Shipwrecks as Reefs: Biological Surveys

Grade Level

- Grade 6 – 8

Timeframe

- 45 – 90 minutes

Materials

- 20ft Measured rope or measuring tape (x2)
- Cut-outs of fish species and benthic species
- 2ft x 2ft square frames (e.g. rulers taped together)
- Clipboards
- Student sheets

Key Words

- Artificial Reef
- Biological Survey
- Transect Line
- Quadrat
- Biodiversity

Activity Summary

The focus of this lesson is to highlight the use of shipwrecks as artificial reefs. Students will conduct a mock biological survey of fish populations using practiced methods of visual census transects and stationary quadrats. Students will apply and practice data sampling, collection, and analysis techniques. Students will make observations of similarities and differences between surveys and then make informed conclusions based on the data.

Learning Objectives

Students will be able to:

- Define artificial reefs and describe their environmental and economic impact
- Demonstrate data sampling and collection techniques
- Illustrate graphical representations of data
- Compare surveys based on similar and different factors, determining the effects of the factors on population and diversity

Background Information

During World War II, many battles were fought on foreign shores. However, few people know about those fought closer to home. The Battle of the Atlantic consisted of several skirmishes and decisive maneuvers between German U-boats and Allied ships all along the coasts of Europe and the United States.

The German submarines were under orders to prevent merchant vessels from getting supplies to Allied nations. The United States deployed their own ships to act as defensive escorts armed with anti-submarine artillery. Many German and Allied ships engaged in battle, fought, and sank off the coasts of North Carolina and Virginia.

The wrecks of these sunken ships still lie at the bottom of the ocean in a stretch of water called the Graveyard of the Atlantic. Though the use of the ships in battle has passed, the wrecks have found new purpose as artificial reefs.

Reefs provide for many species of fish as a refuge and food source. The presence of the wrecks has led to the growth of marine life that may not otherwise exist in those waters. Marine biologists who study the unique features of aquatic habitats survey these artificial reefs in order to determine environmental conditions, species diversity, and potential environmental and/or economic impacts.

Preparation

- Gather the materials: measuring tapes, frames, and clipboards
- Cut out the pictures of *Fish Species* and *Benthic Species*
- Obtain a space approximately 20x10ft
- Set up space for the mock biological survey – refer to *Teacher Page*
- Make copies of *Biological Survey*, *Analyzing Your Data*, *Interpreting Your Data*, *Survey Log-Transect Line*, and *Survey Log-Quadrat* for each student or group of students

Procedure

Provide background information on shipwrecks as reefs; the Battle of the Atlantic; the unintentional role of shipwrecks as artificial reefs; the job of marine biologists; and/or the purpose of biological surveys.

Activity: Biological Survey

1. Give each student or group a *Biological Survey*.
2. Explain "quadrat" and show the layout students will work with.
3. Have students read the background information on the two shipwrecks, and fill in the Summary Table on the *Biological Survey*.
4. Have students choose or assign the survey method to use. They may alternate. Recommended for a class of ~20:
   - One student for every 4ft section of transect line = 5 students per wreck
   - One student for one quadrat every 4ft along the side of transect line = 5 students per wreck

5. Have students participate in data collection by filling in their *Survey Log* (based on their method).
6. Once all students have finished their survey, have the class come together to compile data. Construct a "Class Totals" table on the board for students to fill in.
7. Tell students to use the class data to complete *Analyzing Your Data—Part 1*
    - Label bar graphs
    - Draw the bars based on "Class Totals"
    - Fill in tables comparing the shipwrecks
8. Have students complete *Analyzing Your Data—Part 2*. The students use their bar graphs and tables to write descriptive comparisons between the two shipwrecks comparing:
    - number of fish
    - species of fish
    - number of benthic organisms
    - phylum of benthic organisms
    The students make conclusions about the marine life of the artificial reef with regards to its depth.

Discussion Questions
- What are some challenges of recreational diving offered by deeper wreck sites?
- You compared depth. What other factors could you compare (if given different wreck sites)?
- What are other methods of representing your data besides a bar graph?
- Did you count the entire population or just a sample of organisms?
- Do you think your sample accurately represents the entire population in regards to percentage of species observed?

Extensions
- Use the recommended web resources to compare two shipwrecks acting as artificial reefs that are at similar depths but different water temperatures.
- Create graphical representations of data collected using computer software.
- Research a particular marine species found at a wreck site: habitat, food, migration pattern, etc.
- Research effect on local economy with regards to fishing, tourism, research efforts, etc.

