Impact of Climate Change on Diamondback Terrapin

Region: Eastern Coastline

Grade Level(s): 5-8

Time Required: 4-5 class periods

Focus:

- Students will develop an understanding of the habitat and life cycle of the diamondback terrapin and human influence on this habitat and life cycle.

The Lessons in this kit are:

- **Lesson 1**: Learn where in the watershed a diamondback terrapin lives, and what the habitat looks like.
- **Lesson 2:** Learn how human presence in the coastal area affects the terrapin's habitat.
- **Lesson 3:** Observe how changes in water level will affect the marsh habitat.
- **Lesson 4:** Interpret how human presence affects the ability of the marsh, and therefore the range of the terrapin, to extend inland as sea level rises.
- **Lesson 5:** Discuss what people do to help the diamondback terrapins.

Format:

- The activities in this kit are a series of dramatic play modeling activities. They are a simulation of the coastline and marsh habitat changes that are occurring, as seen through the eyes of a diamondback terrapin.
- These lessons are planned on the 5-E's model: Engage, Explore, Explain, Extend and Evaluate. The 5-E's model is not linear, therefore the activities weave back and forth between the E's to create an increasingly complex understanding of the coastline and marsh habitat changes that would occur, as seen through the eyes of a diamondback terrapin.

Learning Objectives:

- Students will be able to use a map to identify where in the watershed a diamondback terrapin lives and what the habitat looks like.
- Students will be able to explain how humans moving into the coastal area affect the terrapin's habitat.
- Students will be able to explain how changes in water level will affect the marsh habitat.
- Students will be able to explain how human presence affects the ability of the marsh to extend inland as sea level rises.
- Students will be able to brainstorm realistic ways for humans and terrapins to coexist.

Prerequisite Knowledge:

- Students should know the following geographical concepts: watershed, marsh, estuary, mud flat.

Lesson 1 – Learn where in the watershed a diamondback terrapin lives and what the habitat looks like.

Engage:

- The first engage is intended to give the students a personal interest in the diamondback terrapin before beginning the related activities. If possible a field trip to an aquarium to view a live diamondback terrapin would be ideal, but we do not advocate capturing live specimens from the wild. If an aquarium is not available, a demonstration piece, such as the carapace of a terrapin or a life-like model would also capture the student's imagination. This first discussion is intended to last no more than 10 minutes.

Engage:

- Tell the students that the goal of this demonstration is to understand the unique habitat of the diamondback terrapin. Follow with a demonstration of fresh water from the land mixing with salt water from the sea creating brackish water in the Bay. Using a clear fish tank so that student can see the area of mixing, create a larger land model with an ocean area. Make a heavily salted mixture of "ocean water" and color the ocean water with blue food coloring. Put this solution in the ocean side of the tank. Gently run clear water down a river valley on the land side of the tank so that the students can observe the layering and the area where the two types of water mix, it may be necessary to add yellow food coloring to the "fresh" water to make the mixing visible. Introduce the vocabulary words brackish and estuary and let the student's know that the water is colored only for the demonstration, not in real life. Tell the students that the terrapin live in the unique estuarine area where the water is brackish.

Explain:

- Have the students read the "Spotlight on a Species" section of the Eastern Coastline Case Study.

Teacher preparation:

- To prepare for this lesson, you or your students will be making models of the Chesapeake Bay watershed in the Blackwater National Wildlife Refuge. While it would be ideal to have a three dimensional model of the exact watershed, it is not necessary to have an exact model to give the students the concept of a beach and an estuarine habitat. Model kits for drawing topographical maps are available through several science education supply houses or you can make your own. Once your models are made they will last for many sessions:

To make your own model kits you will need:

- dish basins or plastic shoe boxes, one for each team of four students

- oil based modeling clay, enough to shape a landscape into each basin
- a source of water
- one watering can with a sprinkle opening or other water pouring container per student team
- food coloring
- tiny items to use in the second activity that will model houses (monopoly houses or small chunks of Styrofoam), people (toothpicks), terrapins (peas), cats (a tiny scrap of fake fur), foxes (fake fur in another color), food for the terrapins (rice grains) baby terrapins (green cake décor sprinkles), grass clippings

In the bottom of each basin shape the clay to model a landscape. You may use a topographical map of your region to model your watershed or you can create an imaginary landscape which exaggerates the feature you would like the students to focus on. To resemble the Diamondback Terrapin's habitat the landscape should include a very gradual slope from a sand dune down to a beach, then continuing with a gentle slope under the water. The beach side needs to be nearly flat, extending a long way into the water.

