Peabody Fellows

Biodiversity and Global Change Program

The Peabody Fellows Biodiversity and Global Change Program aims to improve science teaching and learning among middle and high school teachers and students in Connecticut around the topic of Biodiversity and Global Change. Global change is among the most scientific and societal issues of the 21st century as humans have an increasing impact on the environment. Understanding how global changes affect biological diversity, and vice versa, requires an integrated knowledge of the earth and life sciences. The curriculum unit, “Lobster Die-off!” developed as part of this project studies one of the local effects of worldwide issues such as ocean warming, pollution and invasive species.

Please note this unit is still in draft form. All comments are welcome.

This program is supported by a Museums for America grant from the Institute of Museum and Library Services, and the Bay and Paul Foundations.
Lobster Die-off!

An Event-based Science Unit

Introduction

*Lobster Die-off!* is a unit covering life science concepts related to the 1999 die-off of lobsters in Long Island Sound. It begins by exposing students to news coverage of this actual event that brought about significant changes in the Long Island Sound ecosystem off the coast of Connecticut and the Connecticut economy. It offers an opportunity for students to understand how natural systems are interrelated and that a problem in the environment may have multiple influences or causes.

The impetus for creating this unit came about through a presentation on the American lobster die-off by research scientist Carmela Cuomo, Ph.D. during the Yale Peabody Museum’s 2005 Biodiversity and Global Change Teachers’ Institute. This unit was made possible through generous contributions from the Bay and Paul Foundations and the Institute for Museum and Library Services *Museums for America* Award.

The Peabody Fellows Program of the Yale Peabody Museum seeks to educate students, to encourage them to experience the diversity of the natural world with a positive attitude toward scientific inquiry, and to promote the incorporation of science and scientific inquiry methods in the classroom. The program works closely with selected teachers to develop science curriculum units aligned with state and national science standards. The program has evolved into a respected resource for professional development that helps teachers show children new ways to view their environment, strengthen their observational and investigative skills, and instill a respect for biodiversity. It provides teachers with access
to the educational resources of the Yale Peabody Museum to enhance the learning experience in their classrooms.

This event-based unit is presented in the following format: Hook-Discussion-Task-Needs Assessment-Instructional Activities-Group Work on Task-Product. The unit begins by engaging students in the problem through real-life news reports and personal stories. We call this first step “the hook” because it grabs and holds students’ attention. Discussion of the event reveals students’ prior knowledge of the related science concepts. An authentic task creates a need for teams of students to refine their knowledge and explore new concepts and processes. Student requests for needed information are met with hands-on instructional activities that prepare students to complete the task. The task leads to a final product that allows students to apply the science they have learned and to be assessed on the quality of their work.

We chose an event- and place-based approach to this unit for several reasons. Today’s literate citizens need to know how to analyze problems, ask critical questions, evaluate competing claims, and formulate and test tentative explanations of events. They also need to acquire scientific knowledge and apply it to new situations. The event-based approach allows students to accomplish all this by placing the study of science in a meaningful, interdisciplinary context in which students can perceive the role that science plays in the lives of ordinary people.

We believe that learning is most effective when students have been actively engaged in its pursuit. Instead of merely memorizing information from a textbook, the students become active participants in an inquiry whose ultimate product is knowledge. Their instructors serve primarily as guides and advisors, assisting students as they build and test their knowledge.
Lobster Die-off! includes a range of activities and strategies. Cooperative learning structures, open-ended laboratory investigations, guided discussions, statistical analyses and performance assessments are included. The unit tells a story about a real event and contains actual news articles, interviews with people who experienced that event, and descriptions of the scientific concepts involved. The resources included here, however, are not intended to be exhaustive. Teachers will want to supplement the texts provided with their own insights, experiences, explanations and demonstrations, encouraging students to explore information at the library, on the Internet, on CD-ROMs, and from other resources. For more information on the event-based science approach to learning, we recommend that educators visit www.eventbasedscience.com.

National Science Content Standards

Scientists try to explain events by observing, questioning, experimenting and confirming. This unit uses these National Science Education Standards (NSES): Science as Inquiry, Physical Science, Life Science, Earth and Space Science, Science in Personal and Social Perspectives, and History and Nature of Science. The chart that follows lists the standards and examples in this unit:
<table>
<thead>
<tr>
<th>Standard</th>
<th>Targets in This Unit</th>
<th>Sample Indicators</th>
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<tr>
<td>Science as Inquiry</td>
<td>• Abilities necessary to do scientific inquiry</td>
<td>• Design a scientifically valid experiment</td>
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<td>• Understanding about scientific inquiry</td>
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<td>Physical Science</td>
<td>• Understanding about properties and changes of properties in matter</td>
<td>• Explore movement of and temperature changes in water</td>
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<td>• Motions and forces</td>
<td>• Identify how organisms can change water chemistry</td>
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<td>• Transfer of energy</td>
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<tr>
<td>Life Science</td>
<td>• Understand structure and function in living systems</td>
<td>• Identify structures on and adaptations of a lobster</td>
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<td>• Populations and ecosystems</td>
<td>• Investigate factors affecting lobster populations</td>
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<td>• Diversity and adaptations of organisms</td>
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<tr>
<td>Earth and Space Science</td>
<td>• Structure of the Earth system</td>
<td>• Explore the relationship between climate and the Earth’s features</td>
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<td>• Earth’s history</td>
<td>• Explore the history of Long Island Sound</td>
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<td>• Earth’s features</td>
<td>• Investigate how orbital and axis variability affect climate</td>
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<td>• Earth in the solar system</td>
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<tr>
<td>Science in Personal and Social Perspectives</td>
<td>• Populations, resources and environments</td>
<td>• Investigate the relationship between population and global changes</td>
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<td>• Risks and benefits</td>
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<td></td>
<td>• Science and technology in society</td>
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</tr>
<tr>
<td>History and Nature of Science</td>
<td>• Science as a human endeavor</td>
<td>• Appreciate that women and men of various ethnic backgrounds successfully</td>
</tr>
<tr>
<td></td>
<td>• Nature of science</td>
<td>engage in science every day</td>
</tr>
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<td></td>
<td></td>
<td>• Recognize that scientists can draw different conclusions from the same data</td>
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The Connecticut Core Science Curriculum Framework
Included within each of the activities are the content standards that give general learning goals for the unit, supportive concepts that provide more specific information about the focus of the learning unit and expected performances which identify specific knowledge and abilities that will be assessed.

