
ESTUARY LIFE

FOR THE TEACHER

Discipline

Biological Science

Theme

Diversity, Systems and Interactions

Key Concept

Estuaries, places where a river meets the ocean, support many different types of living things. Estuary communities are very sensitive to human impact.

Synopsis

Students listen to and interpret the Banana Slug String Band song "Estuary Life". They work in small groups to teach each other about wetlands and then participate in a gameshow to check for understanding. Finally, they transform the song into a mini-drama and stage a performance.

Science Process Skills

communicating, organizing

Social Skills

check for understanding, share information and ideas

Vocabulary

estuary, diversity, invertebrate, adaptation, human impact, mudflat, marsh, bay, wetland, landfill, toxic spills, fry

MATERIALS

INTO the activities

- *Slugs At Sea* audio cassette and a tape player (by Banana Slug String Band) or piano or guitar to play "Estuary Life"
- lyrics and musical score to Estuary Life (see pp. 13-14) for the teacher
- 1 copy of the lyrics to Estuary Life per pair of students
- 7 sheets of chart paper (each about 2x3 feet)
- 4-6 colored marking pens, wide-tip, several colors for the teacher
- masking tape

THROUGH the activities

- 1 Estuary Life Content Card per student (see pp. 8-12) Keep each verse or bridge and chorus grouping of cards together. (Optional: copy cards onto card stock and laminate.)
- a grade-level appropriate dictionary
- a few books about wetlands (see Interdisciplinary section for titles)
- a few posters/videos about wetlands (see Resources section for titles)
- art materials to make simple costumes (ex: construction/butcher paper, tape, scissors, stapler, and marking pens)

BEYOND the activities

- 4 or 5 large, "mural-size" (about 3x5 feet) sheets of butcher paper
- 4 or 5 sets of various colored, wide-tip marking pens/crayons (1 set per group)
- 2 large packages of colored construction paper
- art materials (ex: white glue, stapler, and scissors) for each of 4-5 groups or the class to share
- a few appropriate books and posters (see Resources section for titles)

INTRODUCTION

When a river of fresh water flows into the salty water of the ocean a habitat is created for many organisms. For thousands of years many communities of humans along the coasts of North America subsisted almost entirely on plants, invertebrates, fish, birds, and mammals found in these unique habitats called estuaries. Even today, some of our largest and most economically important cities are located on estuaries formed at the ends of the Mississippi, Colorado and Sacramento Rivers.

Rivers and streams carry nutrients to the estuary from surrounding fields and mountains. Estuaries also collect nutrients from the ocean with the rise and fall of the tides. The quiet, nutrient-filled waters at the mouths of the rivers nurture abundant plant life, the smallest of which are diatoms, a type of phytoplankton. As a result, estuaries make ideal nurseries for a variety of diatom-eating fish and invertebrates. The fish and invertebrates enter the estuary to breed, give birth and raise their young. When the young are strong enough, many will enter the open ocean to live out their adult life until eventually returning to the estuary to complete their own life cycle. The combination of a variety of habitats and the mixing of nutrient rich waters make estuaries one of the most productive and complex systems on Earth. Estuary nurseries supply the open ocean with most of the fish caught in the world's commercial fisheries. Shorebirds take advantage of the fish breeding grounds by stopping to feed on young fish, plants and invertebrates during annual migrations to their own breeding grounds. Many of these shorebirds are feeding within the mudflats and marshes contained within the estuary.

Without the estuary feeding grounds many birds could not survive their long migrations and would die without producing a next generation of offspring. Many organisms depend on wetlands for their survival. The fat innkeeper worm is an inhabitant of mudflats on the west coast of North America. It builds a u-shaped burrow in the mud. The animal gets its unique name from its plump shape and the company it keeps. A crab, a tiny clam and a fish called a "goby" (pronounced "go-bee") often live in the burrow as "commensal" guests. In other words, the organisms do not help or hurt the fat innkeeper worm by living in its burrow, but they clearly benefit from the arrangement themselves.

