ACTIVITY 13

Port to Port

Estuary Principle

Humans, even those living far from the coast, rely on goods and services supplied by estuaries.

Research Question

In what ways do people rely on goods and services supplied by estuaries?

Introduction

Estuaries have significant practical and economic value to humans. Estuaries provide flood protection to coastal communities through their wetlands that absorb and slowly release water from storms. Many species of fish, crabs, and shellfish that live in estuaries for part or all of their lives provide essential food for humans and a livelihood for the people who harvest and sell them.

Estuaries provide more than simply economic value. There are social and cultural benefits derived from estuaries. Millions of people use estuaries for recreational activities such as fishing, bird watching, and boating. Estuaries are also a source of inspiration to poets and painters. They rejuvenate the spirit, kindle curiosity, and reward visitors with discovery.

In this activity, students will participate in a role-playing game in which they trade estuary goods with a ship's captain who travels around North America, visiting different ports in the 1800s. A second game examines the value of estuaries and how human activities and decisions affect the estuaries and change their value.

Climate Extension

Students will explore climate change-related impacts to coastal communities and economies through an interactive game of chance.

Table of Contents

This curriculum was developed and produced for:

The National Oceanic and Atmospheric Administration (NOAA) and The National Estuarine Research Reserve System (NERRS)

1305 East West Highway NORM/5, 10th Floor
Silver Spring, MD 20910

www.estuaries.noaa.gov

Financial support for the Estuaries 101 Middle School Curriculum was provided by the National Oceanic and Atmospheric Administration via grant NA06NOS4690196, administered through the Alabama Department of Conservation and Natural Resources, State Lands Division, Coastal Section and Weeks Bay National Estuarine Research Reserve. Support was also provided by the Baldwin County Board of Education.

TEACHER GUIDE

Port-to-Port

Research Question

In what ways do people rely on goods and services supplied by estuaries?

Content Objectives

Students will understand that:

- Estuaries have economic value.
- Estuaries also have social and cultural value.
- Estuaries can be damaged by human or natural factors.
- Estuaries can be restored by humans to some degree.
- Climate-related impacts along the coast will shape the availability of future goods and environmental services coming from estuaries. Students will learn three ways that coastal communities can adapt to and mitigate climate change impacts.

Exercises

Exercise 1: Port to Port

In this exercise, students participate in a role-playing game in which they trade estuary goods with a ship's captain who travels around North America, visiting different ports.

Exercise 2: Estuarie$ Game

Students play a game to examine the value of estuaries and how human activities and decisions affect the estuaries and change their value.

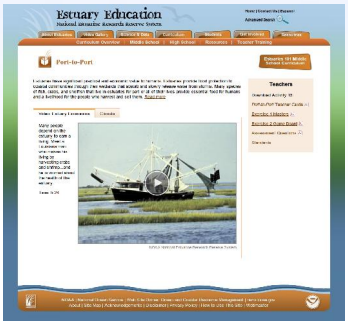
Climate Extension

Students will explore climate change-related impacts to coastal communities and economies through an interactive game of chance.

Assessment Questions

Assessment questions based on content covered in *Port to Port* can be downloaded on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

Find links to NERRS stewardship projects on the web page for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



Vocabulary

Adaptation – adjustment in natural or human systems to minimize the impacts of climate change.

Anthropogenic – arising from human activity.

Aquaculture – the cultivation of aquatic animals and plants, esp. fish, shellfish, and seaweed, in natural or controlled marine or freshwater environments; underwater agriculture.

Climate change – a regional change in temperature and weather patterns. Current science indicates a link between climate change over the last century and human activity, specifically the burning of fossil fuels.

Commodity – an article of trade or commerce, esp. a product as distinguished from a service.

Culture – a particular form or stage of civilization, as that of a certain nation or period.

Economic value – the amount (of money or goods or services) that is considered to be a fair equivalent for something else.

Estuary – a semi-enclosed body of water where fresh water and saltwater mix.

Goods – articles of trade; wares; merchandise.

Greenhouse gases – gases that trap heat in the atmosphere and contribute to the greenhouse effect. The main greenhouse gases that enter the atmosphere because of human activities are Carbon Dioxide (CO2), Methane (CH4), and Nitrous Oxide (N20).

Human impact – impacts arising from human activity; often referring to negative impacts on the environment.

Mitigation – reducing levels of greenhouse gases in the Earth's atmosphere.

Restoration – a return of something to a former, original, normal, or unimpaired condition.

Shipping – the act or business of a person or thing that is sent to another part of the world

Services – the performance of any duties or work for another; helpful or professional activity

Taking It Further

Port to Port

Have your students research fire ants and zebra mussels, two invasive exotic species that arrived in the United States via ships visiting estuary ports. Which parts of the country have been most affected by these two invasive species? What ecosystems have been affected by these two invasive species and what have those effects been? How did these exotic species travel all the way across the world? Through which ports did these two invasive species probably enter the United States? Are there any other invasive species that arrived through our ports?

Estuarie$ Game

Explore with students how different purchase combinations in the game might be more beneficial than others. What is a good balance of properties? Which make you the most money? Which purchases are the most rewarding non-monetarily? Example: Would it make sense to only purchase the shipping company and the amusement park?

EXERCISE 1

Port to Port

Estuary Concept

Estuaries have played an important role in determining the lifestyle and culture of different human populations over time.

Focus Questions

- In what ways do people depend on estuaries for goods and services?
- What were some of the commodities or goods traded at estuary ports in the past?

Performance Tasks

Students will:

- Be introduced to the natural resources once found in and around estuaries within the National Estuarine Research Reserve System. (NERRS)
- Learn some of the historically important products once traded at estuary ports and transported between cities and towns throughout the nation in the 19th century.

Teacher Background

Estuaries have played an important part in the lives of humans for hundreds, even thousands of years. Estuaries are tied to our economy, our hobbies, and our culture. Since civilization began, estuaries have provided people with seafood and jobs, and have served as ports for the transportation of goods across the country and around the world.

