

LESSON 2 Food Chains and Food Webs in an Ecosystem

Important Note to the Teacher: This lesson and the next lesson involve observation and experimentation with guppies, which are vertebrates. Fish are an important part of any aquatic ecosystem, thus the guppies are included in this activity, but the guppies are an optional part of your aquarium. While living organisms provide opportunities for students to develop inquiry skills such as observation and comparison, there are also responsibilities for appropriate and humane care of the fish. When bringing animals into the classroom, a conscious effort must be made to provide guidance for students to develop an understanding of and value for life and living organisms. In addition, if you choose to use guppies or any organism, they are never to be released in our streams or rivers as many of the items in the aquarium are actually invasive species to Hawaiian waters.

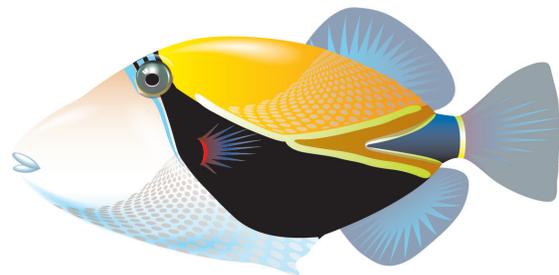
The guppies must be provided with appropriate daily care so that they remain healthy during the course of the experiment and should not be subjected to pain or discomfort. Students need to be supervised by a teacher that understands the safe and responsible use of animals in the classroom and who understands and follows Hawai'i Department of Education policies and other relevant regulations. In this lesson, students will only be observing the classroom bottle aquarium. In the next lesson, they will conduct a class experiment with the bottle aquariums.

Lastly, teachers must develop and implement a plan for the future care of the guppies following the study. (Adapted from the National Science Teacher Association's 2005 Position Paper: "Responsible Use of Live Animals and Dissection in the Science Classroom")

Proper care of guppies includes: 1. Feeding them daily, i.e. making sure there is a source of food such as elodea, or providing fish food flakes, 2. The temperature of the water must be between 72° and 82° F., 3. Change approximately 1/3 of the water every 1 to 2 weeks, or as needed to keep the water in good condition, 4. Create a happy or natural environment by adding things like gravel and plants to the tank. Care of the guppies must be provided daily, including weekends, holidays, and other times school is not in session. When the experiment is over you must continue care of the guppies in the classroom or implement another plan for the continued proper care of the guppies, as they cannot be re-introduced into Hawai'i's environment.

Please see <http://www.habitattitude.net/> for guidance on aquarium disposal.

For further information regarding current policies and regulations in Hawai'i contact the Science Section of the Instructional Services Branch of the Office of Curriculum, Instruction, and Student Support at the Hawai'i Department of Education.



Pre-Lesson Preparation

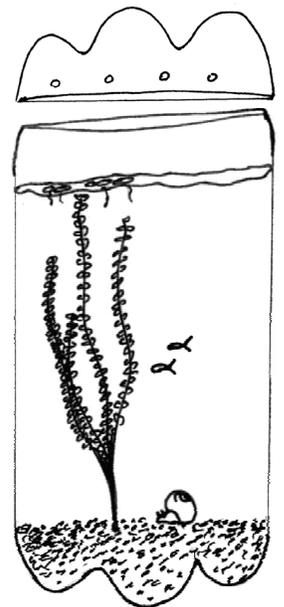
Complete a bottle aquarium as a model for the students. Make this a week or so in advance of showing it to the students. The students will make their own bottle aquarium in the next lesson.

Materials:

- Two, clear two-liter soda bottles (another transparent plastic container may be substituted) You will need 2 bottles to make one bottle aquarium. This bottle aquarium will be used for observation and possibly as the control for the class experiment in the next lesson.
- Water that has sat out for at least 24 hours (This is important to allow chlorine in tap water to settle or evaporate)
- Light source (do not put the bottle aquarium in direct sunlight as it will overheat the water.)
- Guppies (enough for at least one guppy per bottle, but recommend additional guppies if that is the variable that is going to be changed)
- Elodea plants (also called anacharis and can be purchased at pet stores)
- Duckweed
- Fresh water snails
- Gravel, pre-rinsed, so that there is no mud or sand, but enough to fill the bottom of the bottles and hold the Elodea plants in place
- Thermometers
- Scissors
- Waterproof marker
- Optional: aquarium aerator, with tubing and airstone, timers, rulers.