Diver on the *Dixie Arrow*, Courtesy NOAA

Education Standards

National Education Standards	**Math**: (6-8) Data Analysis and Probability – collect data about a characteristic shared by two populations; discuss and understand the correspondence between data sets and their graphical representations; use observations about differences between two or more samples to make conjectures about the populations from which the samples were taken **Science**: (6-8) Science of Inquiry – use appropriate tools and techniques to gather, analyze, and interpret data (6-8) Life Science – populations and ecosystems **U.S History**: (5-12) Era 8: (3) – the causes and course of World War II; the character of the war at home and abroad
Virginia Education Standards	**Math**: 7.12 –represent relationships with tables, graphs, and words 8.13(a) – make comparisons, predictions, and inferences, using information displayed in graphs 8.14 – make connections between any two representations of a given relationship **Science**: 6.1 (i; k) – data are organized and communicated through graphical representation; an understanding of the nature of science is developed and reinforced LS.1 (f; i) – dependent variables, independent variables, and constants are identified; interpretations from a set of data are evaluated and defended BIO.1 (d; e) – conduct investigations in which graphing and arithmetic calculations are used as tools in data analysis; conclusions are formed based on recorded quantitative and qualitative data
Ocean Literacy Principles	5. The ocean supports a great diversity of life and ecosystems (a, d, f) 6. The ocean and humans are inextricably interconnected (b, c) 7. The ocean is largely unexplored (a, b, e)

Resources

Websites

Fish and Habitat Community Assessments on North Carolina Shipwrecks
This research paper details the biological survey used for the activity. Includes further information on four shipwrecks turned reefs, including depth, temperature, location, fish counts, and biomass.
http://sanctuaries.noaa.gov/science/conservation/pdfs/bota.pdf

Monitor National Marine Sanctuary
More information on the Battle of the Atlantic including German, Allied, and merchant vessels involved. Blogs chronicling first-hand experiences during diving expeditions on the shipwrecks.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

NOAA National Marine Sanctuaries
Learn about sanctuaries around the U.S.; educational resources; science data/research; maritime heritage projects; management policies; photo and video catalog; publications; and more.
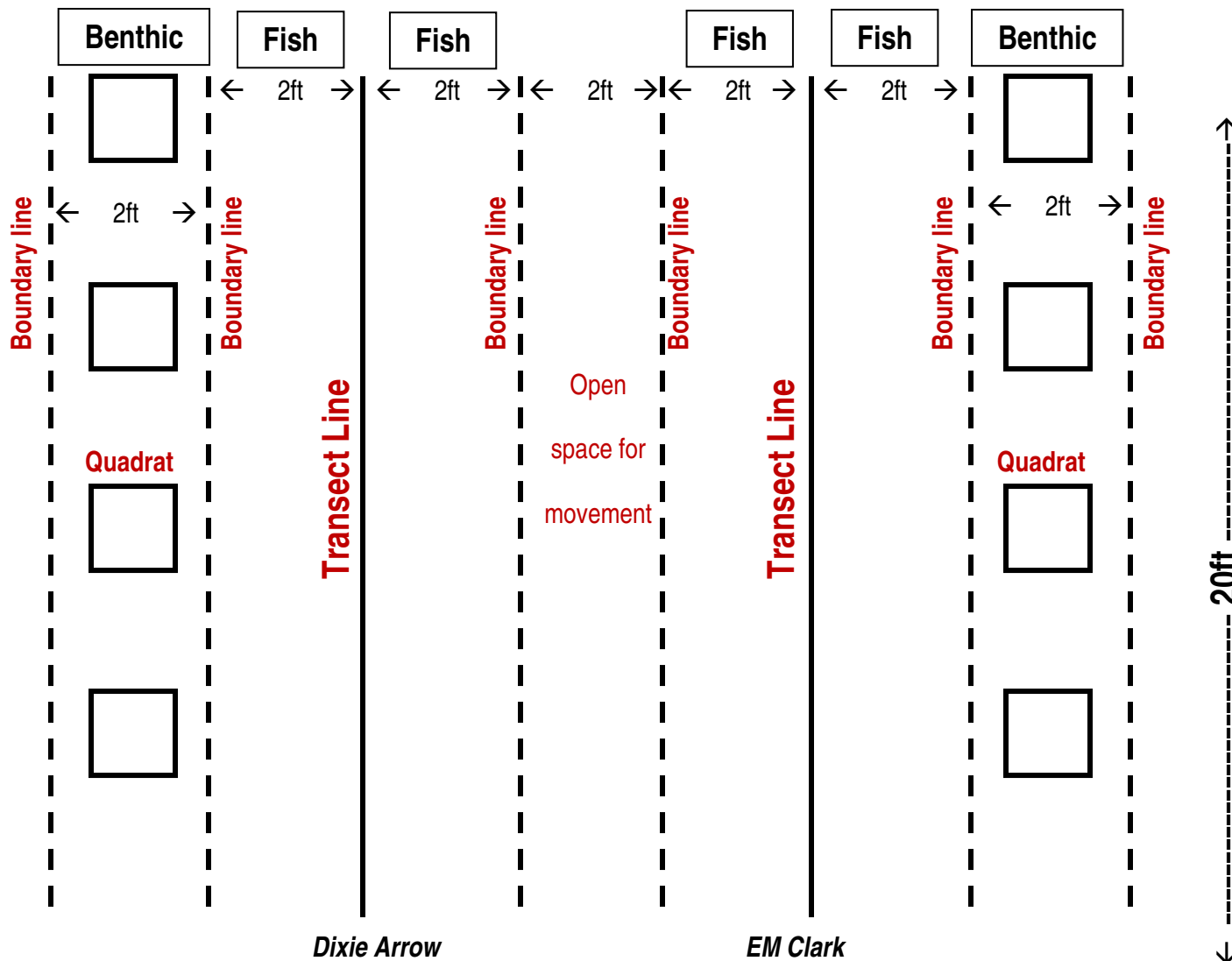http://sanctuaries.noaa.gov/library/welcome.html

