HOW DO SCIENTISTS LEARN ABOUT ECOSYSTEMS?

INSTRUCTIONS

(MODIFIED FOR ADEED)

Overview:

In this 3-4 day investigation, students revisit the sea otter mystery story and discuss what scientists did to study sea otters in the Aleutians. They simulate the observation, identification, sampling, and counting methods used by scientists in two different activities, then reflect, discuss, and pose questions about scientific data collection.

*(**Note:** This is the second investigation from the science unit "The Case of the Missing Sea Otter." Online investigation can be found at http://seagrant.uaf.edu/marine-ed/curriculum/grade-4/investigation-2.html)*

Essential Question:

In what ways are organisms in aquatic environments connected to each other?

Enduring Understandings:

- Organisms in aquatic habitats interact with and depend on one another in various ways.
- An ecosystem is a community of living things with its physical environment, functioning as a unit.
- Science is a way to help us study the many connections in our world.

Targeted Alaska Content Standards:

Science

[4] SA1.2 The student develops an understanding of the processes of science by observing, measuring and collecting data from explorations and using this information to classify, predict, and communicate.

[4] SC3.1 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by identifying examples of living and non-living things and the relationship between them (e.g., living things need water, herbivores need plants).

[4] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking, perspectives, and curiosity by identifying the function of a variety of tools (e.g., spear, hammer, hand lens, kayak, computer).

[4] SG2.1 The student demonstrates an understanding of the bases of the advancement of scientific knowledge by recognizing the need for repeated measurements.

Materials:

- Student handouts and items for group display
- Newspapers
- Color slide frames or cardboard
- Calculator
- Stopwatch
- Whistle
- Internet access
- LCD or overhead projector
- Outdoor area
- Newspaper(s) with 1 page per student
- Quadrats (small)—empty color slide frames or similar cardboard squares, 1 per student
- Calculators (optional)
- Stopwatch
- Whistle
- Quadrats (large) made from meter sticks, hula hoops, or PVC pipes (optional)
- Facility/Equipment Requirements
- LCD or overhead projector
- Internet access

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- Playground or other outdoor area divided into two sections
- Student Handouts
- Sea Otter Story Part 2 (http://aswc.seagrant.uaf.edu/grade-4/investigation-2/sea-otter-story-part-2.html?task=view&id=58)
- Sampling the "e's" Organism Data Sheet (http://aswc.seagrant.uaf.edu/data/grade4/sampling_e.pdf)
- Quadrat Data Sheet (for alternate activity): http://aswc.seagrant.uaf.edu/data/grade4/quadrat.pdf
- Items for Group Display
- Data Table (http://aswc.seagrant.uaf.edu/data/grade4/observations.pdf)

Teacher Background Information:

An ecosystem is made up of plants, animals (including humans), microbes, and physical environmental features that interact with one another. Ecosystems are dynamic and interconnected, both by the physical environment (e.g., currents transporting larvae from one part of the ecosystem to another) and by biological interactions (e.g., kelps or creating habitat or predators consuming prey).

Ecosystems come in many sizes, often with small ecosystems nesting inside of larger ones. For example, a kelp forest represents a small habitat ecosystem nested within a large ecosystem connected by the Alaska Coastal Current. Large ecosystems contain multiple habitats such as sandy beaches, rocky beaches, kelp forests, or pelagic habitat.

(The Beaufort Sea, the Eastern Bering Sea, the Chukchi Sea, and the Gulf of Alaska are recognized as Large Marine Ecosystems among 10 within the U.S. Exclusive Economic Zone.)

The story begins with biologist James Estes being surprised by the results of his sea otter survey of an area in the Aleutian Islands that he has been studying for 15 years. The numbers of otters he sees are far less than in previous surveys. What has happened to the missing otters is a mystery.