Instructions for Assembling the Bottle Aquarium:

- **IMPORTANT:** It's important to know where this lesson leads. **Go to Lesson 3 and read the Lesson at a Glance and the Teacher Prep about the Bottle Aquarium.** You will put the classroom bottle aquarium together for this lesson. Students can start observing the bottle aquarium mini ecosystem to enhance their understanding of the food chain/webs. This aquarium may serve as the control for the class experiment in the next lesson, depending on what the class decides to test.
- You will need 2 2-Liter bottles per class. Rinse and cut the bottles for the aquarium. Make one aquarium per class.
 - 1) Rinse each two-liter soda bottle with clear water to get rid of any residue. Do not use soap!
 - 2) Then cut off the bottle top 1 to 2 cm above the shoulder where the bottle tapers and discard.
 - 3) Cut off the base of the other bottle, and score it with holes (this will be the cover). Repeat the process for as many bottle aquariums as you see fit for the number of classes you have.
 - 4) For the bottle aquarium, you may want to add gravel, elodea, duckweed, a snail, and 1 or 2 guppies. You may add other small plants or creatures that you think would be a good fit for the ecosystem. Keep in mind this is a very small aquarium.
- Prepare to discuss the ethical treatment of living things with the students in regards to the bottle aquarium. As guppies are vertebrates, extra caution and care must be afforded them, if you choose to use them. Please refer to the *National Science Teachers Association Position Statement: Responsible Use of Live Animals and Dissection in the Science Classroom* online at <http://www.nsta.org/about/positions/animals.aspx>. Also, check out the Institute for Laboratory Animal Research (ILAR) Principles and Guidelines for the Use of Animals in Precollege Education at http://dels.nas.edu/ilar_n/ilarhome/Principles_and_Guidelines.pdf. Additionally, you may want to consult "Exploring Safely" by Terry Kwan and Juliana Texly. You may, also, want to check with the Education Specialist for Science in the Office of Curriculum, Instruction and Student Support if you have questions about this. Please see <http://www.habitattitude.net/> for guidance on aquarium disposal.



Lesson at a Glance

Scientists study interactions among plants and animals by observing organisms in the field and in aquariums set up as mini-ecosystems that simulate the natural environment. In this lesson, students will be introduced to the bottle aquarium and they will observe it daily as a class. Students learn new vocabulary terms about feeding relationships and marine environments that they can apply to their bottle aquarium. Each student creates a food chain for the ecosystem in their bottle aquarium, and then combines his/her food chain with the food chains of fellow students to create a food web for an ecosystem.

Lesson Duration

Four 45-minute periods

Essential Question(s)

What role do plants and animals have in an ecosystem?
How are plants important to food chains and webs?

Key Concepts

- Energy is produced (made) by the producers, and then flows through the consumers.
- Many different food chains in an ecosystem will create a food web.

Instructional Objectives

- I can create a food chain for a marine organism.
- I can create a food web for an ecosystem using different food chains.
- I can identify the producers and the consumers in a food web/ecosystem.
- I can identify the important information in a text, and use that information to create my food chain.

Assessment Tools

Benchmark Rubric:

Topic		Cycles of Matter and Energy	
Benchmark <u>SC.4.3.1</u>		Explain how simple food chains and food webs can be traced back to plants	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Compare the characteristics of simple food chains with those of food webs	Explain how both simple food chains and food webs can be traced back to plants	Describe how simple food chains or food webs can be traced back to plants	Recognize that simple food chains or food webs can be traced back to plants

Topic		Unity and Diversity	
Benchmark <u>SC.4.5.2</u>		Describe the roles of various organisms in the same environment	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Analyze how the roles of different organisms affect their interaction in the same environment	Describe the roles of various organisms in the same environment	Identify a few organisms and their role in the same environment	Recall, with assistance, very few organisms and their role in the same environment

Related HCPSIII Benchmark(s):

Science SC.4.5.2
Describe the roles of various organisms in the same environment.

Science SC.4.3.1
Explain how simple food chains and food webs can be traced back to plants.

