LESSON 4 Sustaining Our Ocean Resources

Lesson at a Glance

This lesson gives students a basic introduction to fisheries, why they are important, and the various methods used to maintain sustainable levels of various marine organisms. Students then have an opportunity to use the capture-recapture model to investigate how scientists monitor the size and number of a marine population and monitor whether fish populations are decreasing.

Lesson Duration

Two 45-minute periods

Essential Question(s)

Why do we need to know how many fish of a certain type are in the ocean?

How can humans manage marine resources and assure their sustainability for the future?

Key Concepts

- Field scientists monitor the number, size, and age of organisms to determine whether a marine population is stable or declining.
- Humans are part of the food chain and depend on food from coastal and open-ocean waters.
- Modern technologies provide ways to manage harvesting and sustain ocean resources.

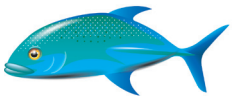
Related HCPSIII Benchmark(s):

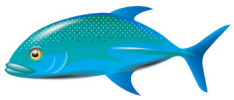
Science SC 5.2.1
Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

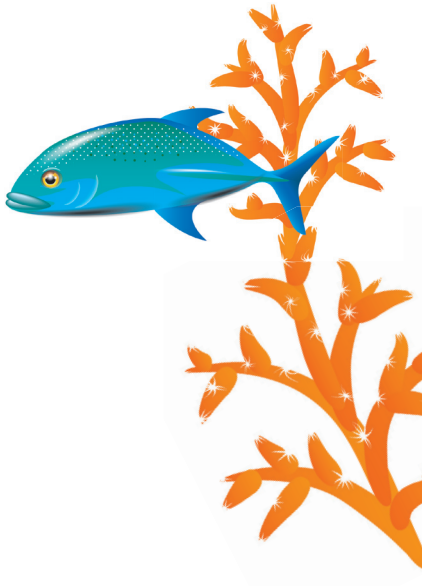
Math MA 5.10.2
Model problem situations with objects or manipulatives and use representations (e.g.,graphs, tables, equations) to draw conclusions.

Instructional Objectives

- I can conduct a simple random sampling, which models the capture-recapture technique.
- I can use a capture-recapture model to investigate how scientists monitor the size and number of a marine population.
- I can describe the criteria used to determine the acceptable size of fish catch.
- I can describe how fish aggregating devices assist us in maintaining sustainable levels of various marine organisms.







Assessment Tools

Benchmark Rubric:

Topic		Unifying Concepts and Themes	
Benchmark SC.5.2.1		Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently select and use models and simulations to effectively represent and investigate features of objects, events, and processes in the real world	Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	With assistance, use models or simulations to represent features of objects, events, or processes in the real world	Recognize examples of models or simulations that can be used to represent features of objects, events, or processes

Topic		Numeric and Algebraic Representations	
Benchmark MA.5.10.2		Model problem situations with objects or manipulatives and use representations (e.g., graphs, tables, equations) to draw conclusions	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Model problem situations with objects or manipulatives and use representations to draw conclusions, with accuracy	Model problem situations with objects or manipulatives and use representations to draw conclusions, with no significant errors	Model problem situations with objects or manipulatives and use representations to draw conclusions, with a few significant errors	Model problem situations with objects or manipulatives and use representations to draw conclusions, with many significant errors

Assessment/Evidence Pieces

Lesson
- Capture-Recapture Student Data Worksheet

Materials Needed

Teacher	Class	Group	Student
• None	• None	• 1 bag of Original Goldfish for each student group • 2-3 boxes of Cheese-Its • 1-3 oz. paper cup for each group • 2 bags Colored Goldfish (1/3 of a bag each student group) • 1 lunch size paper bag or bowl for each group • 1 paper plate for each group	• *Capture-Recapture Student Data Worksheet* • *Student Worksheet L50 Measurement Guide*

Instructional Resources

Student Worksheet: *L50 Measurement Activity Guide*
Student Worksheet: *Capture-Recapture Data Worksheet*
PowerPoint Presentation: *What are Fisheries?*

Student Vocabulary Words

buoys: specially shaped and marked floats, sometimes carrying a signal device, anchored to mark channels, or particular areas in the ocean.

capture-recapture method: two-sample model, used solely to estimate the unknown size of a population.

electronic logs: enhancements to vessel monitoring systems; tools used to monitor fishing activities and enforce conservation and enforcement measures; two-way electronic communication system with fishing industry that contributes fishing vessels, positional records to a managed database.

fish aggregating devices: buoys deployed in waters surrounding main Hawaiian islands to attract schools of tuna, dolphin fish (mahimahi), wahoo (ono), and others; allow fishermen to easily locate and catch these fish species.

fishery: a fishery is an activity leading to harvesting of fish. It may involve capture of wild fish through fishing or raising of fish through aquaculture or fish farming.

GPS: global positioning system – a system of satellites, computers, and receivers that are able to determine the latitude and longitude of a receiver on Earth.

