South Carolina Aquarium

3-5 Linking up Food Chains **Activity**

Overview

Focus Question
Where does the energy in a food chain come from and how does it flow from one organism to another?

Activity Synopsis
The students will participate in an active game in which they learn the identity of organisms in two salt marsh food chains. They will discover the roles (niches) that the organisms play in each food chain. They will also examine the way that energy flows through the food chain, including the loss of energy.

Time Frame
1hour

Objectives
The learner will be able to:

- Explain that the energy in a food chain comes from the sun.
- Define the terms producer, consumer and apex consumer.
- Sort the organisms in a food chain according to the categories of producer, consumer and apex consumer.
- Draw a diagram that shows how energy is passed in a food chain.

Student Key Terms

- apex consumer
- blue crab
- diamondback terrapin
- diatom
- fiddler crab
- food chain
- food web
- marsh snail
- primary consumer
- producer
- river otter
- secondary consumer

Teacher Key Terms

- niche
- organism
- photosynthesis
- tertiary consumer
- trophic level

Standards

South Carolina College- and Career-Ready Science Standards 2021

3rd Grade: 3-LS3-2, 3-LS4-3
4th Grade: 4-LS1-1
5th Grade: 5-PS3-1, **5-LS2-1**

*** Bold standards are the main standards addressed in this activity**

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2014 Academic Standards and Performance Indicators for Science

3rd Grade: 3-LS3-2, 3-LS4-3,
4th Grade: 4-LS1-1
5th Grade: **5-PS3-1,** 5-LS1-1, **5-LS2-1**

*** Bold standards are the main standards addressed in this activity**

South Carolina College- and Career-Ready Science Standards 2021

Third Grade Performance Expectations
3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can thrive, struggle to survive, or fail to survive.

Fourth Grade Performance Expectations
4-LS1-1 Construct an argument that plants and animals have internal and external structures that function together in a system to support survival, growth, behavior, and reproduction.

Fifth Grade Performance Expectations
5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
5-LS1-1 Support an argument with evidence that plants obtain materials they need for growth mainly from air and water.
5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

2014 Academic Standards and Performance Indicators for Science

Third Grade Performance Indicators
3.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
3.S.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.
3.L.5A.1 Analyze and interpret data about the characteristics of environments (including salt and fresh water, deserts, grasslands, forests, rain forests, and polar lands) to describe how the environment supports a variety of organisms.
3.L.5A.2 Develop and use a food chain model to classify organisms as producers, consumers, and decomposers and to describe how organisms obtain energy.
3.L.5B.1 Obtain and communicate information to explain how changes in habitats (such as those that occur naturally or those caused by organisms) can be beneficial or harmful to the organisms that live there.
3.L.5B.2 Develop and use models to explain how changes in a habitat cause plants and animals to respond in different ways (such as hibernating, migrating, responding to light, death, or extinction).

Fourth Grade Performance Indicators
4.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
4.S.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.

4.L.5B.2 Construct explanations for how structural adaptations (such as the types of roots, stems, or leaves; color of flowers; or seed dispersal) allow plants to survive and reproduce.
4.L.5B.3 Construct explanations for how structural adaptations (such as methods for defense, locomotion, obtaining resources, or camouflage) allow animals to survive in the environment.

Fifth Grade Performance Indicators
5.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
5.S.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.
5.L.4A.2 Obtain and communicate information to describe and compare the biotic factors (including individual organisms, populations, and communities) of different terrestrial and aquatic ecosystems.
5.L.4B.1 Analyze and interpret data to explain how organisms obtain their energy and classify an organisms as producers, consumers (including herbivore, carnivore, and omnivore), or decomposers (such as fungi and bacteria).
5.L.4B.2 Develop and use models of food chains and food webs to describe the flow of energy in an ecosystem.
5.L.4B.3 Construct explanations for how organisms interact with each other in an ecosystem (including predators and prey, and parasites and hosts).
5.L.4B.4 Construct scientific arguments to explain how limiting factors (including food, water, space, and shelter) or a newly introduced organism can affect an ecosystem.