The Hook

The Hook used to engage students in global and environmental change is two-part. It begins with a real-life news report as a springboard for discussion that leads to scientific concepts related to the lobster die-off of 1999. Follow this up by having students read the four student handouts for the Hook: Lobster Tales, The Perfect Warm, On the Job: Carmela Cuomo, Ph.D., and Conditions in Long Island Sound. The first is an article about a local lobster fisherman who experienced the die-off firsthand. His story, in which he explains how he was forced out of the work he had pursued for many years, demonstrates the impact that environmental changes can have on the lives of real people. The second offers early theories as to possible causes for the die-off. The third offers a profile of one scientist who studied the event in depth, and the fourth provides insight into Long Island Sound conditions. Small-group discussion of the answers to guiding questions allows the teacher to uncover students’ prior knowledge about this event in Connecticut’s recent history.

Their focus on the 1999 lobster die-off in Long Island Sound will expose students to a range of issues. At the beginning of the event, scientists were extremely puzzled. What was causing the lobsters to die, thereby destroying not only the creatures themselves, but a thriving industry related to lobster fishing? Like those scientists, students will consider a range of possibilities, including: were the lobsters suddenly exposed to harmful bacteria or
parasites? Were they victims of heavy pesticide use and stormwater run-off into their estuarine habitat? Was an invading alien species of plant or bacteria killing them off? Was their habitat drastically altered as a result of climate change, and if so, were they simply unable to adapt to warmer water temperatures, or did warmer water temperatures cause hypoxia – an algal bloom that resulted in greatly reduced oxygen levels in the water, so that the lobsters could not respire?

Divide the class into teams. Designate a recorder for each team. Have each team discuss what they learned and discuss/answer the following:

1. Lobsters are crustaceans. Describe where they live.
2. Lobster harvesting is a major industry. Describe the change that took place in that industry in Connecticut between 1998 and the present.
3. Why might inshore lobsters have been at greater risk to die-off than offshore lobsters?

Have the recorder for each team write the group’s best answer to each question on a large sheet of newsprint for use in a “Blackboard Share” session. Have the recorder report the team’s answers using the recorded list. After all teams have reported their answers, the class should look for areas in which they see agreement or disagreement. The sheets of newsprint can be saved and used at the end of the activity as a way for students to compare their level of understanding before and after the unit.

Distribute the handout for the Hook: Charting Your Conclusions, one to each team. Then ask: What more do you need to know to understand what caused the 1999 lobster die-off in Long Island Sound? Have them work in their teams to fill out the chart, identifying what they know about the die-off so far, what they need to learn in order to understand what caused the die-off and strategies for discovering what they need to know. Share the charts as a whole class activity, then save the charts for students to refer to while completing the Task.
Following their exposure to the Hook, but before they initiate the Task, students will work independently, in pairs and in groups on a series of Investigative Activities. The activities are designed to expose students to concepts that were part of the knowledge base of scientists who worked on the problem. Those basic concepts include the physiology of lobsters, how bacteria and parasites affect living organisms, the Long Island Sound ecosystem, habitat loss, climate change, biodiversity and hypoxia. Following each Investigative Activity, it is important to hold a class discussion on the usefulness of the information gained. Students should be encouraged to brainstorm ways they can use the information in their presentations.
Student Handout: The Hook

Lobster Tales

Theories swirl like the current as the Long Island Sound lobster die-off continues. For nearly 20 years, Tony Carlo of Norwalk had spent his summers hauling lobster traps out of Long Island Sound. “We had some good years and we had some not-so-good years,” Carlo said. “No matter what, though, you knew there would always be something in those traps.”

But in late August and early September 1999, that something turned out to be a lot of dead and dying lobsters, rotting and tangled in his trawls. “I had to throw all of them back,” he said. “I stopped counting at 1,200 lobsters. It was disgusting.” In the two years since, Carlo has all but given up on his profession as a lobster fisherman; he recently opened a landscape company. “I’ve been fishing for lobsters for a long time, and I know it’s a hard business,” he said. “But this isn’t right; it isn’t normal. Now you go out there and you might pull one lobster out of seven or eight traps – if you’re lucky. All the lobsterman are picking up and moving out of here. It’s not like it used to be.”