Estuaries have a long history of use by Native Americans. Many Native Americans historically relied on estuaries for their way of life. Tribes traded shells (wampum) as currency. They used shells as gifts, decoration, tools, and spearheads. Local estuary clay was used for making pottery (pots, cups, plates). Coastal reeds were utilized for basket weaving, cooking, mats, and building homes. Hunting and fishing in and near estuaries occurred with hewn out log canoes, hook and lines, casting nets, handmade spears, or bows and arrows depending on the seasonal variety of animals and fish. Many present day tribes still rely on fishing and shellfish in estuaries for food and income.

This exercise takes place in the early to mid-1800s. Trading ships that sailed great distances were commonly large, three-masted sailing ships. Narrower, faster ships called clippers were used starting in the mid-1800s. Clippers were used in the tea trade from Europe to Asia, as well as the New York to San Francisco route around Cape Horn. Steam-driven ships did not appear until the end of the 19th century.

Overview

In this exercise, students play a role-playing game called Port to Port. In the game, students represent the estuary ports where goods are traded with a 19th century ship's captain and crew who travel around North America.

You may choose to have students do the role-playing Exercise 1: *Port to Port* before playing the game in Exercise 2: *Estuarie$ Game*. *Port to Port* provides a historical look at estuary economics. *Estuarie$* provides a contemporary look at estuary economics. The two exercises can also be completed separately.

Time required

One 45-minute class period

Teacher Preparation

1. Read through the Teacher Background.
2. Print out Teacher Master: *Port to Port Estuary/Port Card*s, preferably on cardstock. Cut out the 10 port cards. You will see that the port cards have the names of a port on the front and information about goods traded at the port during the 19th century on the back.
3. Use hook-and-loop fasteners (Velcro) to attach each port card to a free hanging map of the United States at the locations of the corresponding ports, which are near some of today's NERRS reserves. The front of the card with the name of the port should be visible. Use the Interactive map on the web page for Activity 2: *Seasonal Swings* in the Middle School Curriculum section of the Estuary Education website as a reference for locating where to attach the cards to the map.
4. Make one copy of Teacher Master: *Port to Port Sailing Ship* on cardstock. Cut out the ship.
5. Make 10 copies of Teacher Master: *Port to Port Goods to Trade* and cut apart the commodity pictures. Sort them into 10 small bags. Each bag will contain only the one commodity for a single port (e.g., the Alexandria, Virginia bag will contain 10 images of caviar). Students representing the estuary ports will trade the commodities from their port's bag with the visiting ship's Captain. If you want, you may choose to have props or even larger images to represent the commodities instead of these small pictures.
6. It is suggested that you run this activity in a single class session and with your whole class. If you want to involve more students than the 11 mentioned below (1 captain, 10 ports), then perhaps you can have other students bring the commodities to the ports to trade. For instance, the cotton grown on Sapelo Island or further inland in Georgia would need to be brought to the port of Savannah to be exported. Alternately, each port could be represented by a team of two students: one who reads the card while the other trades goods with the Captain.
7. For the sake of the activity, the Captain's ship will somehow be able to get from the Pacific Ocean ports to the Gulf of Mexico port of Pensacola, Florida. Perhaps the ship was one of the lucky ones able to sail around South America's Cape Horn. Travel between the Pacific and Atlantic oceans became much easier after the Panama Canal was finished in 1914. Getting from the Hudson River to the Captain's last stop in Lake Erie would have been possible using the Erie Canal, which opened in 1825. However, the Captain would have had to leave his ship in New York and use a barge to make the trip through the canals and locks. Again, for the sake of the activity, allow the Captain to take his or her sailing ship directly from New York to Huron, Ohio to complete the trip.

Procedure

1. Invite students to sit around the large map of the United States.
2. Review the definition of commodity with your class. Explain how 19th century trading ships traveled from port to port to trade commodities (also called goods). The ships would bring goods to the port from other places and pick up goods from the port to take back to their home port or still other ports.
3. Tell your students that ports specialized in certain products. Some of those products were derived directly from the estuaries the ports were in or near. If you have props representing the commodities being traded at the estuary ports in this exercise, show them to your students now. If not, show the small photos of each commodity. Tell students that these commodities are just some of the goods traded out of estuary ports around the nation (and parts of western North America that would become states later, such as California, Oregon, Washington, and Alaska) and transported by ocean-going ships in the 19th century. You might also tell your students that the goods being traded in this exercise are representative. The Captain might be able to trade for cotton at any of the Gulf coast or southern Atlantic coast ports, not just the port of Savannah.
4. Pick one student to be the ship's Captain. What types of vessels were used for ocean-going trade in the early to mid-19th century? Give the Captain the cut out version of the ship. Tell the Captain that he or she will sail a route to drop off and pick up a variety of goods or commodities at estuary ports around the west coast, Gulf coast, east coast, and Great Lakes.
5. Select ten students to represent the ten estuary ports located on the U.S. map. Give each port student the bag containing the tradable commodities for that port. Explain that these ten estuary ports are near, but not in, modern-day NERR estuaries. When the Captain's ship comes into their port, these students will trade their port's goods with the goods that the Captain is transporting.
6. As the Captain's ship moves from port to port, the ship docks at an estuary port where the student representing that estuary port tells the Captain (and the class) about the commodity or products available for trade at that port. This is done by having each port student remove his or her port card from the map, read the back of the card out loud to the class, and reattach the card to the map. The Captain then trades the commodity on his or her ship for the commodity being traded at that port.
7. Discuss with your students how, because of geographical constraints, it would not have been practical for the same ship to travel from the Pacific to the Atlantic Ocean and impossible for that same ship to enter Lake Erie from the Atlantic.
8. The Captain's sailing ship is currently docked in Homer, Alaska. Give the Captain an empty bag. The cargo hold (the bag) of the Captain's ship is empty. To trade, the Captain must take on a commodity in Homer to sell or trade at later ports of call. Have the student representing Homer read the Homer port card and "sell" the Captain most or all of the coal that student has on hand.
9. The Captain is now ready to set sail from Alaska. The ship's first port of call