Language Arts LA.4.2.5
Summarize main points found in informational texts.

Language Arts LA.4.6.2
Give a short, informal presentation to inform or persuade.

Topic		Constructing Meaning	
Benchmark LA.4.2.5		Summarize main points found in informational texts	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Summarize the main points and describe their connection to the main idea or focus in informational texts	Summarize the main points found in informational texts	Produce a summary that mixes insignificant points with main points	Summarize information not necessary to understanding the main points of informational texts, or repeat original text rather than summarize
Topic		Discussion and Presentation	
Benchmark LA.4.6.2		Give short, informal presentations to inform or persuade	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Give creative, short, highly effective informal presentations to inform or persuade	Give short, informal presentations to inform or persuade	Give short, informal presentations that are somewhat informative or persuasive	Give short, informal presentations that do not inform or persuade

Assessment/Evidence Pieces

Lesson

- Foodwebs created by student groups

Materials Needed

Teacher	Class	Group
<ul style="list-style-type: none"> • Bottle aquarium (made in Pre-Lesson Preparation) 	<ul style="list-style-type: none"> • Pictures of the ecosystems found • Access to research materials (books and the Internet) 	<ul style="list-style-type: none"> • Pen and paper to take notes and draw the food chains • Chart paper to combine food chains into a web. Try using different colored Post-it notes for each food chain, and then the different colors can be joined to make the food webs. This also allows for easier rearrangements as the food web grows.

Instructional Resources

PowerPoint Presentation: *What is an Ecosystem?*

PowerPoint Presentations: *Invasive Species*

Supplemental Resource: *Aquatic Food Chains Interactive Game*

Suggested reading for the safe use of animals in the classroom:

Kwan, T., and J. Texley. National Science Teachers Association. 2002. *Exploring safely; A guide for elementary teachers*. Arlington, VA: NSTA Press.



Student Vocabulary Words

abiotic: non-living factors in the environment, including, light, temperature, moisture and air.

biotic: of life or living organisms.

carnivore: organisms that eat other animals.

consumers: organisms that must find and eat food and cannot make it themselves.

decomposers: organisms that return nutrients into ecological cycles by breaking down dead organic material.

ecosystem: all the organisms in a given area, as well as the abiotic factors with which they interact, a community, and its physical environment.

herbivore: organisms that eat plant material.

keystone species: a species whose impacts on its community or ecosystem are much larger and more influential than would be expected from mere abundance.

omnivore: organisms that eat both plant and animal material.

predation: the killing and consumption of living organisms by other living organisms.

producers: a green plant or plant-like organism that can make food out of carbon dioxide, water and sunlight.

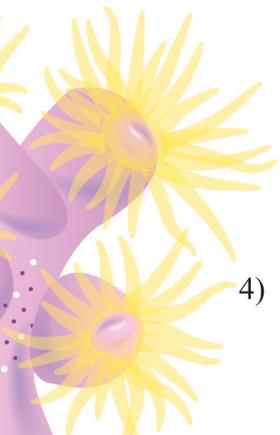
Lesson Plan

Lesson Preparation

- Review the Science Background provided in the unit overview.
- Review the interactive piece *Aquatic Food Chains* to be completed at the end of Step III.
- Preview and make arrangements to project the three PowerPoint Presentations.
- Assemble materials needed and arrange computer access for the student research process.
- Place the pre-made bottle aquarium in an area students can observe.

I. *How do scientists study interactions among plants and animals in the world of water?*

- A. Show and discuss the PowerPoint *What is an Ecosystem?* Discuss with the students their ideas on how scientists learn about the interactions among plants and animals that live in the ocean, or in a freshwater lake, pond, stream, or river.
- 1) Ask students to tell you what they know about how scientists study plants and animals. Ask whether scientists carry out most, or even all, of their studies about plants and animals in their natural habitats (perhaps scuba diving, or viewed from a submersible, or otherwise in *field* situations)? How often can scientists actually study plants and animals underwater? What expenses and risks might be involved? Tell the students that they will be using a model to perform research.
 - 2) Establish that scientists also use aquariums, in which they set up a “model” of a natural ecosystem. Refer to the classroom freshwater aquarium that you have already set up, containing guppies (optional), snails, elodea, and duckweed.
 - 3) Review, or teach, that the aquarium is a model of a small ecosystem that includes non-living physical (abiotic) factors, as well as living plants and animals, or biotic factors. Examples of physical factors include:
 - a. Whether the aquarium contains freshwater or seawater.
 - b. The temperature of the water.
 - c. The amount of sunlight or artificial light.
 - d. Whether there is gravel or sand, or no bottom material (substrate).
 - e. Amount of oxygen in the water.
 (Note to teacher: These are all variables that can be manipulated in an experimental design to test for an effect, if there is no pain or discomfort caused to the animals.)
 - 4) Optional: Ask students their experiences with aquaria, either public aquariums or a home aquarium.



