Between Marsh and Sea: Special habitats called tidal flats often border the seaward edges of salt marshes. Tidal flats are muddy (and/or sandy) areas that lie exposed during low tide and become completely inundated with water during high tide. Most plants—including the hardy spartinas—don't grow in these severe conditions. As a result, tidal flats look pretty barren at first glance.

But there's more to tidal flats than you might think. Algae and bacteria are incredibly abundant in these areas, and they provide food for the clams, crabs, snails, worms, and many other small animals that live in the mud. During low tide, sandpipers and many other birds "flock" to the exposed flats to gobble up these animals. And during high tide, fish and other animals swim into the flats to feed.

MANGROVE SWAMPS

Where the Salt Marshes End: Mangrove swamps are the tropical counterparts to the salt marshes of cooler climates. As in salt marshes, the mangrove swamp community depends on a group of related plants that produce huge quantities of food and provide homes for many different kinds of animals. But the dominant plants of mangrove swamps are mangrove trees, not grasses or other non-woody plants.

Frost can kill mangrove trees, which is why the swamp communities they support occur mainly in the tropics. In the United States mangrove swamps reach their most lush growth along the coasts of southern Florida, although a few small stands of mangroves straggle as far north as coastal Louisiana and Texas.

Living Stilts and Sticks in the Mud: The special habitat most mangroves grow in calls for some special adjustments. For one thing, coasts don't make for very stable growing conditions. Also, mangrove swamp mud doesn't have much oxygen in it. The multitudes of bacteria and other tiny organisms that live in the mud quickly use up oxygen in the process of decomposition.

The roots of certain species of mangroves have evolved some interesting solutions to these problems. For example, red mangroves send out *prop roots:* long roots that grow down from their trunks and branches and become anchored in the mud. These stiltlike roots trap leaves, detritus, and other floating debris, making the trees' footing firmer. Prop roots also absorb oxygen from the air through tiny pores called *lenticels.*

Black mangroves don't need as much support as red mangroves do, so they don't have prop roots. (Black mangroves grow on slightly firmer ground than red mangroves. And they usually aren't exposed to as much wave action, since they grow a little farther inland.) Like red mangroves, though, black mangroves are faced with the problem of low oxygen levels in the soil. They cope with this situation by sending up small, sticklike roots from the mud. These roots, called *pneumatophores*, are covered with lenticels, just as a red mangrove's prop roots are.

"No One Likes the Mangroves...": Author John Steinbeck wrote these words—and at the time he was right. Nearly everybody once thought of mangroves as useless, weedy "junk" trees. Now we realize that there's plenty to like about mangroves and the mangrove swamp communities. For example, they're great storm breakers. And their jungle of roots and dense leaves and branches makes them popular places for wildlife. Some animals—certain kinds of oysters, for example—cling to mangrove roots. Others, such as shrimp, fish, and crabs, hide and feed among the roots submerged by high tide. And in the mangrove branches overhead, storks, herons, egrets, and hundreds of other species of birds nest and roost. To these animals and many others, mangroves are anything but "junk" trees. (For more about the wildlife of mangrove swamps, see "Amazing Mangroves" on page 22.)

Make a Mud Snail

Put together a mud snail puzzle and label its parts.

Objectives:
Name and describe several of the body parts of a mud snail. Talk about some of the adaptations that help a mud snail survive in its habitat.

Ages:
Primary

Materials:
- *copies of page 30*
- *pictures of mud snails*
- *scissors*
- *construction paper or drawing paper*
- *glue*
- *crayons or markers*

Subject:
Science

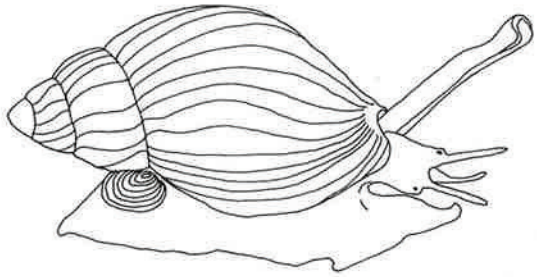
Here's a fun way for the kids in your group to get a close-up look at one saltwater wetland creature—the mud snail. Before you get started, make your own mud snail by following the directions below. Then begin by discussing the characteristics and kinds of saltwater wetlands. (See the background information on pages 18-20). Next, tell the kids that you're going to talk about an animal that lives in many coastal areas, including tidal flats and salt marshes. Read them these clues and see if they can guess what kind of creature it might be.

- It eats mostly plants but also dead animals such as fish and crabs.
- It has a head, two tentacles, and one "foot."
- It carries its "house" on its "back."
- Its "house" has a "door" that the animal carries around on its foot.
- Its teeth and mouth are on the end of a long, trunklike tube.

After the kids have made their guesses, show them pictures of mud snails. Then, using the mud snail puzzle that you made earlier and the information below, discuss the parts of a mud snail. Afterward pass out copies of page 30, scissors, glue, crayons or markers, and construction paper or drawing paper and let the kids make their own mud snails.

Making A Mud Snail

1. Cut out each of the puzzle pieces along the solid lines.
2. Arrange the puzzle pieces to form a picture of a mud snail. Then glue each piece in place on a sheet of construction paper or drawing paper and let dry.
3. Color the snail and label its body parts.



Mud Snail Specifics

Mud snails live along the mud banks and in the muddy tidal creeks of salt marshes, as well as in other coastal areas. Like many snails, mud snails need to stay moist. So when the tide goes out, they often "follow the water" or crawl into pools. If a mud snail does get left "high and dry" and starts to get too hot or too dry, it can burrow down into the surface of the mud to stay moist and cool until the tide returns. Here's a look at the parts of a mud snail:

Shell—A mud snail's shell can be a little over one inch (2.5 cm) long and is usually light brown to black. The shell, like the shell of other snails, is the mud snail's shelter and helps protect it from drying out as well as from some predators. The mud snail can pull its entire body into its shell.

Operculum—The operculum is a horny disc that rides on the back of a mud snail's foot. When a mud snail pulls its body into its shell the operculum comes last, shutting like a door to seal the mud snail inside. When closed, the operculum helps protect a mud snail from some predators and from drying out.

Foot—Mud snails glide from place to place along a single foot. (A snail's foot is the fleshy part of the body that helps the animal move.) As they move along the mud the foot produces a special slime that makes the gliding easier. Chemicals in this slime can be "read" by other snails and thus aid in communication among individuals.

