Lesson Plan—Satellite Tracking

Summary

Students use satellite tagging data to follow the movement of marine animals over time. Examining satellite maps of sea Surface Temperature (SST) and chlorophyll-a data combined with satellite tagging data, students answer questions related to open-ocean animals, their habitats and migratory behaviors.

Subject Areas

Biology, Earth Science

Grade Level

9-12

Key Concepts

- Science and technology are closely linked when organisms under investigation are not easily accessible to scientists.
- A variety of physical and biological factors are involved in determining the behavior, migratory patterns and activities of pelagic predators

Objectives

Students will be able to:

- ***Utilize*** a satellite tracking data set to illustrate migratory and behavior patterns of pelagic species
- ***Explain*** how physical or biological factors influence organism behavior

Materials

- Computers with Internet access

Procedure

1. Begin the class by asking students to brainstorm how and why scientists gather data on open-ocean animals. Introduce students to the idea of satellite tagging.
2. Have students use the "Tagging of Pacific Predators" or ***TOPP*** website "About" section (http://topp.org/about_topp) and gather background information to discover the underlying reasons why researchers are tagging predators. Scroll down this page to gather information on different satellite tags, their uses and the data they generate. What are some of the different types of tags currently in use? What kind of animals can be tagged with each type? What types of data can be obtained through satellite research?
3. Have students work in small groups and use the "TOPP Predators" online section to investigate the variety of animals in the satellite tagging programs and the availability of active data.
4. Have each group choose an active, tagged pelagic predator that they will follow over the course of the activity. Have students gather background information on their chosen organisms (Pacific Pelagic Predators include: Blue Shark, Shortfin mako shark, Salmon shark, Leatherback sea turtle, Black-footed albatross, Northern elephant seal, Laysan Albatross, Sperm whale, juvenile White shark, Southern elephant seal) such as:
    - Animal location
    - Diet
    - Size, lifespan, number of young, parenting style
    - Threats and conservation status
    - Questions answered from tagging information on this animal
5. Have students follow the progress of their organism over the past year. Work with students to have them design their own data sheet in a program such as Excel, or on graph paper based on the information available on the Tagging Pacific Predators website.
    - From the NANOOS site (www.nanoos.org) main page menu on left, choose Data, Observational, then scroll down to find "Tagging Pacific Predators"

- Scroll down to “Deployment Information” for students to find their chosen organism. Under Organisms’ name, have students choose “Browse all daily images.” This will take students to a webpage where they can see animated images of their chosen organism’s daily movement. The image on the left gives the animal’s location; the image in the middle shows the animal’s location along with satellite imagery of sea surface temperature (SST). The image on the right shows the animal’s movement along with satellite imagery of cholophyll-a.
- Allow students time to explore the animations. Be sure students figure out how to move ahead in days or back in days, or jump to a specific day.

6. Once students have become comfortable with the animations, have students investigate oceanographic conditions along their chosen animal’s path during the time of migration.
    - Help students interpret the satellite data correctly; encourage them to be sure to read the scale bar on satellite images. Sometimes the spectrum will cover all possible values and sometimes the spectrum only covers the range in the data set. Be sure students understand what cloud cover looks like on satellite data.
7. Students can then use information regarding their organism’s general habitat, feeding habits and reproductive behaviors, along with the oceanographic data to determine why their animal may have migrated along that particular pathway. Was the pathway predictable based on oceanic conditions? Was it a seasonal migration? Did the predator follow a food source? Was the migration the result of a reproductive strategy?
8. Have groups identify ways in which the information obtained from tracking their predator can be used (i.e., protection, harvesting, environmental assessment, etc.).
9. Have students compile the information and the conclusions they have drawn into a final project to share with their class. All projects should include a written component, accompanied by appropriate visual aids.

Assessment

- **Performance—**Did students participate in discussion sessions and demonstrate an understanding of the factors that influence behavior patterns? Were students able to successfully access and interpret data? Did students appropriately utilize web resources to further investigate behavior patterns?
- **Product—**Did students accurately describe the location and migratory behavior of their chosen organism? Did students include information on the life history of their animal in order to illustrate connections between environmental factors and behavior? Did students present their information in an organized and understandable format?

Resources

- SeaWIFS (chlorophyll-a satellite data): http://oceancolor.gsfc.nasa.gov/SeaWiFS/
- NOAA satellite data: http://www.nesdis.noaa.gov/
- Census of Marine Life: http://www.coml.org/
- Monterey Bay Aquarium Research Institute: http://www.mbari.org/

Standards

Content Standard or Essential Principle	LEARNING GOALS
A.1: Science as inquiry *NSES*	Abilities necessary to do scientific inquiry
A.2: Understanding science as inquiry *NSES*	Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science.
C.5: The Behavior of Organisms *NSES*	Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.
F.6: Science and Technology in Local, National, and Global Challenges *NSES*	Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use--which decreases space available to other species--and pollution--which changes the chemical composition of air, soil, and water.
5. The ocean supports a great diversity of life and ecosystems. *OLEP*	Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy." Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
6. The ocean and humans are inextricably linked. *OLEP*	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 (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores, and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
7. The ocean is largely unexplored *OLEP*	New technologies, sensors, and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

LS.03: Life Science *OR*	Describe and analyze the effect of species, including humans, on an ecosystem.
LS.04: Life Science *OR*	Identify and describe the factors that influence or change the balance of populations in their environment.
SI.01 Scientific Inquiry *OR*	Formulate and express scientific questions or hypotheses to be investigated.
SI.02 Scientific Inquiry *OR*	Design a scientific investigation to answer questions or test hypotheses.
SI.03 Scientific Inquiry *OR*	Conduct procedures to collect, organize, and display scientific data.
SI.04 Scientific Inquiry *OR*	Analyze scientific information to develop and present conclusions.
1.3.10 Interdependence of Life *WA*	Understand how organisms in ecosystems interact with and respond to their environment and other organisms.
2.1.2 Planning and Conducting Safe Investigations *WA*	Understand how to plan and conduct scientific investigations.
2.1.3 Explaining *WA*	Synthesize a revised scientific explanation using evidence, data, and inferential logic.
3.2.4 | Environmental and Resource Issues *WA*	Analyze how human societies' use of natural resources affects the quality of life and the health of ecosystems.

Acknowledgements

This lesson was adapted from a lesson on satellite tracking from Monterey Bay Aquarium Research Institute, available at http://www.mbari.org/earth/lesson_grid.htm .