Cross Curricular Standards

South Carolina College and Career Standards for ELA
Writing (W) – 3-3.1, 4-3.1, 5-3.1
Communication (C) – 3-1.2, 4-1.2, 5-1.2

Common Core ELA Standards
Writing – 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3
Speaking/Listening – 3.1, 4.1, 5.1

Background

Key Points
Key Points will give you the main information you should know to teach the activity.

- A **food chain** is a series of **organisms** linked together in order of who eats whom that shows how energy moves from one organism to the next.
- All the energy in a food chain comes from the sun.
- The organisms in a food chain occupy different **niches**. Plants are **producers**, because they can make their own food from the energy of the sun. Animals are consumers, because they can only get their food by eating other organisms. The species at the top of a food chain that is not eaten by anything else is known as an **apex consumer**.
- The energy produced by plants will not transfer in its entirety across the food chain to the apex consumer. Only 10 to 20% of the energy received by one consumer will pass to the next consumer. Some of the energy will be lost in indigestible food parts and some will used by the various organisms in the food chain to perform their life functions (breathing, moving, growing, etc.). The amount of energy contained in the apex consumer is always less than the amount of energy collected from the sun by the producers. For this same reason, there are always less organisms the higher you go up a food chain because there is less energy to sustain them. There will always be less consumers than producers, and less apex consumers than **primary consumers**.

South Carolina Aquarium

3-5 Linking up Food Chains **Activity**

Detailed Information

Detailed Information gives more in-depth background to increase your own knowledge, in case you want to expand upon the activity or you are asked detailed questions by students.

This activity will focus on one of South Carolina's many aquatic environments- the saltmarsh tidal creek. A South Carolina tidal creek is a creek in a saltmarsh that is made up of both freshwater and saltwater. The freshwater flows down the creek from inland areas and meets ocean water that floods into it during high tide. In tidal creeks the freshwater and saltwater mix together, called brackish water. A tidal creek has a variety of plants and animals, some of which normally live in freshwater, some in saltwater and some that can live in both. For this reason, the tidal creek is a good environment to use for a **food chain** activity.

There are many different possible food chains in a tidal creek, all of which can be taking place at the same time. This activity will focus on potential food chains consisting of only six **organisms**. The two food chains in this activity will always start with **diatoms** and end with **river otters**. Diatoms are small, single-celled algae that live in water. The diatoms in this food chain rest on the bottom of the tidal creek, however many other types of diatoms float in the water. Diatoms use sunlight to make food through the process of **photosynthesis**. Since diatoms produce their own food they are called **producers**. Diatoms are the first stage, or **trophic level**, of these food chains. The next link in the chain can be **fiddler crabs** or **marsh snails**. They are herbivores, or **primary consumers**. An herbivore, or primary consumer, is an animal that only eats plants. Fiddler crabs crawl around on the mud when the tide is out. They scoop up the mud and sift out the diatoms. Marsh snails crawl through the marsh and feed on diatoms and other algae. Marsh snails are prey to **blue crabs**. The next link in the chain is **diamondback terrapins** because they eat fiddler crabs and marsh snails, or blue crabs because they eat marsh snails. Terrapins and blue crabs are carnivores (they eat other animals) and, in this food chain, are considered to be **secondary consumers**. Secondary consumers are animals that eat herbivores. Diamondback terrapins are small turtles that swim around in the salt marsh. These turtles and blue crabs are both prey to river otters. River otters are considered to be **tertiary consumers**. In this food chain, they are also **apex consumers**. An apex consumer is the final link in a food chain. Some examples of possible food chains are as follows: diatoms- fiddler crabs- diamondback terrapins- river otters. Diatoms- marsh snails- diamondback terrapins- river otters. Diatoms- marsh snails- blue crabs- river otters.

