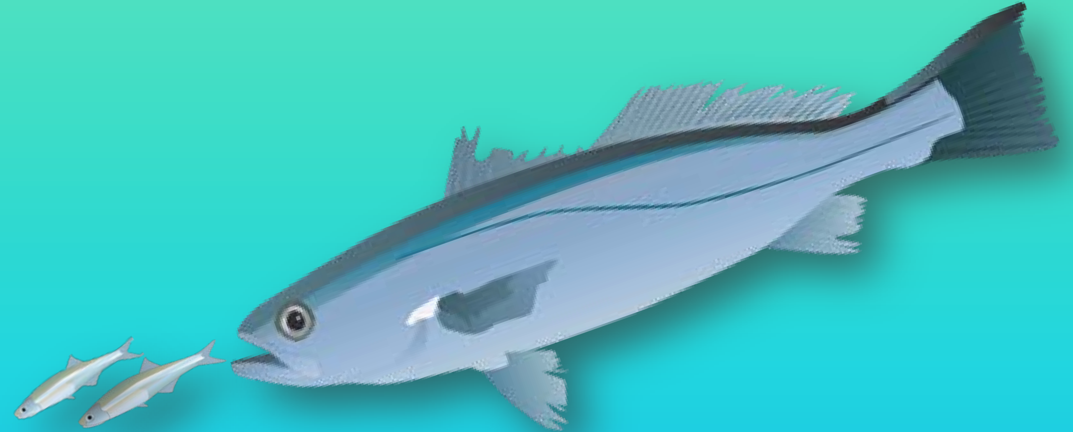
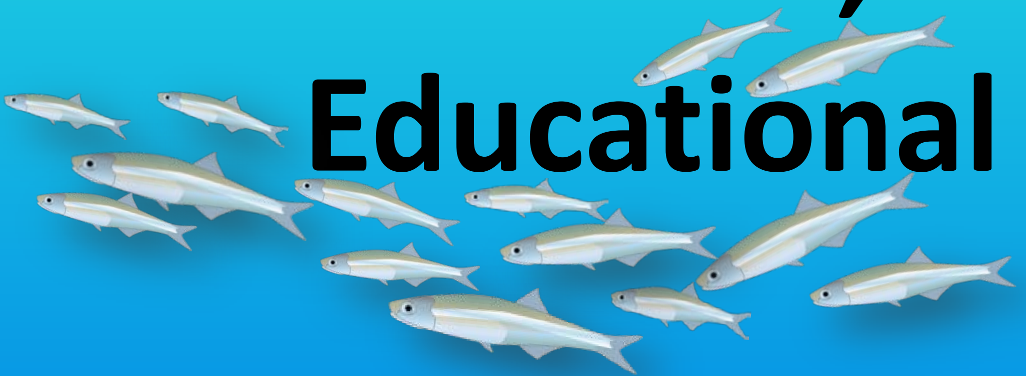


One Fish, Two Fish: An Educational Pilot Study



Jenny Paterno, Lisa Calvo, David Bushek

Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ

Outline

1. Project PORTS overview
2. Conduct scientific study
3. Convert research data into classroom lesson plan

project PORTS

Promoting Oyster Restoration Through Schools

Goals

1

- increase an awareness and understanding of the oyster as a critical species and an important natural resource of the Bay

2

- to promote a basic understanding of important scientific concepts and stewardship values

3

- to contribute to the enhancement of critical oyster habitat in the Delaware Bay