- B. Discuss the ethical treatment of living things with the students.
- C. Begin observing the mini ecosystem daily with the class. The students should make observations for a few minutes every day over a week or so. You can develop an observation record on a piece of chart paper and post it on a wall in the class. For example:

Recorder	Time/Date	What we observed

- D. Ask open-ended questions about the bottle aquarium to stimulate students' thoughts in developing questions for the investigation. Using a KWL chart, record what students know (under K), and their questions about organisms and interactions (under W). You will come back to this chart in Lesson 3.

II. *Feeding classification and roles*

- A. Bring a healthy snack to get the class' attention. (Grapes are a great snack to share.) Tell students to take a grape and eat it. Ask students:
- 1) Why do we eat things?
 - 2) What does that grape give you?
- B. Ask every student to think of an animal and what it eats. Students share their ideas, and create a list on the board. The following is an example of what the chart might look like:

Animal/ Organism	Diet – What does it eat?	What does its prey eat?
Lion (2nd consumer)	Gazelle (1st consumer)	Grass (producer)
Snake	Mice	Seeds
Toad	Grasshopper	Grass

- C. Explain that students will learn and use new vocabulary words to help them better understand the relationships in the bottle ecosystem. Introduce the three terms:
- 1) Carnivore: an animal that eats other animals, such as foxes, frogs, snakes, hawks, and spiders
 - 2) Herbivore: an animal that eats plants, such as mice, rabbits, deer, beavers, moose, cows, sheep, and goats
 - 3) Omnivore: an animal that eats both plants and animals, such as bears, turtles, monkeys, or squirrels
- D. Add a column to the chart on the board. Ask students to apply the terms, Carnivore, Herbivore, and Omnivore to the organisms they chose:

Animal/ Organism	Diet – What does it eat?	What does its prey eat?	Classification (Omnivore, Carnivore, or Herbivore)
Lion (2nd consumer)	Gazelle (1st consumer)	Grass (producer)	Carnivore
Snake	Mice	Seeds	Carnivore
Toad	Grasshopper	Grass	Omnivore

- E. Have students add creatures in the bottle aquarium to the chart. Then ask the following questions:
- 1) How would you classify the organisms in our bottle aquarium?
 - a. Guppies -? (*omnivores, students will probably think they are herbivores unless they observe them eating the snails or a dead guppy.*)
 - b. Snails -? (*herbivores*)
 - 2) How would you classify the elodea and duckweed?
 - 3) Do they fit into one of our classifications?
 - 4) Do the elodea and duckweed *eat*?
- F. Introduce that organisms can also be categorized as producers, consumers, and decomposers. Plants and plant-like organisms (that are green and contain chlorophyll) are **producers** that create their own food through photosynthesis.
- 1) Animals are **consumers** that depend on other organisms for food/energy.
 - 2) **Decomposers** include animals that eat and break down dead or decaying material into simpler substances. Ask students where the decomposers are in the aquarium. (*in the gravel*)
- G. Add a column to the chart as seen here:

Animal	Diet – What does it eat?	What does its prey eat?	Classification (Omnivore, Carnivore, or Herbivore)	Role (producer, consumer, decomposer)
Lion (2nd consumer)	Gazelle (1st consumer)	Grass (producer)	Carnivore	
Snake	Mice	Seeds	Carnivore	
Toad	Grasshopper	Grass	Omnivore	
Guppy				

- 1) Ask students to fill in the Role column for all organisms.