Dr. Estes was surprised by the obvious decline in numbers because he had previously studied the sea otters when populations were expanding. Sea otters disappeared from much of their range from the Aleutians to California as a result of the fur trade during the late 18th and the 19th centuries. Several small remnant populations remained, however, in the Aleutians. These populations reproduced rapidly and eventually recolonized all of the available habitat around the islands.

Prior Student Knowledge:

1. Knowledge of the sea otter ecosystem from Investigation 1. Some experience reading and making data tables.
2. 2-3 digit multiplication, division by single digit.

Activity Preparation:

1. 45 minutes to read, practice activity, and prepare student materials
2. Read lesson materials and background.
3. Learn and practice data collection activities from lesson.
4. Calculate the number of quadrats per newspaper page (area of page/area of quadrat) and enter on the "Sampling "e's" Organism Data Sheet, step 5.
5. Make copies of data sheets.
6. Make overhead transparency of data table (or prepare to project it).
7. Choose an object to sample on the playground and decide how to divide the playground.

8. Teacher's Background: http://aswc.seagrant.uaf.edu/data/grade4/observations.pdf and Resources: http://aswc.seagrant.uaf.edu/grade-4/bibliography-&-resources.html
9. Teacher Background for Investigation 2: http://aswc.seagrant.uaf.edu/grade-4/investigation-2/teacher-background.html?task=view&id=59
10. Some vocabulary words to know: Abundant, Data, Dense, Organism, Protocol, Quadrat, Random, Sample, Tally, Uniform

Tips from Teachers:

Tie this investigation to an estimation unit in math.

If it will be difficult for students to find and count "organisms" on your playground, you may consider hiding some ahead of time.

Curricular Connections:

1. Mathematics: Combine the "e" activity with a math lesson on area, and have students calculate the area of the newspaper page, the area of the quadrat, and the number of quadrats on the newspaper page.

Lesson Credit:

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Activity 1 (one 25-minute class period)

Focus Question: How do scientists learn about ecosystems?

Procedure:

Engagement (20 - 30 minutes):

1. Bring students' attention back to the Missing Sea Otter story from the previous lesson. Read the Sea Otter Story Part 2: http://aswc.seagrant.uaf.edu/grade-4/investigation-2/sea-otter-story-part-2.html?task=view&id=58. Show students the Data Table: http://aswc.seagrant.uaf.edu/data/grade4/observations.pdf, and fill in some of the scientists' observations as you read.
2. Review what the scientists knew before they started their investigations. See Teacher Background for Investigation 2: http://aswc.seagrant.uaf.edu/grade-4/investigation-2/teacher-background.html?task=view&id=59.
3. Ask them: What did Jim Estes and John Palmisano do to study the otter ecosystem? What questions were they asking?
4. List all student ideas.
5. Discuss: Through observation, recording, and communicating, scientists know when change occurs in an ecosystem. (Scientists observed, identified, counted, researched, developed a hypothesis, and used oral stories form elders and locals).
6. Ask students to come up with a hypothesis based on the observations of the differences between the two islands and other facts the scientists knew. See Teacher Background for Investigation 2.
7. Show students the Monterey Bay Kelp Forest Virtual Dive or another video clip that shows scientists studying the ocean floor.
8. Ask students how they might count animals like sea otters and sea urchins and measure kelp forests. Pose questions related to some of the difficulties in getting exact counts or measurements, and explain why sampling and estimating are often required. See Teacher Background for Investigation 2: http://aswc.seagrant.uaf.edu/grade-4/investigation-2/teacher-background.html?task=view&id=59.