RUTGERS UNIVERSITY

Photo by Lisa Calvo

Science

Social Studies

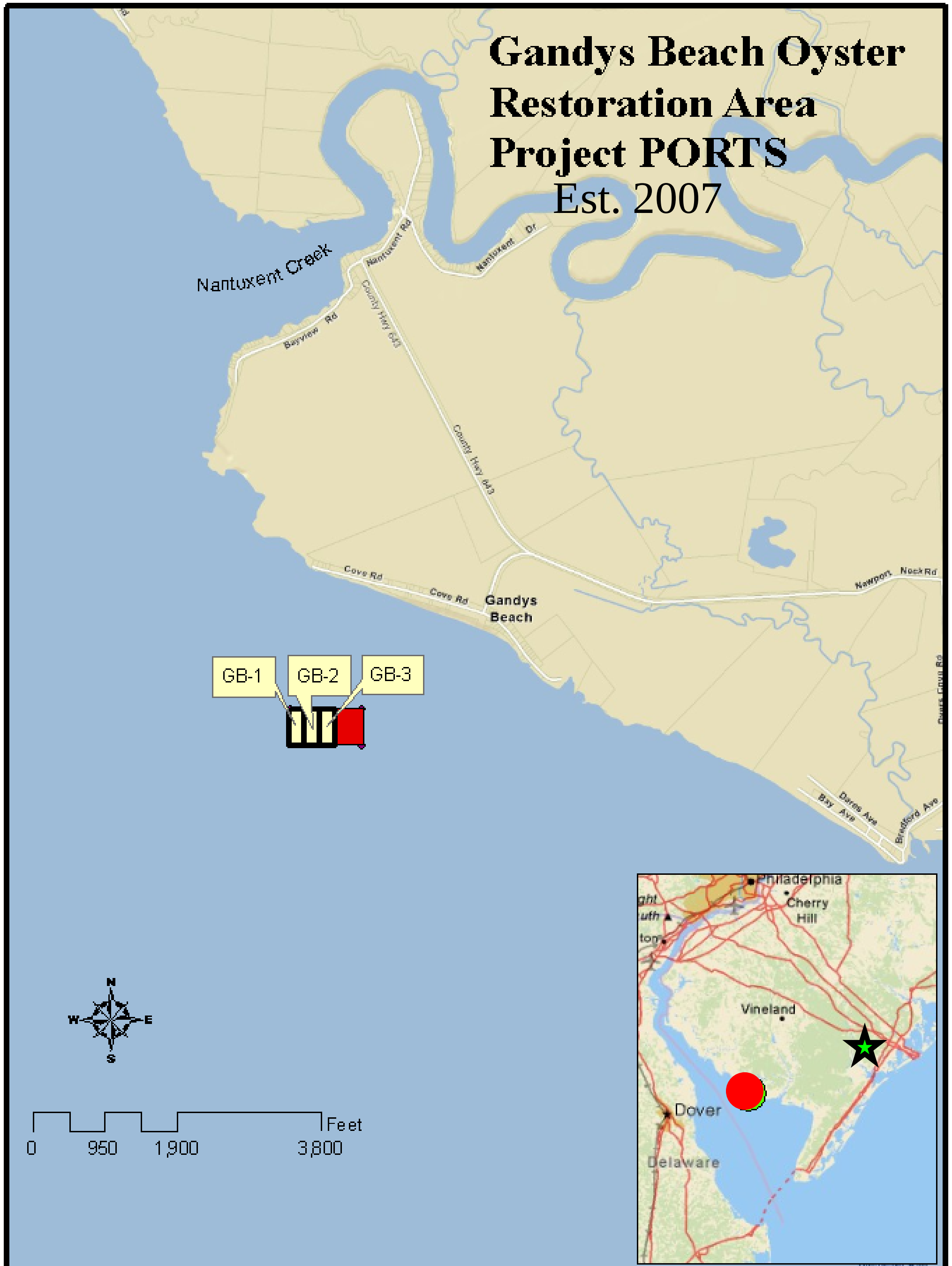
Math

Language Arts

Stewardship

Project PORTS Curriculum and Activity Guide

Stewardship activity



Student-stewards have constructed **14,000 shell bags** supporting the restoration of more than **20 million oysters** on a 5-acre oyster reef at the Gandy's Beach Oyster Restoration Enhancement Area (GBOREA).