Proboscis—At the tip of this trunklike tube are the mud snail's teeth and its mouth. The mud snail uses its teeth to scrape algae and other food from the surface of the mud and to scrape flesh from the bodies of dead animals that it finds. As the food is scraped off it goes into the mud snail's mouth.

Siphon—Mud snails' siphons draw water into their bodies and around their gills, which absorb oxygen and give off carbon dioxide. The water pulled in by the siphon also circulates through a special organ inside the snail's body. This organ can detect chemicals in the water. (Chemicals in the water help a mud snail find food and detect predators. They also aid in communication among individuals.)

Tentacles—A mud snail uses its two tentacles to feel things in front of it and to detect chemicals in the water.

Eyes—The two tiny eyes near the bases of a mud snail's tentacles can't see images the way human eyes do. Instead they detect differences in the amount of light.

Amazing Mangroves

Answer questions about a mangrove swamp scene and sing a song about mangrove communities.

Objectives:
Describe some of the animals that live in a mangrove swamp. Explain the ways these animals use mangrove trees.

Ages:
Primary

Materials:
- ***copies of page 31***
- ***crayons or markers***
- ***guitar or piano (optional)***

Subjects:
Science and Music

Luise Woelflein

Here's a way to introduce your kids to the mangrove swamp community. First pass out copies of page 31. As the kids look at the scene, discuss some of the ways mangrove trees are adapted to living in coastal waters. (See "Living Stilts and Sticks in the Mud" on page 20.) Tell the kids that the two trees illustrated are red mangroves. Then talk about each of the animals that live on or around the trees using the background information in "Who's Who in the Mangrove" on page 23. Here are some sample questions to ask:

1. How many crabs are there in the picture? Where are they? Do you think they eat the same things?
2. How many birds are there in the picture? Can you name two of the things they are doing?
3. Can you see a snake in the picture? What do you think it's trying to do?
4. Where is the snail? What do you think snails eat?
5. Why do you think the smaller fish are clustered around the roots of the tree?

Wrap up the discussion by explaining that animals use mangrove trees as a place to nest, find food, raise their young, and as protection from other animals that want to eat them. Then pass out markers or crayons and have the kids color their mangrove swamp scenes.

A Mangrove Sing-Along

After talking about mangrove swamps, try some singing and movement to help your kids remember what they've learned. Have the kids form a circle. As you lead the song below (to the tune of "Old MacDonald"), have the kids make the movements that go along with each animal. The suggested movements appear at the end of the song.

Pelicans live in mangrove trees,
e-i-e-i-o.
They build their nests among the leaves,
e-i-e-i-o.
With a *flap-flap* here and a *flap-flap* there,
Here a *flap*, there a *flap*, everywhere a *flap-flap*.
Pelicans live in mangrove trees,
e-i-e-i-o.

Rat snakes prowl the branches high,
e-i-e-i-o.
They gulp down eggs and birds they spy,
e-i-e-i-o.
With a *gulp-gulp* here and a *gulp-gulp* there, etc.

Crabs crawl in the mangrove trees,
e-i-e-i-o.
They snip off lots of mangrove leaves,
e-i-e-i-o.
With a *pinch-pinch* here, and a *pinch-pinch* there, etc.

Crocs live in the mangrove swamp,
e-i-e-i-o.
They catch their prey with a mighty chomp,
e-i-e-i-o.
With a *chomp-chomp* here and a *chomp-chomp* there, etc.

Oysters cling to the roots below,
e-i-e-i-o.
They filter out their food, you know,
e-i-e-i-o.
With a *slurp-slurp* here and a *slurp-slurp* there, etc.

Movements:
Pelican—flap arms up and down
Rat Snake—hold arms at sides and wiggle body
Crab—move thumbs back and forth like a pincer
Crocodile—have the left hand grab the right shoulder and the right hand grab the left shoulder and move elbows up and down in opposite directions
Oyster—keep heels of hands together as rest of hand opens and shuts

WHO'S WHO IN THE MANGROVE

WHITE IBIS
- nests in mangrove trees
- builds platform nest of twigs
- nests in colonies
- feeds on crabs and other small animals it picks out of mud at low tide

BROWN PELICAN
- makes sturdy nest of sticks, reeds, and twigs woven into the upper branches of mangrove trees
- usually nests in large colonies
- makes flying dives into the water to scoop up fish
- endangered in parts of the United States, but is now making a "comeback"

MANGROVE SNAPPER
- swims among submerged mangrove roots
- feeds on shrimp, small crabs, and other crustaceans
- young stay among roots to hide from predators

BLUE CRAB
- has paddlelike fifth pair of legs that help it swim
- clings to roots when in "soft shell" stage after molting
- eats plant material, shrimp, small fish, oysters, clams, and animals that have recently died

AMERICAN CROCODILE
- waits among submerged mangrove roots for fish, mammals, and birds—quickly snaps up prey
- female builds nest of sticks and leaves
- is endangered; only a few hundred remain in the United States

YELLOW RAT SNAKE
- climbs among the trees
- is not poisonous
- eats rodents, birds, and eggs

SEA HORSE
- is a type of fish
- uses prehensile (grasping) tail to cling to mangrove roots
- father carries young in a brood pouch until they hatch
- eats plankton that it sucks in through tubelike mouth

OYSTER
- feeds on organic material by sucking in water through siphon and filtering out food
- attaches to prop roots with fingerlike extensions along shell
- grows in large clusters

GREEN-BACKED HERON
- builds platform nest of sticks in mangrove roots, only inches above high tide mark
- hunts for fish, frogs, insects, and small snakes in shallow water

MANGROVE TREE CRAB
- feeds on mangrove leaves
- lives in upper branches of mangrove trees
- if alarmed, drops from branches into the water

ANGULATE PERIWINKLE
- is one of the most abundant snails in mangrove swamps
- browses on algae and other plant material
- is found on roots and branches above high tide mark

Salty Discoveries

Hatch brine shrimp eggs and observe their development.

Objectives:
Design an experiment.
Discuss the adaptability of saltwater wetland creatures.

Ages:
Primary, Intermediate, and Advanced

Materials:
- *white paper*
- *magnifying glasses*
- *brine shrimp eggs*
- *small, clear containers*
- *marine salt or non-iodized salt*
- *medicine droppers (optional)*
- *aged tapwater or spring water*
- *crayons or markers*
- *packaged yeast (optional)*

(continued next page)

Can you imagine spending your life swimming in salt water? Lots of creatures do, including those that live in salt marshes, mangrove swamps, and tidal flats. These animals all have built-in adaptations to deal with salt water. And many can live in fluctuating levels of salinity. By raising their own brine shrimp in water of different salinities, the kids in your group can see firsthand that many coastal wetland creatures are well adapted to changeable saltwater habitats. (*Note:* Brine shrimp live in saltwater lakes and in coastal salt pans. They usually are not found in coastal saltwater wetlands. However, they have some of the same adaptations to salt water as grass shrimp and other animals that *do* live in coastal wetlands. And they are easy to raise in a classroom or nature center.)