Salmon are also dependent on estuaries for their survival. Salmon lay their eggs on rocks at the bottom of rivers. When the eggs hatch, the baby fish begin looking for food and swimming toward the ocean right away. Salmon are one of the few types of fish that can live part of their life in salt water and part in fresh water. The salmon fry (baby fish) need to acclimate, or adjust their bodies, from living in fresh river water to living in the salt water of the ocean. The semi-salty estuary is the crucial transition zone for salmon. Without the estuary, far fewer salmon could survive long enough to make the necessary physiological changes to withstand the salty ocean.

Despite all we know many people continue to think wetlands are useless except as dumping grounds for human waste. During the last one hundred years wetlands have been filled in to build airports, shopping malls, homes, parking lots, prisons, garbage dumps, and more. Pesticides, oil and other toxic wastes continue to be dumped directly into wetlands as well..

The majority of toxins enter wetlands through "non-point source" pollution. This occurs when rains wash pollutants off city streets into rivers and storm drains which often carry the poisons downstream directly to estuaries. Another damaging pollutant is engine oil that drips onto roads from old or poorly tuned cars. Much of the oil is washed by the rains into storm drains, which carry the contaminated water directly into estuaries and bays. Much more oil enters the ocean this way than through the many commercial oil spills, such as the 1989 Exxon Valdez disaster in Alaska, that are publicized in the news.

Farmers using toxic herbicides and pesticides on agricultural fields are another major contributor to non-point source pollution.

Some humans have made tremendous efforts to preserve our remaining wetlands and their inhabitants. Scientists know the soil and plants in wetlands extract many natural and synthetic toxins out of the water. A few small human communities such as in Arcata, California have begun using natural wetlands as the primary purification system for their sewage. The sewage is purified by plants, invertebrates, and bacteria that filter out and

digest waste, reconfirming our knowledge that wetlands play a vital role in the continued survival of clean water on our planet.

In many towns and cities, storm drain stenciling projects have labeled thousands of storm drains with the words "No Dumping, Drains to Bay," to educate those who might otherwise dispose of used oil, paint and other waste there.

INTO THE ACTIVITIES

The Music

1. Have the class listen to "Estuary Life" on tape, or play it for them live on guitar or piano. Post the lyrics on the wall in large letters with the chorus and each verse in a different color on a separate sheet of paper. Point to the verses and chorus as they come up in the song.
2. Give each pair of students a copy of the lyrics. Have the students circle all the words or sentences they do not understand. Have the class listen to the song again, singing along this time.

Think/Pair/Share

See the Teaching Strategies section for how to present this activity

1. Have students "Think" about anything they don't understand about the song.
2. Now have each student "Pair" up again and using their marked copy of the song, discuss the things they do not understand about the song. Can they answer any of each others questions?
3. After a few minutes, have them "Share" their unanswered questions with another pair of students. Can the group of four answer any of each others questions?
4. Finally, have each group of four share their still unanswered questions with the class as you record them under the appropriate verse posted on the wall.
5. Add questions to address any additional content you want presented, e.g. what are the similarities and differences between estuaries, mudflats, marshes and bays? At this point you will probably want to discuss the distinctions between each of the different types of wetlands (estuary, mudflat, marsh and bay) that are mentioned in the song. Because the song does not explicitly define each of these, without a follow up discussion many students may be unclear on the central concept of "what is a wetland."

Tell the students that in the next part of the activity they will work in cooperative groups to answer all their questions about the song. Each group will concentrate on one part of the song.

THROUGH THE ACTIVITIES

The Jigsaw

1. Divide students into seven groups of four to five students each. Assign one group the bridge and chorus, and assign each of the other six groups one of the numbered verses. Pass out the corresponding set of Estuary Life Content Cards (see pp. 8-12) to each group.
2. Have students divide the cards among themselves and learn the information on their card. After they understand their own card, they will teach, in their own words, the most important thing on their card to the rest of the group.

Sidebar: If students have questions about their card, have them raise their hand and the teacher or older student peer teachers can answer specific vocabulary questions for individual students, or refer them to a grade-appropriate dictionary. Help students understand the context and the general concepts rather than focusing on the specific vocabulary. Also, suggest looking for information in pictures, posters and books around the room.