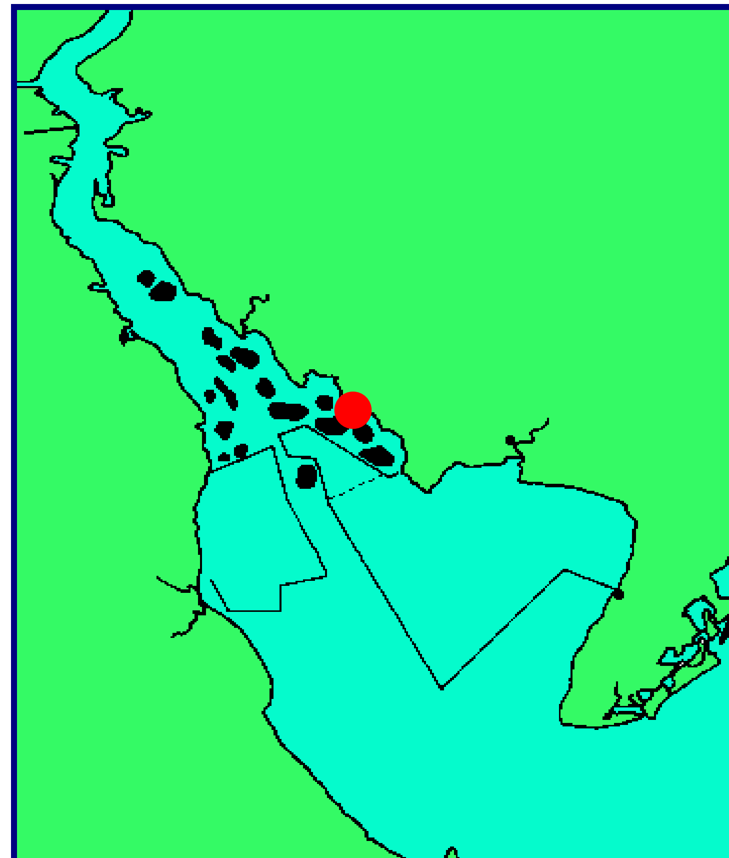


Photo credits: Lisa Calvo

Ecosystem Engineers

Photo credit: M. Luckenbach, VIMS

project PORTS

Promoting Oyster Restoration Through Schools

Impact 2007-2014:

- 1 conservation site
- 20 partner schools
- 20,000 student learning experiences
- >500 volunteer experiences
- 14,000 shell bags
- 5 acres of enhanced habitat
- 20+ million oyster spat

Photo credit: Lisa Calvo

Outline

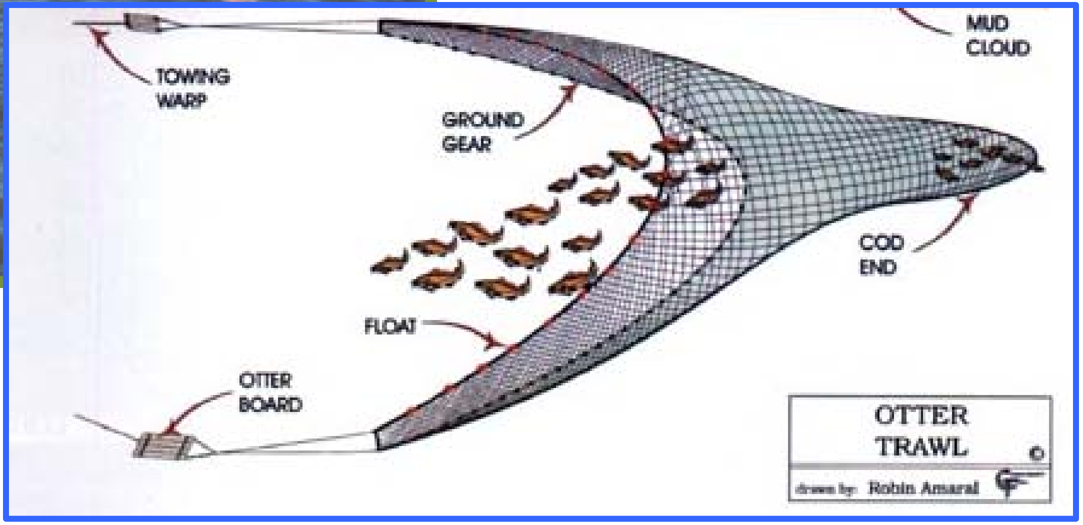
1. Project PORTS overview
2. Conduct scientific study
3. Convert research data into classroom lesson plan