Start off by discussing the characteristics of saltwater wetlands, using the background information on pages 18-20. Then briefly tell the kids how some animals and plants in a salt marsh deal with the changing conditions. (See "Changing with the Tide" on page 27.)

Credit: DJPMapleferryman/Wikimedia

brine shrimp

Now pass out a sheet of white paper and a magnifying glass to each child. Sprinkle a few brine shrimp eggs onto each sheet, but don't tell the kids what they are. Ask the kids to describe them. What do they think they are?

Tell the kids that they're looking at the eggs of an animal that lives in saltwater

Subject:
Science

Ellen Lambeth

lakes and, like the animals that live in saltwater wetlands, is adapted to salty conditions. Explain that the eggs hatch in salt water but that the kids must figure out just how salty the water should be.

Ask the kids how they could find out what amount of saltiness is best. Help them design an experiment to test their ideas. For example, they could set up several containers of water, put fresh water in one, and then put water that's increasingly salty in the others. You can mix up a few batches of salty water for the kids to use or let them make their own. Just be sure to use only spring water or aged tapwater in the mixtures, and have the kids label their containers. (One tablespoon [15 ml] of salt mixed with one cup [240 ml] of water is usually a good mixture for the eggs, so you might want to make your samples more or less salty around this ratio. Or you can let the kids discover a ratio for themselves.) Then have the kids add some eggs to each container and watch to see what happens. (It will take a day or two for the eggs to hatch.)

Once the shrimp have hatched, the kids can continue to observe them. Have them keep records on how long they live, how they move, what they look like, and so on. Younger kids can keep their records by drawing pictures. (Enough tiny algae and bacteria may grow in the containers to feed the brine shrimp. You may also want to add *small* amounts of packaged yeast as well. [A pinch of yeast is all you need. Too much yeast can kill the shrimp.])

Older kids may want to design other brine shrimp experiments. For example, they might want to see what happens if they transfer the hatched shrimp to water of different salinities. Do the shrimp survive? How big a salinity change can they stand? The kids could also try to figure out if different temperatures affect the hatching of brine shrimp eggs. (For more about brine shrimp and brine shrimp experiments, see the *Teacher's Guide for Brine Shrimp* available from Delta Education [see below]).

After the kids have finished their experiments, have them report their results to the rest of the group. Then discuss what they found out. Brine shrimp, like many creatures that live in salt water, can tolerate very different salinities. These animals can remain relatively active even if the salinity isn't at an "optimum." Explain that many other creatures, such as mussels that live in salt water, are active in a narrower range of salinities. These creatures tend to shut down when conditions aren't "just perfect." (The salinity in a coastal wetland often changes drastically as the tides come and go and when it rains. Animals and plants that live in these areas must be able to cope with these conditions.)

Solutions To Salt

Here's a brief look at a few of the adaptations that help coastal wetland creatures cope with salt.

- The shells of many saltwater creatures, such as crabs and some shrimp, are impervious to salt. The only way these animals can take up salt is through their food and water.
- Some animals, such as some crabs, bivalves, and seabirds, have special glands that excrete extra salt.
- Some animals, such as some fish, clams, and shrimp, can excrete salt across their gills.
- Some fish conserve water by excreting very concentrated urine.

Where to Get Brine Shrimp

Brine shrimp eggs and marine salt are available at most pet stores that carry aquarium supplies. Brine shrimp eggs, clear plastic containers, magnifying glasses, medicine droppers, marine salt, and a teacher's guide are also available in a kit called *Brine Shrimp* from Delta Education. (The teacher's guide and all of the other materials can be ordered separately too.) To order write Delta Education, P.O. Box M, Nashua, NH 03061-6012 or call (800) 258-1302. In NH, HI, and AK call (603) 889-8899 collect.

Note: This activity is adapted with permission from Delta Education Corporation.

Build a Mangrove

Build a life-sized model of a mangrove tree.

Objective:
Name some of the animals that live in a mangrove swamp and describe how they use mangrove trees.

Ages:
Intermediate and Advanced

Materials:
- ***copies of page 31***
- ***construction paper***
- ***glue***
- ***scissors***
- ***egg cartons (optional)***
- ***pipe cleaners (optional)***
- ***green and blue tissue paper***
- ***tape or stapler***
- ***stepladder (optional)***
- ***thin cardboard***
- ***crayons or markers***

Subjects:
Science and Art

Clear a corner of your classroom or meeting area and make way for a mangrove to take root! First give each child a copy of page 31. Explain that this mangrove swamp scene shows some of the animals that live in mangrove trees. You can use the background information on page 23 to talk about these animals.

Then tell the kids that they'll be working together in groups to make a red mangrove tree complete with roots, branches, leaves, and wildlife. Divide the kids into three teams—the Trunk Team, the Root Team, and the Canopy Team. Directions on how to make the three parts of the tree are listed below. We've also included a short section on page 26 about how to make some of the animals that live on and around mangrove trees. (Have the kids look at their mangrove scenes to decide where the animals should go. Also see "Trees that Walk," *Ranger Rick,* Nov. 1986, pp 38-46, for more about mangrove swamps.) Then bring out construction paper, glue, scissors, tissue paper, egg cartons, and pipe cleaners, and watch that mangrove grow!

TRUNK

1. Tape or staple several sheets of brown or black construction paper together to form a trunk about one foot (30 cm) wide and three feet (90 cm) long.
2. Tape the trunk in the corner, attaching the sides of the trunk to the two walls. (This will give the effect of a three-dimensional tree.) The base of the trunk should be about two feet (60 cm) above the floor (see diagram on next page).
3. Create water around the mangrove by taping several sheets of blue tissue paper to the wall. The "sea" should reach from the floor to the base of the trunk.

ROOTS

1. Cut black or brown construction paper into long strips about 1 inch (2.5 cm) wide and 2-3 feet (60-90 cm) long. Also cut some shorter strips to make "accessory" roots that branch off the longer ones.
2. Beginning at the bottom of the trunk, tape the strips end to end to form roots reaching along both walls and extending away from the corner into the "water" (see diagram on next page). Anchor the roots by taping them to the floor.
3. Tape more strips along the main roots to make a maze of roots. Keep attaching more strips until the tangle of roots reaches into the water and a bit higher than the base of the trunk.