His story echoes along the Fairfield County coastline, where lobster catches are a fraction of those in the eastern part of the Sound and in northern New England. The fishermen have their own theories about what caused – and continues to cause – the die-off, while government officials offer a different set of possible explanations. Meanwhile, two years after Tony Carlo first pulled decomposing lobster carcasses from his traps, the animals have yet to make a comeback.

To help understand the problems, some knowledge about this crustacean is needed. Lobsters are solitary, territorial crustaceans that live in a variety of different habitats preferring areas that have a rocky or soft mud bottom to one that is sandy. Inshore lobsters
like those in Long Island Sound are thought to move in localized areas during their lifetime, while offshore lobsters often migrate long distances from the edge of the continental shelf to inshore waters in late spring and summer and back again in the fall. Lobsters eat a variety of slow moving bottom-dwelling shellfish like mussels, clams, sea urchins, starfish, worms, crabs – even small fish. They are nocturnal animals that generally avoid sunlight, and will seek out crevices in the rocks to spend the daylight hours, especially in shallow waters.

Lobster harvesting has been a Long Island tradition since colonial times. Lobsters are primarily harvested in Long Island Sound with baited pots that are set at the bottom and marked by buoys. The lobster pots today are similar to the pots that were used throughout the Northeast for decades. But in recent years the lobster industry has implemented several improvements, one of which is an increase in the size of the opening in the pots, allowing more and undersized lobsters to return to open waters.

The American Lobster is one of the most important seafood products harvested in New York and Connecticut both in terms of the total value of lobsters landed and the number of commercial fishermen who make their living in the lobster fishery. Earning a dockside value in New York alone of over $29 million in 1998 according to the National Marine Fisheries Service statistics, the lobster catch was greater than the value of all fin fish combined in 1996, 1997, and 1998. Their decline since fall 1999 is therefore a cause for great concern.

It appears then that the problems that are currently concerning scientists, and lobstermen, surround populations in specific areas. In Long Island Sound there have been abnormally large lobster die-offs caused at least in part by diseases since 1999. Scientists are exploring multiple avenues in order to discover the origins of these unusually large die-offs. Some factors include:
• bacterial infections that cause the breakdown of the exoskeleton
• a parasite that attacks the nervous system
• higher than normal water temperatures
• environmental effects of pesticide use
• pollution
• changes in dissolved oxygen levels

For more information, see www.seagrant.sunysb.edu/LILobsters/aboutlobsters.htm
Student Handout: The Hook

The Perfect Warm – The Long Island Sound Die-Off by Mike Crowe

In September 1999 the lobster fishery in western Long Island Sound sustained a sudden 98 percent die-off.

The disaster put many lobster fishermen in the Sound out of business. The states of New York and Connecticut began investigations into the dramatic event. The immediate focus was on a parasite, a paramoeba, found in the flesh of some lobsters. Another early suspect were the pesticides used in the West Nile virus scare that same fall.

At the Fishermen’s Forum held in March ’05, in Rockland, Me., scientists who have studied the problem in the years since, presented their findings in an all-day seminar. Scientists from Maine, Connecticut, New York, Georgia and Canada reported on various aspects of the problem; a few had some of the same conclusions to offer.

Some fishermen were convinced that the die-off was the result of chemicals sprayed along the coast. The chemicals were sprayed to kill mosquitoes believed responsible for the West Nile virus. Others blamed the paramoeba. None of the scientists identified a very specific cause, but many at the Forum agreed that lobsters are very temperature-sensitive. This, many agreed, could be critical to understanding whatever it was that killed the lobster in such great numbers.

For more information, see www.fishermensvoice.com/archives/perfectwarm0905.html
On The Job: Carmela Cuomo, Ph.D., Marine Benthic Biogeochemical Ecologist

Dr. Carmela Cuomo’s job title is a special one: Marine Benthic Biogeochemical Ecologist. Marine means salt water. Benthic means “at the bottom.” Biogeochemistry involves the study of the chemical, physical, geological and biological processes and reactions that control the make-up of the natural environment. Ecology is the study of interrelationships between living things and their non-living parts of the environment.

Dr. Cuomo presented information gathered as a research scientist at Yale University in New Haven, Conn. Cuomo coordinates the marine biology program at the University of New Haven. Having done research on low oxygen marine systems, she was one of the scientists asked to study the lobster die-off and the conditions of the lobster habitat at that time. Cuomo’s presentation brought together lobster stress factors that had been known to exist in the Sound. These factors and others were brought together, she believes, by a weather event that led to a weakening of lobsters to a point where practically anything would have . Other scientists at the Forum had studied the effects of various substances in the environment on the health of lobsters.

All interested parties were asking the same questions: What was the cause and what was the cure? They also wondered how to prevent this from occurring elsewhere.
Student Handout: The Hook

Conditions in Long Island Sound

What do the researchers know about conditions in Long Island Sound in 1999? In the fall of 1998, lobster deaths and reports of a new disease were coming in from widely dispersed geographical locations. In the fall of 1999, the focus zeroed in on Long Island Sound, where the second successive year of high mortality was taking a toll on lobster landings. Elsewhere, landings remained high. What was different about the Sound?

Lobsters are long-lived animals. Their natural life expectancy is estimated to be somewhere between 50 and 100 years. The largest lobsters ever measured weighed in at more than 40 pounds! For some reason, lobsters in Long Island Sound don’t seem to grow this large or live this long. They grow faster than lobsters elsewhere and have a life expectancy of only five or six years. Large lobsters seemed to be extremely rare or non-existent in the Sound.