The Gameshow

1. Have the students pass in the cards and stop sharing information. At this point, each member of a group should be able to describe any and all of the content cards given to their group for their part of the song. Have each student number off within their group; there will be seven students with number one, seven with number two and so on.
2. Make a chart on the board with seven columns, one for each group. Label the columns with the part of the song assigned to the group. As answers are given by each group, write them down in the appropriate column on the board or have the student write them along with the awarded points. Alternatively, instead of writing the answers, a sketch can be made.
3. Ask one group at a time a question about their set of content cards. The entire group can discuss the question and decide on an answer. Then after you again repeat the question, use Numbered Heads Together (*see the Teaching Strategies section for how to present this activity*) to choose a student to answer. Pick a number out of a "hat", announce it to the class, and the student in that group with that number then stands and gives the answer.

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- a. If that student gives a “complete” answer (it is up to the teacher to decide what a complete answer is), their group gets five points.
 - b. If that student isn't able to respond or gives only an incomplete answer, pick another number and call on a different member of that group. If the second student adds to the first student's answer, their group may still get five points.
 - c. If the second student is unable to answer, pick another number and call on another member of that group. If that student can give an answer, then the group may still receive their five points.
 - d. If the third student is unable to answer, give the group its partial (or zero) points. It is now another group's turn.

Each group gets three chances to get a total of five points per round and then it is another group's turn.

4. Proceed verse by verse through the song. Questions for the gameshow can be taken from the original charts. After the gameshow, ask if there is anybody who can now answer the previously unanswered questions still left on the original charts. The teacher can either write in the answer or check off or cross out each answered question. These questions can be used as extra credit in a bonus round of the gameshow.

Poster Making

Have the students create a poster, with each “expert group” illustrating the content from their verse. Have each group try to answer the questions the class generated about their verse. Tell each group to present their answers to the class, while sharing the poster they created.

Genre Transformation: Song to Dramatic Presentation

1. Tell the class that each group is going to work together to design and perform a skit or mini-drama about one part of the song, either a verse or the bridge and chorus. Divide the class into seven groups of four or five students. Assign each group one of the verses or bridge and chorus and refer them to the posted lyrics and poster for their part of the song.

Sidebar: Since the class was already divided into seven groups for the Jigsaw, you can either simply keep the same groups or you can form entirely new groups. It may be an extra challenge for students to dramatize a different part of the song than they studied in the Jigsaw part of the activity.

2. Give the groups 15-20 minutes to develop a drama about their part of the song, and to design simple costumes from materials around the room. Tell them to be as creative as possible. They can use humor, but they must also include accurate scientific information to describe the concepts presented in

their assigned part. Invite the groups to perform one to two minute skits in rapid sequence for the class until the entire song has been performed.

3. Now, have each group decide on portions of their mini-drama which they can perform as the song is being played. Remind them that the verses are sung very rapidly in succession so they need to be ready to go on as soon as they hear their cue (the last line of the previous verse). It is helpful to place all the lyrics in order around the room and have each group stand in front of their verse or the bridge and chorus.

4. Play the song again and have the students present their excerpt of their mini-drama with costumes as the rest of the class sings the words to the verse as it comes up in the song. Each time the bridge and chorus is repeated, the bridge and chorus group leads the rest of the class in singing along (but they don't need to repeat their dramatization every time!).

BEYOND THE ACTIVITIES

Library Research: What is Estuary Life?

If there are still any unanswered questions from the original charts, these can be used for small group research projects at the library.

Class Mural

Divide the class into four or five groups of about seven students each, with one student from each of the jigsaw expert groups in each group. Have the students create a mural, with each "expert" illustrating the content from their own part of the song. The students will need to decide between themselves how each of the different communities the song describes fit together. Keep in mind how the various organisms and ecosystems might interconnect with each other.

Field Trip

- Take a field trip to a local wetland and investigate the organisms living in the mudflats and adjacent marshes. Compare your local wetland to other wetlands seen in videos or those you might have previously visited. Note any similarities and differences between salt and freshwater wetlands.
- Follow a local stream or river to its headwaters or where it feeds into a different body of water. You can also get water maps for your area and follow the local streams and rivers as a map exercise.

