The Competitive Edge

Theme: **Natural History**

Authors: **Claire Antonucci and the Educational Staff**
Marine Sciences Consortium

Subject Areas
Science, Physical Education

Duration
Two or three class periods to complete all three activities and discussion

Setting
Large open area — indoors or outdoors

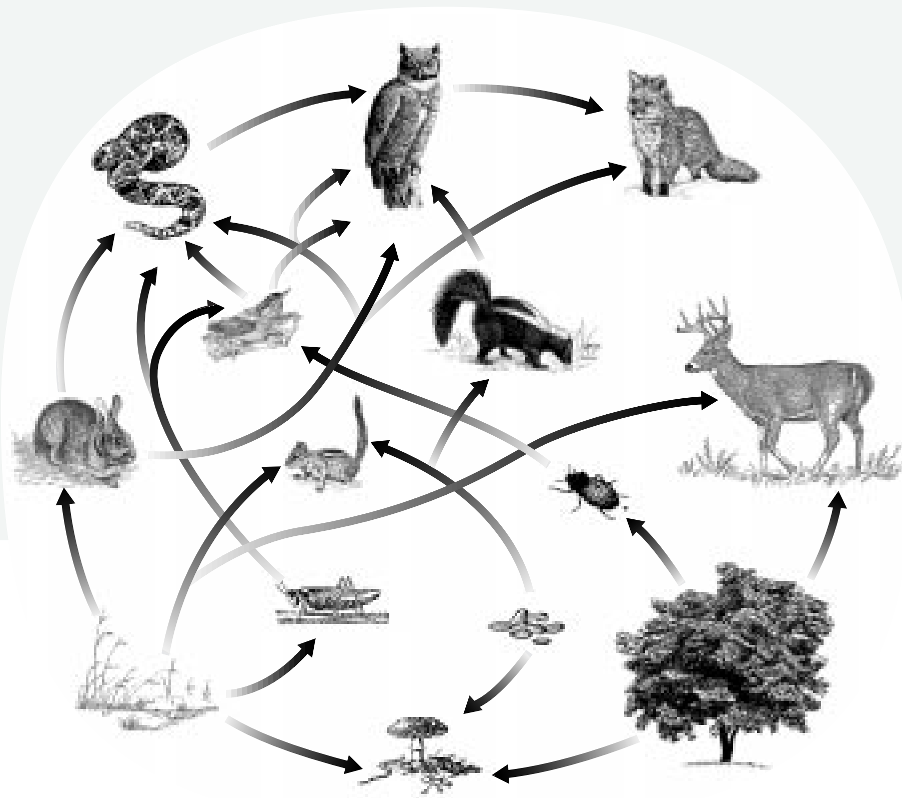
Skills
Simulating, describing, role playing, interpreting, graphing, explaining, hypothesizing

Charting the Course
A basic understanding of food chains and ecosystem dynamics is helpful for this activity. Prior knowledge of animals of the estuary and saltmarsh is also recommended.

Vocabulary
Carrying capacity, competition, habitat, niche, resource, predator, prey, survival of the fittest

Correlation to NJ Core Curriculum Content Standards

Science	Physical Education
5.1 (2, 4)	**2.5** (1, 3, 4)
5.2 (1)	
5.5 (4)	
5.6 (2, 3, 6)	
5.7 (1, 4, 5, 6, 8, 9)	
5.12 (1, 3, 7)	



The Competitive Edge

Objectives

Students will be able to:

1. Use a model of a simple food chain
2. Understand how organisms compete for food and shelter.
3. Explain how the availability of a resource can limit a population which depends on that resource.

Materials

180 bite-size pieces of candy (wrapped) or small boxes of raisins

20 bags

Eight jackets

28 paper flags

16 safety pins

Two desks

A tape player and a music tape (Octopus' Garden by the Beatles is appropriate, but any music will do)

A clip board with a note pad and a pencil

Making Connections

The importance of animals and animal interactions is critical to an understanding and appreciation of the intricacies that are inherent to the bay and estuary ecosystem. This interactive game provides a fun and fast-paced way to examine the carrying capacity of an ecosystem and the competition that occurs among species.

Background

All organisms occupy a niche in a habitat. The most simple definition of a habitat is a place where an organism lives. Therefore, all the things an organism needs to live must be contained in a habitat. The essentials are air, water, food, shelter, and space. These essentials are called resources. Resources, however, are limited. There is only so much food and space available on this earth, and in each habitat, and only a certain number of organisms can be supported. This is called the carrying capacity of a habitat. When the number of organisms has reached carrying capacity, the organisms will begin to compete for resources. Some organisms are better competitors than others, and they will survive while the weaker organisms die. This is the basis of Charles Darwin's Theory of Evolution – "Survival of the fittest." This simulation activity examines this basic and fundamental function as it occurs in an estuarine ecosystem.

Procedure

Warm Up

This activity is best played outside or in a large open area like a gym. Simply moving all desks and chairs away from the center of the room may suffice if the classroom is large enough. Tell the students that they are going to play a game and will each have specific roles to play.