BRANCHES AND LEAVES (CANOPY)

1. Cut branches out of black or brown construction paper and tape them to the top of the trunk.
2. Use sheets of green tissue paper to make layers of leaves. Tape a few sheets of tissue paper together and attach to the two walls of the corner.
3. Add a few more layers of tissue paper, each one a little higher and a bit farther from the corner (see diagram on next page).
4. If you want to get more kids involved, have them cut out individual leaves from green construction paper and tape them to the branches.

(continued next page)

MANGROVE ANIMALS

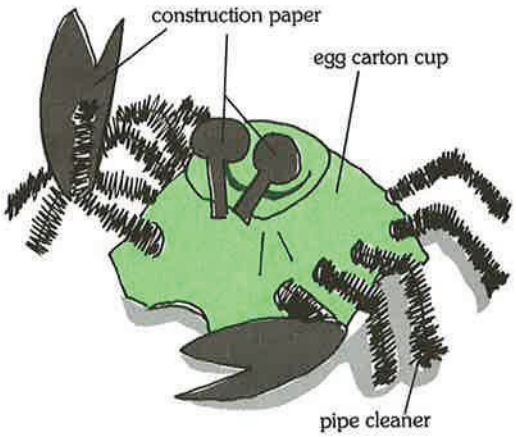
- For larger animals such as herons, pelicans, and crocodiles, cut outlines out of thin cardboard. Color them with crayons or markers and tape them in the appropriate places on the tree.
- Cut smaller animals (snakes, turtles, fish, and so on) out of construction paper and tape them on the tree.
- By following the directions at the right, you can also make crabs and snails out of egg cartons.

CRAB

1. Cut out one cup from the egg carton and turn it upside down.
2. On each side of the cup, poke four holes in a line about a half-inch (1.3 cm) above the bottom edge (see diagram). Also poke two holes in the front section of the cup.
3. Poke one pipe cleaner through a side hole and out the hole on the other side. Then bend the pipe cleaner ends downward to form the legs of the crab. Repeat with three other pipe cleaners.
4. Push a fifth pipe cleaner through the holes on the front of the crab, and bend the ends forward. These will form the clawed legs.
5. Cut claws and stalked eyes out of construction paper. Glue the eyes on the top of the cup and the claws on the ends of the pipe cleaner (see diagram).

SNAIL

1. Cut out one cup from an egg carton and turn it upside down.
2. Cut out a foot, head, and tentacles from construction paper and glue them to the cup (see diagram).



Changing with the Tide

Make a salt marsh display board to show how some animals are affected by the changing tides.

Objective:
Give several examples of how animals and plants are adapted to the changing conditions in a salt marsh.

Ages:
Intermediate and Advanced

Materials:
- ***copies of page 32***
- ***pieces of corrugated cardboard***
- ***scissors***
- ***glue***
- ***crayons or markers***
- ***construction paper***
- ***thin cardboard***
- ***paper***
- ***yarn***
- ***paper punch***
- ***pictures of a salt marsh***
- ***reference books***
- ***chalkboard or easel paper***

Subject:
Science

In this activity the kids in your group will learn about some of the plants and animals that live in salt marshes and how their lives are influenced by the tides. (*Note:* The specific plants and animals in salt marshes in different parts of the country vary. Those discussed in this activity would be found in a salt marsh along the mid-Atlantic coast of the United States, though many are also found in salt marshes in other parts of the country.)

Before you get started, make a salt marsh board by following the directions on page 28. Then make some wearable salt marsh signs by writing "fiddler crab," "ribbed mussel," "raccoon," and "killifish" on separate sheets of paper, punching two holes in the paper, and threading a piece of yarn through the holes. Also make three or four signs for each of these plants: cordgrass, marsh hay, and spike grass. (You'll be using the board and the signs later on.) Then copy the picture at the top of the next page onto a chalkboard or large sheet of easel paper.

Begin by using the background information on pages 18-20 to explain the general characteristics of a salt marsh. Next tell the kids that the plants and animals in a salt marsh live in different parts of the marsh depending on how tolerant they are of salt, changes in salt concentrations, changes in temperature, and changes in water levels. For example, plants and animals that can withstand being alternately flooded for long periods of time and then left "high and dry" each day live in the part of the marsh that's closest to the sea. This area is called the *low* marsh. Plants and animals less tolerant of salt water live farther away from the sea in the *high* marsh. The high marsh is flooded for only a few hours each day or even just a few hours twice a month.

To get the kids thinking about what life in the marsh is like, try the following demonstration.

Part 1: Low Tide/High Tide

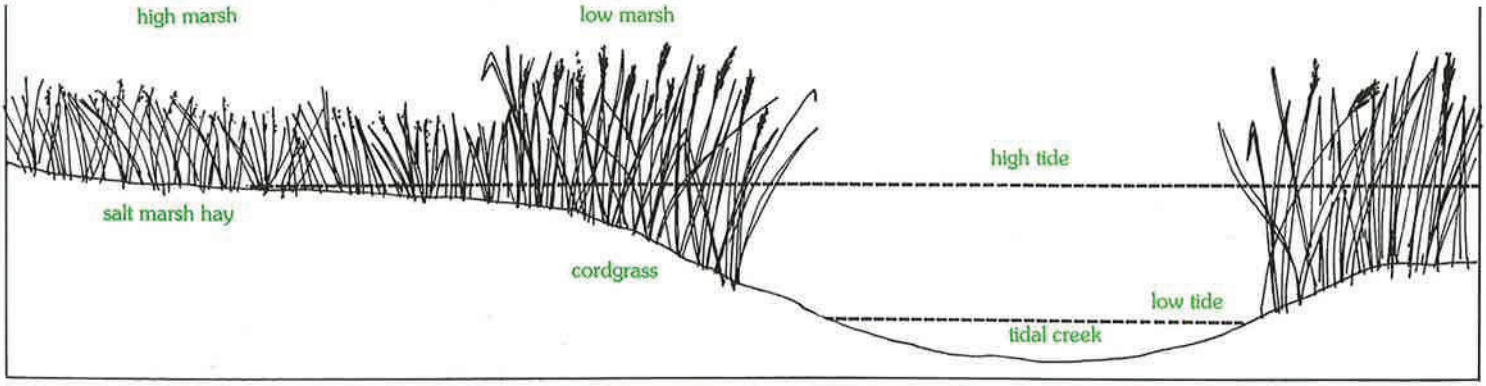
Have several kids volunteer to be salt marsh cordgrass and have them wear the cordgrass signs you made earlier. Have these kids stand near one side of a large, open area outside to represent the low marsh. Explain that in many salt marshes cordgrass is about the only plant that grows in the low marsh. Next, have a few kids volunteer to be some of the plants that grow in the high marsh—marsh hay and spike grass, for example. Give these kids the appropriate signs to wear and have them stand next to the cordgrass. Then have a few kids wear the salt marsh animal signs and stand aside. (They'll be in the salt marsh later.) Finally, have the rest of the kids become the salt water.