Materials

- Teacher Master: *Port to Port Estuary/Port Cards*
- Map of United States
- Map of the NERRS estuaries for reference
- Teacher Master: *Port to Port Sailing Ship*
- Teacher Master: *Port to Port Goods to Trade*
- Hook-and-loop fasteners (Velcro)
- 11 small bags (paper or plastic)
- Scissors
- Tape or glue

will be North Bend, Oregon. After the port student reads the card for North Bend, take a moment to have a discussion centered around the following questions:

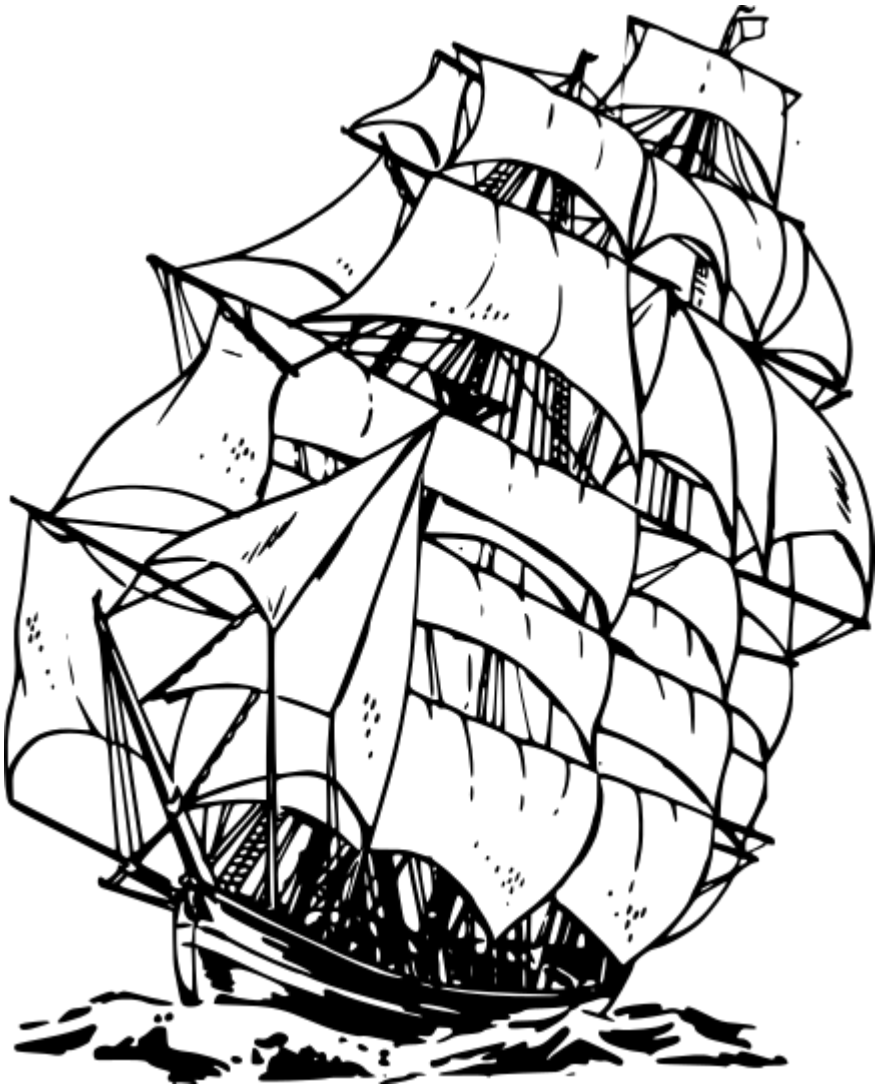
- What does it mean to engage in trade? Is it really trading?
- What happens when the Captain's ship comes to a port to trade? What does the Captain try to do with the goods he has on board the ship?
- What do the merchants trading goods at the port try to do with the goods they have on hand? What does the Captain have to offer them?

As a noun, *trade* means the buying and selling of goods. The goal of trade is to acquire something you don't have in exchange for something you do have and don't need. Often, this is an exchange of goods for money, resulting in profit. Students might also realize that this exercise isn't showing money as part of the trading process. The Captain might have had to buy the coal in Homer. At any point, the Captain might sell what's on the ship and use the money to buy more goods. We see that in the exercise as swapping, but it is a form of trade: buying and selling goods.

10. From North Bend, the ship journeys from port to port, trading commodities. The next port of call is Pensacola, Florida. Students should realize that the Captain might trade only some of his or her cargo and save some to trade at a later port. For instance, the Captain coming into port in North Bend from Homer might trade some of his or her coal for lumber in Oregon and then trade the rest of the coal at a later port for something else.
11. When the Captain has visited each estuary port, the Captain will end up at the port of Huron, Ohio where he/she trades for fruit that has come from Star Island on Lake Erie. For now, the Captain's journey is done. What might the real Captain have done? Students should realize that ships made repeated trips, back and forth along trade routes.

TEACHER MASTER

Port to Port Sailing Ship



Duplicate the above ship on cardstock and use scissors to cut it out. This will be the Captain's trading ship for the Port-to-Port game.