Teacher Page

Sample Layout of Transect Lines and Quadrats:

| Benthic | Fish | Fish | | Fish | Fish | Benthic |

← 2ft → ← 2ft → ← 2ft → ← 2ft → ← 2ft →

Boundary line ← 2ft → Boundary line

Boundary line Boundary line Boundary line Boundary line ← 2ft → Boundary line

Transect Line

Open space for movement

Transect Line

Quadrat

Quadrat

20ft

Dixie Arrow

EM Clark

Distribution

Wreck	Almaco Jack	Black Sea Bass	Red Barbier	Sand Tiger Shark	Scad	Sheepshead Porgy	Tomtate	Vermillion Snapper
EM Clark	4	0	35	3	0	0	2	0
Dixie Arrow	0	4	0	3	30	2	20	10

❖ Wreck	Algae	Cnidaria	Chordata	Arthropoda	Echinodermata
EM Clark	10	7	0	20	7
Dixie Arrow	40	5	10	1	3

❖ Try to create even distribution within the given area

Name: _____

Date: _____

Biological Survey
Collecting Your Data

Reefs provide many aquatic species a refuge and food source. The presence of shipwrecks off the North Carolina coast has led to the growth of marine life that may not otherwise exist in those waters. Marine biologists, who study the unique features of aquatic habitats, survey these artificial reefs in order to determine environmental conditions, species diversity, and potential environmental and/or economic impacts.

Two shipwrecks located off the North Carolina coast that have recently been surveyed are the *EM Clark* and the *Dixie Arrow*. A brief synopsis of each is provided below:

➢ The *EM Clark* was attacked by U-*124* on March 18th, 1942. The tanker was transporting 118,000 barrels of heating oil. It was hit by two torpedoes. Forty of 41 crewmembers survived. The ship sank in 70°F water southwest of Diamond Shoals to a depth of 72m.

➢ The *Dixie Arrow* was attacked by U-*71* on March 26th, 1942. The tanker was hit by three torpedoes, igniting the 86,000 barrels of crude oil on board. Twenty-two members of the 33-man crew survived, but the ship sank. The wreck rests at a depth of 25m in 70°F water close to Diamond Shoals.

Activity:

Your job is to conduct a mock biological survey of two shipwrecks. The survey includes (1) a visual census along a transect line, and (2) a stationary quadrat.

1) Transect Line: Walk along the 20ft transect line and count the number of fish (while categorizing the species) within 2ft on either side of the line. (Time should not exceed two minutes.) Record your findings in the *Survey Log—Transect*.
2) Quadrat: Count the number of benthic organisms (while categorizing the type) within a 2ft x 2ft frame off to the side of the transect line at 4 or 5ft intervals. (Time should not exceed two minutes.) Record your findings in *Survey Log—Quadrat*.