Explore:

- Have the students put about 2 cm of water in the bottom of the model to create the Chesapeake Bay. Give the students grass clippings to represent a marsh area in the shallow region along the shore. Use peas or other tiny objects to represent terrapins in the marsh. Let the students name their terrapins to develop empathy. Use rice grains to represent the crabs, mollusks, crustaceans, insects, fish and carrion that the terrapins eat. Put some sand along the beach for nesting. Put a tiny scrap of fake fur on land to represent a fox and a small feather to represent a gull. Explain that the students now have a model of what the terrapins' habitat looked like before people came.
- Have the students dramatic play through a female going up on shore to lay her eggs and the predator prey relationships in play for the survival of the babies. Green cake décor sprinkles can model babies, first in a nest of sand then hatching and "rushing" to the water. Two students can model the babies by moving the cake decors, with tweezers, to the relative safety of the water. One student in the team can hold the fur and model the behavior of the fox, one student can hold the feather and model the sea gull, using tweezers, to grab up the babies as they emerge from the nest and try to make it to safety. Caution the students not to grab or scratch each other with the tweezers as they compete for the baby turtles.

Explain:

- End the modeling with a discussion on the natural life expectancy of terrapins. Give the students time to write their data.
- Clean-up: Have the students reset the marsh as best they can after playing.

Lesson 2 – Learn how human presence in the coastal area affects the terrapin's habitat

Explore:

- Now have some "people" move into the area. Use monopoly houses or similar tiny boxes to represent homes along the shore. Use toothpicks to represent people/themselves on the beach and swimming in the water. Use popsicle sticks as boats in the water.
- Put some colored water as motor oil/pollution on an upstream road. Put another color of fake fur on shore to represent cats or dogs. If the students have pets they can name the fake fur after their pet.
- Again have the students go through the dramatic play of the terrapin's life cycle, only this time the terrapins have to get to nesting areas disrupted by people, with people, pets and boats added to the play. Remember to have it "rain" with a sprinkling can to show the rain washing the pollution downstream into the marsh.

Explain:

- Discuss how the terrapin's life is different with the presence of people.
- Do not clean-up yet, this model will be used in Lesson 3.

Evaluate:

- This is a creative presentation that involves the students using additional information gained from doing some independent literature searching. Have the students draw, write or paint an answer to the following prompt: "Choose any animal or plant that lives in the Chesapeake Bay, other than the diamondback terrapin. Draw, paint or write a poem or song, that shows how the life of the animal or plant has been affected by the presence of humans. Include the affect of people's behavior, people's houses, people's pets, and people generated pollution on your animal or plant."

Extend:

- Activity #10 from the NPS Anacostia watershed kit, www.nps.gov/anac/forteachers/upload/watershedkit.doc. This activity is a field trip where students walk a creek in their watershed to assess its health according to a point system. The activity, #10, can be adapted by the instructor to include coastal shoreline scoring.

Lesson 3 – Observe how changes in water level will affect the marsh habitat

Explore:

- To the models created in Lessons 1 and 2 above, have the students add a small amount of water to simulate rising sea level.

Explain:

- Discuss the results regarding the shape of the shore line, how much land is now underwater, what is the effect on the terrapin habitat in relation to the shoreline and nesting grounds. What is the effect on human structures? Have the students write their observations on the data and analysis page.

Extend:

- Students can be given digital cameras to take pictures of the shore areas adjacent to the diamondback terrapin habitat. These pictures can form a cumulative data set of human, environment interactions over time in a particular location as sea level and shore conditions change.

Lesson 4 – Interpret how human presence affects the ability of the marsh and therefore the range of the terrapin to extend inland as sea level rises.

Explore:

- Using the model in Lesson 3 above, have the students use popsicle sticks to create sea walls to protect their houses. Then add more water to represent rising sea level.

    a. Have them dramatic play what it means to adults to loose the investment in their homes and property.
    b. Have them dramatic play what the affect of seawalls are on the diamondback terrapins, include nesting areas, food sources, pollution and marsh grasses.

Lesson 5 – Discuss what people can do to help the diamondback terrapins

Evaluate:

- Have the students write a response to the brief constructed response prompt: “What is one action that you can take to help the diamondback terrapins survive? Why do you choose this action and why do you think it will be effective? Use observations that you have gathered above in Lessons 1-4 to support your answer.”