TEACHER MASTER

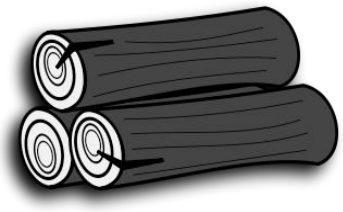
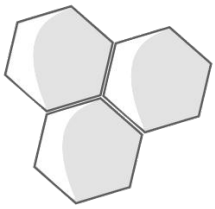
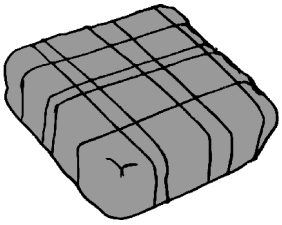
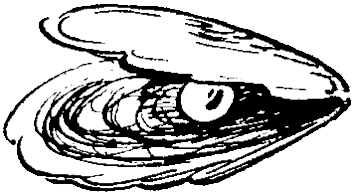
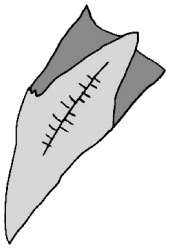
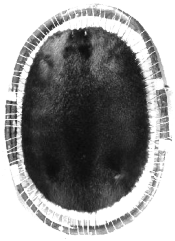
Port to Port Estuary/Port Cards

Front	Back
Port Homer, Alaska	Port: Homer, Alaska Near Kachemak Bay, Alaska NERR Item to trade: Coal Kachemak Bay first attracted the attention of Russian fur traders in the late 1700s because of the sea otters that were plentiful in this region. From around 1850 to around 1930, coal was mined, gathered on the Homer Spit and then shipped out from the port of Homer. This dirty, high-sulfur coal was eventually replaced by other fuel sources.
Port North Bend, Oregon	Port: North Bend, Oregon Near South Slough, Oregon NERR Items to trade: Lumber, furs North Bend, Empire City, and the town of Coos Bay were all ports in the protected waters of Oregon's Coos Bay inlet, just north of what is now the South Slough NERR. Early trade with Native Americans led to fur exports, but later trade was centered on lumber.
Port Pensacola, Florida	Port: Pensacola, Florida Near Apalachicola, Florida NERR Item to trade: Tupelo honey Beekeepers have known for a long time that bees in Florida's Apalachicola River swamp make a delicious honey near the end of April. This valuable honey, derived from the Ogeechee tupelo trees, is called tupelo honey. It never crystallizes, unlike other types of honey.
Port Savannah, Georgia	Port: Savannah, Georgia Near Sapelo Island, Georgia NERR Items to trade: Cotton and sugarcane There was a plantation on Sapelo Island in the early 1800s. Slaves worked the fields, raising cotton, corn, and sugarcane. The plantation also sold oak trees for shipbuilding. Silk and indigo also passed through the port of Savannah.
Port Georgetown, South Carolina	Port: Georgetown, South Carolina Near North Inlet Winyah Bay, SC NERR *Item to trade:* Rice, indigo dye In the late 1700s, indigo, a plant used to make blue dye, was the main cash commodity crop in this part of South Carolina. By the mid-1800s, areas near the port of Georgetown were producing nearly half of the rice crop in the United States. At one point, Georgetown was the largest rice-exporting port in the world!

Front	Back
Port Alexandria, Virginia	Port: Alexandria, Virginia Near Chesapeake Bay, Virginia NERR *Item to trade:* Caviar Caviar has long been a delicacy. On the east coast of North America, the fish eggs that we call caviar were harvested from the Atlantic sturgeon, a fish once abundant in Chesapeake Bay. Sadly, Alexandria was also one of the nation's largest slave trading ports in the early 19th century.
Port Wilmington, Delaware	Port: Wilmington, Delaware Near Delaware Bay, Delaware NERR *Item to trade:* Oysters, gunpowder, leather During the height of oyster export, you could find oysters from Delaware estuaries in restaurants in New York, but also inland as far as Chicago and St. Louis. By the time the Civil War started, the port of Wilmington was important for the export of gunpowder as well as leather goods such as shoes.
Port Portsmouth, New Hampshire	Port: Portsmouth, New Hampshire Near Great Bay, New Hampshire NERR *Item to trade:* Fish (salt cod), lumber, furs In the 1800s, Portsmouth was mainly a center for regional trade along the northeastern U.S. Atlantic coast. Before that, Portsmouth had been known for exporting lumber, dried fish, and furs to Europe.
Port New York, New York	Port: New York, New York Near Hudson River, New York NERR *Items to trade:* Furs (beaver pelts) In the Hudson River area, the earliest European colonists were particularly interested in beavers and other fur-bearing mammals. These furs left for Europe via the port of New York at the mouth of the Hudson River.
Port Huron, Ohio	Port: Huron, Ohio Near Old Woman Creek, Ohio NERR *Items to trade:* Fruit The Great Lakes provide a microclimate that favors the growing of fruits and vegetables. Star Island, which is an island in the heart of the reserve, was known as a good source of grapes, raspberries, strawberries, currants, and tree fruits such as apples.

TEACHER MASTER

Port to Port Goods for Trade

Coal Homer, Alaska 	**Wood** North Bend, Oregon 
Tupelo honey Pensacola, Florida 	**Cotton** Savannah, Georgia 
Indigo dye Georgetown, South Carolina 	**Caviar** Alexandria, Virginia 
Oysters Wilmington, Delaware 	**Salt cod** Portsmouth, New Hampshire 
Fur and animal skins New York, New York 	**Fruit** Huron, Ohio 

EXERCISE 2

Estuarie$ Game

Estuary Concept

Estuaries have significant economic value to humans and should be protected.

Focus Questions

- How do people depend on estuaries for various goods and services?
- What is an estuary worth?
- What are some present uses of estuaries?
- How might an environmental disaster affect the value of an estuary?
- In what ways will climate change impact good and services from the estuary that people depend on?

Performance Tasks

Students will:

- Understand that estuaries have economic value and that there are many uses of estuaries by humans.
- Understand that estuaries have social values as well.
- Understand that estuaries can be damaged by human or natural factors and restored by humans to some degree.

Teacher Background

Estuaries have significant practical and economic value to humans. Estuaries provide flood protection to coastal communities through their wetlands that absorb and slowly release water from storms. Many species of fish, crabs, and shellfish that live in estuaries for part or all of their lives provide essential food for humans and a livelihood for the people who harvest and sell them.