Field study

My Question:

Does the Project PORTS enhancement effort alter species abundances and community assemblages relative to unenhanced (natural) bottom?

Trawl monitoring



Benthic habitat trays

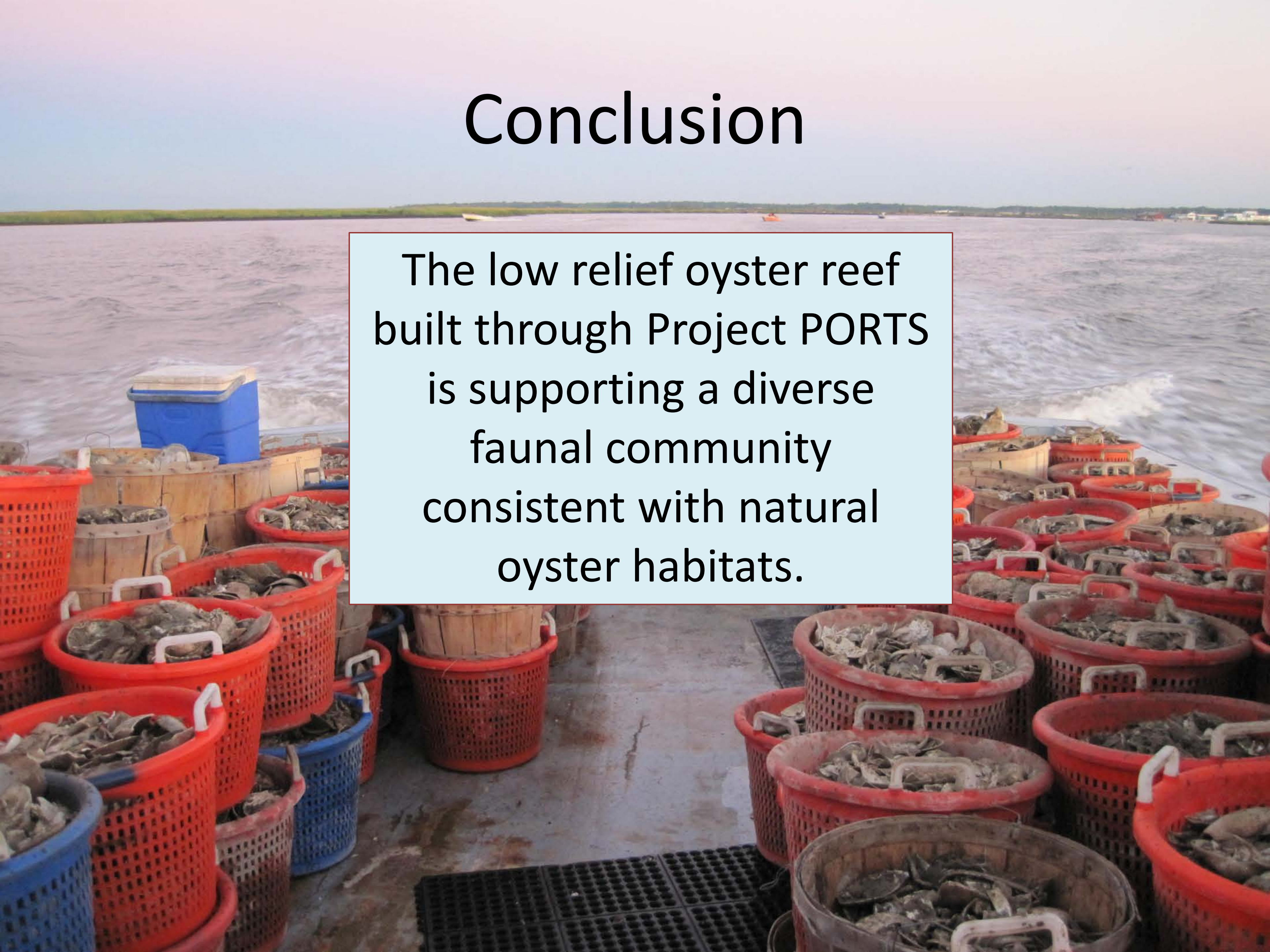
Low oyster density bottom

Restoration area

High oyster density bottom

12 quarts (~11.3 liters) of substrate put into each tray from that site- collected using a lined dredge

Conclusion



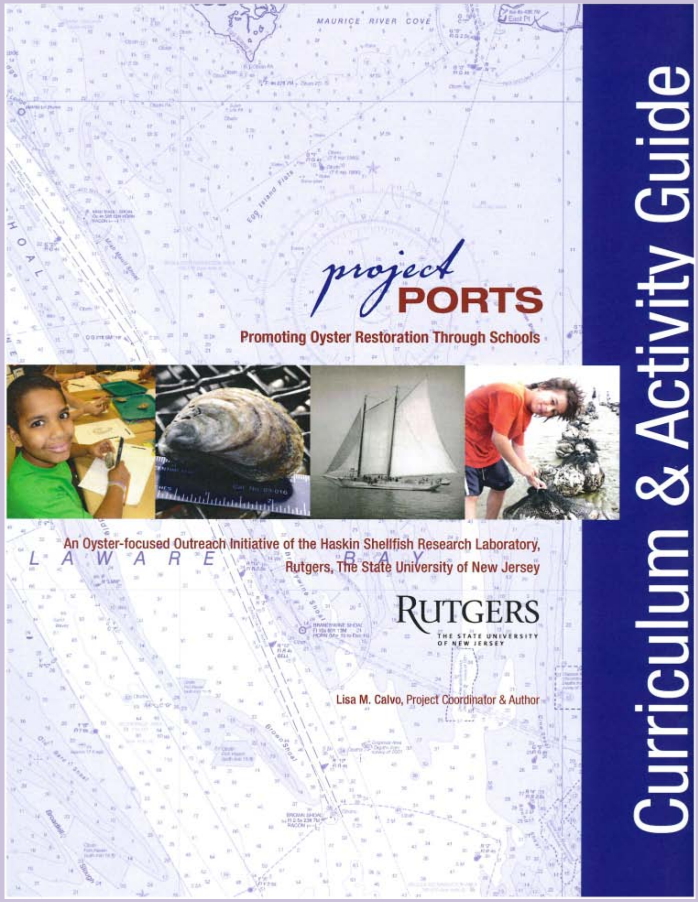
The low relief oyster reef built through Project PORTS is supporting a diverse faunal community consistent with natural oyster habitats.

Outline

1. Project PORTS overview
2. Conduct scientific study
3. Convert research data into classroom lesson plan

Activity 3.7, "One fish, Two Fish- Assessing Habitat Value of Restored Oyster Reefs"

- Located in Project PORTS Curriculum and Activity Guide
- Geared towards grades 6-10
- Introduces students to:
    - habitat restoration
    - oyster ecology
    - graphing and interpreting data
    - understanding how animal communities might vary with habitat conditions



Activity 3.7

- 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

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

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:

$1\text{-}D$, 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.