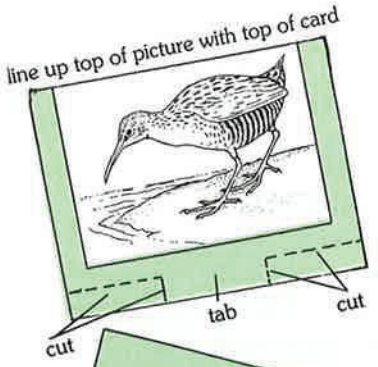
Start off by having the water be at low tide. (The "ocean" should be at the far end of the cordgrass, on the side farthest away from the plants of the high marsh.) Then make the water rise by having the ocean slowly walk up through the low marsh plants and into the high marsh plants. Then have the tide flow out again.

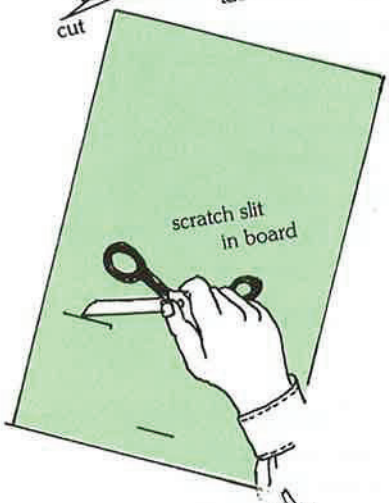
After the tide has risen and fallen once or twice, ask the kids which plants were covered by water for the longest time. (cordgrass) Then have the animals come into the salt marsh. First have the ribbed mussel and fiddler crab stand in the low marsh and explain that these animals both live in the low marsh. What do the kids think these animals might do as the tide comes and goes? (See "Plants and Animals of the Salt Marsh" on page 29.) Next have the raccoon stand in the high marsh and the killifish stand in the ocean and ask the kids what they think these animals might do as the tide comes and goes. (Depending on the size of your group, you may want to include other animals.)

Once again, have the tide rise and fall. But as the tide moves in and out, have the animals act out what they would do in a real salt marsh. (For example, to hide in its burrow the fiddler crab could crouch down low. And the killifish could swim into the marsh with the tide.)

(continued next page)





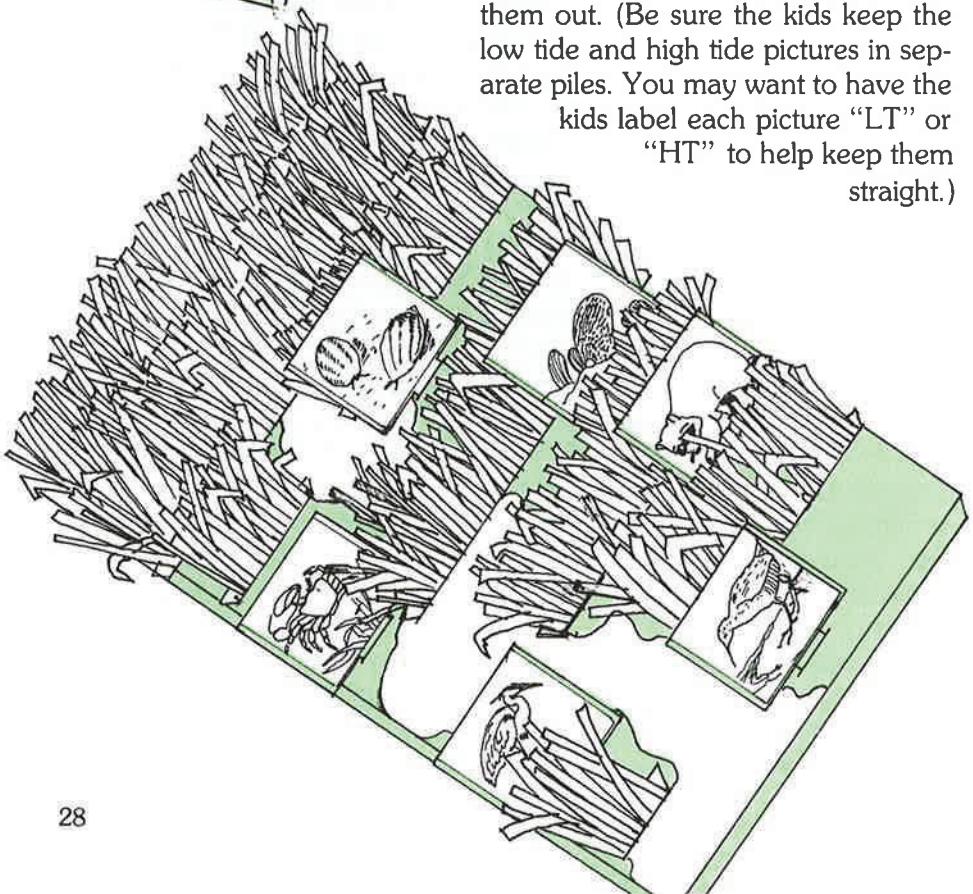


PART 2: DISPLAY BOARDS

Now pass out copies of page 32. Explain that the pictures on the top half of the page show what some salt marsh animals might be doing when the tide is out. The pictures on the bottom half of the page show what some of these animals, plus a few others, might be doing while the tide is in. Using the information on the next page and the display board that you made earlier, talk about each of the creatures on the sheet as well as some of the plants that live in salt marshes.