Small lobsters molt more frequently than large lobsters. Molting is a physiologically demanding and weakening process. Therefore, lobsters are more susceptible to death when they are molting. If a large lobster is afflicted with an ailment, it has more time to deal with the problem before it has to go through a molt (shed).

Chemicals had been sprayed along the Connecticut Coastline to kill mosquitoes believed to be responsible for West Nile Disease. Hypoxia had been a recurring problem in western Long Island Sound since the early 1990’s and a moderately severe hypoxic event occurred in LIS during the summer of 1999 (Cuomo) A parasite called paramoeba was found in the flesh of some lobsters. Western Long Island Sound is described as heavily
industrialized. A large amount of organic material is released into the sound from 140 sewage treatment plants.

As reported by Dr. Cuomo, surface temperatures for 1999 were high (exceeding 22°C) for an extended period of time. The winter of 1999 was followed by an above-average warmer summer, resulting in warmer than normal surface water temperatures. An August storm in 1999 caused an unusual mixing event in which temperature, salinity, and oxygen experienced a rapid change in the bottom waters of western Long Island Sound. In September 1999, stratification was re-established by the rainfall caused by Tropical Storm Floyd. Bottom temperatures were recorded at 24°C. This destratification resulted in a rapid 1°C increase in the bottom water temperatures in LIS over a 6-hour period. Bottom water temperatures remained above 21°C for September.
### Charting Your Conclusions

<table>
<thead>
<tr>
<th>What we know about the lobster die-off in Connecticut</th>
<th>What we want to know about the lobster die-off in Connecticut</th>
<th>Strategies for learning what we want to know</th>
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The Task
The culminating product for this unit is a 10- to 15- minute newscast. Students will take on the role of a news team to produce a newscast on one of five possible causes of the lobster die-off. Teams may choose to perform their newscast live for the rest of the class or play a videotape they produce themselves. After the class is divided into teams, each team should meet to develop a list of questions they wish to have answered before they are ready to start the task, as well as the different sub-tasks involved and the team members who will be responsible for each. A student handout is provided to help facilitate this team-organizing activity. Background information to help students begin answering their questions is provided by Discovery Files.

Different phases of the Task allow the teacher to monitor the progress of each team. You may want to schedule team and/or individual checkpoints to keep students focused and moving ahead. If some students finish science activities early, you may want to let them begin working on the task.

Plan to allow students some class time to organize and practice their newscasts. Some may be able to meet and work outside of class, but others will need in-class time. Have all team members keep an activity journal containing their notes, ideas, results, charts, graphs, and art developed as the activities are completed. This activity journal will be very helpful to students as they prepare for the task itself. Toward that end, teachers will want to provide class time for students to write in their journals. It may also be helpful to create classroom space in which journals may be stored to increase the likelihood that regular journal entries will be made.

Once sufficient background has been covered, have students identify roles within their teams. With teacher assistance, most students will do a good job of matching their skills and interests to the requirements of each role. Some students will need extra guidance to help
them develop their newscast. Teachers will want to keep a set of reference books in the classroom during the course of the unit.

Performance assessment is reflected within all the activities and within the final task itself. The unit can be completed in four to six weeks, depending on how much time the teacher chooses to devote to each activity. A four-week framework is outlined here. We recommend setting up the Winogradsky Column for Activity 6 at the beginning of the unit since the activity must be completed in weekly stages. Upon completion of the Investigation Activities, students will be ready to take on the challenge of the Task: an in-depth look at one of a number of influences upon the lobster die-off. At the end of the presentations, you will want to engage in a whole class discussion, allowing teams the opportunity to hypothesize which of the influences studied is believed by scientists to be the actual cause of the die-off. Remind students that even scientists disagree on this final cause, but a majority of them have formed similar conclusions based on the available evidence.

**Four-week Unit Framework**

**Week 1 (Topic: Lobsters)**

Hook and Task introduction

Set up Activity 6: A Microbial City

Activity 1: Lobster Food Web

Activity 2: Lobster Physiology, Parts 1, 2, and 3

**Week 2 (Topic: Long Island Sound and Biodiversity)**

Activity 3: Long Island Sound

Activity 4: Temperature Tracking
Activity 5: Temperature and Biodiversity

Activity 6: A Microbial City, Week 2 Observations

Week 3 (The Task)

Activity 6: A Microbial City, Week 3 Observations

Students work on the Task

Week 4 (Presentations)

Activity 6: A Microbial City, Week 4 Observations

Students work on the Task

Student presentations and evaluations
Student Handout: The Task

You’ve seen the news. The lobster industry in Connecticut is collapsing. Lobsters, once in plentiful supply in Long Island Sound’s waters off Connecticut, are dead and dying. People who have spent their lives as lobster fishermen can no longer work at what they know how to do.

What is happening? What is killing off the lobsters in Long Island Sound? Is it hypoxia? Higher water temperatures due to climate change? Disease? Pollution, such as chemicals sprayed to control mosquitoes that have gotten into the Sound through run-off? Or is it the over-exploitation and over-harvesting of the lobsters themselves?

The 1999 lobster die-off in Long Island Sound was a real event that still has repercussions today in Connecticut’s economy and how we view the Sound. Your team will take one of five possible issues and investigate it in detail, presenting your findings to the rest of the class. Then, as a class you can hypothesize which issue or issues actually brought about the lobster die-off. Finally, your teacher will share with you the findings of scientists who studied the die-off and what they now conclude really happened.