The terms "food chain" and "**food web**" are often confused. Although both are grounded in similar theory, a food chain is very different from a food web. A food chain is a simplified illustration of the predator-prey relationships between a few organisms within an environment. A food chain depicts the transfer of energy from trophic level (feeding level) to trophic level. A food web, on the other hand, shows the predator/prey relationships of many organisms in an environment. A food web is the elaborate, interconnected feeding relationships of who eats whom in an ecosystem. An illustration of a food web, with lines drawn between predators and prey, creates a web of relationships. In fact, a food web may have many different food chains embedded in it.

If we follow the energy that flows through a food chain, we discover that much of the original energy from the sun is lost from one step in the food chain to the other; thus the shape of an energy pyramid. The loss of energy starts with the plants. Plants are not very efficient at converting the sun's energy into food. The sun provides solar energy to plants. Plants change this energy through the process of photosynthesis into food (starch). Plants are only able to convert 1-3% of the light that falls on them into food.

Animals are not very efficient either. They are not able to digest 100% of the energy stored in the foods they eat. A lot of the energy is lost via indigestible pieces and in the production of heat. In fact, the amount of energy that moves from one step in the food chain to another is only about 10-20%. Eventually the energy runs out. The food chain cannot go on forever. Some food chains can support up to five trophic levels, while others can only support two or three.

Because there is less energy available at each feeding level (trophic level), there are also fewer individual organisms at each level, as well. Therefore, there are fewer secondary consumers than primary consumers, and fewer primary consumers than autotrophs. Scientists often depict the flow of energy within a community or ecosystem as a pyramid of energy. The triangular shape represents two things:

1. As you move up the food chain, more of the original energy from the sun is lost
2. As you move up the food chain, there are fewer organisms at each feeding level (trophic level).

It takes a lot of energy and a lot of organisms at the bottom of a food chain to support a few organisms at the top.

3-5 Linking up Food Chains **Activity**

South Carolina Aquarium Spotlight Organisms

Diatoms (class Bacillariophyceae)
Diatoms are very small, single-celled algae. Algae are aquatic plants that use the sun's energy in the process of photosynthesis to create sugars for food energy and oxygen. Diatoms have an external skeleton made of silica that is divided in two pieces. The pieces can split and form two new diatoms, which is one way that they can reproduce. The shells of diatoms come in a variety of sizes and shapes and are quite beautiful in their designs. A microscope is needed, though, to see them.

Fiddler crab (*Uca pugilator*)
Fiddler crabs are small crabs, usually less than two inches in size, that are found predominately in the intertidal zone of the salt marsh. Fiddler crabs are easily recognizable, because the males have one very enlarged pincer, or front claw. They live along the sandy edges of salt marshes. They dig burrows up to two feet deep to escape predators and to protect them when the high tide covers their burrows. They eat bacteria, diatoms (algae), and detritus. Their predators include blue crabs, terrapins, fish, raccoons, clapper rails and other marsh birds.

Marsh Periwinkle (*Littorina irrorata*)
Marsh periwinkle snails are gray to white in coloration and grow to be 1 ¼ in long. They live in salt marshes on blades of Spartina grass. They eat detritus and algae, including diatoms, deposited on the grass by the tidal water. Their radula, which is similar to a tongue, can have up to 300 rows of teeth on it. They use the teeth to scrape algae and detritus off of the marsh grasses. Their predators include blue crabs and shore birds. Periwinkles are also eaten by humans as escargot.

Blue crab (*Callinectes sapidus*
Callinectes means "beautiful swimmer" and sapidus means "tasty", so their scientific name means tasty beautiful swimmers. An adult blue crab can have a shell nine inches wide. Blue crabs have ten legs with the back two modified into paddle shaped swimming legs. Their claws are bright blue and their shell color is olive-green. Blue crabs live in brackish estuaries and salt marshes, but may wander into freshwater. They eat fiddler crabs, marsh periwinkles, shrimp, small fish, and animals that have died. Blue crabs are eaten by octopus, fish, gulls, herons, and humans. These crabs are a very important commercial species, the annual catch ranging from 20-80 million pounds.

