Farmed vs. Wild Systems

For use with Fish Watch at www.fishwatch.gov

Grade Level
9-12

Materials
- 1 Fish bowl and all the necessary parts for a fish bowl system (live goldfish, pebbles, fish food, plants, water, etc.)
- Copies of handouts included in lesson
- Chart paper and markers (or projector screen and projector)
- Markers/colored pencils
- Computers with Internet access

Audio/Visual Materials
- Projector
- Computers with Internet (one for each pair of students)

Teaching Time
Two to Three 45-minute class periods

Seating Arrangement
Pairs

Key Words
- Sustainability
- System
- Boundaries
- Inputs/Outputs
- Elements
- Aquaculture

Focus
- Systems and sustainability

Focus Questions
- What is a system?
- What are the elements, boundaries, inputs and outputs of a farmed shellfish system?
- What are the elements, boundaries, inputs and outputs of a wild shellfish system?
- How is sustainability an integral piece of the balance of the shellfish system?

Learning Objectives
- Explain the concept of specifically farmed vs. wild systems.
- Describe the relationship between systems and sustainability

Background Information
In this lesson, students will learn about the similarities and differences between farmed and wild seafood systems.

“Sustainable seafood is a hot topic these days. “Sustainability” is based on a simple principle: meeting today’s needs without compromising the ability of future generations to meet their needs; for example, using a resource, but

National Science Education Standards

Grades 9-12

Content Standard C: Life Science

- Interdependence of organisms/ecosystems
- Matter, energy and organization in living systems

Content Standard F: Science in Personal and Social Perspectives

- Environmental Quality

Ocean Literacy Essential Principles

Essential Principle 6

The ocean and humans are inextricably connected.

Fundamental Concept b

From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our economy, serves as a highway for transportation of goods and people, and plays a role in national security.

Fundamental Concept e

Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

Fundamental Concept g

Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean.

leaving some for the future. In terms of seafood, this means catching or farming seafood responsibly, with consideration for the long-term health of the environment and the livelihoods of the people that depend upon the environment. For example, U.S. seafood is wild-caught and farm-raised under strict regulations that work to keep the environment healthy, the fish populations thriving, and our seafood industry on the job." (Quote from www.fishwatch.gov)

Have you ever thought about where that piece of salmon on your plate came from? It could have been caught in a wild fishery or harvested from an aquaculture operation. It might have come from the United States or maybe it was imported from Canada or Chile. Perhaps you're wondering why any of this matters. It is important to know the source of your seafood because not all of them measure up the same. Some seafood is caught or farm-raised under regulations that protect the health of the marine environment, the animals that live within it, and the people who eat it; however, some is not. By buying seafood from reputable sources, you are helping to conserve our ocean resources and support the economies and communities that ensure our seafood supply is safe, healthy, and sustainable.

Wild-caught seafood is big business in the United States. Our fisheries provide more than a great meal - they provide jobs and recreation and help keep our coastal communities vibrant. From recreational and small-scale tribal fishermen to large-scale vessels harvesting and processing millions of tons of fish, U.S. fisheries are scientifically monitored, regionally managed, and legally enforced under ten strict national standards of sustainability. NOAA Fisheries Service's dynamic, science-based management process is rebuilding depleted fish populations and maintaining healthy ones, benefitting fishermen, fishing communities, and our fishing and seafood industries. Our nation's journey toward sustainable fisheries began more than 35 years ago and continues to evolve.

Approximately half the seafood eaten worldwide - including in the United States - is farm-raised. Because harvest from many wild fisheries has peaked globally, aquaculture is widely recognized as an effective way to meet the seafood demands of a growing population. As a result, aquaculture is the fastest growing form of food production in the world.

Aquaculture - also known as fish or shellfish farming - refers to the breeding, rearing, and harvesting of plants and animals in all types of water environments including ponds, rivers, lakes, and the ocean. Researchers and aquaculture producers are farming all kinds of freshwater and marine species of fish and shellfish. Aquaculture produces food fish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, and fish eggs.

Marine aquaculture in the United States consists of a small but vibrant community that contributes to seafood supply, supports commercial fisheries, enhances habitat and at-risk species, and maintains economic activity in coastal communities and at working waterfronts. However, U.S. marine aquaculture is quite small relative to overall U.S. and world production. A compelling case can be made for growing more seafood in the United States - half of what we import is from aquaculture, yet we produce so little at home.