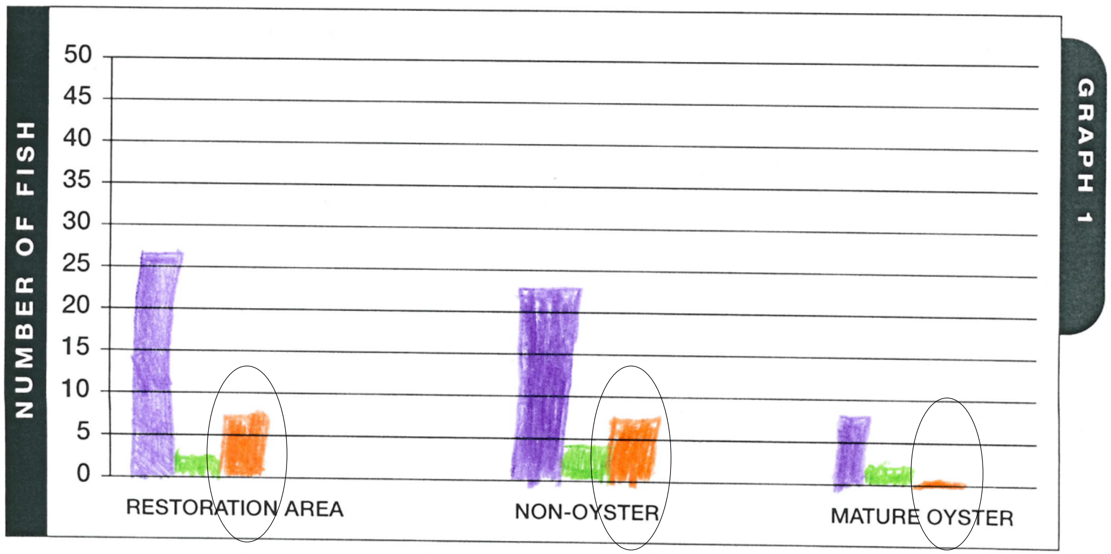
Student Worksheet Activity 3.7—Assessing Habitat Value of Restored Oyster Reefs

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

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)



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?

non-oyster = highest
matureoyster = lowest

3. Compare species diversity for each habitat. Which habitat has the greatest diversity? Which habitat has the lowest diversity?

reston
mature
2 non-oyster

4. What conclusions can you draw about the restoration area based on your results? Is it providing useful habitat to the fish? yes becuse it gives them a second chanceinlife

5. Why might some fish species benefit from the restoration project and others not? (Hint: think about life cycle, feeding, hiding from predators etc.)

well for some its a second chance of life and if they are salt water fish or eating needs habatat needs etc.

Educational Pilot Study

- Engaged 21 students (grades 6-8) from a local school in Activity 3.7 during one 40-minute session
- Assessments, including learning tasks, were administered to all students before and after participation in the activity

The assessment consisted of:

- Ecology and oyster multiple choice questions
- Creating a bar graph learning task
- Interpreting a line graph learning task

Sample assessment questions

What is species diversity?

a. It describes what part of the world a plant or animal lives in
b. Measure of how many offspring and animal can have
c. Measure that includes the number species and their relative abundances in a community
d. I'm not sure

The following data were collected in an experiment to study trees in different south Jersey habitats:

	Number of trees/plot		
	Forest (most dry)	**Meadow (part wet)**	**Swamp (most wet)**
Red Maple	10	6	7
White Oak	17	0	3
White Cedar	0	2	20

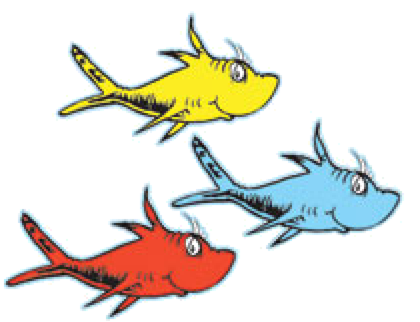
7.

a. **Create a bar graph of a tree of your choice.** ______________________________