H. Ask students if any of the above terms describe the elodea and duckweed.

II. **Connect Food Chains to the Bottle Aquarium**

- A. Based on their daily observations of their bottle aquarium, ask the students to create one or more food chains for the animals in their mini-ecosystem.
- B. Once the food chains are complete, they will create a food web for their bottle aquarium ecosystem. Using their food web, ask them “do all the organisms in our aquarium have the food that they need to survive?” Students will share their answers and explanations. They can’t really have a strong food web with only four organisms. Have the class share their thoughts of what would happen if a top predator was introduced, such as a crayfish, goldfish, or African frogs.
- C. Optional: This is a good place to bring up, what happens when invasive species are introduced in the food chain. How do invasive species alter food chains and food webs? Show the PowerPoint Invasive Species.

III. **Drawing a Food Chain**

- A. Have students draw simple food chains to show what the fish and the snail eat.
 - 1) The food chain that they develop needs to be based on observed evidence. Students should refer back to their observations on the chart paper on the wall for evidence of their findings.
 - 2) Be sure that the food chains the students create start with a plant. Two plants are visible in the aquarium: elodea and duckweeds. Have they seen either the fish or the snail eat either plant? Is

there evidence of any other plant life in the aquarium? (*Look closely because it is possible that microscopic freshwater algae may have formed as well, and if it becomes dense enough may appear either as a greenish film, or perhaps a greenish hue in the water.*)

- 3) Reinforce that simple food chains can be traced back to plants. In other words, plants can produce their own food, but animals cannot. Animals are dependent on plants for food. If time permits allow students the opportunity to practice creating food chains using the interactive game *Aquatic Food Chains*.

IV. *Sample Food Webs*

- A. Explain that an ecosystem is composed of many different plants and animals. When the food chains for these plants and animals are combined, they become a food web.
- B. Divide the class into three different ecosystems: ocean, stream and land. Show pictures of the different ecosystems and provide the students with a list of animals for each of the ecosystems. Add to the suggested list below.
 - 1) Ocean (coral reef): coral, shark, sea birds, turtles, sting ray, seaweed, squid, Portuguese-Man-O-War, parrotfish, octopus, cone snails, eels, butterfly fish.
 - 2) Wetlands: snail, crayfish, prawn, *ʻōpū*, shrimp (*ʻōpae*), tilapia, swordtail, guppies, elodea, duckweed.
 - 3) Grasslands: insects, birds, mongoose, rats, cats, snakes, cattle, goats, grasses and shrubs,
- C. Decide who, within each group/ecosystem, will look up which animal to learn what it eats and to draw a food chain that starts with a *plant* and ends with their animal. Who in the group will study the plants in the ecosystem and how they obtain energy from the sun and what animals feed on them.
- D. Allow time for students to use books or the Internet to look up information.
- E. Ask each group to combine their food chains to draw a food web on chart paper. Time permitting, they may illustrate the organisms.
- F. Have groups describe and share their food webs with the class to address benchmark LA 4.6.2.
- G. Post the charts.

Extended Activities

1. Make flash cards of vocabulary words using the students' own words with graphic representations.
2. Do a special lesson on the Ahupua'a, and invite a kupuna, makua, or parent to give a talk about the Hawaiians' use of wetland areas.
3. Have students play another game that will reinforce their understanding of Hawai'i's coastal marsh food web provided in the Moanalua Gardens Ohia Project Curriculum. Preview the Marsh Connections lesson. For additional information, visit <http://www.mgf-Hawaii.org/PDF/OP%20Grade%203/connect.pdf>
4. Technology Integration Ideas—Sign up for time in your school computer lab, or facilitate use of your classroom computers to allow students to read additional information about the topics introduced in Lesson 2, such as Hawai'i's coastal marsh organisms and wetlands specific to Hawai'i. The following websites could be used as resources for this exercise:
 - *Lāi'e* Wetlands at
 - <http://www.hear.org/naturalareas/laie/index.html>
 - *Nū'u* Coastal Wetlands Refuge at www.fws.gov/pacific/news/2007/RO_CWGrant.pdf
 - *Kahana* Ponds, *Maui*, at
 - <http://www.hear.org/naturalareas/kanahabeach/maps/wetlands.htm>
 - *Hanalei* coastal wetlands, *Kaua'i*, at http://findarticles.com/p/articles/mi_hb5066/is_200701/ai_n19221259