Afterward, pass out thin cardboard, scissors, glue, crayons or markers, construction paper, and pieces of corrugated cardboard (the sides of boxes work well) and have the kids follow these directions to make their own salt marsh boards:

1. Color the pictures on page 32 and cut them out. (Be sure the kids keep the low tide and high tide pictures in separate piles. You may want to have the kids label each picture "LT" or "HT" to help keep them straight.)
2. Cut out six rectangles from the thin cardboard (about 2½ × 3½″ [6.3 × 8.8 cm]).
3. Glue each of the low tide pictures to a separate card and let dry. (Line up the top edge of each picture with the top edge of the card so that you have excess cardboard along the bottom edge for a tab [see step 4].) Then glue a high tide picture to the back of each card.
4. Trim the bottom edge of each card to form a tab (see diagram).
5. Use pointed scissors to make six slits in the display board. The slits should be just a little longer than the tabs on the cards and should be spread out on the board. Use a pencil to mark how long each slit should be. Then hold the scissors completely open and *scratch* a slit between the marks. (Don't press too hard or you'll crush the board.)
6. Make one end of the board the high marsh and the other end the low marsh. Use construction paper to decorate it. For example, you can fringe dark green construction paper for cordgrass and fringe light green paper to make marsh hay. You can also make other salt marsh plants, a tidal creek, or any other decorations. (Pass out reference books and encourage the kids to decorate their boards accurately.) Glue the decorations onto the board between the slits.
7. Place a card in each slit so that all of the low tide pictures face the same direction. Then, to show what happens when the tide comes in, remove each card, turn it around, and put it back in.



Adapted from *Smithsonian Estuarine Activities* with permission from the Smithsonian Institution.

Plants And Animals Of The Salt Marsh

Note: Some of these animals and plants are found on both the Atlantic and Pacific coasts. For those found only on the Atlantic coast, we've listed similar Pacific coast species in parentheses at the end of each section.

Blue Crab—Moves into marsh as tide rises. Feeds on worms, snails, oysters, and other marine animals. Moves out of the marsh with the tide. Breathes with gills. If gets caught in salt marsh as tide goes out, it will bury itself in the mud and wait for the tide to rise again. (yellow shore crab)

Clam Worm—Burrows in mud of salt marsh and as it burrows it secretes slime that "glues" sand grains together and then hardens into a flexible tube. When tide covers the mud it may come out of its tube and swim around looking for food. Feeds on other worms, dead fish, other soft-bodied animals, and algae. Remains in tube while tide is out. Is very tolerant of changes in salinity.

Clapper Rail—Nests in drier areas of high marsh. Feeds mostly at low tide along mud flats and along creek banks in the salt marsh. Eats fiddler crabs, worms, snails, small fish, and other marine animals. Hides in grass of high marsh during high tide.

Fiddler Crab—Digs burrows in mud or sand of the low marsh. Feeds on algae, bacteria, and decaying plant and animal matter that covers the surface of the mud. Comes out of its burrow at low tide to feed. Breathes air with gills that must be kept moist. Returns to burrow and may plug it with sand or mud during high tide. Can withstand long periods without oxygen. Can live in varying concentrations of salt water. (California fiddler crab)

Great Blue Heron—Hunts in shallow water of the salt marsh. Grabs fish with its long, sharp bill. May also eat shrimp, insects, small mammals, and other animals in the marsh. As tide rises, moves higher on the marsh (to stay in shallow water) or may leave the marsh completely.

Killifish—Lives in shallow waters of the salt marsh. Moves into and out of the higher parts of the marsh with the tides. Feeds on mosquito larvae and other small animals as well as plants. Can withstand low concentrations of oxygen. (California killifish)

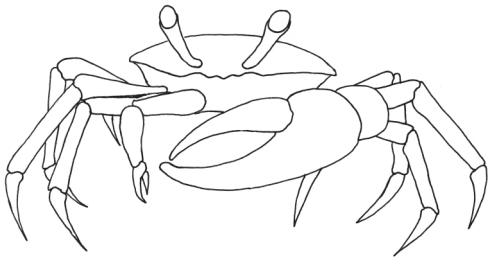
Raccoon—Comes to the salt marsh to hunt. Feeds on crabs, clams, fish, and other animals. Leaves the low marsh as the tide rises.

Ribbed Mussel—Lives half-buried in the mud of the low marsh where the tide floods regularly. Feeds on tiny plants and animals suspended in the water. Breathes with gills. While submerged, pumps water through its body, across its gills, and out again. Filters out food as the water passes through. When uncovered by water, leaves its shells slightly open so it can continue to breathe. If conditions get too bad, closes its shells completely and "holds its breath" until the tide returns.

Salt Marsh Snail—Usually lives in high marsh. Feeds on algae and bits of decaying grass on the surface of the mud. Lacks an operculum (see page 21), so during the day it crawls under the mat of dead marsh hay at low tide to keep from drying out. Breathes air with a lung. Crawls up spartina stalks (see below) during high tide to escape the water. Can "hold its breath" for one to two hours if it becomes submerged. (California salt marsh snail)

Spartina—Absorbs water through its roots without absorbing much salt. Salt that is absorbed is secreted through its leaves. Its long leaves also get rid of excess heat. Mud in salt marsh has very little oxygen in it but air tubes connect the surface of the spartina leaves with the roots and bring air down to them. Two major species grow in many salt marshes. Cordgrass grows in the low marsh where it gets flooded by water for long periods of time each day and can even be completely submerged by the highest high tides. Marsh hay grows in the high marsh where it gets flooded for only a few hours each day or even just a few hours each month.

Other Plants—Spike grass, blackgrass, salt marsh aster, sea lavender, seaside plantain, and many other plants may grow among the marsh hay and in the highest parts of the salt marsh. Some, such as spike grass, have a high saltwater tolerance and can stand being flooded by the tide periodically. But others, such as sea lavender, can withstand only occasional salt spray. (The plants in western salt marshes are often different from those in eastern salt marshes. Several kinds of spartina grasses grow in western marshes, but other plants are often more abundant. Depending on where a marsh is located along the Pacific Coast, there may be pickleweed, spike grass, sedges, salt rush, tule, milkwort, Pacific silverweed, and/or other plants.)



