



Killer Clams • *The Lifespan of Overfishing* Lesson Plan

by Mellie Lewis

Jonathan Bird travels to Micronesia in the South Pacific to investigate Tridacna, the giant killer clam. On a shallow dive, Jonathan examines the gross anatomy of a “killer” clam as he quickly debunks the “killer” label. Tridacna clams are difficult for Jonathan to find as he discovers that humans are the killers through overharvesting. Jonathan visits a “clam farm” at Kosrae Island and he explores some of the advantages and disadvantages of aquaculture

Science Lesson: The Lifespan of Overfishing - Based on Webisode #14 *Killer Clams*

Grade Level: 6-8

Time: One to two (45-50 min) class periods

Introduction

Human impact on the marine environment extends to many areas and is frequently very detrimental. The ocean's supply of fish is a common food resource that is rapidly being depleted. The fishing industry's use of trawling kills many target (wanted) and by-catch (not wanted) species as well as threatening the stability of many habitats. According to the United Nations, 15 out of the 17 world fisheries are overfished or depleted. Between 1950 and 1994 commercial fishermen increased their catch by 400% in order to keep up with the growing demand for seafood. Since 1989, the oceans have been over-fished and fish are being caught faster than they can reproduce. Ninety percent of the large fish species in the oceans have been fished out in the last 50 years. Throughout the world, fisheries are threatened with collapse due to unsustainable fishing methods and ecosystem destruction.

In this simulation students will be introduced to the problem of overfishing. Working in teams students will catch “fish” - crackers, cheerios, raisins and grapes - from paper plate oceans and experience the need to develop a strategy in order to maintain a sustainable fishery. Students will spend four 30-second years fishing in their oceans during which they can fish using straws and masking tape as their poles and hooks. Each fish has a different monetary value and each student must catch a minimum dollar amount of fish in order to stay in business the following year. Also there must be at least 2 fish of a species at the end of a “year” for that species to reproduce. The fish will need to eat in order to survive and reproduce so students will need to pay attention to the food web.

The discussion at the end of the lesson will examine the problem of overfishing and solutions that lead towards sustainable resource management.

Science Standards

National Science Education Standards

Life Science:

- Structure and Function of Living Systems
- Regulation and Behavior
- Populations and Ecosystems

Science in Personal and Social Perspectives:

- Populations, Resources and Environments
- Natural Hazards
- Risks and Benefits

Ocean Literacy Principles

- *Principle #6:* The ocean and humans are inextricably interconnected.
- *Principle #7:* The ocean is largely unexplored

Objectives

By the end of the lesson, the students will be able to:

- Graph changes in a population over time.
- Define what over-fishing means and its effect on fish stocks.
- Create a strategy to manage natural resources.



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Prior Knowledge

Students should have a solid understanding of food webs.

Students should have experience monitoring population changes over time using tables and graphs.

Helpful Vocabulary

Collapse:	The collapse of a fishery is defined as a decline in catches to 10% of the maximum previous level.
Fishery:	The Magnuson-Stevens Fishery Conservation and Management Act defines fishery as “one or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational, and economic characteristics.
Fish Stock:	The Magnuson-Stevens Fishery Conservation and Management Act (reauthorized in 2006) defines fish stock as “a species, subspecies, geographical grouping, or other category of fish capable of management as a unit.”
Mantle:	The fold of skin covering all or part of the body of a mollusk. The outer edge of the mantle secretes the animal’s shell.
Overfishing:	The excessive fishing or catching of aquatic (ocean or freshwater) animals to the point that the amount of animals being caught is greater than the amount of animals born. When more animals are caught than are being born, the aquatic environment is left depleted of the targeted animals.
Siphon:	A hole or tube through which water enters or leaves an animal’s body cavity.
Spawn:	The release of sex cells, eggs or sperm, into the water.
Species:	A group of organisms capable of breeding and producing fertile offspring; organisms that share the same gene pool.
Sustainability:	When the population of a species of fish is managed in a way that provides for today’s needs without damaging the ability of the species to reproduce and be available for future generations.
Symbiotic relationship:	The living together of two dissimilar organisms.
Vulnerable:	A species that is not declining in number but is of special concern because it is sensitive to pressure by human activities or natural events.
Zooxanthellae:	Tiny single-celled algae called dinoflagellates that have a symbiotic relationship with an organism like the giant clam or corals. In exchange for a safe place to live under the organism’s skin, the zooxanthellae provides its host with nutrients it makes using the sun’s energy.