L50: the length at which half (50%) of a fish species may be able to spawn or reproduce.

satellite tracking tags: tagging of large fish, such as sharks, migratory fish, such as whales, and other diverse large marine species; allow satellites to track movements, activities, and whereabouts of these species continuously.

satellites: objects orbiting the Earth.

Lesson Plan

Lesson Preparation

- Review the Science Background provided in the Unit Overview.
- Preview PowerPoint Presentation *What are Fisheries?* Make arrangements to project it.
- Review and make copies of Student Worksheets *L50 Measurement Guide and Capture-Recapture Data* Worksheet.
- Create sets of material for each student group, which includes 1 bag of Original Goldfish, 1/3 of a bag of Colored Goldfish, a 3 oz. paper cup, a paper plate and a paper bag or bowl.

I. What are Fisheries?

A. Ask students if they know how seafood is obtained. Introduce the term fishery and explain that the term fishery is used in different ways, including:

1. The kinds of organisms caught (e.g., squid fisheries, tuna fisheries).
2. Where the organisms are caught (e.g., bottom fishing, fishing in waters deeper than 300 feet).
3. The kinds of technologies used to catch the organisms (e.g., gill netting or longlines)/

B. Explain that National Oceanic and Atmospheric Administration's (NOAA's) Marine Fisheries Service is the organization that determines and manages fisheries. Show PowerPoint Presentation: *What are Fisheries?*

II. How do scientists know how many fish are present in a given fishery area?

A. Begin by asking students to discuss possible strategies for determining the number of fish in a fishery area.

B. After the students have had a chance to discuss their ideas, introduce the capture-recapture procedure as a statistical method often used to estimate large populations of organisms in the wild. Connect the ideas presented by students during their discussion to the concepts that underlie the capture-recapture method.

C. Tell students they will be trying the capture-recapture method. It is based on the idea that if we measure a portion of a large population, count, tag, release them, and then take another sample, we should be able to estimate the total population based on the proportion of number tagged to the total sample. *Note: This method is dependent upon the assumption that the population will be randomly distributed throughout the sample.*

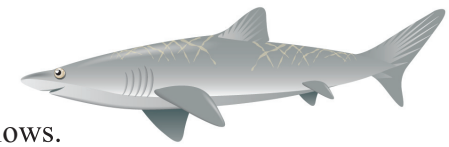
D. Since it is unrealistic for your class to count entire populations fish in the ocean, introduce the idea of a simulation. Explain to students that they are going to use a brown bag to represent a fishery, and goldfish to represent a population of fish in that part of the ocean.

1. CAPTURE

- Divide students into groups of four.
- Capture a sample of goldfish from the ocean (bag or bowl) using the net (cup) and count them. Students should record this number in the first capture column of their data table.
- Tag these captured fish by replacing each one with a colored fish.
- *Note: Since in this lesson we are tagging by replacement, the goldfish replaced by color can no longer count as part of the population and MUST be disregarded or eaten.*
- Put these tagged fish back into the ocean (bag). Emphasize that the number in the population is unchanged.

2. RECAPTURE

- Shake or mix the goldfish to distribute the tagged (colored) fish and insure randomness.
- Capture another sample using the net (cup).
- Record the number of color and non-color fish in the appropriate columns. Return the entire sample to the bag.
- Shake the bag to re-distribute them.
- Repeat the above process a minimum of 3 times or more as time allows.

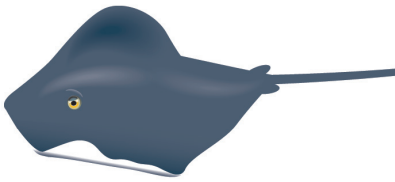


Data Sample Number	Recapture Tagged/ Color	Recapture Non-color	Recapture Total fish	Sample Ratio of Color to Total	1st Capture	Total Population	Population Ratio of Color to Total	Estimated Population
1						P		
2						P		
3						P		
4								
5								
Total								

3. DISCUSSION
    - What information has been obtained from the capture? How many fish are to be tagged (a different color).
    - Do we know how many are in the ocean yet? No.
    - With each recapture, what information did you obtain? How many total fish are in the recapture and how many of them are tagged?
4. CALCULATING TOTAL POPULATION
    - Post the following proportion on the board:

$$\frac{\text{Recaptured Tagged/Colored Fish}}{\text{Recaptured Total Fish}} = \frac{\text{Size of 1st Capture}}{\text{Total Population}}$$

    - Introduce to students that a ratio is used to calculate how the number of tagged fish relates to the total number of fish in the bay.
    - Explain that the size of the population is estimated on the principle that the proportion marked in the second sample equals the proportion of marked individuals in the population as a whole.
    - Conduct a calculation together as a class, then have students work on their data calculations within their groups.



5. SUMMARY AND CONCLUSIONS
    - Have student groups share their calculations.
    - Have students count the total number of fish in their bag (bowl).
    - Discuss how their calculations compare to the actual count numbers. Were their calculations fairly accurate? What may account for discrepancies?
    - Explain how calculations of population size assist scientists and fish regulators in determining fish regulations and fish catch limits.

    NOTE: Ask students to refrain from consuming the goldfish as all materials will still be needed for Part III.