Diamondback terrapin (*Malaclemy terrapin centrata*)
Diamondback terrapins are turtles that grow to be four to nine inches long and have shells with bold patterns of dark rings on them. They swim in the waters of salt marshes, and are the only turtles regularly found in brackish water. They can often be found sunbathing on a log or the banks of a marsh. These turtles eat crabs, snails, insects, fish and sometimes worms. Their predators include raccoons, crows and humans.

River otter (*Lontra Canadensis*)
River otters are mammals with an elongate body, webbed toes with claws and a thick coat of brown fur. They can grow to a length of three to four feet and a weight of 11-23 pounds. River otters live in aquatic habitats from coastal estuaries and lower river systems to mountain streams, where they eat fish, crayfish, crabs, turtles, amphibians and even bird eggs. Young otters are prey to bobcats and alligators. River otters can swim up to 12 mph and can hold their breath for four to eight minutes.

Procedures

Materials

- Medium-sized brown paper bags, with holes in bottom
- Scissors
- Small round disc-shaped objects such as buttons, popcorn, cutout paper, etc.
- Animal pictures (1 for each student); Based on a class size of 32:
    - 18 diatoms
    - 4 fiddler crabs
    - 4 marsh snails

- 2 diamondback terrapins, blue crabs, & river otters

Procedure

1. Introduce the term "food chain" to the students. Have the students' think of an animal from an environment they are familiar with, such as the ocean, and then construct a food chain around the animal. For example, the students might suggest a shark. From there they might suggest that a shark would eat a smaller fish, the fish would eat a shrimp and the shrimp would eat algae or seaweed. Write their responses on the board so the students can see how the animals link in the food chain.

2. Explain to students that one of the reasons we eat food is to provide energy (calories) for our bodies. This energy passes from one organism to another through a food chain. Ask the students to discuss where the energy comes from that travels through the food chain. For hints, think about how plants get the energy to make food and what provides energy for our entire planet (Answer: the sun). Ask them if all of the energy made by the plants will make it the entire way through the food chain? Is there a point in the food chain where energy no longer gets passed along?

3. In the classroom, divide the class into 6 groups. Groups will be divided up as follows: 18 students will be diatoms, 4 students will be fiddler crabs, 4 students will be marsh snails, 2 students will be blue crabs, 2 students will be diamondback terrapins, and 2 students will be river otters. Adjust the numbers of each group proportionately, according to class size.

4. Pass out pictures. Review with the students whom they will be eating in the game and who will eat them. (Fiddler crabs and marsh snails will eat diatoms. Blue crabs will eat marsh snails. Diamondback terrapins will eat fiddler crabs and marsh snails. River otters will eat diamondback terrapins and blue crabs.)

5. Pass out the paper bags with holes in the bottom to each student before the activity begins. The size of the hole should be between the sizes of a quarter and a half dollar. Explain to the students that the objects such as popcorn that falls out of the bags as the game progresses represents energy used by the organism in its life processes (energy used for moving, growing, etc.) or energy in indigestible form, like the energy caught up in bones, and therefore is energy that cannot be transferred to another organism when it is eaten, because it has already been used or lost.

6. Designate an area in the classroom or outdoors as the "salt marsh tidal creek habitat" (an area of at least 15 feet by 15 feet). Have the students stand on the outside of the area in their groups. This activity can be a high-energy event for the students. Set ground rules about running and jumping. The students should walk around in the habitat area or hop on one foot. Also, make sure the students know that they do not need to tackle other students. They only need to tag their prey, take its "stomach" bag and empty the contents into his/her own bag.

7. Start the activity by having the diatoms from both groups enter the habitat area, spread out and sit down (in the salt marsh the diatoms rest on the bottom).