Your Task

People are concerned about what is happening in Long Island Sound. Reacting to those concerns, the local television station has decided to air a special segment each night for one week on the possible causes of the lobster die-off. The station has hired your news team to produce the special. Your task has two parts: the production itself and a presentation, in which you will either dramatize or videotape your special news segment for the rest of the class. Each news team will focus on one possible cause of the lobster die-off and create their special segment.
**Part 1: The Production**

The program must contain general information about lobsters and their physiology, as well as the estuary habitat of Long Island Sound where they live. Your special segment must include facts about how the possible cause you are investigating affects lobsters. The News Editor at your television station wants you to document the accuracy of your presentation, so you will need to keep a log. The log should contain all notes, science activities, charts, graphs, and/or photocopied materials you use to prepare your news segment.

**The Roles**

There will be four members on your team. Each member has a different job to perform. The jobs are producer, scriptwriter, director and prop manager. When you first meet with your team, decide how you will assign the jobs. Make a list of who will do each job and submit the list to your teacher. Also discuss whether or not you are ready to begin. Is there anything about lobsters or Long Island Sound that you need to know more about? How might you go about gathering the information that you need? Let your teacher know about any concerns you have about getting started.

**Job Descriptions**

**Producer will:**

1. Write the portion of the script about the American lobster and develop visual aids that describe the American lobster and how it is being affected by the issue your team is investigating.
2. Write a memo to the News Editor of the station to keep that person informed about your team’s daily progress.
3. Develop an outline of your news segment for the News Editor of the station at least three days before you are ready to videotape or dramatize it. Provide a description of the topics you plan to present.

4. Keep a time line of the production schedule and ensure that the team is staying on schedule.

5. Take part in the dramatic presentation as needed.

Scriptwriter will

1. Write the portion of the script and develop visual aids that explain what effect if any the issue you are investigating has on biodiversity in Long Island Sound. Explain the effects on the lives of people in Connecticut.

2. Work with the other members of your news team to develop the final script of the program, indicating the scenes, character names and words to be spoken.

3. Assist the director in helping other team members with their jobs.

4. Take part in the presentation.

Director will:

1. Assist the producer to write the portion of the script and develop visual aids that explain how the issue you are investigating affects lobsters and how it may contribute to the lobster die-off.

2. Select a musical theme for the news segment and assist other members of the team with their jobs.

3. Organize and direct rehearsals for the presentation.

4. Take part in the presentation as needed.
Prop Manager will:

1. Write the portion of the script and develop visual aids that describe background information surrounding the issue your team is investigating. Present facts about the issue.

2. Prepare a large, colorful and creative poster announcing the name of your news segment.

3. Create or gather all necessary props, posters, charts, maps and other materials needed for the news segment.

4. Operate the camera (if the team is producing a video) or take part in the presentation as needed.

**Part 2: The Presentation**

The final part of this unit is the performance itself. All members of your news team will perform the program. The performance should include guest “experts,” played by members of your team. Experts could include lobster fishermen, marine biologists, concerned citizens and others.

Your team may decide whether to videotape the program or perform it live in the classroom. The program will be between ten and fifteen minutes long. Be creative in developing your presentation.

**About Lobsters**

Before proceeding to the Investigative Activities, you will want to review and set up Activity 6: A Microbial City. Students will subsequently make observations at the end of each week and record data using the Student Handout for Activity 6.
Activity 1: Lobster Food Web

Objectives

Students will understand where lobsters fit in a Long Island Sound food web.

CT Science Content Standard

6.2 An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact

- Populations in ecosystems are affected by biotic factors, such as other populations, and abiotic factors, such as soil and water supply.

NSES Content Standards

- Populations and ecosystems
- Diversity and adaptations of organisms

Materials

Discovery File: What is a Lobster?

Long Island Sound Study’s “Inside a Long Island Sound Food Web”

Procedure

1. Have students read the Discovery File: What is a Lobster? If time allows, have students research more on lobster natural history.

2. Hand out Long Island Sound Study’s “Inside a Long Island Sound Food Web”:

http://www.longislandsoundstudy.net/soundhealth/Poster_Letter_size.pdf

Have students draw in a lobster and draw connections to other organisms in the web. Have students write an explanation about where and why connections were made.
3. Discuss connections. Are there any additional plants or animals that should be included?

**Scoring rubric**

- The student’s connections to and from the lobster on the food web are reasonably accurate and titled and labeled properly. The explanation of lobster interrelationships are well written and reasonably accurate. 3 points
- The student’s connections to and from the lobster on the food web are partially accurate and titled and labeled properly. The explanation of lobster interrelationships is complete but shows some lack of understanding of concepts and is not written clearly and properly 2 points
- The student’s connections to and from the lobster on the food web are wholly inaccurate and incompletely titled and labeled. The explanation of lobster interrelationships is incomplete and shows significant lack of understanding of concepts or is not written clearly and properly. 1 point
Discovery File: What is a Lobster?

What is a Lobster?

What does a lobster have in common with a grasshopper? Well, more than you might think. It might be hard to believe that lobsters are actually related to insects, but like insects, they belong to the invertebrate phylum Arthropoda. Insects and lobsters are animals that have an exoskeleton (outer skeleton) and jointed legs.