As a complement to wild harvest fisheries, aquaculture can help meet the growing demand for seafood, reduce our dependence on imports, and help rebuild wild fish stocks. Domestic aquaculture is also critical to maintaining an infrastructure in coastal communities to support both commercial fisheries and aquaculture and all of the jobs associated with the seafood industry.

The largest single sector of U.S. marine aquaculture is molluscan shellfish (oysters, clams, and mussels), which accounts for about two-thirds of total production. Marine aquaculture also produces shrimp and salmon as well as lesser amounts of barramundi, sea bass, and sea bream. Marine aquaculture can take place in the ocean (in cages on the seafloor or suspended in the water column) or on land in manmade systems such as a recirculating aquaculture system. Source: www.fishwatch.gov

Learning Procedure

1. Pre-Assessment: What is a system? Ask students to complete the pre-assessment handout. Allow 10-15 minutes for completion. When finished, allow students to share their thoughts and ideas on systems.

2. Use the goldfish bowl as a model of a system. Examine the concept of systems and introduce the essential understandings about systems.

"A System is a collection of things and processes that interact with each other and together constitute a meaningful whole. Examples from the realm of science include atoms, chemical reaction systems, individual cells, organs, organ systems, organisms, ecosystems, solar systems, the banking system, transportation systems, and so on. All systems share certain properties.

Systems Generalizations:

- Systems have identifiable elements
- Systems have definable boundaries
- Most systems receive input in the form of material or information from outside their boundaries and generate output to the world outside their boundaries.
- The interactions of a system's elements with each other and their response to input from outside the system combine to determine the overall nature and behavior of the system."

3. Looking at an empty fishbowl, describe a boundary and ask what the boundary would be for some fish living together in the bowl.

4. Have a student pour some water into the fishbowl and ask if the boundary for where the fish might live has changed.

5. Add more water until the bowl is full and ask again about the changing boundary. Is any part of the fishbowl constant?

6. Add fish and discuss the elements in a system of fish living together in the fishbowl.

7. Describe input (e.g. light, food) and output (e.g., dirty water) of a fishbowl system.

8. Talk about interactions (e.g., fish and plants, light and plants, fish and food) within a fishbowl system.

9. Provide situations that would put stress on the system: if there were six goldfish in the bowl, or if insufficient food were added to the system or if a pregnant fish were added, but no additional food, or a sick and contagious fish. What would happen to the system elements, input, output and interactions in those cases? Introduce the idea of natural regulation in the system (that the amount of oxygen regulates the number of fish).

10. As you are discussing the Goldfish Bowl system, students can make notes about systems and the examples given about the goldfish system on *The Goldfish Bowl* handout.

11. Once they have completed the Goldfish Bowl system activity, ask students in small groups to come up with several examples of a system. Then have them categorize their examples and discuss.

12. Ask students to think of examples of non-systems – (e.g., a pencil, a shoe, a noodle.)

13. Revisit the generalizations about systems outlined above.

14. Introduce the concept of aquaculture by showing *Exploring U.S. Aquaculture* at www.nmfs.noaa.gov/aquaculture/homepage_stories/aquaculture_video.html. Additional introductory videos about aquaculture include *Fish on a Farm* at http://oceantoday.noaa.gov/fishonafarm/welcome.html and *Building Good Mussels* http://oceantoday.noaa.gov/buildinggoodmussels.

15. Have students work in pairs and provide access the Internet. Students should go to www.fishwatch.gov to learn about aquaculture (under the Farmed Seafood tab).

16. Students will now begin to learn about the similarities and differences between wild caught and farm-raised systems. Students should visit NOAA's FishWatch website: www.fishwatch.gov to find information about wild caught Atlantic sea scallops. Students should also visit the New England Aquarium website: www.neaq.org/conservation_and_research/projects/fisheries_bycatch_aquaculture/sustainable_fisheries/celebrate_seafood/ocean-friendly_seafood/species/bay_scallops.php to find information about farmed bay scallops.

17. Students can also listen to a NPR podcast *Maine Lobstermen Give Farming Sea Scallops A Try* about farming sea scallops off the coast of Maine: http://www.npr.org/2012/08/12/157674235/maine-lobstermen-give-farming-sea-scallops-a-try

18. Students should complete the *Systems Parts Chart* with their partner while they are researching. Discuss the responses as a whole class upon completion of the research.