Estuary Life Content Cards

Bridge and Chorus: Card 1

An estuary is a place where fresh water from a river flows into the ocean. When they meet, the salty and fresh water mix. The water becomes saltier than the river, but not as salty as the ocean.

Bridge and Chorus: Card 2

In an estuary salty and fresh water mix together. Many plants and animals can live only in an estuary, with this special mix of salty and fresh water.

Bridge and Chorus: Card 3

A lot of plants grow in estuaries. Life is good there, especially if you like to eat those plants. All those plants also act as filters to help keep the water clean.

Bridge and Chorus: Card 4

Clams, crabs, worms, fish, and birds are some of the diverse animals living in estuaries. They find a lot of food to eat there, and many raise babies there, too. They think life is pretty good by the bay.

Bridge and Chorus: Card 5

Sometimes estuaries are in ocean bays where the ocean water is partly surrounded by land - like in San Francisco Bay. In these estuaries the fast moving water of the river and ocean do not pull animals and plants out to the open ocean very fast.

Verse 1: Card 1

Diatoms are tiny plants living in the water. They need sunlight and fertilizer to grow just like other plants. Dead stuff is the best fertilizer, and there sure are a lot of dead plants and animals in an estuary. (Organic Decay is the fancy way of saying fertilizer made of dead stuff!)

Verse 1: Card 2

Rivers sometimes travel long distances before they empty into the ocean. When a river flows into the ocean it carries a lot of things in it from all the places it has traveled.

Verse 1: Card 3

Rivers carry nutrients that can feed tiny plants in the ocean called diatoms. Nutrients come from plants and animals which have died and decayed. They are like fertilizer.

Verse 1: Card 4

Tiny plants called diatoms are eaten by small fish. Small fish are eaten by larger fish, which are eaten by seals, humans, and many other things. This is called a food chain. Diatoms are one of the most important parts of an estuary food chain.

Verse 1: Card 5

An estuary is a place where the river meets the ocean. Estuaries are protected from waves. They have a lot of food and hiding places for animals. More animals and plants can live in an estuary than in most habitats on Earth.

Verse 2: Card 1

Innkeeper worms look like fat, dark pink sausages. They are experts at digging holes in the mud to live in. They are called "innkeepers" because so many other animals like to share their home. An "innkeeper" is someone who runs a hotel.

Verse 2: Card 2

Several animals often live in the burrow of the innkeeper worm. The guests get a good place to live and plenty to eat. They don't help the innkeeper, but they don't cause trouble either. That's what it means to live commensally.

Verse 2: Card 3

The burrow that an innkeeper worm digs in the mud to live in has two openings. If you could peek through a window into its home you would see that the burrow is shaped like the letter "U."

Verse 2: Card 4

There are often three guests that live with the innkeeper. There is a small crab that walks through the burrow looking for food. There is a tiny clam buried in the mud in the bottom of the burrow, and there is a small fish called a goby that eats the innkeeper's leftovers.

Verse 2: Card 5

A mudflat is a place near the ocean shore, where there is lots of mushy mud that gets uncovered at low tide. Sometimes mudflats form when a river carrying lots of mud flows into the ocean. Mudflats are a great place to live because there is lots of food to eat there. Most animals there protect themselves by digging into the mud.

Verse 3: Card 1

Some shorebirds have long legs and some have short legs. Birds with long legs can wade further into the shallow water of estuaries while they search for food.

Verse 3: Card 2

Invertebrates are animals without backbones. Clams, crabs and worms are some of the invertebrates that birds like to eat in the estuaries. Crustaceans are one group of invertebrates. Crabs, shrimps and crayfish are crustaceans.

Verse 3: Card 3

Every type of bird has a beak shaped to catch the specific type of food it eats. Different types of birds have different shaped beaks. Specially shaped beaks are an important shorebird adaptation.

Verse 3: Card 4

Birds poke their beak into the mud to find tasty things to eat. The birds find different types of food depending on how deeply they probe into the mud.

Verse 3: Card 5

When adults go to eat at a fancy restaurant, they call the meal "cuisine." For many birds, estuaries are their fancy restaurants, and "invertebrate cuisine" is the best meal around.