Adapted from:

- Freed, Ben, Lockhart, Tom, and Bounket, Soumaly: Instructors Notes for the Sampling Technique: Muncie Capture-Recapture
  mtsu32.mtsu.edu:11281/.../Class%20activity%20worksheet%20with%20lesson%20plan.doc
- Data Collection Activities for Middle School Students: Go Fish
  http://ehow.com/list_6395544_data-activities-middle-school-students.html
- Florida Oceanographic Coastal Center: Fish Count
  www.floridaoceanographic.org

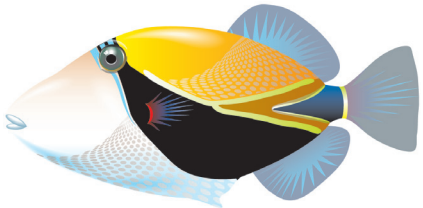
III. What are some of the ways fishermen can work to help sustain adequate fish stock/populations?

A. Fish Aggregation Devices

1. Introduce to students that scientists and fish regulators identify the size and types of fish that can be caught in order to maintain fish populations at sustainable levels. Explain that fish size is an indicator of maturity. There needs to be enough fish existing within a population that are sufficiently mature to reproduce and replenish what is being caught.
2. Define for students that there are special fish aggregation devices that enable fisherman to catch the right size or right species of fish. Among these devices are specialized nets that capture more mature sized fish and allow juvenile fishes to escape.
3. Explain to students that they will now use the same materials from the Capture-Recapture Method to simulate this fish aggregation device.
4. Begin by replacing one-fourth of the goldfish with Cheese-Its. The goldfish are now the juvenile fish and the Cheese-Its are the larger, more mature fish. Gently shake the bag (or stir the contents of the bowl) to insure randomness.
5. Cut two dime-sized holes in the bottom of the paper cup (net). The holes should be large enough to enable the smaller fish to slip through, but not so large as to allow the larger fish to escape.
6. Capture a sample of fish from the bag (ocean) using the net (cup). Shake gently to allow the smaller fish to slip through. Have students repeat the process if necessary.
7. Conclude by discussing their observations using the follow questions as a guide:
   - Can a fish aggregation device such as a specialized net be successful in releasing smaller juvenile fish?
   - What are factors that may prevent the smaller fish from escaping?
   - How might a device such as a specialized net be improved?
   - Why is it important to implement fish aggregation devices?
   - Why is it important to sustain fish populations in terms of food chains and food webs (Lesson 1)?

B. L50 Fish Measurement Guide

1. Reinforce that in order to maintain a population of fish at sustainable levels, there needs to be enough fish that are sufficiently mature to reproduce and replenish what is being caught. Scientists and fish regulators have identified the length of various fish species at which half (50%) may have been able to spawn and maintain sustainable fish populations. This is called an L50 Measurement Guide.
2. Explain that one of the ways fishermen (such as yourselves) can directly impact the conservation of living resources and sustain healthy fish populations is to learn and implement the L50 Measurement Guide. Handout Student Worksheet L50 Measurement Guide. Discuss the worksheet with students.
   - NOTE: Visit the NOAA Coral Reef Conservation Program website to download a PDF file of the Hawaiian Fish Species Actual Reproductive Size Poster.



LESSON 4

Names: _____ Date: _____

Capture-Recapture Data Worksheet

1. In your group, assign and take turns assuming the following roles: Supplier, Fish Catcher, Fish Counter, Recorder
2. Supplier: get all of the following materials:
   - One bag each of Original and Colored Goldfish crackers
   - One lunch-sized paper bag or small bowl (ocean)
   - One paper plate
   - One 3 oz. paper cup (net)
3. Place the entire bag of Original Goldfish crackers in the paper bag or small bowl.
4. **Capture a sample** of goldfish from the brown bag (one cup full), count them, and record the number of fish captured (Column 6).
5. Tag these captured fish by replacing each one with a colored fish *(Since, in this lesson, we are tagging by replacement, the goldfish replaced by colored fish can no longer count as part of the population and MUST be disregarded or eaten.)*.
6. Put these tagged (colored) fish back into the bag and shake the bag (or stir the fish in the bowl) to distribute them.
7. **Recapture** another sample from the bag using the cup and pour onto the plate.
8. Record the number of colored and non-colored fish in the appropriate columns. Return the entire sample to the bag.
9. Shake the bag to distribute them.
10. Repeat steps 7-9 two or more times (The number of 1st Capture remains constant for all samples.).
11. Complete the table by using the proportion.

$$\frac{\text{Recaptured Tagged/Colored Fish}}{\text{Recaptured Total Fish}} = \frac{\text{Size of 1st Capture}}{\text{Total Population}}$$

12. Count the actual number of the population: _____

Data Sample Number	Recapture Tagged/ Colored	Recapture Non-colored	Recapture Total fish	Sample Ratio of Colored to Total	1st Capture	Total Population	Population Ratio of Colored to Total	Estimated Population
1						P		
2						P		
3						P		
4								
5								
Total