Impact of Climate Change on Hawaiian Monk Seals
Activity 2: The Odd Couple

Region: Pacific Islands

Grade Level(s): 5-6 (Life Science)

Time Required: One class period (approximately 45 minutes)

Focus Questions:

- Why do some hermit crabs have sea anemones attached to their shells?
- What are symbiotic relationships?
- What type of relationship does the Hawaiian monk seal have with coral?

Learning Objectives:

- The students will be able to define and describe symbiotic, mutualistic, commensal, and parasitic relationships between organisms.
- Students will be able to describe the benefits of a mutualistic relationship between hermit crabs and sea anemones, as well as Hawaiian monk seals and coral.

Materials:

- The "Odd Couple Investigation" Worksheets – one for each student available at: http://oceanexplorer.noaa.gov/explorations/02hawaii/background/education/media/nwhi_oddcouple.pdf
- Northwestern Hawaiian Islands Expedition log entries for September 17-20, 2002 available at: http://oceanexplorer.noaa.gov/explorations/02hawaii/welcome.html

Background:

- Coral reefs are abundant in the Northwestern Hawaiian Islands and protect a chain of small islands and atolls that stretches for more than 1,200 nautical miles (nm) northwest of the main Hawaiian Islands. While scientists have studied these shallow areas for many years, almost nothing is known about deeper ocean habitats below the range of SCUBA divers. Only a few explorations have been made with deep-diving submersibles and remotely-operated vehicles (ROVs), and these explorations have yielded discoveries of new species and species previously unreported in Hawaiian waters. Northwestern Hawaiian Islands are home to the Hawaiian monk seals, one of only two species of monk seals remaining in the world (the Caribbean monk seal was declared extinct in 2008; the other remaining species is the Mediterranean monk seal). Waters around the Northwestern Islands are an important feeding area for the seals, some of which appear to feed on fishes, octopus, and crustaceans that find shelter among colonies of deep-water corals. These corals are also of interest, because they include several species that are commercially valuable for jewelry. The possibility of discovering new coral and sponge species also has commercial importance as well as scientific interest, since some of these species may produce materials of importance to medicine or industry.

- The 2002 Ocean Exploration Expedition to the Northwestern Hawaiian Islands included mapping the previously-unexplored deep-sea regions around the islands; investigations of deepwater fishes and corals; exploration of deepwater habitats; and studies of ecological relationships between monk seals and the deep-sea environments of the Northwestern Islands. On September 20, 2002, scientists aboard the deep-diving submersible Pisces IV observed and photographed a hermit crab with what appeared to be several sea anemones attached to its shell. While none of the Expedition scientists were able to identify the species of these animals, associations between hermit crabs and sea anemones are one of the classic examples of symbiotic relationships between marine organisms.

Procedures/Instructional Strategies:

1. Introduce the location of the Northwestern Hawaiian Islands, and point out some of the features that make this area important (discussed above). Have students read the Northwestern Hawaiian Islands Expedition log entries for September 17-20, 2002 (http://oceanexplorer.noaa.gov/explorations/02hawaii/welcome.html) (you may want to have this discussion in the latter half of one class period, and assign the log readings as homework in preparation for the remainder of the activity).

2. Call students' attention to the observation of the hermit crab and cnidarian described in the September 20 log entry. Ask students to speculate on why these animals are so closely associated. Students should infer that at least one of the organisms is receiving some benefit from the association. Introduce the following relationships between organisms:
   - **symbiotic** – a relationship in which two organisms exist in close association, which may or may not benefit both organisms
   - **mutualistic** – a relationship between two organisms in which both organisms benefit
   - **commensal** – a relationship between organisms in which one organism benefits and the other is not affected
   - **parasitic** – a relationship between organisms in which one organism benefits and the other is harmed

3. Have students research answers to questions on "The Odd Couple Investigation" Worksheet using classroom references, school or public library resources, or the Internet (this research may be assigned as homework or work in-class). Suggest that one member of each group research answers to questions about hermit crabs, and the other member find answers for sea anemones. Students may find reference materials that specifically describe the hermit crab-sea anemone symbiosis.