Summary Table

Name of Ship	Cargo	When Sunk	Where Sunk	Depth	Temperature of water

Name: _____   **Shipwreck:** _____

Date: _____

Survey Log – Quadrat

Benthic Phylum	Number of Individuals (tally)	Class Total
Algae – green, photosynthetic organisms that cover surfaces (looks like grass or moss)	=_____	
Chordata (a.k.a Sea Squirt)	=_____	
Cnidaria ("nye-dairy-an")	=_____	
Arthropoda e.g. crab, lobster	=_____	
Echinodermata (i.e. starfish)	=_____	
Total Number of Organisms		

Name: _____   **Shipwreck:** _____

Date: _____

Survey Log – Transect Line

Fish Species	Number of Individuals (tally)	Class Total
Almaco Jack	= _____	
Black Sea Bass	= _____	
Red Barbier	= _____	
Scad	= _____	
Sheepshead Porgy	= _____	
Tomtate	= _____	
Vermilion Snapper	= _____	
Sand Tiger Shark	= _____	
Total Number of Fish		

Analyzing Your Data
Part 1

Now that you made observations and collected data, what do you do? In order to draw conclusions or make inferences about the environment, scientists must be able to analyze data they have collected. Follow the steps below using the species count data you have collected.

1. Create bar graphs for the Transect Line – Fish Counts
   a. Title each according to the shipwreck surveyed
   b. Label the x-axis and the y-axis
   c. Draw bars based on your fish counts
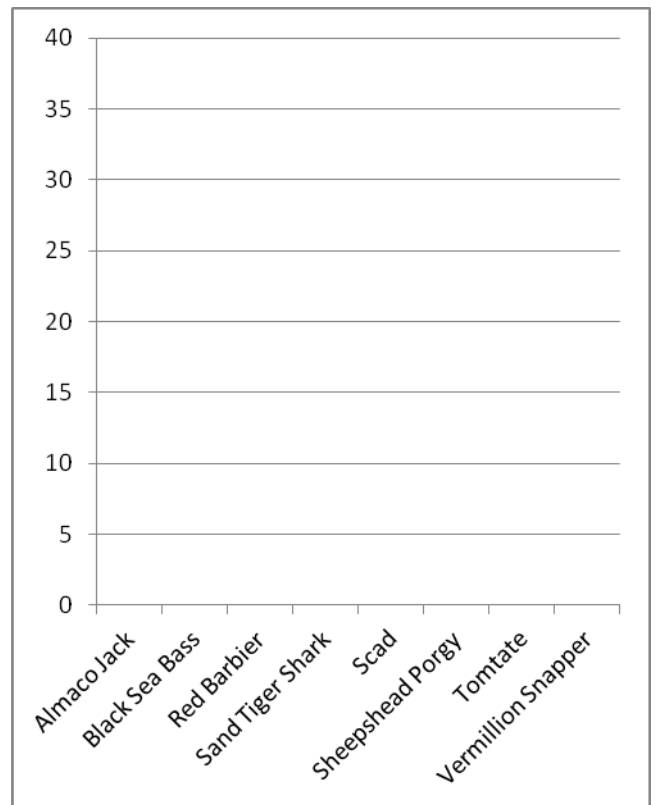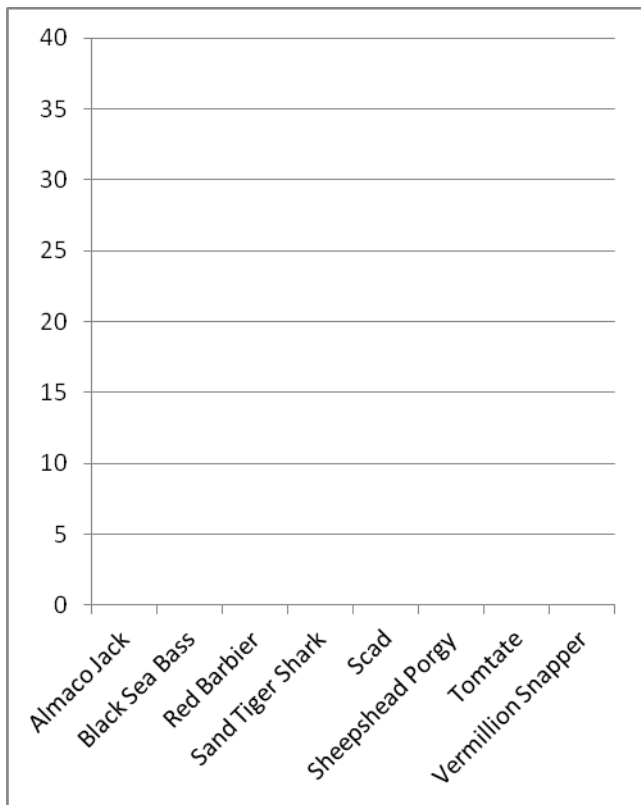
2. Compare the shipwrecks:

Shipwreck	Total Number of Fish	Total Number of Species	Most Common Species	Least Common Species	Species present at both wrecks
EM Clark					
Dixie Arrow					