Estuaries provide more than simply economic value. There are social and cultural benefits derived from estuaries. Millions of people use estuaries for recreational activities such as fishing, bird watching, and boating. Estuaries are also a source of inspiration to poets and painters. They rejuvenate the spirit, kindle curiosity, and reward visitors with discovery.

Climate Extension

While climate change impacts vary regionally, coastal communities and estuaries are clearly on the front lines of climate change. The coastal land of the contiguous U.S. represents 17 % of the nation's continental land area and yet it is inhabited by over half of the U.S. population. These coastal communities will experience the impacts of climate change in a variety of ways. As the climate changes it will have direct impact on many coastal economies like fishing, shipping and tourism. Increases in sea level, storm frequency and coastal

Overview

In this exercise, students play a game in which they encounter some of the many common value-added businesses or human-used features of the estuary. As students play the game, they experience the common values of estuaries, the associated costs and benefits, and see how humans affect or change each of them.

You may choose to have students do the role-playing Exercise 1: *Port to Port* before playing the game in Exercise 2: *Estuarie$ Game*. *Port to Port* provides a historical look at estuary economics. *Estuarie$* provides a contemporary look at estuary economics. The two exercises can be completed separately.

Time Required

One 45-minute class period to play the game and another half period for class discussion

For resources and links related to this Climate Extension, look for the Climate tab on the web page for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.

currents could result in flooding and erosion of man-made infrastructure, like roads, airports, shoreline housing developments and recreation areas. Salt water intrusion (e.g. the movement of salt water into fresh surface water or groundwater) due to rising sea levels, could also impact a coastal community's drinking water supplies. Freshwater estuaries, like those in Great Lakes, are expected to show an overall decline in water levels as a result of climate change. In these estuaries, the shipping industry will be highly impacted, must likely leaving coastal infrastructure high and dry.

Although coastal communities will be impacted by climate change, they also have the power to take actions to reduce climate change impacts and adapt to the impacts that we can't avoid.

Teacher Preparation

1. Print copies of Teacher Master: *Estuarie$ Game Board*. You will need one assembled game board for each group of students.
2. Print sets of Property, Chance, and Marsh cards. Use the provided Teacher Master: *Estuarie$ Game Cards* and double-sided printing to create cards that have the correct labels (e.g., Property) on one side, and the description on the other side.
3. Finally, print enough of the game money (Teacher Master: *Estuarie$ Bay Bucks*) for each group. You may want to get your students' help in cutting out all of the cards and money!
4. Each player will need a player token to move around the game board. These can be any small object as long as it can be different for each player. You may choose to use small pictures of different estuary animals.
5. Read through the game rules below and familiarize yourself with the game so that you can tell students the rules and help troubleshoot game play during the exercise.

Materials

Per group

- 1 assembled game board (from Teacher Master: *Estuarie$ Game Board*)
- 1 set of Property, Chance, and Marsh game cards (from Teacher Master: *Estuarie$ Game Cards*)
- Game money (from Teacher Master: *Estuarie$ Bay Bucks*), 1 sheet per student player plus another 4 sheets per Banker
- 1 pair of dice/number cubes
- Player tokens, one per player

Procedure

1. Divide students into groups of 4-6 students to play the game.
2. Each group should select one player to act as "banker" and manage the bank. The banker needs to keep his or her individual money separate from the bank's money. Players either pay money to the bank during the game or are paid money from the bank. The bank also holds all Property cards until they are purchased by players.
3. The banker gives each player, including himself, the following money to start the game: two $500's, four $100's, and two $50's.
4. While the banker is distributing money, another player should shuffle the Marsh and Chance cards (separately) and place the two sets of cards face down at the center of the game board.
5. Each player selects a player token and places that token on the "NERR" space to start.
6. Each player rolls the dice. The player with the highest roll starts the game. That player rolls again and advances his or her token in a counter-clockwise direction the number of spaces indicated on the dice. Play then passes to the

Take Note

This activity includes a Climate Extension. Please make sure to review the procedures and materials related to the Climate Extension before proceeding with this activity.

next player on the right (i.e., also counter-clockwise).

7. A player is subject to the consequences of the space upon which his or her playing piece lands. If the player lands on a Property space, the player has the option to purchase that property from the bank for $500. If purchased, the bank gives that Property card to the player. The player then reads the facts about that property to the rest of the players. If a player decides not to buy the property, any player may bid any price to buy it. The highest bidder receives the Property card for the space. If a player lands on a Property space that has already been purchased, that player's turn is over and play moves to the next player.
8. If the player lands on a Marsh space (a black circle with a large white M), a card is drawn from the stack of Marsh cards. The player reads the Marsh card and places it back at the bottom of the stack of Marsh cards.
9. If the player lands on a Chance space (a black circle with a large white question mark), a card is drawn from the stack of Chance cards. The player reads the Chance card and follows the instructions on the card. Consequences or benefits of the Chance cards go to the owner of the property named on the card. For example, if the Chance card reads "A family of tourists, visiting the beautiful estuary, goes to your clam shack for dinner. If you own the clam shack, collect $100", then the owner of the clam shack Property card gets $100 from the bank. If no one has bought the clam shack yet, that Chance card is disregarded. After play, the card is then placed back at the bottom of the stack of Chance cards.
10. There are special Environmental Disaster cards in the Chance card stack. If a player draws an Environmental Disaster card from the Chance cards, the player must move his or her playing piece to the Environmental Disaster space, pay the fine listed on the card, and play moves to the next player.
11. If a player lands on the Environmental Disaster space as the player moves around the board, the player must pay $200 to the bank for a cleanup. Play moves to the next player.
12. Continue playing the game until the end of the set time period. The player with the most money at the end wins the game!
13. After your students have played the game — perhaps the next class session — use the Discussion Questions on the next page to have a class discussion about the economic importance of estuaries. The answers provided are new information that you can give your students or use yourself as additional Teacher Background.