4. Have students pool their answers, and lead a discussion of the potential benefits of the symbiosis to the hermit crab and the sea anemone. Be sure students realize that the hermit crab lives in a borrowed shell, often formerly occupied by a mollusk. Students should recognize that the anemone benefits by having a source of transportation, and may also receive a nutritional benefit from food scraps that escape the crab's feeding activities. A sea anemone is capable of moving on its own by alternately attaching to the

substrate with its tentacles and pedal disk in a sort of cartwheeling motion, but it is a very slow process.

- The primary benefit to the hermit crab is protection from predators. Students should recognize that the crab is prey to fishes and octopi, and typically retreats into its borrowed shell for protection. The octopus, however, has a strong beak that is capable of crushing mollusk shells, and the entrance to octopus dens are often marked by numerous fragments of shells that contained former meals. Sea anemones (and cnidarians in general) are equipped with stinging cells called nematocysts that may contain powerful toxins (the deadly sea wasp jellyfish is an extreme example). Octopi and many fishes are sensitive to these toxins, and the anemone is capable of delivering a discouraging sting to potential crab predators.

5. Call students' attention to the fact that the hermit crab must periodically move into a larger shell as it grows, and ask what happens to the sea anemone when the crab changes shells? A striking fact about this relationship is that when some hermit crabs change their shells, they take their anemones along! The crab causes the anemone to release its attachment to the old shell by stroking the column of the anemone, then brings the anemone close to the new shell. The anemone holds onto the new shell with its tentacles until it re-attaches its pedal disk, then the happy couple is off again!

6. Final outcome/assessment: R.A.F.T. Assessment: Role of the writer, Audience, Format, Topic. (See References section for more information on R.A.F.T.)
   - Have the students role play a symbiotic relationship with another organism. Have them summarize their perspective of the symbiotic relationship.

Extensions:

- Have students write a short essay describing a symbiotic relationship that they personally have or have had (for example, with a friend, a parent, a pet, etc.)
- Have the students pretend they are the newly appointed Hawaiian Monk Seal Recovery Team. Ask them what steps they would take to protect and conserve the population, and what their recovery plan would entail.

National Science Education Standards:

Science as Inquiry

- Developing the abilities necessary to do scientific inquiry.
- Developing understandings about scientific inquiry.

Regulation and Behavior

- Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

Populations and Ecosystems

- A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers--they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Diversity and Adaptations of Organisms

- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Earth Science – Structure of the Earth System

- Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle". Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain

or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.

- Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.

- Clouds, formed by the condensation of water vapor, affect weather and climate.

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Physical Science

- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Additional Resources:

- National Marine Sanctuary Maps
  http://sanctuaries.noaa.gov/pgallery/atlasmaps/nwhimnm.html
- Hawaiian Monk Seals
  http://www.earthtrust.org/wlcurric/seals.html
- Crittercam
  http://www.nationalgeographic.com/crittercam/
- NOAA Ocean Explorer
  http://oceanexplorer.noaa.gov
- Biology of Anomurans
  http://museumvictoria.com.au/crust/hermbiol.html
- Volcanoes of the Deep
  http://www.pbs.org/wgbh/nova/teachers/activities/2609_abyss.html
- Papahānaumokuākea Marine National Monument
  http://www.hawaiireef.noaa.gov/imagery/welcome.html
- Northwestern Hawaiian Islands vs. the United States
  http://www.hawaiianatolls.org/maps/NWHI_atop_US.jpg

References:

1. The Odd Couple Lesson Plan, NOAA
- http://oceanexplorer.noaa.gov/explorations/02hawaii/background/education/media/nwhi_oddcouple.pdf

2. Strategies for Reading Comprehension: R.A.F.T. Papers, Nancy Vandervanter, in Adler, 1982 (http://readingquest.org/strat/raft.html)

3. Rubric for R.A.F.T.
(http://tides.sfasu.edu/Teachers/LessonPlans/PaulaWarden/RaftRubric.pdf)