Analyzing Your Data, Part 1, Continued

3. Create bar graphs for the Quadrat – Benthic Organisms
   a. Title each according to the shipwreck surveyed
   b. Label the x-axis and the y-axis
   c. Draw bars based on your benthic counts
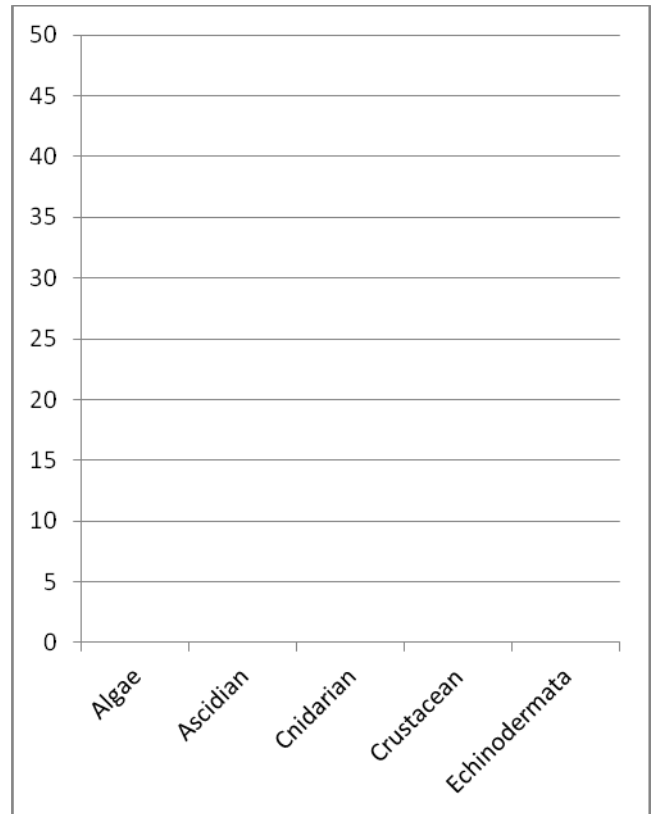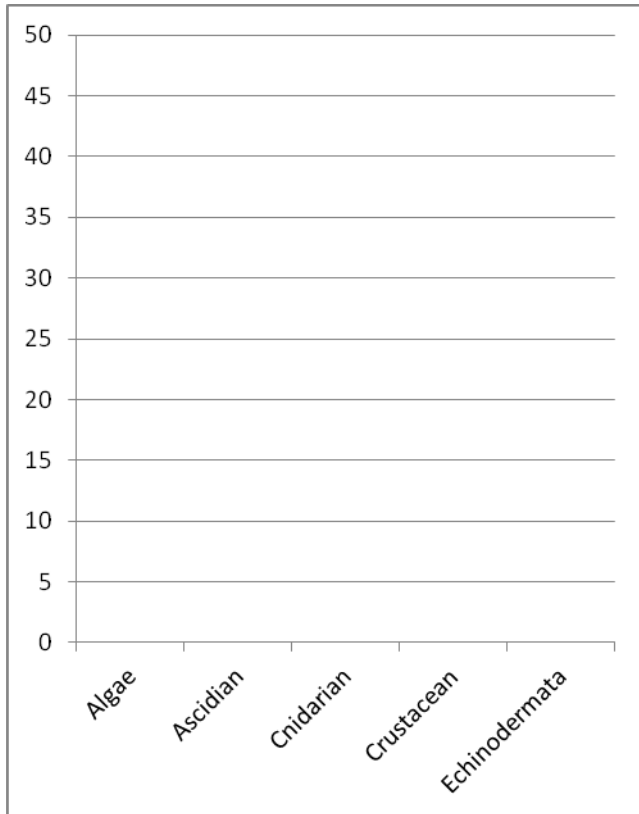
4. Compare the shipwrecks:

Shipwreck	Total Number of Organisms	Total Number of Phylum	Most Common Phylum	Least Common Phylum	Phylum present at both wrecks
EM Clark					
Dixie Arrow					

Interpreting Your Data
Part 2

Both ships sank in the same year, are located in a similar geographical area, and sit in the same temperature of water. However, the *Dixie Arrow* rests at a depth of 25m, whereas the *EM Clark* is at 72m. Based on your observations and analysis of both shipwreck sites, what can you infer (compare, describe) about:

1) The number of fish?

2) The species of fish?

3) The number of benthic organisms?

4) The phylum of benthic organisms?

What are your conclusions about the similarities/differences of biological factors between two artificial reefs at different depths?