Unlike insects, lobsters belong to the class Crustacea, along with other marine organisms like crabs, crayfish and shrimp. A crustacean is an invertebrate animal with several pairs of jointed legs, a hard protective outer shell, two pairs of antennae, and eyes at the ends of stalks. Because lobsters have ten legs, they belong to the order Decapoda (latin for ten feet). The American Lobster or true lobster (as opposed to the spiny lobster) is classified as follows: Kingdom: Animalia, Phylum: Arthropoda, Subphylum: Crustacea, Class: Malacostraca, Order: Decapoda, Family: Nephropidae, Genus: Homarus, Species: Americanus.

Lobsters live on rocky, sandy, or muddy bottoms from the shoreline to beyond the edge of the continental shelf. They generally live singly in crevices or in burrows under rocks. Although many studies have suggested that lobsters are primarily scavengers, that is, animals that consume already dead organic life-forms, recent studies have shown that they primarily feed on live fish, dig for clams, sea urchins, and feed on algae and eel-grass. They occasionally eat other lobsters, too. An average adult lobster is about 230 mm (9 inches) long and weighs 700 to 900 g (1.5 to 2 pounds). Lobsters grow throughout their lives, molting or shedding their exoskeleton or outer body covering as they increase in size.
Like all arthropods, lobsters are largely bilaterally symmetrical, although they have unequal, specialized claws, a **cutter claw** for tearing food and a **crusher claw** for crushing food. The anatomy of the lobster includes the **cephalothorax** which is the head fused with the upper body, both of which are covered by the **carapace**, or shell. The **walking legs** of the lobster extend from the cephalothorax. Lobsters have two **antennae** on their heads that serve as sensory organs. Lobsters have compound **eyes** at the end of short stalks. Because they live in a murky environment at the bottom of the ocean, however, their vision is poor and they rely on their antennae as sensors. The spine-like projection on the front part of a lobster is called the **rostrum**. The **abdomen** is sometimes referred to as the “tail” of the lobster. It includes the **pleopods** or swimming legs, sometimes called swimmerets. The **telson** is the fan-like part at the end of the abdomen.

Lobsters have a simple **brain**, a collection of nerve endings. Its **heart** is a simple nerve-muscle system. The **nerve cord** connects the brain to major muscles and organs of the body. The lobster extracts oxygen from the water with the use of twenty **gills** attached to the base of the legs and to the sides of the body.

In general, lobsters move slowly by walking on the bottom of the seafloor. However, when they are in danger and need to flee, they swim backwards quickly by curling and uncurling their **abdomen**. A speed of five meters per second has been recorded.
[STAND IN PAGE FOR LOBSTER FOOD WEB VISUAL]
Activity 2: A Lobster’s Body

Objectives

Students will identify the different body parts of a lobster, preparatory to relating how changes in the Long Island Sound ecosystem affected lobsters physiologically.

CT Science Content Standard

7.2 Many organisms have specialized organ systems that interact with each other to maintain dynamic internal balance

• Multicellular organisms need specialized structures and systems to perform basic life functions

NSES Content Standards

• Structure and function in living systems
• Diversity and adaptations of organisms

Materials


Procedure

1. Complete a classroom crayfish dissection using the guide provided or have students view the online virtual crayfish dissection located at http://biog-101-104.bio.cornell.edu/BioG101_104/tutorials/animals/crayfish.html
2. Guide students in defining the terms dorsal (from the top), ventral (from the bottom) and interior (inside) and physiology (about the body). Working in pairs, students identify the following lobster physiology terms on the three A Lobster’s Body handouts: Dorsal, Ventral and Interior Views: abdomen, antennae, brain, carapace, cephalothorax, crusher claw, cutter claw, eyes, gills, heart, nerve cord, pleopods, rostrum, telson, walking legs. List the lobster physiology terms on the chalkboard or refer students to the handout Lobster Labels. Review the lobster handouts. Then have students complete the handout Lobster Labels by matching up each body part with its description. Answer Key: 1. j, 2. m, 3. n, 4. o, 5. e, 6. g, 7. f, 8. h, 9. d, 10. a, 11 l, 12. k, 13. b, 14. c, 15. i.

3. As a follow up, students complete the word search puzzle of words relating to lobster physiology. Correct using the key below.

```plaintext
N E R V E C O R D C
H C U
C A R A P A C E R A T
N Y A U B T B
T E R S D E R
C E P H A L O T H O R A X
N E M C I
N O S L E T R E L N
A S C N A
E T S B O L W
R O S T R U M A L
S D O P O E L P W I
W A L K I N G L E G S G
```
Scoring Rubric

Assess students on the basis of the lobster diagrams labeled correctly, the number of correct lobster physiology terms defined using the keys for these activities.

• Almost all lobster parts correctly labeled and terms correctly defined.  3 points
• Most lobster parts correctly labeled and terms correctly defined.  2 points
• Few lobster parts correctly labeled and terms correctly defined.  1 point
Activity 2, Part 1a Student Handout

Lobster Physiology: Dorsal View

Name ________________________________

Directions: Identify the body parts from the list of lobster physiology terms on the lobster dorsal view below.

[LOBSTER DORSAL VIEW VISUAL TO COME HERE]
Activity 2, Part 1b Student Handout
Lobster Physiology: Ventral View

Name ________________________________

Directions: Identify the body parts from the list of lobster physiology terms on the lobster ventral view below.

[LOBSTER VENTRAL VIEW VISUAL TO COME HERE]
Activity 2, Part 1c Student Handout

Lobster Physiology: Interior View

Name ________________________________

Directions: Identify the body parts from the list of lobster physiology terms on the lobster interior view below.