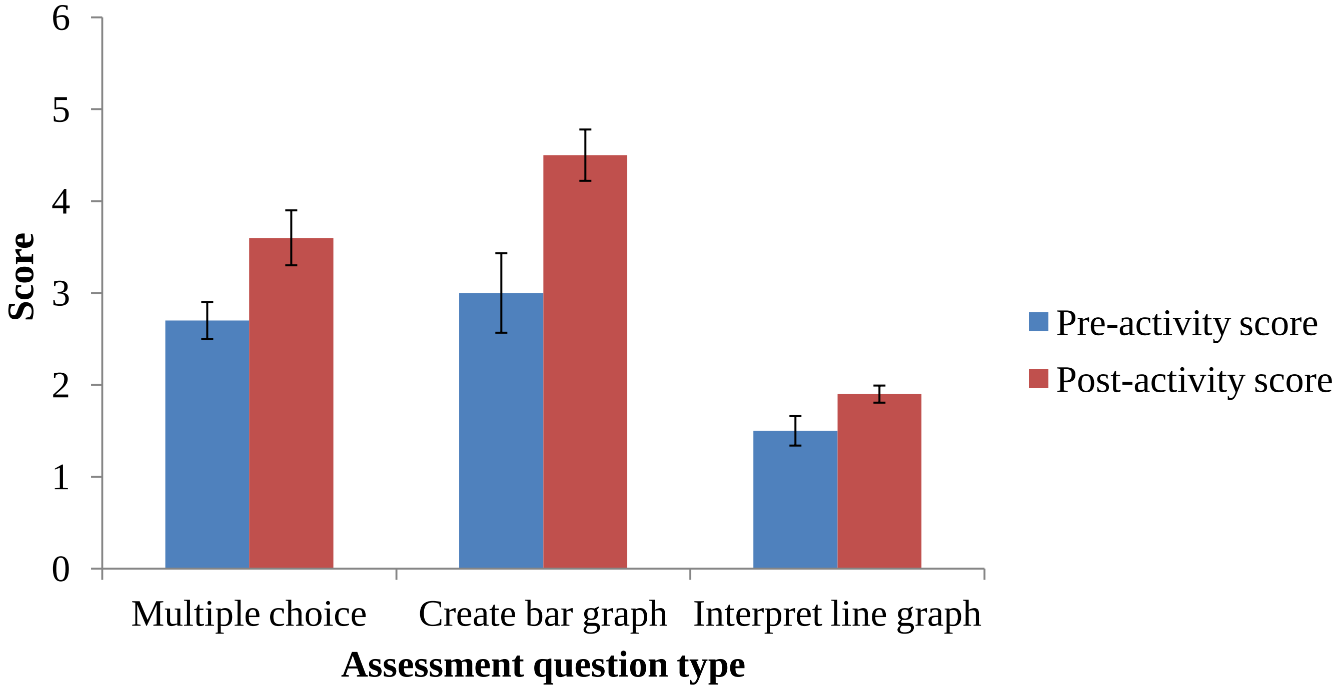
b. Based on your plots, what is one conclusion you can make about the species you chose?

Assessment Score Rubric

	0	1	2	3
7a. Bar graph	Did not plot graph at all, no effort shown	Draws on graph, but does not create bars (uses lines, dots, etc)	Draws bars, but not plotted on graph correctly: wrong values, missing bars etc.	Draws all bars accurately
7b. Conclusion question	Did not write in an answer	Answer does not demonstrate understanding of data	Answer demonstrates some understanding of data, but does not include moisture characteristic	Answer includes all information provided (tree species, habitat and moisture), clear understanding of data table
Notes:			Multiple choice:	/ 5
			Rubric score:	/ 6
			Line graph score:	/ 2
			TOTAL	**/ 13**



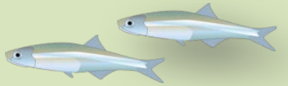
Results of the assessments indicate students made strong gains in knowledge about oyster ecology and improved analytical skills by graphing data.

