The Gulf of Maine

High School Lesson Plan

Topic The impact of human activity on a marine ecosystem

Grade Levels 9-12

Overview

This QUEST episode, *The Gulf of Maine*, explores changes in the Gulf of Maine ecosystem. The Gulf of Maine stretches from Cape Cod in Massachusetts to Nova Scotia in Canada. Extending out to the Atlantic Shelf, or Georges Banks, it has been one of the richest fishing grounds in the United States. Over the past few decades, however, a crisis has developed. Today in the Gulf of Maine, as in the rest of the world, only 10 percent of the previous fish populations remain. Researchers, fishermen, and policymakers are all examining the situation to determine the best course of management to save this vital ecosystem.

Introduction

This teaching unit addresses changes in ecosystems. Students will begin by examining their own lives. They will recognize how equilibrium is maintained in their own environment despite a variety of changes that can occur. They will then transfer this concept of dynamic equilibrium to ecosystems, where species populations may change but the ecosystem as a whole is maintained. Finally, students will explore the Gulf of Maine ecosystem to understand the impact of pace and rate of change on an ecosystem. They will learn how this dynamic balance can be pushed out of equilibrium if the rate and pace of change are too much and/or too rapid.

At the end of this teaching unit, students will be able to:

- Explain the concept of equilibrium in an ecosystem
- Identify key changes and the pace of change in the Gulf of Maine ecosystem
- Correlate changes in the ecosystem to human use of the available resources
- Identify major threats and initiatives that could regain the equilibrium of the Gulf of Maine ecosystem

Time Allotment Six 45-minute class periods or 3-4 longer blocks of class time

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Accessing Prior Knowledge

Students should have a basic understanding of the interdependencies of organisms in an ecosystem. They should able to apply concepts learned about terrestrial ecosystems to an aquatic one.

Concepts to Clarify

Prior research indicates that students often think that populations of organisms increase because there is more demand for them as food, rather than populations increasing because resources are available and favorable reproduction conditions exist. In addition, many students hold onto the idea that if circumstances in the environment change, an organism can readily change its needs, change its physical structure, or move to a more suitable habitat.

CONNECTIONS TO THE STANDARDS

Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards	National Science Education Standards	Benchmarks for Science Literacy
Continuity and Change B4. Analyze the impact of human and other activities on the type and pace of change in ecosystems.	**Life Science** 3b. Trace the history of an interaction between man and the environment that demonstrates how human activities can deliberately or inadvertently alter the equilibrium in an ecosystem.	**The Living World: Organisms, Evolution, and Interdependence** 7.13.ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply them to local, regional, and global systems).	**Content Standards (9-12)** C. Life Sciences The Interdependence of Organisms: Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability; and if not addressed, ecosytems will be irreversibly affected.	**Chapter 5: The Living Environment** 5D. Human beings are part of earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

Materials Needed

- TV with VCR
- QUEST *Gulf of Maine* video
- Computers with Internet access (for teacher to print materials, and for students to either read or conduct research online; alternatively, the teacher can create a "library" of research materials)
- 1 journal per student
- Chart paper and markers
- Student Handout 1: QUEST: *Gulf of Maine* Video Recording Sheet
- Student Handout 2: Fisheries Research – Gulf of Maine Species
- Student Handout 3: *QUEST at Home:* Exploring the Gulf of Maine

1. Introducing the Concepts

This first activity will provide a connection between students' everyday lives and the lesson content involving change. Students will first reflect on some major changes in their lives and the effects these changes have had on them – both immediately and over time. They will then think about changes that have occurred in their environment, again reflecting on both the immediate and the long-term impact. Finally, students will imagine the types of changes that might occur from which they, or their environment, might not regain equilibrium.

Step 1

Lead students to consider change in their lives. Have them first reflect on what they do for routines (meals, sleep, school, jobs, etc.). Then sort them into teams. In teams, students should discuss major personal changes that have upset their routines. (Changes could range from starting a diet to illness to moving to family separation.) Students should next identify some short-term impacts of each of these changes. On chart paper, record students' answers. List changes in one column and short-term impacts in another column. Create two additional columns for the chart as well. Then ask teams to consider whether any of the impacts they have mentioned lasted for a long time, or whether things returned again to a balanced routine in their lives. In the third column of the chart, indicate whether each situation regained its equilibrium or remained out of balance. In the last column, indicate how long it took for each situation to regain its equilibrium, or (if appropriate) how long students predict it will take for this to happen.