Climate Extension

14. Print the set of "Climate Chance" cards provided in the Teacher Master: Estuarie$ Game Cards. Make sure to use double-sided printing to create cards that have the "Climate Chance" on one side and the description on the other side. To have your students begin to understand climate change impacts on goods and services from the estuary, switch out the regular Chance cards with the "Climate Chance".

Discussion Questions

Q1. How do people depend on estuaries for various goods and services?

Estuaries are close to cultural and population hubs such as New Orleans, San Francisco, and New York City.These hubs are there because of the estuaries. Over 50% of the U.S. population lives near the coast and therefore near estuaries. Estuaries are important parts of our lives. They are part of our economy, hobbies, and culture. Estuaries often serve as ports for the transportation of goods across the country and the world. Estuaries are an important source of food. Salt marsh soils and grasses buffer floods, absorb excess water, and slow down storm surges. They protect and buffer coastal shores, towns and communities from ocean waves and storms.

Q2. What do you think an estuary is worth?

It would be difficult to measure the actual value of an estuary in dollars. But let's consider seafood as one indicator of an estuary's value. In 2006, the U.S. exported over $3.9 billion in seafood. Estuaries provide the habitat for over 75% of the U.S. commercial seafood catch. Without estuaries, the trade of seafood, which is so vital to the U.S. economy, would not exist.

There is also commercial value in some other, unexpected estuarine organisms. For example, oyster and clam shells can be crushed and used as fertilizer. An extract of horseshoe crab blood is used by the pharmaceutical companies to ensure that their products (such as intravenous drugs and vaccines) are free of bacterial contamination.

Q3. What are some uses (historically and present) of estuaries?

Many Native Americans historically relied on estuaries for their way of life. Some still do. Tribes traded shells (wampum) as currency. They used shells as gifts, decoration, tools and spearheads. Local clay was used for making pottery (pots, cups, plates). Coastal reeds were utilized for basket weaving, cooking, mats, and building homes. Hunting and fishing in and near estuaries occurred with hewn out log canoes, hook and lines, casting nets, handmade spears, or bows and arrows depending on the seasonal variety of animals and fish.

Seafood is just one example of how people currently use estuaries. U.S. consumers spent an estimated $69.5 billion on fishery food products in 2006. Besides fish and shellfish, many different types of kelp and algae can be eaten or used in processed foods.

Q4. How does an environmental disaster affect the value of an estuary?

Students should understand that there are many kinds of environmental disasters. Hurricanes, floods, and severe droughts are natural disasters that can be environmental disasters. Oil spills are environmental disasters that are not natural disasters; they are caused by humans. All of these environmental disasters can affect populations of plants and animals that live in the estuary or use the estuary at some point in their lives. That can affect the value of the estuary. An estuary in which no seafood grows or in which the seafood is unsafe to eat has lost its former value as a source of seafood, as a place for people to earn a living harvesting that seafood, and so on.

Q5. What are ways that coastal communities can adapt to the impacts of climate change?

Students should understand that adapting to climate change is the adjustment in natural or human systems to minimize the impacts of climate change to coastal habitats and communities. Students should understand there are many ways for coastal communities to adapt to climate change. To adapt to rising sea level rise coastal communities could move, plan and build infrastructure (i.e. roads, homes, and other developments) that will be on higher ground or otherwise buffered from sea level rise. Communities could shift coastal economies in an effort to adapt to the likely impacts of climate change to fisheries, tourism and shipping.

Q6. What are some ways that coastal communities can mitigate the impacts of climate change?

Students should understand that coastal communities can mitigate the impacts of climate change by reducing the levels of greenhouse gases in the Earth's atmosphere. Students should understand there are many ways for individuals, business and communities to mitigate climate change, including reducing the amount of energy used, using energy efficient appliances and switching to alternative energy sources. Plants take in CO2 from the atmosphere during the photosynthesis process, so restoration projects involving plantings can be an important way of sinking CO2 from the atmosphere into roots and trees. This process is called carbon sequestration and is another way of reducing the levels of greenhouse gases in the Earth's atmosphere.

