NATIONAL GEOGRAPHIC

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ACTIVITY : 1 HR

Fish Tagging and Monitoring

Students analyze two fish monitoring methods: movement mapping, or tracking, and mark and recapture. Then they work in teams to simulate the mark and recapture method and analyze their data.

GRADES

9 - 12+

SUBJECTS

Biology, Ecology, Earth Science, Oceanography, Geography, Physical Geography, Mathematics

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OVERVIEW

Students analyze two fish monitoring methods: movement mapping, or tracking, and mark and recapture. Then they work in teams to simulate the mark and recapture method and analyze their data.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/fish-tagging-and-monitoring/

DIRECTIONS

1. Discuss how and why scientists monitor fish populations.
Ask students to brainstorm a list of reasons scientists might want to monitor the populations of marine organisms like fish. Write students' responses on the board. Prompt them to include reasons such as understanding population dynamics and migration patterns, knowledge of breeding sites and feeding habits, and management strategies such as setting catch limits or providing species protection. Then ask:

- *What difficulties are researchers likely to encounter while trying to observe fish in the ocean?* (large schools, constant swimming, tracking movement throughout the water column or migration to different locations, distinguishing one fish from another, lack of technology or resources)
- *How might scientists go about monitoring fish?* (tagging, tracking, mark and recapture, collection, and data collection)

Explain that two common methods used to monitor fish populations are movement mapping, or tracking, and mark and recapture. Tracking is a process in which marine biologists and resource managers use technology to tag fish and map their movements. Mark and recapture is a process where a small group of a particular fish species is captured, marked or tagged, and then released so they can be recognized during a later recapture. These methods help scientists better understand the numbers and distributions of fish populations.

2. Introduce the fish mark and recapture simulation activity.
Tell students that fish tags are important tools for assessing fish populations. Conducted properly, tagging can provide information on movement patterns, seasonal variations, harvest levels, and birth and mortality rates—all of which can lead to healthier fish stocks. Divide students into teams of three. Tell students that they will conduct a simulation to estimate the population of *Carassius auratus* (goldfish) within a specific area using the mark and recapture method. Explain that after a population of fish has been captured, marked, and released, scientists then go back and recapture another sample of fish from the same area; some of which may be marked and some of which may not be marked. A simple ratio is then calculated to represent the total population of the species. The population size can be estimated from as few as two visits to the study area, but more than two visits are desired for increased accuracy. If needed, demonstrate the mark and recapture process, including the completion of a data table section, before students conduct the experiment on their own.

3. Have students conduct the first trial in the fish mark and recapture simulation.
Have each team assign team members the roles of marker, trapper, and data recorder. Give each team a copy of the Fish Mark and Recapture Simulation worksheet. Have each team go to a station with two different colored markers and a medium-sized bowl containing approximately 200 goldfish-shaped crackers and approximately 50 fish-shaped pretzels. Explain to students that the goldfish-shaped crackers represent goldfish, their target species, and the fish-shaped pretzels represent bycatch, or the unwanted portion of a fishing catch. First, have teams guess the number of goldfish in the bowl and record it under the “original estimation” column of the data table. Then have the trapper close his or her eyes and scoop a

sample from the bowl. Have the marker write the letter M on all goldfish in the sample. Have the data recorder record the number of goldfish (M) and the number of fish-shaped pretzels (bycatch caught). Return the fish back to the bowl and mix thoroughly.

4. Have students conduct the second trial in the fish mark and recapture simulation.
Have the trapper collect a second, larger sample of fish. Have the marker write the letter C on all goldfish and the letter R on the goldfish that were recaptured. Have the data recorder use the data table to record the number of fish that were captured (C), the number of fish that were recaptured (R), and any bycatch.

5. Ask students to estimate the size of the population.
Once students have conducted two trials, have them estimate the size of the target species population (N) using the following formula:

 # target fish caught in Trial 1 (marked M) × # target fish caught in Trial 2 (marked C) ÷ Total # recaptured fish in Trial 2 (marked R) = Estimate of target species population (N)

Write the following example on the board: Scientists catch and tag 100 salmon in the initial catch (M), and they mark all of these fish. When they collect a second catch (trial 2), they capture a total of 70 salmon (C), of which 10 are marked (R).

100 fish caught and tagged in Trial 1 (M) × 70 fish caught in Trial 2 (C) ÷ 10 recaptured fish that had tags (R)

(100 × 70) ÷ 10 = 700 (Or, there are approximately 700 target species, salmon, in the population.)