Step 2

Examine the data in the chart with the class. Try to relate the scope of each impact to the length of time before balance returned. Explore with students some situations in which they might not be able to regain balance. Relate this to the scope of the impact, or multiple impacts, over a short time period.

Ask students to now reflect on changes to their natural environment in the same way. When have there been major changes? What was the immediate impact of each change? How long did it take for the ecosystem to return to "normal"? Students might cite weather-related changes (snow storms, droughts), natural disasters (floods), habitat changes (development, lumbering), insects, diseases, or invasive species

(gypsy moth, milfoil). Create a chart similar to the one you created for students' personal lives, listing what each change was, what the impact was, whether balance was regained, and how long it took to regain equilibrium. Discuss the data.

Step 3

If students have not been able to identify any changes from which equilibrium was not regained, ask them to imagine one – either for themselves or for their environment. Discuss why the person or ecological system involved could not recover. Explore their ideas about pace and rate of change and its effect upon the equilibrium of systems. Ask students if they have any questions they may want to try and explore in this unit of study. Have them write their questions in their journals and share some with the class.

2. Exploring the Concepts

In this activity, students will view a video about the Gulf of Maine. They will use a recording sheet to note the types of changes that have occurred in the Gulf of Maine. They will also be rating these changes as to whether they were high-impact or low-impact changes, and whether they had short-term effects or long-term effects.

Step 1

Distribute Student Handout 1: QUEST: *Gulf of Maine* Video Recording Sheet to each student. Explain that the class will be watching a portion of a video that explores research into the changes occurring in the Gulf of Maine. Students are to take notes on each species that is mentioned in the video. They should also note the changes in the Gulf of Maine that are described. When they are done, students will be divided into teams. Each team will create a master list that identifies whether the changes were high- or low-impact and whether they had short-term or long-term changes.

Step 2

Play the video, starting with the segment where Bruce Bourque is describing the history of the fisheries with the animated time line. **Stop** at the end of the discussion on losing biodiversity. If students are not familiar with the Gulf of Maine and time allows, view the entire video. Allow time for students to complete their handouts and for teams to create their master lists.

3. Developing the Concepts

In the next activity, students will use Internet sources to further explore the species in the Gulf of Maine that are mentioned in the video. They will examine data on each species' life history and population changes over the past decades (using fisheries' landing data).

Step 1

Have each team select one of the species discussed in the video to research further. Distribute copies of Student Handout 2: Fisheries Research – Gulf of Maine Species.

Step 2

Using the resource list at the top of the handout, student teams should conduct research on their selected species. Each team's report should respond to the questions included on the handout. For species that are of interest to commercial fisheries, the reports should include information about the species' life history and its use by humans. These reports should also identify the requirements of the chosen species to sustain its populations. Student teams that are investigating these species will need to download landing data from the National Marine Fisheries Web site. These data will enable them to analyze their species' population trends. For food resource organisms, such as phytoplankton and zooplankton, teams will need to create a food web for the Gulf of Maine. For rare species, they will be asked to identify key threats to the species. For invasive species, they will need to identify the threats these species pose to native organisms. Some Web sites are listed on the handout, but others may be used.

4. Synthesizing the Concepts

In the next activity, students will share their research reports with the whole class. Together they will gain a better understanding of the breadth of changes and the impacts of those changes in the Gulf of Maine ecosystem. They will also learn more about the threat that such changes pose to the overall equilibrium of the region.

Step 1

After student teams have completed their reports, they can take turns sharing what they have learned with the whole class. On chart paper, record a master list of all the changes that are happening to the various species in the Gulf of Maine. Also record all of the factors posing threats to these species.

Step 2

Create a class diagram of the Gulf of Maine food web. Indicate with arrows all of the organisms whose populations are under stress, with resulting downward trends in population. Near each arrow, indicate the cause of the decline. Finally, rate each organism on a scale of 1 to 3 in order of its importance to humans; use stars of three different colors for your ratings. Rate each organism again on a scale of 1 to 3 in order of the level of impact on it caused by humans; again, use stars of three different colors for your ratings.

5. Applying the Concepts

In the next activity, students will explore how fisherman and policymakers for federal fisheries are addressing the critical issue of managing the Gulf of Maine ecosystem.