The Activity

Part 1: Competition for Food

1. Select 12 students to be Atlantic Silversides, and give them each a bag. The bags are their stomachs, and the candy or raisins represent zooplankton (microscopic animals that live in the rich waters of the estuary.) Silversides LOVE to eat zooplankton.
2. Scatter 120 pieces of the candy or boxes of raisins around on the ground. When the music starts to play, the Silversides will try to "eat" as much zooplankton as they can without taking it away from other Silversides.
   As each Silverside "eats" a "Zooplankton," he or she puts it in his or her "stomach" (bag.) When all the zooplankton has been "eaten," stop the music and have everyone sit down in a circle.
3. All the Silversides should empty their stomachs on the ground in front of them. Did all of the Silversides get the same amount of food? The answer is probably no. Some fish are better at searching for food than others. Those that ate more produce more offspring. Record the results on a data sheet. Silversides that ate fewer than nine zooplankton starve to death, those that ate 9-11 had one offspring, those that got 12 or 13 zooplankton had two offspring, and those that ate more than 13 zooplankton had three offspring.
4. Repeat the game for the next generation of Silversides. The number of Silversides in this round should equal the number of offspring from the last round. Re-scatter the "zooplankton," and have the new Silversides "eat." Record the results again and repeat the game again.
5. For the fourth round generation, pretend that there were fewer nutrients in the water. There was less phytoplankton production, and therefore there was less zooplankton production because zooplankton eats phytoplankton. Remove half of the zooplankton, and repeat the game. For the fifth and sixth round generation, phytoplankton and zooplankton return to normal and all 120 "zooplankton" are used.

6. Back in the classroom, graph the results on the blackboard. Plot the number of players (Silverside offspring) on the y-axis (vertical) and write the number (generation) on the x-axis (horizontal). The number of players initially should be marked at zero along the x-axis, the number of offspring from the first round of the game at round (generation) one, and so forth. Draw a dotted line across the graph representing the carrying capacity (K) of the environment. This is the number of organisms that can be supported at any point in time. For generation four, K=6, and for all other generations and the initial population, K=12.

Discussion

Discuss how the numbers of offspring relate to the carrying capacity of the environment. Even though there was enough food at first for all the Silversides, some were better at competing for food than others, and they used this extra food to reproduce. The better competitors had more offspring. If this trick or adaptation is inherited, the next generation will also be better at finding food, and more animals in the next generation will be more fit competitors because the better competitors have more offspring.

Part 2

1. Go back outside for two more rounds. There is no need to record results this time. For the first round, start with twelve Silversides. All the Silversides should be given paper flags to pin to their backs. Have two people represent Bluefish that prey on the Silversides, and have one side of your field (or classroom) represent saltmarsh cordgrass which provides a good hiding spot for the Silversides. Mark this side of the field with two desks (or cones.) Once a Silverside passes between the two desks, it cannot be eaten by a Bluefish. Once again, scatter the "zooplankton" on the field (ground or floor) and begin to play. This time, each Silverside has a paper flag pinned to his or her back, which the Bluefishes try to tear off. If the Bluefish tears off a Silverside's flag, the Silverside must give the Bluefish his or her "stomach" and leave the playing field.
2. When all the food is gone, stop the music and count the number of offspring for each surviving Silverside. How did predation on the Silversides reduce competition for food among Silversides?
3. For the final round, increase the number of zooplankton to 180 and keep the number of Silversides at 12. There will be no predators for this round. Scatter the food over the field and play again. Count the number of offspring produced. Did the number of offspring increase toward the new carrying capacity of the environment (18)? If you like, play enough rounds to get the population to meet environmental carrying capacity.

Part 3:
Competition for Shelter

1. Set up your playing field for a different scenario. Place two desks at opposite ends of the field as shelter. Each shelter is only large enough for two organisms, but these two organisms are safe from predators when in their shelter. Scatter eight jackets around the player field. Have three students playing Blue Crabs ready to eat newly settled Hermit Crabs.
2. Select sixteen students to play Hermit Crabs that have just settled out of the plankton. These Hermit Crabs need to find shells (jackets) to live in to protect them from being eaten by predators. Each Hermit Crab has a flag pinned to its back, representing its life.
3. Begin playing the music, and have the Hermit Crabs move out onto the field. The Hermit Crabs need to find shells (jackets) before they are eaten by the Blue Crabs. Meanwhile, the Blue Crabs try to take the flags off the Hermit Crabs' backs. If a Hermit Crab loses his or her flag, he or she must leave the field. When all jackets are gone, all shelters are occupied, and there are no more Hermit Crabs to be eaten, turn off the music and end the game.

Discussion:

1. How does this activity relate to the real life situation?
2. Discuss how the more "fit" Hermit Crabs found shelter and escaped being eaten.
3. How does predation pressure help prevent the number of organisms exceeding environmental carrying capacity?

Wrap Up

Have students describe the predator/prey relationship shown in this activity. What factors can influence the carrying capacity of the ecosystem?

Assessment

Participation in the activity and discussions.