19. Students should re-visit their Pre-Assessment and write a response about what they have learned about systems and the scallop species.

20. Conduct a class discussion about the importance of sustainability and why it's an integral part of the balance of a system.

The Bridge Connection

www.vims.edu/bridge
Under Ocean Science Topics, click on Human Activities, then Environmental Issues or Aquaculture.

The "Me" Connection

Ask students to listen to the podcast *Is It Time To Move Fish Farming Into Open Waters?*: http://www.kpbs.org/audioclips/11933/ and then answer the following question: How will increasing U.S. aquaculture efforts affect you?

Connections to Other Subjects

English, Language Arts, and Social Studies

Evaluation

The *Systems Parts Chart* can serve as an assessment piece. Additionally, students' reflections on their pre-assessment can be the post-assessment for this lesson.

Extension

Visit the following site www.sites.ext.vt.edu/virtualfarm/main.html and select *aquaculture*. Students should take time to read/answer each of the seven modules in order to learn more about aquaculture.

Additional Resources

NOAA Fisheries – Aquaculture Video Gallery
www.nmfs.noaa.gov/aquaculture/library/aq_video_gallery.html

NOAA Fisheries FishWatch
www.fishwatch.gov

NOAA Fisheries Service – Office of Aquaculture
www.nmfs.noaa.gov/aquaculture/

NOAA Fisheries – Office of Sustainable Fisheries
www.nmfs.noaa.gov/sfa/sfweb

NOAA Announces Aquaculture Fishery
www.noaanews.noaa.gov/stories2011/20110711_aquaculture.html

Canadian Farmed Scallops
www.aquaculture.ca/files/species-scallops.php

Aquaculture Best Practices and Consensus Building
www.neaq.org/conservation_and_research/projects/fisheries_bycatch_aquaculture/aquaculture_research/best_practices_and_certification.php

Pre-Assessment: What is a System?

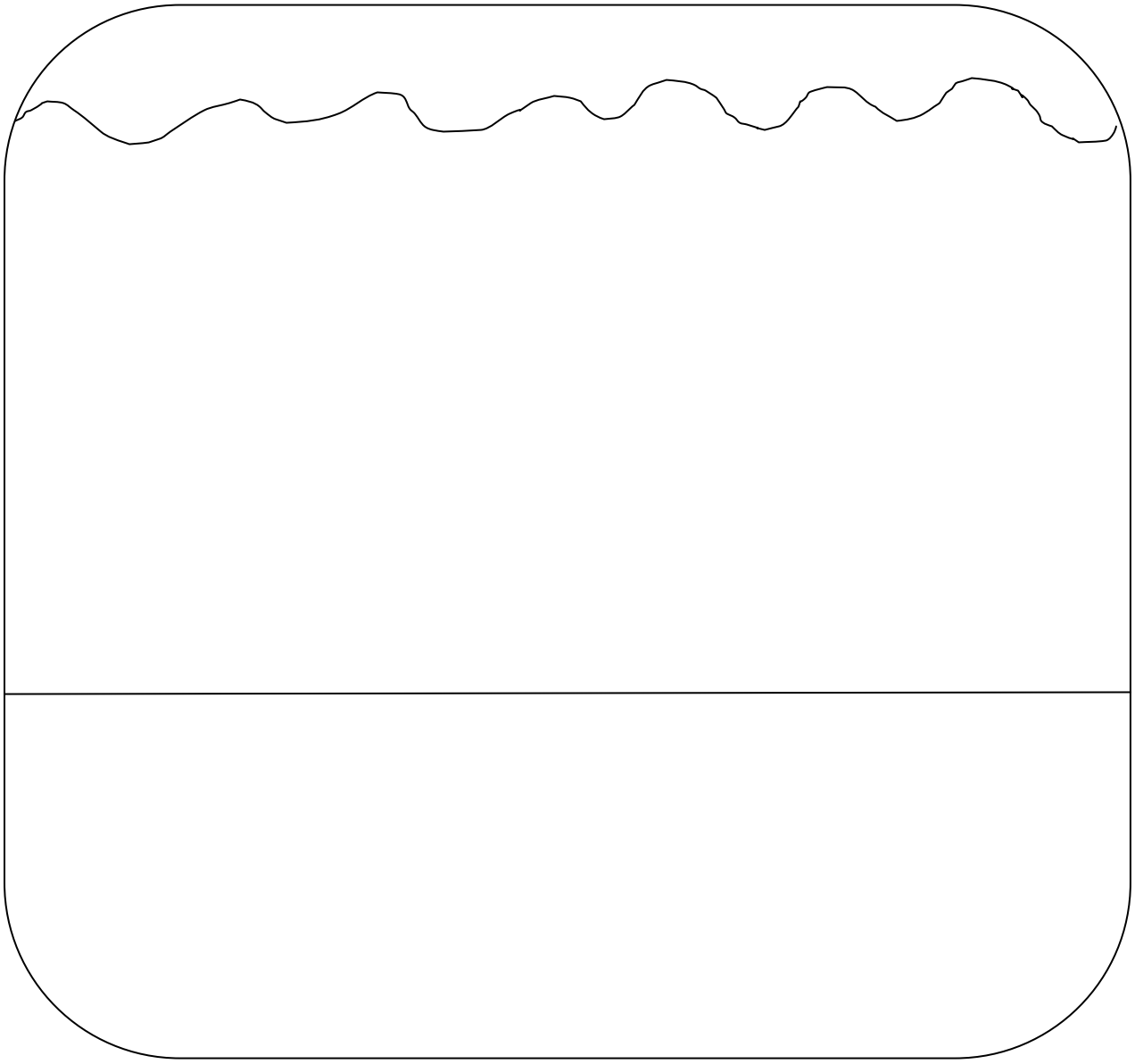
What is a system?	Examples of systems…
What is not a system?	How is aquaculture part of a system?