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Background

Tridacna gigas, the giant clam, is usually blue, golden brown, yellow, or green. This clam really is a giant, growing to 4 feet long and weighing over 500 pounds and it can live for more than one hundred years. Each side of the shell is made by the outer edge of the mantle. The shell is fused together at the dorsal surface and encloses the mantle cavity, the fleshy part of the giant clam. The giant clam has two siphons one to suck water in and the other to push water out. *Tridacna* can squirt a forceful jet of water out of its “excurrent” siphon by quickly opening and closing its shell. Perhaps one of the most unusual attributes of this clam is that its colorful skin hides a thick layer of zooxanthellae or algae. The zooxanthellae and the clam have a symbiotic relationship. The zooxanthellae make food for the clam using the energy from the sun. The algae feed off the clam’s waste. The water the clam sucks through its “incurrent” siphon brings the tiny algae oxygen and flushes away excess waste materials. Most of the giant clam’s nutrients come from the zooxanthellae living under its skin. The giant clam farms its zooxanthellae.

Since the giant clam can’t move, reproduction is done by spawning. Each *Tridacna gigas* produces sperm and eggs. Through a synchronization process each clam releases either sperm or egg into the water to complete the spawning process. The giant clams release their gametes into the water at the same time, in the hopes there will be enough gametes to fertilize each other. When this event happens, the water looks milky.

Tridacna has been historically misunderstood. Some scientific and technical manuals once claimed that the great mollusk had caused deaths. In those days the *Tridacna* was also known as the killer clam or man-eating clam. Older versions of the U.S. Navy Diving Manual gave detailed instructions for releasing oneself from the clams grasp by severing the adductor muscles used to close its shell. We know now that

the giant clam is neither aggressive nor dangerous; the shell’s closing action is actually a defensive response, it closes slowly and not tightly.

The International Union for Conservation of Nature and Natural Resources (IUCN) lists *Tridacna* as vulnerable because its numbers have been greatly reduced by extensive harvesting for food and aquarium trade.



Giant Tridacna clams on a reef in Kosrae, Micronesia.



Giant Tridacna clam, Raja Ampat, Indonesia.

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Lesson Procedure

Materials: (Note: The first four items will depend on school policy and food allergies. Other food or non-food items may be substituted.)

- 1 carton of Goldfish crackers
- 1 box Cheerios
- 1 box of raisins
- 1 bag of grapes
- 1 roll of Scotch tape per group of 4 students
- 1 paper plate per group of 4 students
- 1 paper towel per student
- 2 drinking straws per student
- 4 plastic spoons for transferring fish from teacher stock to student oceans
- A watch or clock with a second hand
- A buzzer or bell
- Graph paper
- Colored pencils – each student will need four different colors

1. Begin class with a discussion of fishing. What fish do you eat? What do you know about where the fish came from and how they were caught?
2. Introduce today's simulation and review the rules and food web with the students. In this ocean's food web the Goldfish eat seaweed of which there is always plenty, the Cheerios fish and Raisin fish eat the Goldfish, and the Grape fish eat both Cheerios fish and Raisin fish. There must be at least 2 Cheerios Fish and 2 Raisin Fish in the ocean for these fish to survive.
3. Pass out the simulation rules and data tables. Have one person from each group collect a plate, 8 straws, 4 napkins and a roll of tape for the members of their group. Students may use the straws and tape to create any fishing device they want. The key is to get fish out of the ocean and onto their boat.
4. Meanwhile, the teacher will start off each ocean with: 4 Goldfish, 4 Cheerio fish, 4 Raisin fish, and 4 Grape fish.
5. When all oceans are stocked, fishing gear made, and groups are ready the teacher will say, "GO." Students will have 30 seconds to fish and then the teacher will ring a bell or say, "STOP." All fishing poles must be put down. Any fish on the table or still attached to the fishing pole do not count.
6. Students should fill in their data tables with the number of each species of fish that remains in the ocean, the number and value of their catch, and the income earned by each student in their group. Once their tables are filled out, they can eat their catch!