Step 1

Arrange students in teams of four. Provide each team member with one of the four resources listed below, making sure that each student has a different resource.

Step 2

Have students read their assigned materials so that they can identify the tools being used to manage fisheries. When everyone has finished their reading, direct team members to take turns discuss what they have read. Teams should then analyze how these management plans would affect the Gulf of Maine food web. (Refer them to the class diagram you made in the last activity.)

1) **Successful Rebuilding of NE Fish Stocks Continues**
   http://www.nefmc.org/press/press_releases/PRstockstatus.pdf

2) **Northeast Multispecies (Large Mesh/Groundfish) Fishery Management Plan**
   http://www.nefmc.org/nemulti/summary/large_mesh_multi.pdf

3) **Catching the Last Fish: In the End, Fishery Management Comes Down to Politics**
   http://www.workingwaterfront.com/article.asp?storyID=20031201

4) **America's Living Ocean: Charting a Course for Sea Change – Executive Summary**
   http://www.pewoceans.org/oceans/oceans_overview.asp

6. Extending the Concepts

QUEST at Home

Distribute copies of Student Handout 3: *QUEST at Home:* Exploring the Gulf of Maine. Review the handout with students before they take their copies home. Agree upon a due date for students to return to class with their findings.

Community Connections

- As a class, study some of the organisms that live along the coast of Maine and New Hampshire. If possible, find a location that has an interpretive center that you might visit to learn more. Or, arrange a field trip so that the class can take a walk by the sea and identify as many plant and animal species as possible. Which are the most plentiful? Which are the rarest? Can you see any invasive plants or animals?

- Have one or more students write to your state legislator to find out his or her opinion on the state of fisheries in the Gulf of Maine. They can share what they have learned with the rest of the class.

- Visit a working waterfront with your students. Find a place where boats are unloading their catch. Talk with fishermen, fish store owners, or boat operators about their concerns regarding the Gulf of Maine.

Career Opportunities

Discuss some of the following marine-related career options with students. If possible, invite one or more of these professionals to come to school and speak with the class about their jobs and what they entail.

Biologist: Fisheries biologist, ichthyologist, coastal ecologist, marine biologist
Fisheries: Fisherman, fish supplier, fisheries manager, fisheries policymaker

Resources

Seacoast Science Center, Odiorne State Park
A New Hampshire state park and interpretive center in Rye, New Hampshire.
www.seacentr.org

Wells National Estuarine Research Reserve
Conducts research and education on estuarine resources located in Wells, Maine, with a visitors center.
www.wellsreserve.org

Great Bay National Estuarine Research Reserve
Conducts research and education on estuarine resources located on Great Bay in New Hampshire, with a visitors center.
www.greatbay.org

Rachel Carson National Wildlife Refuge
National Wildlife Refuge along the coast of Maine.
rachelcarson.fws.gov

Acadia National Park
National Park on islands along the coast of Maine.
www.nps.gov/acad/home.htm

Island Institute
Nonprofit organization that supports island communities and their way of life.
www.islandinstitute.com

Gulf of Maine Aquarium
Research and education programs on the Gulf of Maine.
octopus.gma.org

Gulf of Maine Council on the Marine Environment
Representatives from three states and two Canadian provinces working together to manage the Gulf of Maine; good overview of Gulf of Maine resources.
www.gulfofmaine.org

Maine Department of Marine Resources
Policy, educational resources, and an aquarium.
http://www.maine.gov/dmr/

Maine Sea Grant
Seeks to promote marine science and education in the development, management, and stewardship of marine and coastal resources.
www.seagrant.umaine.edu

Bigelow Laboratory for Ocean Sciences
Primarily a research program on marine resources, but with good educational materials and outreach resources.
www.bigelow.org

QUEST: The Gulf of Maine
Video Recording Sheet

Species	Change	Impact	High/Low	Short-term / Long-term Effects

Fisheries Research – Gulf of Maine Species

* Commercial Species
** Food Resource for Commercial Fisheries
*** Rare Species
**** Invasive Species

Barnacles
Barnacle general biology
http://www.mov.vic.gov.au/crust/barnbiol.html

Sea Cucumbers, Sea Squirts, or Starfish
Stellwagen Banks: Invertebrates
http://www.coastalstudies.org/stellwagen/invert.htm