Have students write a short story that describes the key concepts that were demonstrated with this game.

What would be the impact if there was no carrying capacity for certain species?

Extensions

Play the game again and introduce a variety of environmental changes that will impact the outcomes:

There has been an excess amount of nutrients (nitrogen and phosphorous) dumped into the system. This has caused a phytoplankton bloom. What happens to the number of Silversides?

An extremely high tide has occurred due to the full moon (called a spring tide.) Many of the silversides were stranded in the marsh as the tide receded. How does this affect the number of Blue Crabs and their survival?

Many people have started harvesting silversides for bait fish. Introduce a human who “seines” and catches the fish. How does this impact the number of offspring produced? The carrying capacity?

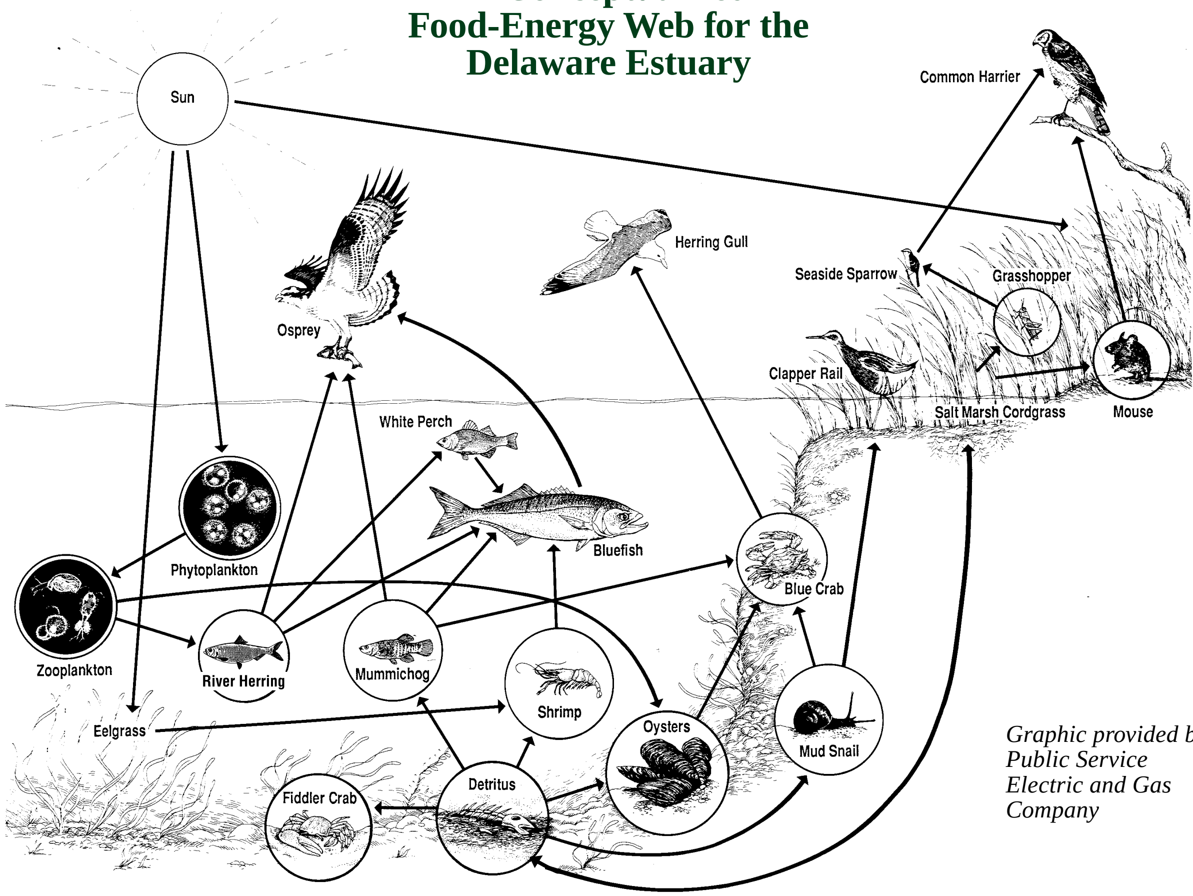
An oil spill has occurred in the estuary. The water is coated with black junk and no light can penetrate. The phytoplankton all dies off. What happens to the zooplankton? The Silversides? Etc.

Resources

The Biology of the Hudson-Raritan Estuary, *1998. Antonucci, Claire, et. al. New Jersey Marine Sciences Consortium, Building 22, Fort Hancock, Sandy Hook, NJ 07732.*

There is an excellent book with “lots of adventures, projects and ideas for exploring the world of oceans, shores and coastal waters” called ***Marine Biology****, Doris, Ellne, The Children’s School of Science, Woods Hole, Massachusetts, 1993. Thames and Hudson, Inc., New York. This book is a comprehensive and exciting collection of hands-on experiences for children as they explore the marine world. Highly recommended!*

A Conceptualized Food-Energy Web for the Delaware Estuary



Graphic provided by Public Service Electric and Gas Company