Extend:

- Have the students discuss and brainstorm solutions to the problem of how humans and the diamondback terrapin can co-exist and then act on one solution. They can write letters to the newspaper, or work with their legislatures suggesting changes.

Resources:

- http://ian.umces.edu/pdfs/stevenson_6.pdf

References and additional resources:

- National Research Council, Learning to Think Spatially, The National Academies Press, Washington, D.C., 2006
- Maryland Department of Natural Resources Satellite Imagery: http://mddnr.chesapeakebay.net/NASAimagery/EyesinTheSky.cfm
- National Wildlife Federation discussion of the effects of climate change on Maryland: www.nwf.org/globalwarming/pdfs/Maryland.pdf
- U.S. Geological Survey's Patuxent Wildlife Research Center web site with links to recent research and articles: www.pwrc.usgs.gov
- Massachusetts Division of Fisheries & Wildlife's web page about their Natural Heritage and Endangered Species Program: www.nhesp.org

National Science Education Standards Addressed:

Life Science:

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Earth Science:

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

- Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.

- Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

Science and Technology:

- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis.

- Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

Science in Personal and Social Perspectives:

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.

- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids.

- Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

- Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

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- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.

- Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and with personal hazards (smoking, dieting, and drinking).

- Individuals can use a systematic approach to thinking critically about risks and benefits. Examples include applying probability estimates to risks and comparing them to estimated personal and social benefits.

- Important personal and social decisions are made based on perceptions of benefits and risks.

- Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment. The effect of science on society is neither entirely beneficial nor entirely detrimental.

- Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.

- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions. They should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

- In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered. Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.

- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Although scientists may disagree about explanations of phenomena, about interpretations of data, or about the value of rival theories, they do agree that questioning, response to criticism, and open communication are integral to the process of science. As scientific knowledge evolves, major disagreements are eventually resolved through such interactions between scientists.

Name:
Date:
Period:

Student Data and Analyses Sheet for Eastern Coastlines - Chesapeake Region: Impact of Climate Change on Diamondback Terrapin

Lesson 1:

Describe the habitat of the diamondback terrapin:

a. what is the relative depth of water It is very shallow water.
b. what type of plants grow there Eel grass
c. where does it lay its eggs? On shore in the sand bank.
d. what does it eat? crabs, mollusks, crustaceans, insects, fish and carrion
e. who eats the terrapin? Small mammals such as fox; birds; pets; humans.
f. Relatively how many of the baby terrapins made it off the beach to the relative safety of the water? Very few

Lesson 2:

Describe how the presence of houses, people and pets has changed the landscape.

Answers will vary based on observations.

How do people change the terrapin's habitat?

a. What happens to nesting areas along the beach when people build their houses and play on the beach? They get destroyed.
b. What happens to the terrapins' food when people go fishing? They have less food to eat.
c. What do boats do to the terrapin's habitat? Boats leak oil into the water which is a pollutant. The boat propellers rip up the eel grass, destroying both shelter and hunting ground.
d. How do pets affect the terrapins? Pets kill terrapins.
e. describe how the motor oil/pollution gets to the marsh? Run-off from roads and sewers.

Lesson 3:

When you added the water to simulate rising sea level, what happened to:

a. the marsh? It was buried in deeper water where it could not get enough light to survive.
b. the houses? Those close to the shore were flooded.
c. the beach and nesting area? They were flooded.

How will this affect the terrapins?

The terrapins will not have a place to live if the eel grass dies. The entire ecosystem will die.

Lesson 4:

After the people added sea walls to protect their houses what happened to

a. the marsh? It was drowned. It had no way to migrate inland.
b. the houses? They were safe.
c. the beach and nesting area? The beach was preserved for people but the sea wall blocked the turtles from going up to lay their eggs. It was no longer a gradual slope into the water, but rather a sudden drop.
d. Is it possible for the marsh to re-grow on higher ground? No, the sea wall blocks the marsh from spreading inland.

Extend:

- Have the students do some research on the following topics: How long it takes to establish a marsh? How fast is sea level rising?

Lesson 5: Evaluate

Write a brief constructed response to the following prompt:
"What are two actions that you can take to help the diamondback terrapins survive? One action should have a direct effect on the habitat of the diamondback terrapin and the second action should help the world avoid sea level rise due to human induced climate change.
In each case explain why do you choose these actions and why do you think they will be effective? Use observations that you have gathered above in Steps 1-4 to support your answers."

Answers will vary.

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Extend - A role playing game in which the students will explore the impact of global warming on various cultures which use the Bay and conversely explores how people can adapt their actions to save the terrapin.