Exploration (1 class period):

9. Explain to students that you will be using a method to collect data that is similar to methods scientists use in the field.
10. Complete the following "Counting the e's" activity to allow students an opportunity to experiment with a sampling technique and form inquiries about effective sampling techniques.
11. Concept: It is important to have a uniform sampling tool and guidelines, or protocols, for selecting how and where to sample. Data that are collected must be an accurate representation of what was sampled, so that it can be compared with data collected in other areas using the same protocol.
12. Counting the e's:
    a. Introduce the activity by telling students that the class has the task of determining how many "e's" are used in a newspaper. Ask students for ideas on strategies that could be used to count the "e's" in your sample newspapers. List all possibilities. Discuss the meaning of "sampling" and what some objectives might be for sampling various things.
    b. Distribute a page of newspaper to each student. Tell them they will be counting the number of "e's" used in their section of paper to get an estimate of the total number of "e's" found in a newspaper. Let them count for 3 minutes.

c. After 3 minutes discuss the results. Brainstorm ideas for a more efficient way to sample the newspaper. Introduce the idea of "random sampling" to get an estimate of population density. Discuss possibilities for making the sampling uniform.

d. Introduce the slide holder, which will represent a quadrat (a common unit for sampling) as a means of getting a "population" estimate. Instruct the students to randomly toss their quadrat onto a sheet of newspaper and count the number of "e's" in the quadrat.

e. Continue to follow the instructions on the Sampling the "e's" Organism Data Sheet: http://aswc.seagrant.uaf.edu/data/grade4/sampling_e.pdf. After students have completed their 3 counts, you may wish to lead them through steps 3-7 as a whole class.

f. When everyone has finished, share your results.

g. Discuss the following questions as a class:
- How close was your answer to your estimate?
- Did we really answer the question of how many "e's" are in a newspaper? If not, how could we?
- How does this relate to how you might count the number of snails on a seashore?

This activity was designed by GLOBE teacher Peggy Lubchenco in Santa Barbara, California.

Exploration 2: (1 class period):

13. Alternate Exploration 2 (if playground or outdoor area is unavailable): http://seagrant.uaf.edu/marine-ed/curriculum/images/stories/grade4/quadrat.pdf

14. Divide class into groups of 4 and assign each group an "organism" to count for a set amount of time. Your "organism" can be anything that is found in some quantity on your playground. For example, you can count trash, certain color rocks, pre-planted items such as cones, balls, and popsicle sticks. Divide the playground or study area into two parts, and assign half of the groups to each part.

15. Have students set up a page for data collection in their science notebooks (see http://seagrant.uaf.edu/marine-ed/curriculum/science-notebooks/21.html?task=blogcategory) with Place, Time, and Name of Item being counted. Use a whistle to signal the start time. Set your count time to 5 or 10 minutes depending on the size of your area and/or the abundance of the items you are counting. Have students count their "organisms" for the designated time, and when signaled, stop counting and regroup to go over their findings.

16. Make a playground data table to compare the two sides of the study area. Lead a discussion about what assumptions can be made about playground use based on their findings. Go over any problems or situations that may have come up such as picking up the item and moving it or keeping it, more than one person counting the same item, how to spread out and cover the most ground as a group, etc.

17. If time permits, switch items to count and do the activity again, or do the activity again using quadrats made from meter sticks or hula hoops to sample the "populations" using the method you used in the "e" activity.

Explanation (30 minutes):

18. As a whole class, discuss the methods used in the data collection activities and why they might be helpful to scientists. Review methods used by scientists including:
- Data recording
- Quadrats
- Random sampling
- Repeating the study using the same method
- Observing changes

19. Discuss how science is different from casual observation.
20. Break into small groups and discuss:
    - How did the scientists' investigation methods in the Aleutians compare to the ones you did in class?
    - How do protocols help scientists to observe an aquatic ecosystem over time?

Extension (Application): (15 - 20 minutes)

21. Ask students to write in their science journals (see http://seagrant.uaf.edu/marine-ed/curriculum/science-notebooks/21.html?task=blogcategory):
    a. How do scientists learn about ecosystems?
    b. What are some of the problems that scientists have to solve when they collect data?
    c. How would you count _____? Give an example of local or familiar animals (migrating geese, slugs in the garden, etc.)

Evaluation:

16. Formal Evaluation will be done at the end of the unit.