[LOBSTER INTERIOR VIEW VISUAL TO COME HERE]
**Activity 2, Part 2 Student Handout: Lobster Labels**

Name __________________________

Directions: Match the names and descriptions below. Write the letter of the description in the space next to each lobster body part.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>____ Antennae</td>
<td>a. Organ used for seeing; in the lobster they are moveable, stalked and compound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>____ Cephalothorax</td>
<td>b. Bundle of nerves that connects the brain to major muscles and organs of the body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>____ Rostrum</td>
<td>c. Swimmerets or swimming legs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>____ Abdomen</td>
<td>d. Appendages that allow a lobster to be mobile on the bottom of the ocean floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>____ Carapace</td>
<td>e. The top of the hard exoskeleton, or shell of the lobster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>____ Crusher Claw</td>
<td>f. The smaller of the lobster’s claws, used in tearing flesh to help feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>____ Cutter Claw</td>
<td>g. The heavier of a lobster’s claws, used to crush food.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>____ Telson</td>
<td>h. The second segmented section of lobster. A lobster’s tail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>____ Walking legs</td>
<td>i. Used to extract oxygen from the water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>____ Eyes</td>
<td>j. A pair of slender movable organs of touch on the head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>____ Brain</td>
<td>k. Simple nerve-muscle system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>____ Heart</td>
<td>l. In the lobster, a collection of nerve endings or ganglia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>____ Nerve cord</td>
<td>m. Joined head and thorax or upper body segment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>____ Pleopods</td>
<td>n. Spine-like projection on the front part of a lobster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>____ Gills</td>
<td>o. Often called the tail, the second segmented section of a lobster.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Activity 2 Student Handout: Lobster Word Search

Name __________________________

Directions: Circle the following words related to lobster physiology in the puzzle. Words may appear forwards, backwards, up, down and diagonally.

<table>
<thead>
<tr>
<th>abdomen</th>
<th>crusher claw</th>
<th>nerve cord</th>
</tr>
</thead>
<tbody>
<tr>
<td>antennae</td>
<td>cutter claw</td>
<td>pleopods</td>
</tr>
<tr>
<td>brain</td>
<td>eyes</td>
<td>rostrum</td>
</tr>
<tr>
<td>carapace</td>
<td>gills</td>
<td>telson</td>
</tr>
<tr>
<td>cephalothorax</td>
<td>heart</td>
<td>walking legs</td>
</tr>
</tbody>
</table>
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A Sense of Place: Long Island Sound

Activity 3: Where and What is Long Island Sound?

Objectives
Students will be familiar with the geography of the Sound, will understand that the Sound impacts Connecticut’s economy, and will understand that the Sound is an estuary.

Connecticut Science Standards
TO COME

NSES Content Standards
TO COME

Materials
Map showing Connecticut and Long Island Sound

Background
Part of the reason the lobster die-off was chosen as a topic for this unit was its relationship to Connecticut and Long Island Sound. The Sound an important feature of Connecticut’s landscape and traditionally has played an important role in CT’s economy. The Sound provides feeding, breeding, nesting and nursery areas for a diversity of plant and animal
life, and contributes billions of dollars each year to Connecticut’s economy from boating, commercial and sport fishing, swimming, and sight-seeing.

More than eight million people live in the Long Island Sound watershed that includes Connecticut, parts of other New England states and New York. The development in this region has increased some types of pollution, altered land surfaces, reduced open spaces, and restricted access to the Sound.

Procedure

1. In order to help give students a sense of place, share the map of Connecticut’s coast that shows where the Sound is located. Help them identify the four major rivers that provide freshwater to this estuary ecosystem: the Connecticut, Thames, Housatonic and Quinnipiac. Then help them identify the two connections to the Atlantic Ocean that provide the salt water to the Sound: The Race at the eastern end of the Sound and the East River at the western end.

2. As a whole class activity, have students divide into teams and see which team can come up with the most ways in which Connecticut residents benefit from living on or near the Sound.

3. Ask if students can define the word estuary. Guide students in understanding the meaning of estuary: a place where salt water and fresh water meet and mix. Then have them read the Discovery File: Long Island Sound: An Estuary Ecosystem. As an extension activity, you may want to share the Discovery File: How the Sound Came to Be.
Discovery File: An Estuary Ecosystem

Long Island Sound is an ecosystem, that is, a community of organisms that interact with one another and with their environment. The elements of an ecosystem are interdependent – so much so that if one part of the physical environment changes or is destroyed, the entire ecosystem can be affected.

Within a single ecosystem, a number of habitats may exist. A habitat is the place where a plant or animal lives. A habitat provides certain basic needs of any organism including food, oxygen or water, space and shelter. Different habitats found in the Long Island Sound ecosystem include sandy beaches, tidal flats, salt marshes, and intertidal zones.

Long Island Sound is also an estuary – a protected coastal body of water in which salt water from the ocean meets and mixes with fresh water from a river or stream. Long Island Sound is a very large, very complex estuary. It encompasses two sources of salt water from the Atlantic Ocean (the Race at the eastern end of the Sound and the East River at the western end of the Sound) and four major rivers: the Connecticut River, Thames River, Housatonic River and Quinnipiac River, as well as many streams. Long Island Sound contains estuaries within estuaries where each of these rivers or streams enters the larger Sound.