***Cod, Flounder , Red Fish, Cusk, Snake Blennies, Radiated Shanies, or Swordfish**
Fishes of the Gulf of Maine (by Henry B. Bigelow and William C. Schroeder) *http://www.gma.org/fogm/*

***Lobster**
All About Lobsters
http://www.gma.org/lobsters/index.html

***Sea Urchins**
Stellwagen Banks: Invertebrates
http://www.coastalstudies.org/stellwagen/invert.htm

***Worms, Softshell Clam**
Teacher's Guide to Marine Life of the Gulf of Maine
http://www.maine.gov/dmr/rm/aquarium/teachers_guide/sample_pages_of_teachers_guide.htm

**** Phytoplankton and Zooplankton**
National Marine Sanctuary Management Plan
http://stellwagen.noaa.gov/management/1993plan/pt2sc2b2b.html
http://stellwagen.noaa.gov/management/1993plan/pt2sc2b2a.html

Stellwagen Bank: Phytoplankton
http://www.coastalstudies.org/stellwagen/phyto.htm

Stellwagen Bank: Zooplankton
http://www.coastalstudies.org/stellwagen/zoo.htm

*****Pimnola and Paragorga Coral**
Deep Sea Coral of Nova Scotia
http://biotype.biology.dal.ca/biotype/1998/dec98/coral.html

*****Porpoises or Whales**
Pilot Census of Marine Life in Gulf of Maine
http://www.usm.maine.edu/gulfofmaine-census//Docs/Reference/cetaceans.htm

******Exotic or Invasives: European Periwinkle, European Green Crab, Asian Shore Crab**
Marine Bioinvasions Fact Sheet
http://massbay.mit.edu/resources//pdf/case-studies.pdf

Using the resources above, conduct research with your team and create a report that responds to these questions about your chosen species:

- How would you describe the appearance and size of your selected species? Include a picture if possible.
- How would you describe the life cycle of this species?
- How would you describe the distribution of this species in the Gulf of Maine?
- What is the importance of this species?

- For Commercial Species(*): How would you describe the fisheries landing history of your species? Where applicable, create a graph of the fish landings over time.
- For Food Resource Species (**): How does your species fit into the overall food web? Create a food web diagram for your chosen species for the Gulf of Maine.
- For Rare Species (***): What are the key threats to your species' population?
- For Invasive Species (****): What threats does your species pose to native populations in the Gulf of Maine?

Additional Resources

Northeast Fisheries Science Center
Status of fisheries resources by species
http://www.nefsc.noaa.gov/sos/spsyn/species.html

Virtual Gulf of Maine
http://www.atlantisforce.org/gombankmap.html

Electronic Atlas of Groundfish Research Trawl Surveys
http://gmbis.marinebiodiversity.ca/aconw95/aconscripts/groundfishsurveymap1.html

Exploring the Gulf of Maine

You're on a QUEST!

Explore the Gulf of Maine and its watershed with your family.

1. Begin by collecting background information on the Gulf of Maine. To do this, visit your local library, or go to the Internet. Research the following:

- Find the geographic boundaries of the Gulf of Maine.
- Trace all of the rivers emptying into the Gulf of Maine back to their sources.
- Make a copy of a map of the Gulf of Maine. Draw a boundary around the Gulf of Maine watershed.

2. Investigate what you eat. Select a species of fish that you might eat that comes from the Gulf of Maine. Then research the following:

- Find out the life cycle of your species. Where does it spawn? Does it lay eggs? For how long does it live? How long does it take for it to mature so that it can reproduce?
- Does this species always live in the open waters of the ocean, or does it come closer to shore, or go upstream in a river, during some part of its life?
- Are there any threats to this species in the Gulf of Maine today?

Here are some Internet sites you can visit for your research:

Gulf of Maine Aquarium Research and education programs on the Gulf of Maine
octopus.gma.org

Gulf of Maine Council on the Marine Environment
Representatives from three states and two Canadian provinces working together to manage the Gulf of Maine; good overview of Gulf of Maine resources
www.gulfofmaine.org

Maine Department of Marine Resources Policy, educational resources, and an aquarium
http://www.maine.gov/dmr/

Northeast Fisheries Science Center Status of fisheries resources by species
http://www.nefsc.noaa.gov/sos/spsyn/species.html

Virtual Gulf of Maine
http://www.atlantisforce.org/gombankmap.html

3. Finally, support your local fishermen by eating a seafood meal!

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