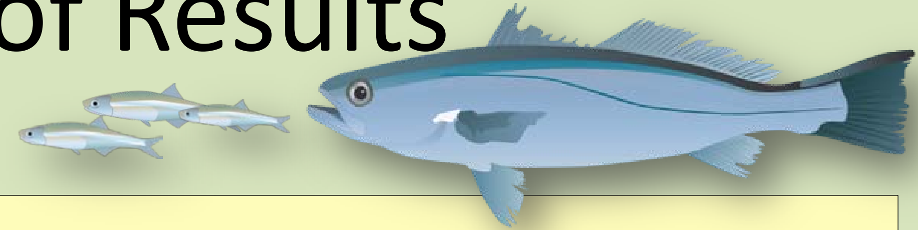


	Pre mean (SD)	Post mean (SD)	df	F	P-value
Ecology multiple choice	2.76 (1.00)	3.71 (1.31)	1	7.04	0.011 *
Create bar graph	2.95 (2.38)	4.55 (1.22)	1	7.48	0.009 **
Interpret line graph	1.54 (0.81)	1.81 (0.60)	1	1.17	0.286

* Significant at the 0.05 level
** Significant at the 0.01 level

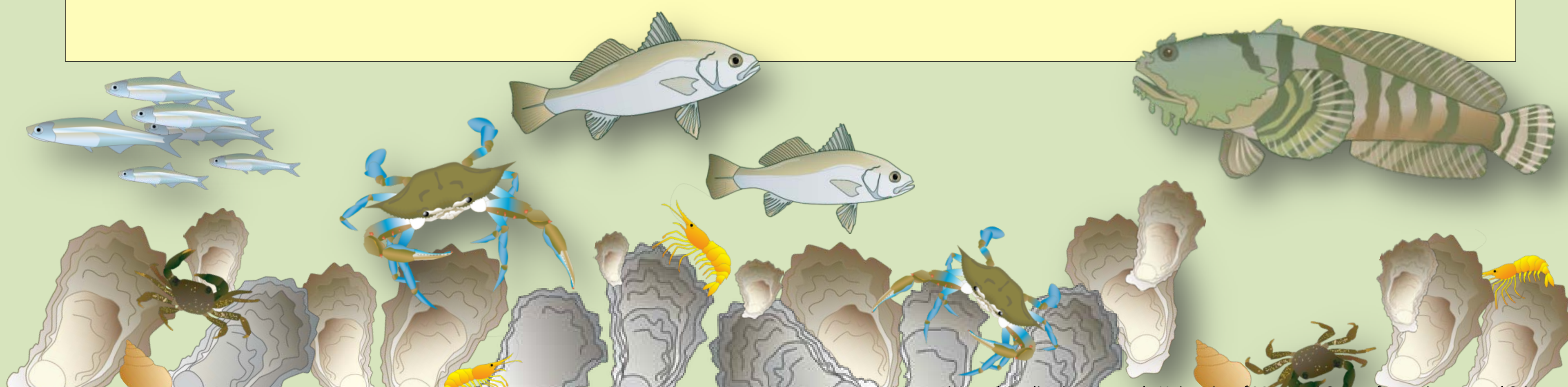
Summary of Results





- Using data from an actual research experiment to initiate problem-based learning improved science and math literacy in middle school students.

- This study demonstrates that a novel education program with a local, real-world connection can positively enhance crucial estuarine habitat while expanding participating students' STEM knowledge.



Integration and Application Network, University of Maryland Center for Environmental Science

Acknowledgements

Lisa Calvo, Program Coordinator, Rutgers University

Funding

- Dupont Clear into the Future
- Geraldine Dodge Foundation
- The National Partnership between NOAA's Community-based Restoration Program and Restore America's Estuaries
- NJ Sea Grant

Partner: American Littoral Society

Advisor: David Bushek, Committee members: Thomas Grothues, Rebecca Jordan and Olaf Jensen

Special thanks to my dedicated field crew: Iris Burt, Sarah Borsetti, Amy Danka, Jessica Horton and Jennifer Gius

Jenny.paterno@rutgers.edu