The Sound is located at 41 degrees North latitude, 73 degrees West longitude, is about 110 miles long and 21 miles long at its widest point. Its average depth is 65 feet, although it is 350 feet deep at its deepest point. Long Island Sound is a place of rich biodiversity with many different kinds of plants and animals. The organisms of the Sound must often adapt to significant fluctuations of temperature and salinity (how “salty” the water is).
The salinity of the Sound can vary greatly, depending on the time of year, weather and tides. Ocean saltwater has a salinity of 35 parts per thousand (35 ppt). The average salinity of the Sound is 28 parts per thousand (28 ppt). Where the Quinnipiac River enters New Haven Harbor, the salinity of the surface water can be as low as 15 ppt after a rainstorm. Cold salt water has a higher density than warmer fresher water. This results in thermal stratification, giving the waters of the Sound a unique circulation pattern.

The Sound was formed during the last ice age more than 20,000 years ago. A glacier known as the Laurentide ice sheet nearly a mile thick covered the region, and ground up about 20 meters of surface sediments as it gradually moved south. The area that would become the Sound was a fresh water lake up until about 15,000 to 19,000 years ago. At that time, the level of the sea rose until it met the level of the fresh water. Sea levels continued to rise to the level of the current shoreline and the Sound became the estuary that it is today.

(Adapted from *Long Island Sound in a Jar* by Heather M. Crawford, published by Connecticut Sea Grant, Groton, Connecticut, 1999.)
Discovery File: How the Sound Came to Be

The surface of the Earth is made up of series of rigid plates that move. When these plates collid, mountains are formed and oceans disappear; when these plates separate, oceans form and continents split apart. Sometimes the plates just move past each other, triggering earthquakes as they go. A very long time ago, 500 million years in fact, eastern Connecticut and western Connecticut were separated by a portion of the Iapetus Ocean, much like modern-day Japan is separated from the Asian mainland. Over time, plates began to collide and the Iapetus Ocean started to close, bringing the land that now makes up eastern Connecticut into contact with the land that forms modern-day western Connecticut. By the time the Iapetus Ocean was done closing, all of the Earth’s continents were arranged into one giant continent called Pangaea (which mean "all one Earth"). This collision formed the Appalachian Mountain chain, which includes the Berkshire Mountains in western Connecticut. The collision took a many thousands of years to happen, but over time, the two sides of the state of Connecticut were pushed into each other. As the rocks were squeezed together, they also heated not enough to melt them, but enough to change them. Geologists call rocks that have changed in response to heat and pressure metamorphic rocks. You can see these metamorphic rocks, such as marble, when you drive along roads in the western and eastern parts of the state of Connecticut.

The supercontinent Pangaea did not stay together very long. In fact, it started to break apart around the time that the dinosaurs started to roam the Earth. This time, about 200 million years ago, is called the Mesozoic Era by geologists. One of the places that Pangaea started to break apart was right in the middle of the state of Connecticut! A rift valley formed as the eastern and western sides of the state started to move away from each other. This valley became filled with water and formed a very large rift lake. The water level in the lake fluctuated – it went up
and down over time. Sometimes it was very deep and other times it was shallow enough for
dinosaurs to walk in it. The dinosaur footprints found at Dinosaur State Park in Rocky Hill,
Connecticut were once on the bottom of this rift lake. The sediments that filled the bottom of this
lake eventually formed the black and red sedimentary rocks that can be seen along Interstate 91.

As the continents continued to rift apart, lava started to flow into the rift valley, forming the
igneous rocks that also can be seen along Interstate 91. The rift valley in Connecticut was not the
only rift basin to form as Pangaea broke up. In fact, several formed along the east coast of North
America — including one in New Jersey, one in Canada, and one directly to the east of these. This
last one eventually opened up faster than all the others and became the Atlantic Ocean. The rest
of the rift basins, including the one in the middle of Connecticut, stopped opening and are known
as failed rift basins. The bedrock geology of the state of Connecticut consists, then, of rocks
recording three different episodes in Earth history — when the Iapetus Ocean existed, when the
Iapetus Ocean closed, and when the Atlantic Ocean formed.

One of the last great shaping influences here in Connecticut was the Laurentide Ice Sheet, the most recent glacier to come through about 10,000 years ago. This glacier still exists, but you
have to travel into Canada to find it. At one time, the glacier covered all of Connecticut, most of
Canada, and much of the northern third of the United States. It was several miles thick and
weighed many, many tons. Everything under the glacier was under massive pressure. Although
a glacier is made from ice and snow, it is not solidly frozen like an ice cube. The pressure melts
some of the ice at the bottom of the glacier into a sort of slush, which then flows along the
bottom of glacier towards oceans or lakes at the edge of the glacier. This slush carries along
anything that is not firmly attached to the ground underneath. So, rock, sticks, trees, and more
get carried along by the glacier. As objects are moved along by the slush, they bump into each
other, as well as the ground over which the glacier is moving. This bumping and grinding causes softer rocks to crumble when they come into contact with harder rocks.

When the Laurentide ice sheet came, many of the softer rocks in Connecticut were crushed and crumbled into sand by the glacier and now make up the soil of Long Island. Long Island was at the very edge of the Laurentide ice sheet in this area of the world. The river valleys in Connecticut collected a rich array of ground up rocks as the glacier melted and the waters flowed through the state into Long Island Sound. The minerals left in those ground up rocks support the rich diversity of species found in Connecticut and Long Island Sound today.