Fiddler Crab

Credit: USFWS

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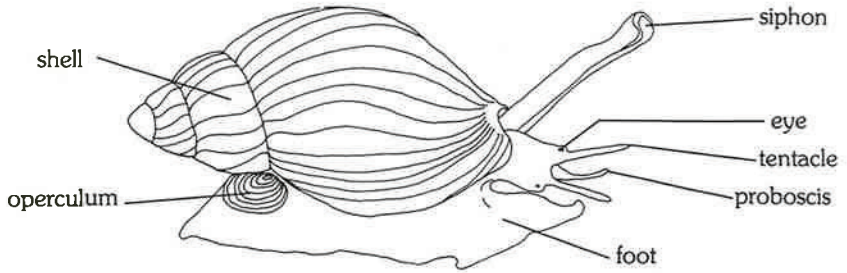
MAKE A MUD SNAIL



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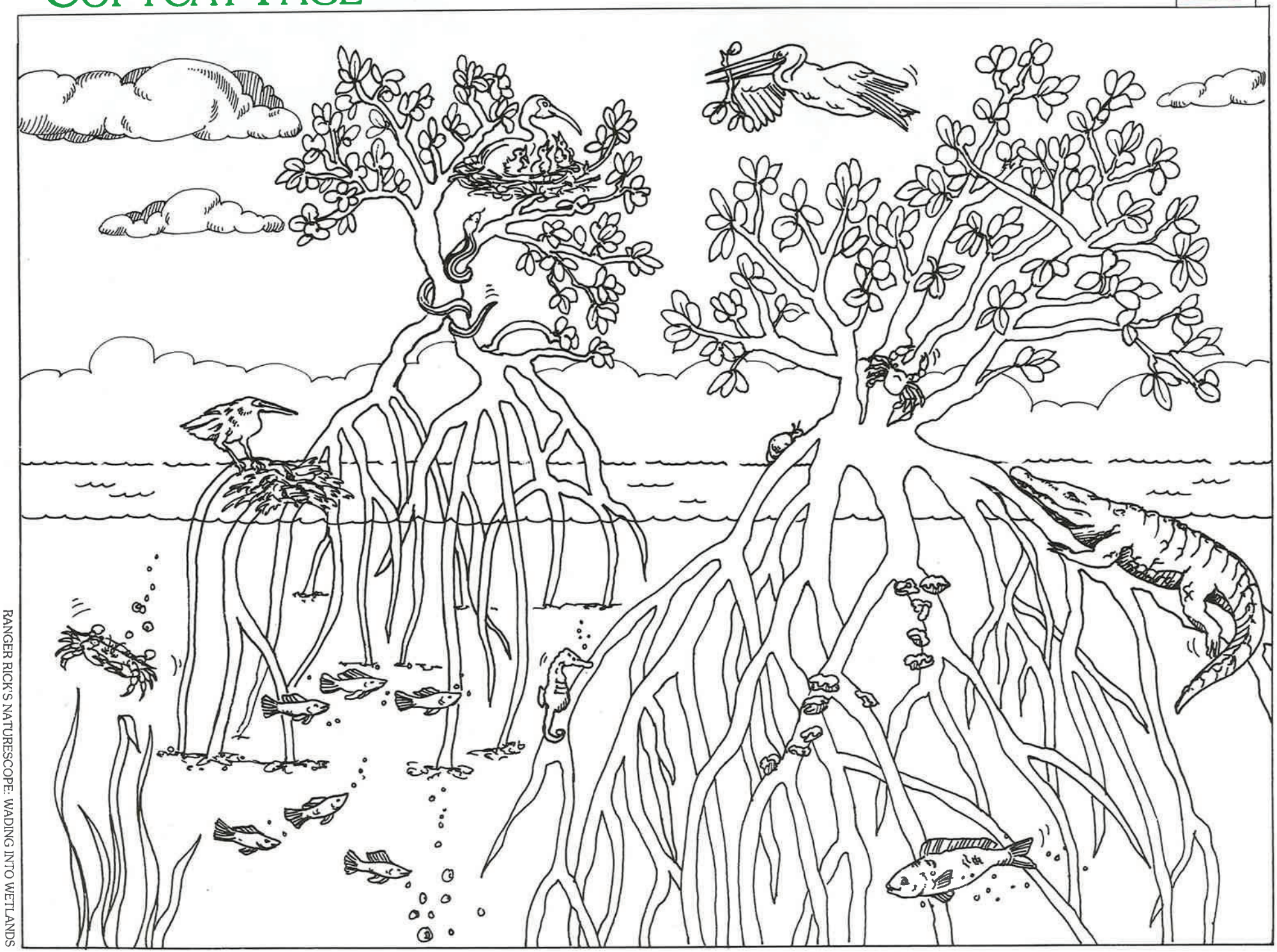
AMAZING MANGROVES



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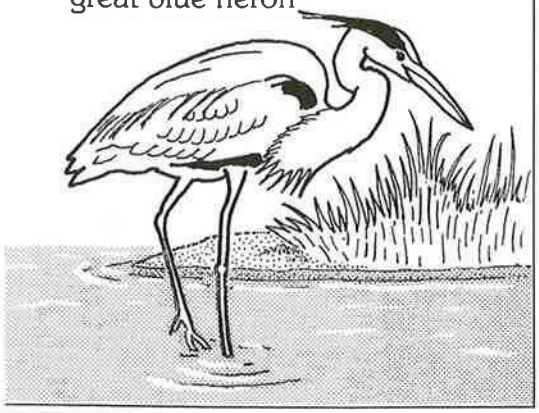
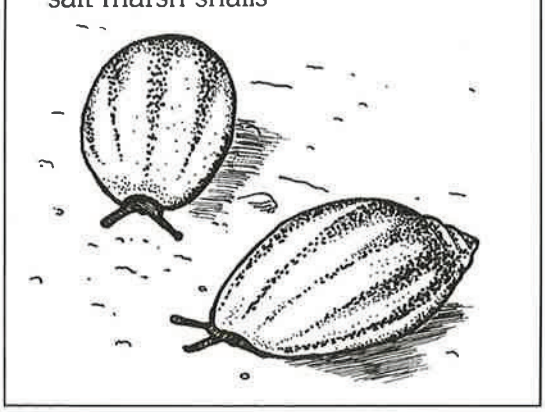
CHANGING WITH THE TIDE