8. Assign an adult to be the sun. The sun should walk through the habitat area and drop the popcorn or other objects into the bags of the diatoms. The objects represent the sun's energy falling down to the diatoms. If possible, before the activity, count the total number of objects or cups of objects that will be used in the activity. The amounts of "original energy" and "energy in the otters' stomachs" can be used in a math follow up activity.

9. As the diatoms catch the objects have them say "producer," to remind them that they are the only organisms in this food chain that can produce food from the sun's energy.

10. Allow the primary consumers from each food chain, the marsh snails and fiddler crabs, to enter the habitat area and tag one or two diatoms (no more than three). Have the snails and crabs say "primary consumer" as they "eat" a diatom and empty their "stomach" bag, because they are the first organism in this food chain to get their food by eating another organism.

11. The diatoms leave the habitat and the secondary consumers, the diamondback terrapins and blue crabs, enter the area and tag the primary consumers. Have the terrapins and crabs say "secondary consumer" as they "eat" a primary consumer.

12. The primary consumers leave the habitat area and the apex consumers, the river otters, enter the area and tag the secondary consumers. Have the otters say "apex consumer" as they "eat" a secondary consumer.

13. After all of the members of the food chain have “eaten” everyone gather in the “salt marsh habitat area.” They should sit down, pretend to die and rot away. Remind them that bacteria and other decomposers aid in the process of decomposing.

14. While students are “decomposing,” review the elements of the activity with them. Also pose questions to the students, such as: Where does the energy come from? Can a food chain exist without the sun? Can a food chain exist without producers? How much energy was lost during the activity (measure the objects in the otters’ stomach bags and compare it with the original amount of objects given to the diatoms)? Does all the energy made by the diatoms (the producers) make it to the river otters (the apex consumers)? Is this what happens in a real food chain? If the river otter was the apex consumer in a community and blue crabs were the secondary consumers and the main prey of the river otter, would there be more blue crabs or more river otters in that community? Why?

Follow-Up Questions

- In a salt marsh community, are there more organisms than the six organisms discussed in this activity? Would a river otter be able to eat other animals besides diamondback terrapins and blue crabs?
- In a community, are you always going to have the same food chain, or can you have many different ones?
- What is a food web?

Assessments

Assessment #1:

Give students the Food Chain Assessment Worksheet. Have them cut out the organisms on the second page and create 2 salt marsh food chains, labeling each organism as a producer, consumer, apex consumer or decomposer. Next, have them fill in the food chain pyramid and answer the following question: Why do you think scientists draw illustrations showing how energy flows through a food chain in the shape of a pyramid (triangle)?

Scoring rubric out of 100 points (Food Chain Assessment Worksheet Answer Key)

Correctly creates and labels each food chain: 20 points each (total 40 points)
Correctly labels pyramid: 10 points each level (total 40 points)
Correctly explains the pyramid shape: 20 points

Assessment #2:

Have students select an ecosystem different than the first assessment salt marsh ecosystem (like a pond, river, forest, desert,…) and design a food chain using drawings or pictures of organisms found in that ecosystem. They should label each organism as a producer, consumer, apex consumer and decomposer. Secondly, have them create a food web that incorporates this chain as well as others.

Scoring rubric out of 100 points

For correctly creating a food chain: 30 points
For correctly labeling producer, consumer, apex consumer and decomposer: 40 points
For correctly creating a food web: 30 points

Assessment #3:

Ask students to select one of the habitats from the first 2 assessments and that have them consider what would happen if an oil spill occurred in the ecosystem. Have them think of these questions to help them write an essay.

- What organisms would be affected?
- Could it harm humans?

Cross Curricular Extensions

STEM Extension
From Assessment #3, have students design a solution to the oil spill problem.

Language Arts Extension
Have students select their favorite animal and then from the animal's perspective write a narrative about its life within its habitat and food chain.

Resources

Teacher Reference Books

Audesirk, Gerald and Teresa Audesirk. *Biology: Life on Earth.* Macmillan Publishing Company, New York, 1993.
Do not be afraid of college textbooks. They are often the best sources for detailed information on general subjects such as biology and food chain ecology.