Verse 4: Card 1

Baby salmon are hatched in fresh water rivers, but "migrate" toward the ocean. The babies migrate through the estuary on their way out to sea. They migrate through the estuary again when the adults come back to the river to lay their eggs.

Verse 4: Card 2

Salmon lay their eggs among rocks at the bottom of fresh water rivers. The water and the rocks have to be perfectly clean and unpolluted or the salmon won't lay their eggs.

Verse 4: Card 3

Baby animals are sometimes called something different than the adult animal. A baby salmon is called a "fry." The fry use estuaries to get used to the differences between the freshwater river and the salty ocean.

Verse 4: Card 4

Salmon are fresh water fish when they hatch. Most fresh water fish cannot survive in salt water. Salmon use estuaries to "acclimate" - to change from being a fresh water fish to an ocean fish. Without estuaries the change would be too sudden.

Verse 4: Card 5

Salmon spend two or three years living in the ocean. They grow bigger and bigger, getting ready to return to the river to lay eggs. They always lay their eggs in the same river where they were hatched.

Verse 5: Card 1

Humans have destroyed most of the wetlands in the United States. Almost all the wetlands around the San Francisco Bay are gone. When wetlands disappear, there is a great danger to plants, animals AND people that depend on them.

Verse 5: Card 2

Many airports, parking lots, farms, and houses are built on land that used to be wetlands. The animals that used to live in the wetlands cannot survive, raise their babies, or eat when their home is covered with cement.

Verse 5: Card 3

Native Americans lived near, fished in, hunted on, and protected wetlands for thousands of years. Today people can be poisoned by eating fish caught in wetlands in polluted areas. People depend on healthy wetlands.

Verse 5: Card 4

Recycling, picking up garbage, and not littering are all ways that we can help protect the wetlands. We can also remind adults not to throw away oil and old paint in street gutters. Those gutters often carry things straight to wetlands and the ocean.

Verse 5: Card 5

Many people don't know how much they depend on wetlands for food, to absorb floods and to filter toxins out of our water. We can help save the wetlands by telling other people about how important and fragile they are.

Verse 6: Card 1

An estuary is a place where a river of fresh water flows into the salty water of the ocean. A lot of plants and animals live in estuaries. There is a lot of food for plants and animals in estuaries.

Verse 6: Card 2

A mudflat is a wetland where there is lots of mushy mud that is uncovered at low tide. A marsh is a wetland with a lot of grasses, reeds, and other plants growing in it. A lot of animals live in mudflats and marshes.

Verse 6: Card 3

Ocean bays are places where a section of ocean water is partly surrounded by land, but has a wide opening to let the water out to the rest of the ocean - like Monterey Bay.

Verse 6: Card 4

A wetland is a place where there is land that is wet! An estuary, marsh, mudflat and bay are all different types of wetlands.

Verse 6: Card 5

Many people think wetlands are useless and want to dump toxins there or fill them in with dirt. Then people can build houses, airports, and parking lots where the wetlands used to be. Destroying habitats kills animals and plants, though. It is also dangerous to human health.

Estuary Life

Bridge:

Life is good here by the bay

Chorus:

Estuary, salty and fresh,
the river mixes with the sea
Estuary, salty and fresh,
life has diversity (2 times)

Bridge**Verse 1:**

Diatoms bloom and grow from organic decay
The food chain starts where the river outflows
its' nutrients to the bay (bridge)

Verse 2:

The innkeeper worm digs his habitat
and lives commensally
In a U shaped burrow on the tidal mudflat
with a crab, and a clam, and the fish go-by (bridge...chorus...bridge)

Verse 3:

Wading birds eat crustaceans
an invertebrate cuisine
Leg and beak adaptations
dig deep, shallow, or in-between (bridge)

Verse 4:

Salmon use the estuary
when they must migrate
before the fry swim out to sea
Here's where they acclimate (bridge...chorus...bridge)

Verse 5:

Some bays are changing dangerously
with our human impact
Let's learn some ways to live so we
can keep our bay life intact (bridge)

Verse 6:

Estuary, mudflat, marsh and bay
our wetland communities
keep fill and toxic spills away
from this good life by the sea (bridge...chorus...bridge)