National Estuarine Research Reserve

Start Here

Estuaries

Ecotourism Business

Marine Research Lab

Marina

Shipping Business

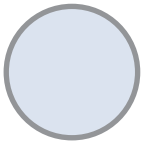
Essential Oils

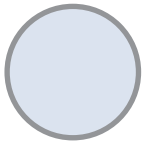
ENVIRONMENTAL DISASTER


Amusement Park

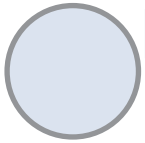

Clam Shack


Beach House



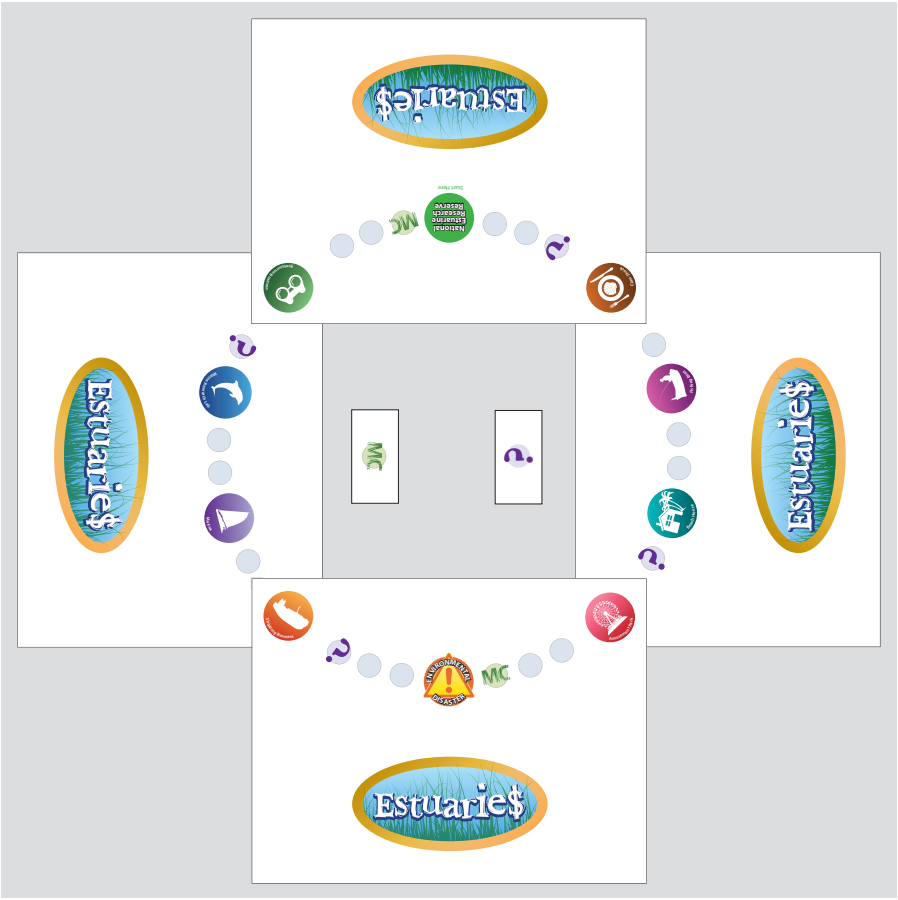



Fishing Boat




Estuarie$

Print the game board pages and arrange them like this.



MARSH CARD

You've restored 5 acres of marshland!
This restoration has helped reduce harmful effects of runoff into the estuary by keeping toxic chemicals from entering the water. Clean, clear water is very important for healthy underwater plants.

MARSH CARD

15 acres of marsh cleaned up! Great job!
You've collected lots of trash that was polluting the water. During your cleanup efforts, you spoke to TV and newspaper reporters. Now others will know how to recycle and keep trash out of the waterways.

MARSH CARD

The 20 acres of restored marsh has really made a difference. You've helped bring back a decreasing osprey population. Your cleanup campaign has reduced pollution in the water. Now the more abundant yellow perch are making the osprey fat and happy.

MARSH CARD

25 acres of marsh restored! Way to go!
With clean water, large beds of underwater grasses, healthy fish and birds, and abundant harvestable seafood, the economy dependant on this estuary will be much stronger than it was before.

ENVIRONMENTAL DISASTER!

Dead Zone

Water temperatures rise in your estuary. The dissolved oxygen levels in the water drop and many fish die. Pay $200 local tax for cleanup. Go to the Environmental Disaster square.

ENVIRONMENTAL DISASTER!

Oil Spill

A large oil tanker hits a rock and spills oil in the bay outside the estuary. Thousands of birds and other animals become covered in oil. Pay $200 to fund an animal care facility. Go to the Environmental Disaster square.

ENVIRONMENTAL DISASTER!

Drought

With less fresh water flowing into the estuary from the watersheds, the estuary water salinity rises and nutrient levels fall. Animal and plant populations suffer. Pay $200 local tax for cleanup. Go to the Environmental Disaster square.

ENVIRONMENTAL DISASTER!

Hurricane

You've survived the hurricane but the estuary has taken a hit. Pay $200 for barrier island restoration. Go to the Environmental Disaster square.

Clam Shack

A family of tourists, visiting the beautiful estuary, goes to your clam shack for dinner. If you own the clam shack, collect $100.

Clam Shack

A red tide event has closed down your shellfish harvesting area. Clams are not edible now. If you own the clam shack, pay $300 for clean clams from the research lab's aquaculture facility.

Fishing Boat

A healthy estuary means a bountiful catch this year. If you own the fishing boat, you made $200.

Fishing Boat

There are too many fishing boats out this year and the catches of fish are down, possibly from overfishing. Pay $200 for fuel fees to the bank.

Ecotourism Business

A rare bird sighting and gorgeous views attract tourists to take kayak tours. If you own the ecotourism business, you made good profits this year. Collect $200.

Ecotourism Business

Unseasonably rainy weather means no kayaking. If you own the ecotourism business, pay $150 for lost business.

Marine Research Lab

You discover the cure for a type of cancer in a type of marine algae! If you own the lab, get $500 for Nobel Prize in Medicine.

Marine Research Lab

A hurricane brushes the coast near the lab and causes damage from wind and flooding. If you own the lab, pay $250 for repairs.

Marina

The marina brings tourists and recreational fisherman to your town. If you own the marina, you make $150 selling bait.

Marina

Marshland was lost when the marina was built. If you own the marina, pay $300 for marsh restoration.

Amusement Park

The amusement park hosts an Estuary Day event to bring awareness of estuaries to the public. If you own the amusement park, you made $100 in donations to help keep the estuary clean.

Amusement Park

Runoff from the amusement park's parking lot contains oils that can pollute. If you own the amusement park, pay $150 to replant trees and build a drainage pond to catch runoff and reduce pollution.

Beach House

The views from the beach house inspire you to organize a beach clean-up with your friends. Collect $50 thank you from the city for your efforts.

Beach House

Rising sea level threatens coastal homes. If you own the beach house, it must be moved back 100 feet. Pay $350 to move your house.

Shipping Company

Switching to biofuels on super tankers provides a tax break. If you own the shipping company, get $250 tax break.

Shipping Company

Dumping ballast water can release unwanted invasive species. Pay $100 fine if you own the shipping company.

Ecotourism Business

Congratulations on the purchase of your "Bay Time" ecotourism business. According to one study by the Fisheries Center of the University of British Columbia, whale watching alone could generate two billion dollars per year and create 19,000 jobs worldwide.