Hickman, Cleveland, Allan Larson and Larry Roberts. *Integrated Principles of Zoology.* Wm. C. Brown Publishers, 1996.
Another college textbook and another good source of information on animals.

Keener-Chavis, Paula and Leslie Reynolds Sautter. *Of Sand and Sea: Teachings from the Southeastern Shoreline,* SC Sea Grant Consortium, Charleston, 2000.
An excellent look at the biotic and abiotic factors that characterize the Coast and Ocean regions of South Carolina including information on the salt marsh.

Meyer, Peter. *Nature Guide to the Carolina Coast,* Avian-Cetacean Press, Wilmington, NC, 1998.
An informative look at the characteristics and wildlife of the Coast and Ocean regions of South and North Carolina, including much on the Salt Marsh.

Raven, Peter H., Ray F. Evert and Susan E. Eichhorn. *Biology of Plants,* W.H. Freeman and Company, New York, 1999.
Though admittedly college textbooks are often a little too dry and in-depth, with their text, photographs and illustrations they are often the best resources for finding information on a particular subject. This college textbook is an excellent resource for anyone wanting to know more about the biology of plants.

Ricklefs, Robert E. and Gary L. Miller. *Ecology*, W.H. Freeman Company, 1999.
This college textbook is a great resource for finding out how wildlife communities interact with each other as well as the abiotic factors of their environment.

Teal, John and Mildred. *Life and Death of the Salt Marsh,* Ballantine Books, New York, 1969.
An in-depth look at one of the most important and productive ecosystems in South Carolina, with chapters on spartina grass and the other marsh plants and their effect on the surrounding wildlife communities.

Teacher Reference Videos

Attenborough, Sir David. *Trials of Life* (Video series), Turner Home Entertainment, 1995.
This is the most famous work of heralded nature documentary filmmaker Sir David Attenborough. This series shows the various behaviors animals have adapted in order to survive, including much on feeding. Though the entire series may be too advanced for elementary students, it is a wonderful resource for teachers.

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Teacher Reference Websites

Animal Planet
http://animal.discovery.com
This site contains information and interactive games on a variety of animals

Food chains: Prey and Predators
http://www.cas.psu.edu/DOCS/WEBCOURSE/WETLAND/WET1/main.html
This website created by Pennsylvania State University contains activities and information on food chains.

Student Reference Books

Bennett, Paul. *Nature's Secrets: Catching a Meal.* Thomson Learning, New York, 1994.
Uses photographs and simple text to show the variety of different adaptations animals have developed to help them catch their prey.

Brooks, Bruce. *Predator!* Farrar Straus Giroux, New York, 1991.
A more in-depth look at how animals get the food they need that uses photographs and text.

Eyewitness Books: Plant, Alfred A. Knopf, Inc, New York, 1988.
These very attractive books use photographs, illustrations and text to teach the readers about plants and trees. Contains everything from photographs that show how a seedling grows to photographs that show how fallen leaves decompose.

Eyewitness Science: Ecology, Dorling Kindersley, New York, 1993.
These very attractive books use photographs, illustrations and text to teach the readers about ecology, communities and the interactions of plants and animals. Includes information on food chains and producers and consumers.

Kalman, Bobbie D. *How A Plant Grows,* Crabtree Publishing Company, 1996.
Text for students on plants that includes information on photosynthesis and the importance of plants to food chains. Includes experiment activities.

Matthews, Downs. *Wetlands,* Simon & Schuster Books, New York, 1994.
This book describes different types of wetlands and the plants and animals found there.

Curricula

Aquatic Project WILD
Aquatic Project WILD is an interdisciplinary curriculum for K-12 teachers on aquatic wildlife and ecosystems. The activities cover a broad range of environmental and conservation topics.
For more information click on http://www.projectwild.org/ProjectWILDK-12AquaticcurriculumandActivityGuide.htm

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