The Goldfish Bowl

Name: _____

Using the goldfish bowl diagram below, draw and label the elements, inputs, and outputs of the goldfish bowl system. Be sure to place them in the correct location in the system. Then label the boundaries of the goldfish bowl.

What are some interactions that happen in this system?



Systems Parts Chart

1. What are the boundaries of the farm raised scallop system?

2. How are these boundaries different from the wild caught scallop system?

3. List some important elements of both systems.

4. Describe inputs into the farm raised scallop system. Where do they come from?

5. Describe outputs from the farm raised scallop system. What part(s) of the system produce them?

6. Describe some important interactions in farm raised scallops:
    a. Among system elements

    b. Between system elements and inputs into the system.

7. What would happen to the system if the interactions in 5a could not take place? In 5b?

Systems Parts Chart
POSSIBLE ANSWERS

1. What are the boundaries of the farm-raised scallop system?
   Scallops can be farmed in lantern nets that hang off lines suspended in the water column or directly on the seafloor. Both methods of culture do not cause significant damage to the seafloor (Neaq.org Conservation Notes for Bay Scallops).

2. How are these boundaries different from the wild caught scallop system?
   Atlantic sea scallops are found in the Northwest Atlantic Ocean, from Newfoundland to Cape Hatteras, North Carolina. Adult scallops live close together in groups called "beds" on sandy or gravelly parts of ocean floor generally at depths of about 100 to 300 feet on Georges Bank and in the Mid-Atlantic. Sea scallops can be found in shallower waters in Maine and Canada (Fishwatch.gov).

3. List some important elements of the system.
   Ocean water, phytoplankton or other small organisms, many kinds of pelagic fish and invertebrates (eat scallop larvae), cod, wolffish, eel pout, flounder, crabs, lobster, sea turtles, and sea stars (feed on juvenile and adult scallops)

4. Describe inputs into the farm raised scallop system. Where do they come from?
   - *fishing vessels*
   - *trawlers*
   - *nets*
   - *predators (fish, crabs, lobster, sea turtles, sea stars)*
   - *sunshine*
   - *pollution into water*

5. Describe outputs from the system. What part(s) of the system produce them?
   - *scallops*
   - *filter-feeding action may even improve local water quality*

6. Describe some important interactions:
   a. Among system elements
      - *Scallops eat phytoplankton*
      - *Fish feed on juvenile scallops*

   b. Between system elements and inputs into the system.
      - *We farm scallops and add them to the system*
      - *Environmental changes can have a huge impact on quantity of scallops each year (dredging hurts ocean floor and impacts habitat and other species)*

6. What would happen to the system if the interactions in 6a could not take place? In 6b?

- *Local water quality may not improve. Fish may have to find another source of food.*
- *If demand stayed same and we did not adjust by setting catch limits of farming scallops, then sustainability of scallops would be in danger. Overfishing or overfished populations may occur.*