Beach House

Congratulations on the purchase of your new island beach house. With the estuary and marshes on one side and the ocean on the other, the view from your house is incredible. When you are not using the house, you will be able to easily rent it for top dollar to island visitors.

Fishing Boat

Now that you've purchased your own charter fishing boat, you can enjoy the freedom of the open sea while making a living. It's great being able to share what you love to do with others who are willing to pay for the opportunity! Charter fishing is big business in coastal communities who have healthy estuaries.

Marina

Congratulations on the purchase of the "Big Fish" marina. Fishing for redfish and spotted sea trout in the estuary is amazing and all of the rental-boats, bait, snacks, and fishing tackle that anglers need will be purchased from your marina store.

Clam Shack

Oh boy! You're now the owner of the "Happy as a Clam" clam shack! Your restaurant will offer classy but casual dining for all seafood lovers in the area. It's important to serve sustainable seafood on your dinner tables to ensure healthy, plentiful harvests and full bellies.

Marine Research Lab

After making millions in software engineering, you finally decided to purchase the marine lab you visited on a third grade field trip. You are wise to realize that many valuable products have been developed by studying marine animals and plants, including antimicrobial and anti-inflammatory drugs from ocean sponges.

Amusement Park

Step right up ladies and gentlemen! The hottest, new attraction to hit the beach this year will be YOUR boardwalk, equipped with roller coaster rides, funnel cake stands, and carnival games. Families will be able to have a great time, all while enjoying the beautiful outdoors. Just remind them to use the recycle bins you've provided!

Shipping Business

Much like Christopher Columbus sailing the seas, bringing goods from an exciting new world, your shipping business helps import and export goods from your estuary. Your business will expand the economy and world trade. Just watch out for sneaky invasive species hiding in your cargo or ballast!

Print four copies of this page, plus one additional copy for each player.

CLIMATE CHANGE DISASTER!

Dead Zone

Water temperatures rise in your estuary. The dissolved oxygen levels in the water drop and many fish die. Pay $200 to help with the fish kill clean-up efforts. Go to the Environmental Disaster square.

CLIMATE CHANGE DISASTER!

Saltwater Intrusion

The sea level has been rising for many years in your community, but today the saltwater has intruded on the aquifer where the community gets it drinking water. Pay $200 to explore other drinking water sources. Go to the Environmental Disaster square.

CLIMATE CHANGE DISASTER!

Drought

Climate change has caused a long-term decrease in precipitation in your watershed. With less fresh water flowing into the estuary, the water quality and nutrient cycling becomes poor. Animal and plant populations suffer without the freshwater inflow. Pay $200 local tax for cleanup. Go to the Environmental Disaster square.

CLIMATE CHANGE DISASTER!

Hurricane

Increased severe coastal storm events are a common indicator of climate change. You've survived the hurricane but the estuary has taken a hit. Pay $200 for barrier island habitat restoration. Go to the Environmental Disaster square.

CLIMATE

Clam Shack

The clam shack delivery truck is converted to run on bio-fuel from the shack's deep fryer. If you own the clam shack, collect $250 for your net savings on gasoline.

CLIMATE

Clam Shack

Climate change has been causing more frequent harmful algae blooms over the 45 years your clam shack has been open. Today there is another bloom making the clams not edible. If you own the clam shack, pay $300 to owner of the marine research lab to purchase clean clams from their aquaculture facility.

CLIMATE

Fishing Boat

Climate change has gradually increased the temperature of the estuary over time, allowing for new fish species to extend their range from southern waters. If you own the fishing boat, you start catching these fish and make $250 in profits.

CLIMATE

Fishing Boat

Climate change is causing increases in the number of jellyfish in your fishing grounds. The jellyfish are eating all of the copepods the striped bass you are fishing rely on. Pay $200 for extra fuel so that you can travel to new fishing areas to find healthy striped bass populations.

CLIMATE

Ecotourism Business

As the climate in your estuary becomes warmer it enables a rare southern species of bird to extend its range into your area. If you own the ecotourism business, you make good profits from the additional tourists flocking to your area. Collect $200.

CLIMATE

Ecotourism Business

Climate change is causing an increase in precipitation in your estuary. Tourists don't want to go kayaking on rainy days. If you own the ecotourism business, pay $150 for lost business.

Marine Research Lab

Your research on climate change catches the eye of the city officials. They give you a research grant to study shoreline change, to help them develop a science-based plan for sustainable shoreline development. Collect $350.

Marine Research Lab

Climate change has caused a change in coastal currents, resulting in rapid erosion of one of your research field sites. If you own the lab, pay $150 to move your research site and purchase new research equipment for the field.

Marina

The marina considers rising sea levels and more frequent coastal storm events when expanding and building new docks. If you own the marina, you save in long term maintenance costs. Collect $200.

Marina

Important marshland habitat was lost when the marina was expanded. If you own the marina, pay $250 for marsh restoration.

Amusement Park

The amusement park becomes the first park completely powered by alternative energy. If you own the amusement park, you get $250 tax break.

Amusement Park

Climate change is causing more frequent coastal storms in your area. If you own the amusement park, pay $150 for increased winter maintenance costs.

Beach House

Instead of installing a seawall, you enhance the natural shoreline habitat on your beachfront property by placing a living shoreline of native plants, stones and other organic material. Save on post storm event maintenance costs. Collect $100.

Beach House

Rising sea level threatens coastal homes. If you own the beach house, it must be moved back 100 feet. Pay $350 to move your house.

Shipping Company

Reducing the speed of ships decreases greenhouse gas emissions and fuel costs. If you own the shipping company, collect $250 in fuel savings for reducing your ships' speed by 20%.

Shipping Company

Climate change is causing changes in how coastal currents carry and deposit sediments. These currents have increased the deposition rate of sediments in channels so much so that shipping channel has to be dredged twice a year instead of once a year. Pay $100 dredging tax if you own the shipping company.