LOW TIDE

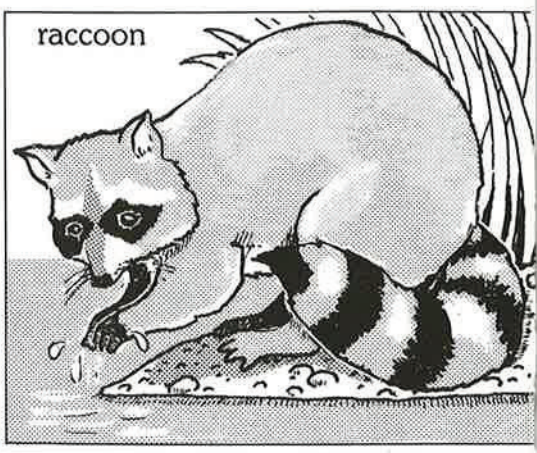
great blue heron



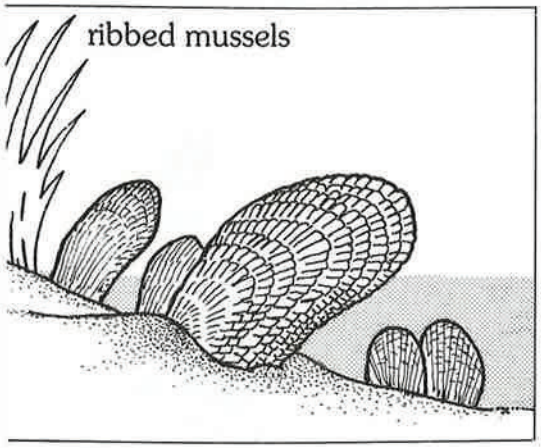
salt marsh snails



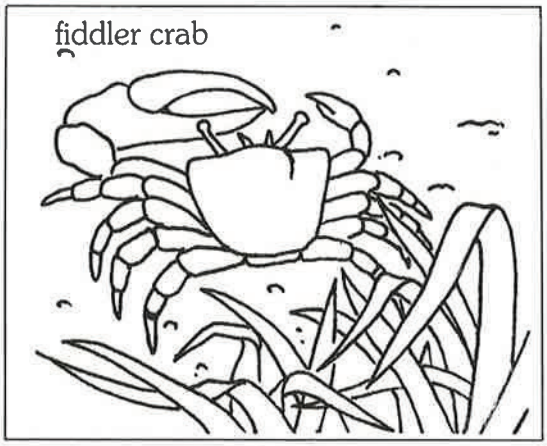
raccoon



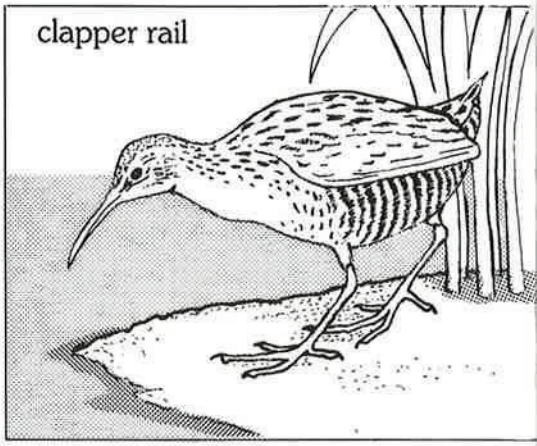
ribbed mussels



fiddler crab

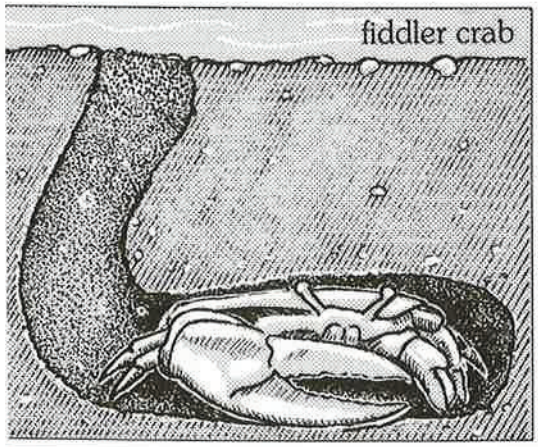


clapper rail

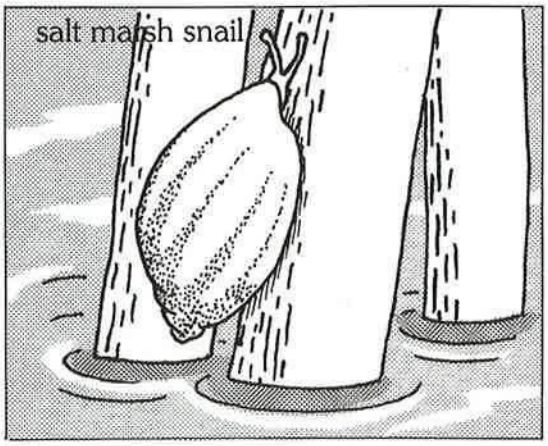


HIGH TIDE

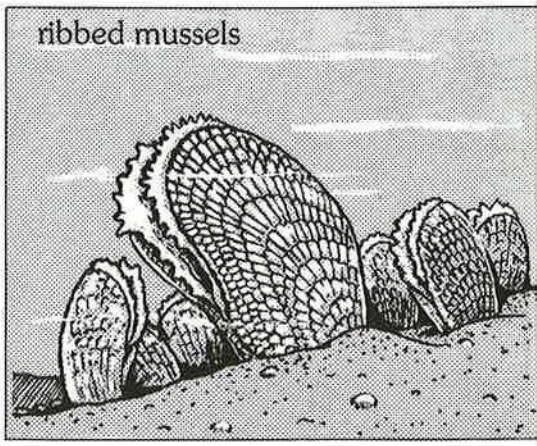
fiddler crab



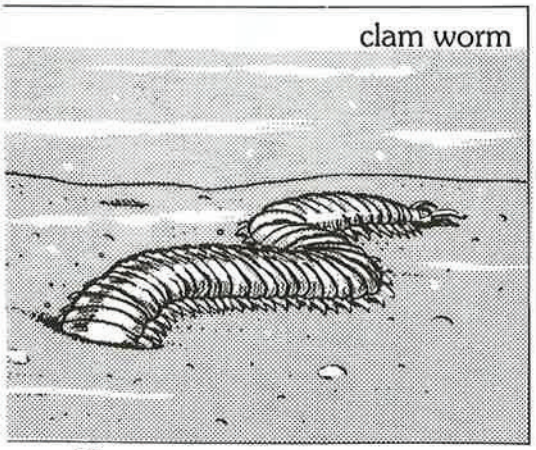
salt marsh snail



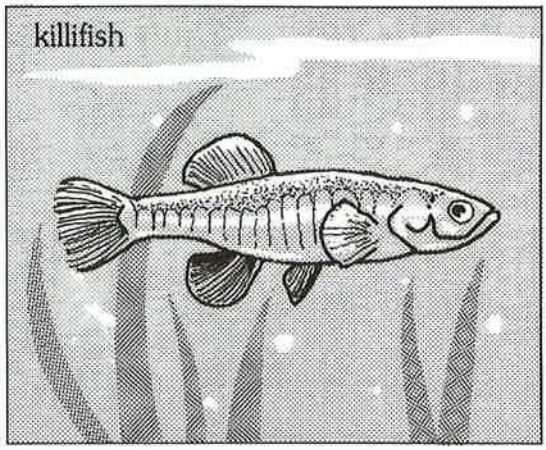
ribbed mussels



clam worm



killifish



blue crab