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Lesson Procedure (continued)

7. As they fill in the tables, the teacher will go around and adjust the number of fish in each ocean for the next round. Remember, there must be a food source and 2 fish of that species for them to reproduce and survive.
8. Repeat steps 5-7 three more times until there have been 4 years of fishing.
9. You may want to have students work on creating a line graph to show changes in their fish population over time. This may help students think about their own ocean before comparing the results between groups. The line graph could be completed as a homework assignment.
10. Have each group report to the class the final number of fish remaining in their oceans after year 4. Some oceans may be completely empty of fish. Others may have figured out a way to fish sustainably so that there are many more fish than when they started. Discuss the various strategies the different groups used (or didn't use) to manage their oceans.
11. Introduce the concepts of overfishing, environmental collapse, sustainability, and resource management as they become relevant to the discussion.

Follow-up Questions

1. What are the effects of overfishing?
2. What happens when a large percentage of a fish species is removed from the ocean?
3. Where does your family get the fish you eat? Does that fishery practice fishing sustainably?

Going Further

What fish is available at your supermarket? Using information on the U.S. Fish and Wildlife Service (<http://www.fws.gov>) students can find annual landing summary for their stat. Using the National Marine Fishery Service (NMFS) Landings Query Results http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html

Students can find the pounds caught and dollar amount paid for the catch. Have students compare the two findings.



Rules: The Economics of Overfishing

In this simulation you will become fishermen for the day. Your task is to make as much money as you can during the four years of fishing while at the same time creating a sustainable fishery so you can keep fishing. Remember, when your ocean is depleted of fish you are out of the simulation.

Rules:

1. You will be fishing cooperatively in an ocean (a paper plate) with three other fishermen.
2. Touching, tipping, or moving the ocean is not allowed.
3. Each fisherman will be given 2 fishing poles (straws) and a net (a short length of tape) to fish with. Fishing with hands or anything else is not allowed.
4. Place the fish you catch in your boat – a paper napkin. Fish that fall out of the boat onto the table do not count!
5. You will be fishing in your ocean for 4 years. Each year you will have 30 seconds to bring in your catch.
6. There are 4 different species of fish in the ocean. The dockside market value for each fish is: Goldfish \$3, Cheerios fish \$5, Raisin fish \$5, and Grape fish \$10.
7. Each fisherman must earn at least \$5 of income annually to stay in business. However, you should try to earn as much money as possible.
8. At the end of each year, the fish have a chance to reproduce. For every pair of the same species of fish left in your ocean, 2 baby fish will be born.
9. Fish need to have food in order to survive. The food web in your ocean is as follows:
 - Goldfish eat seaweed and there is a lot of seaweed in your ocean.
 - Cheerios fish and Raisin fish eat Goldfish; there must be at least 1 Goldfish in the ocean for each of these fish to survive.
 - Grape fish eat both Cheerios fish and Raisin fish; there must be at least 1 Cheerios fish and Raisin fish in the ocean for the Grape fish to survive.

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The Economics of Overfishing Data Table

Number of Fish Remaining After:

	Year 1	Year 2	Year 3	Year 4
Goldfish				
Cheerios fish				
Raisin fish				
Grape fish				

My Catch

	#	Value	#	Value	#	Value	#	Value
Goldfish (\$3)								
Cheerios fish (\$5)								
Raisin fish (\$5)								
Grape fish (\$10)								

My Group's Total Income

Names	Income Year 1	Income Year 2	Income Year 3	Income Year 4
My Total Income				
_____ 's Income				
_____ 's Income				
_____ 's Income				
Ocean Total Income				