6. Ask students to calculate the percentage of bycatch.
Have groups calculate the percentage of bycatch in their total catch for each trial using the following formula and multiplying the result by 100:

Bycatch Total (Bycatch Trial 1 + Bycatch Trial 2) ÷ Total # fish caught (M + C + # Bycatch Trial 1 + # Bycatch Trial 2) = Bycatch Ratio

Bycatch Ratio × 100 = Percentage of Total Bycatch

Tell students that, unlike in a real ecosystem, they can check how well their mark-recapture

method worked. Have teams count the actual number of target species (goldfish) in their bowl and write it in the worksheet.

7. Analyze the data as a class.
Have a whole-class discussion about the data. Ask:

- *Did any team have a population estimate that matched the actual total?*
- *How many of you overestimated in your guess? How many underestimated?*

Ask students if they noticed any errors in their sampling methods or if there were any differences in students' attitudes about the sampling method within their group. Explain that when doing data collection fieldwork in groups, differences in attitudes and methodology can create a “sampling bias” in the data. Tell students it is important to follow established methods closely and conduct as many trials as possible to ensure accurate data.

Modification

In Step 3, you can use colored beans, cut up pieces of straws, paper fish, or other objects instead of edible goldfish-shaped crackers.

Informal Assessment

Have students work independently to solve the following word problem: A group of scientists are studying cod (*Gadus morhua*) populations in the southern Gulf of St. Lawrence to see if they are increasing or decreasing in numbers. The scientists are using fish tag data compiled from a sampling series using the mark and recapture method. To estimate the number of cod in the area, scientists captured 1,500 fish, marked them, and let them go. The next day, they captured 1,675 from the same area. Of these, 270 had been marked the day before. About how many cod are in the Southern Gulf of St. Lawrence? (9,306 cod)

Extending the Learning

Have students follow up on what they learned by writing their responses to the following questions on a separate sheet of paper and discussing their answers as a class.

- *Why might a scientist use an estimate instead of counting each and every individual?* (Catching every individual fish in a population is impractical.)
- *What are advantages and disadvantages of using the mark and recapture method?* (Advantage: Scientists are able to estimate population size when it is too difficult to count individuals; Disadvantage: Estimates are not always accurate. They depend on the number

of individuals in the area where the population is sampled being indicative of how many organisms can be found in one spot for the entire population.)

- *What factors must scientists consider when choosing a monitoring method?* (program's objectives, cost, animal size, tag size and color, number of animals to mark, area of study, effects on the animals)
- *To sample fish populations in the field, what types of instruments or tools would a scientist need?* (nets or traps, computer, maps, GPS unit)

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Physical Geography

- Mathematics

Learning Objectives

Students will:

- explain why researchers study fish populations
- describe two methods used by researchers to study fish populations
- simulate the mark and recapture method
- estimate the size of a fish population and the percentage of bycatch

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Cooperative learning

- Discussions
- Information organization
- Simulations and games

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Geographic Skills
  - Analyzing Geographic Information
  - Answering Geographic Questions

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Data Analysis & Probability (9-12) Standard 3:**
Develop and evaluate inferences and predictions that are based on data

NATIONAL GEOGRAPHY STANDARDS

• **Standard 16:**
The changes that occur in the meaning, use, distribution, and importance of resources

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard A-1:**
Abilities necessary to do scientific inquiry

• **(9-12) Standard E-2:**
Understandings about science and technology

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6b:**
From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.
• **Principle 6c:**
The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Calculators
- Colored markers
- Fish-shaped crackers
- Fish-shaped pretzels
- One medium-sized bowl per group
- Paper
- Pencils

PHYSICAL SPACE

- Classroom

SETUP

Set up each team station and materials in advance.

GROUPING

- Large-group instruction

Background Information

Scientists use various methods to study fish populations, including tagging and mark and recapture. The information can aid researchers and managers in evaluating abundance and migration patterns, birth rates, mortality rates, and harvest levels of different marine populations. As with any scientific methodology, error and bias can be introduced and should be addressed appropriately.

Prior Knowledge

["basic algebra"]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
bycatch	*noun*	fish or any other organisms accidentally caught in fishing gear.
mark-recapture method	*noun*	way of monitoring animal population. A random group of animals is captured, marked with a tag or band, and released before another random group from the same population is captured. Some of the animals from the second group may have been tagged previously. Also called sight-resight, band recovery, and capture-mark-recapture.

For Further Exploration

Websites

- Census of Marine Life: Investigating Marine Life
- The Biology Corner: Mark-Recapture Game

- R.J. Dunlap Marine Conservation Program: Virtual Expedition
- National Geographic Education: National Teacher Leadership Academy (NTLA)

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