Activity 3.7

One Fish, Two Fish—Assessing Habitat Value of Restored Oyster Reefs

- Grade Level
  6-9
- Subject Areas
  Science, Mathematics
- Duration
  One to two 40 minute class sessions
- Setting
  Classroom
- Skills
  Graphing, interpreting, explaining, hypothesizing
- Vocabulary
  Habitat, restoration, diversity, species richness
- Correlation with Next Generation Science Standards
  MS-LS2-1, MS-LS2-4, MS-LS2-5, MS-ETS1-1, HS-LS2-1, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS4-5, HS-LS4-6

Materials:

- ☐ Student Worksheet-Activity 3.7
- ☐ Computer graphing program (optional)
- ☐ Calculator

Charting the Course

In this exercise students will examine data collected in a real scientific study conducted by Rutgers University. Students will analyze data and make conclusions about potential results of the experiment. Using this study as a model, students will develop a clearer understanding of aspects of the scientific method: analyze data, make conclusions and communicate the results.

Background

The Gandy's Beach Oyster Restoration Enhancement Area (GBOREA) is a subtidal ten-acre plot located in the upper Delaware Bay. The GBOREA was established by the New Jersey Department of Environmental Protection to provide a target site for community-based oyster restoration efforts. Since 2007, Rutgers University's outreach program Project PORTS (Promoting Oyster Restoration Through Schools) has engaged school children in restoring the area. Participating students have built more than 8,000 shell bags, which have provided substrate for oyster larvae settlement (see activity 3.4 for more information on the oyster life cycle). More than 20 million spat (newly settled juvenile oysters) have been planted at the enhancement site as a result of these efforts.

Simply put, environmental restoration is the act of returning an area to a former condition. Scientists examine various parameters when evaluating the success of a restoration project. Since oyster reefs are important habitat for many estuarine fish species, determination of the abundance and diversity of fish species at a restored reef can be one way to measure the ecological value of the reef.

This activity focuses on an examination of data collected in 2013 by Rutgers University scientists to examine fish and invertebrate utilization of the GBOREA site in comparison to that at a natural mature oyster reef and at a non-oyster bottom (rocks, sand, mud) site. Scientists deployed habitat trays (trays filled with material collected from the site) monthly to collect resident fishes and invertebrates living on the bottom. They also used an otter trawl (weighted net towed behind a boat) to collect both resident and transient fishes twice a month. Each animal captured was identified, measured and weighed before being released back into the Delaware Bay.

In addition to counting each individual and comparing abundances directly, scientists compare communities by calculating species richness, an index relating to the diversity of species in an area. Species richness is the number of different species present in a community. For example, the species richness for a habitat containing a striped bass, weakfish and toadfish is 3. Diversity indices are commonly used to measure richness while also reflecting the evenness of the species distributed amongst habitat types. In this activity, students will employ The Simpson Index of Diversity (Figure 1) to examine and compare species use of the three types of habitats sampled. Based on this examination, your students should discuss whether Project PORTS efforts have been successful.

Objectives / Students will be able to:

1. Define restoration
2. Graph and interpret data
3. Describe how species abundances change in different environments in the study areas
4. Show how the restoration efforts may have impacted habitats in the estuary

Procedure / Warm Up

Introduce habitat restoration using the GBOREA as an example in a class discussion. Briefly describe the study and site types. Query, what is the purpose of habitat restoration? What benefits can it provide to the environment, animals and humans? Explain that scientists can use the number of species (diversity) in a habitat to better understand the animal community. Introduce Simpson's Index of Diversity and discuss how this might be a valuable tool. Ask students to make a prediction of how species numbers will differ between sites.

The Activity

1. Divide the class into teams of restoration scientists assigned with the project of studying the effects of the Gandy's Beach Oyster Restoration Enhancement Area on native fish species.
2. Each team will receive a copy of the data set on Student Worksheet – Table 1 (page 21).
3. Students should graph the data (either by hand or using excel if proficient in it). They should graph the abundances of three fish species of their choice.
4. Using their bar graphs, students should:
   a. Compare their selected species abundance across bottom types
   b. Determine which species were most abundant and least abundant on each habitat type
5. Calculate Simpson's Index (D) for each of the three bottom types using the equation in Figure 1 (example below).

Example: Calculating D for the restoration area would look like this:

$D= (44/163)^2 + (22/163)^2 + (27/163)^2 + (24/163)^2 + (14/163)^2 + (7/163)^2 + (6/163)^2 + (2/163)^2 + (17/163)^2 = 0.17$

Simpson's Index of Diversity: 1-D = 1-0.17 = 0.83

Figure 1. Formula for Simpson's Index of Diversity:

1-D, where $D = \sum(n / N)^2$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

6. Using the calculated ranges from 0 to 1, low to high, determine which bottom type hosts the highest diversity of fishes.

   note: -Simpson's Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species.
   -Simpson's Index of Diversity (1 – D): ranges between 0 and 1, the greater the value, the greater the sample diversity.
7. Ask students what conclusions they can draw about the restoration project?

Extensions / Complement this activity with Activity 1.3, Life in the Estuary, to continue learning about some of the same species in this study.

Student Worksheet

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Name____**Date** __________________

TABLE 1

Common Name	Scientific Name	Restoration Area	Non-oyster	Mature oyster
Atlantic croaker	*Micropogonias undulatus*	44	50	21
Weakfish	*Cynoscion regalis*	22	30	29
Hogchoker	*Trinectes maculatus*	27	28	8
Oyster toadfish	*Opsanus tao*	24	6	24
Blue crab	*Callinectes sapidus*	14	19	14
Northern kingfish	*Menticirrhus saxatilis*	7	7	0
Silver perch	*Bairdiella chrysoura*	6	2	4
Spot	*Leiostomus xanthrus*	2	4	2
White perch	*Morone americana*	17	2	7
TOTAL		**163**	**148**	**109**

A. **Using the chart below and the data in Table 1, choose three fish species and create a bar chart showing their abundance at each habitat.** Color or pattern the bars for each species and create a legend to denote each species. Note: each site should have three bars (one for each species)

GRAPH 1

Student Worksheet Activity 3.7—Assessing Habitat Value of Restored Oyster Reefs

B. Using the formula below calculate Simpson's Index of Diversity including all the species for each of the three different habitats shown in Table 1.

Formula for Simpson's Index of Diversity:

1-D, where D = $\sum(n / N)^2$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

1. Using the data in Table 1 find n and N for each site.
2. Calculate D using the equation (hint: $\sum$ means sum, calculate $(n/N)^2$ for each species and then add all the values together). Calculate D for the data from each site.
3. Subtract D from 1 to calculate Simpson's index of Diversity. D ranges between 0 and 1, the greater the value, the greater the diversity.

C. After completing your graphs and calculating Simpson's Index of Diversity answer the following questions.

1. Compare fish abundances at each habitat.
2. For each of the three fish that you chose, which bottom type had the greatest number? The least number?
3. Compare species diversity for each habitat. Which habitat has the greatest diversity? Which habitat has the lowest diversity?
4. What conclusions can you draw about the restoration area based on your results? Is it providing useful habitat to the fish?
5. Why might some fish species benefit from the restoration project and others not? (Hint: think about life cycle, feeding, hiding from predators etc.)