Lesson 10: Oyster Reefs and Their Inhabitants

Focus Question:
What animals use oyster reefs for habitats?

Objective:
- observe properties of animals found within a bag of oysters;
- Infer about the quality of the oyster reef as a habitat based upon observations of biodiversity

SC Science Standards:

5-2.5 Explain how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

Purpose:
This is an interactive, lab-based activity in which students will use observations to investigate the differences among two oyster clusters ("young" and "aged"). Oyster clusters form reefs that serve as habitat for other estuarine organisms.

Time Duration: 2 hours

Materials:
Teacher Preparation:
- For Charleston area educators, contact South Carolina Department of Natural Resources, SCORE Program staff: Nancy Hadley (843.953.9841) or Michael Hodges (843.953.9241) for bagged oysters. If this source is unavailable, then small oyster clusters may be collected from the wild. (Note: Be sure to ask SCDNR about permits.)
- Background (Appendix 4) can help with understanding of terms and concepts.

Each student group:
- Phylum ID Sheet (Appendix 1)
- Oyster Bag Data Sheet (Appendix 2)
- Cluster from "young" oyster bag
- Cluster from "aged" oyster bad
- Caliper or ruler
- Tweezers
- 2 Trays or dishpans
- Paper towels
- Newspaper
- Gloves for each student
- Seawater from estuary or artifical seawater (optional)
- Sorting dishes (egg carton, petri dishes or bowls, etc)
- Permanent Marker
- Magnifying lens

Safety Concerns: Please note that students should wear gloves as oyster shells can be sharp. Have students wash hands with soap and water when the lesson is finished.
Oyster Restoration Bags either can be brought to the classroom in a cooler within a few hours of being removed from their habitat. Or, if the bags are small enough, they can be put in a large cooler and covered with seawater for a few hours of transient or possibly overnight with a air pump.

Vocabulary:

Spat: juvenile oysters that have just settled out from their planktonic form onto hard substrate such as dock pilings, rocks, or shell.

Diversity: the variety of organisms that can be found in a habitat.

Diversity Index (DI): the calculation of a habitat's diversity based on the number of species counted and the total number of individuals. When calculated, DI's closest to 1 are considered to have the highest diversity.

Habitat: the environment in which animals and plants live and where they find food, water, shelter and space.

Oyster Reef: an estuarine hard structure habitat made of clusters of oysters.

Aged Oyster Bag: A plastic mesh bag full of discarded shell that has been placed in the estuary for several weeks or months and spat, barnacles, tube worms, and many other organisms have moved in and settled. Aged oyster bags typically have a higher diversity than young oyster bags.

Young Oyster Bag: A plastic mesh bag full of discarded shell that has recently been placed in the estuary and does not contain many species or large diversity.

Student Engagement:

Use a KWL Chart to find out students' knowledge about oyster reef and their inhabitants. Ask the focus question: What is an oyster reef? What animals use oyster reefs as habitats? Ask them to predict whether they think an old oyster reef would have more diversity of animals than a younger oyster reef? List responses under the "K" column.

Ask students to think about questions they have pertaining to oyster reef habitats and inhabitants- write these questions under the "W" column.

Be sure to wrap up the KWL Chart after this lesson by completing the "L" column indicating what the students learned.

Methods:

Prior to distributing materials, review vocabulary and safety procedures below:

- Handle oysters & animals gently and carefully
- Be careful of sharp oyster shell edges and sharp tools
- Keep gloves on throughout this lesson.
- Optional: Sorted animals can be put in a little seawater in their dish or egg carton for later release.

Cover tables with newspaper. Distribute either in two separate areas on newspapers or sequentially, partial contents of two bags of oysters. one from a "young" oyster bag and one from an "older or aged" oyster bag, For each Bag, use the same procedures:

1. Sort the loose shells and live oysters looking for small organisms. .
2. Place small animals into some sorting trays. If possible, try to identify the organism in to the Phylum and by species level (if you can't identify the species, then just make up a name and

put in the table as "other"). Try to keep the samples of each Phylum separated from others. Using the Phylum ID Guide (Appendix 1) to help identify animals. The point is that the students observe differences and count the numbers of the same type. The point is not that they identify everything perfectly, but to sort.

3. Record the number of individuals you find on the Cluster Data Form (Appendix 2).
4. Count and record all species as best you can from this oyster bag.

Results:

On the "young" oyster bag data sheet, tally the total number of individuals that you found in this cluster. Record total on data sheet. Now calculate the total number of species that you found in this cluster and record this amount on the data sheet.

Repeat both calculations for the "aged" oyster cluster.

From the data you collected, calculate a Diversity Index for each oyster bag:

Total # of species / Total # of individuals = Diversity Index

a. Diversity Index for AGED:

b. Diversity Index for YOUNG:

Note: The most diverse oyster bag will have a Diversity Index closest to 1. (Read background in Appendix 4)

Conclusion:

1. Which bag had higher diversity and why?

2. What evidence do you now have to evaluate if oysters and oyster reefs are good habitat for estuarine animals?

Student Reflection:

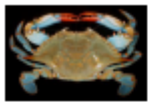
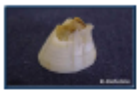
What do your observations about the age of a reef habitat and its DI tell you about the value of maintaining oyster reefs in the estuarine environment?

Why are oyster restoration programs important for more than just oysters?

Complete the KWL Chart

Appendix 1: Oyster Bag Photo ID Sheet

Arthropoda: *Jointed-legged animals*

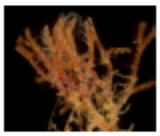
	**Blue Crab** *Callinectes sapidus*	These swimming crabs have a pair of flat hind legs that work as oars. *15 cm *length
	**Acorn Barnacle** *Balanus eburneus*	These barnacles are light in color and grow on hard surfaces in the intertidal zone,*2cm
	**Green Porcelain Crab** *Petrolisthes armatus*	A recent arrival to Georgia and South Carolina coast. It uses its hairy mouthparts to filter small food particles out of the water, *3 cm
	**Grass Shrimp** *Palaemonetes sp.*	These small shrimp live in shallow water, mostly in tidal creeks, salt marshes and around floating docks. They are transparent and have a faint orange tint, *2 cm
	**Amphipod** *Ampithoe valida*	Amphipod means "many feet;" the first two feet have pincers, while the remaining do not. The latter are used for locomotion. Amphipods are also laterally compressed *3 mm
	**Snapping Shrimp** *Alpheus heterochaelis*	This shrimp uses its enlarged claw to make popping or snapping sounds which can easily be heard at low tide. This sound stuns prey and predators, alike, which in turn allows the shrimp to capture their meal or defend themselves, *5 cm
	***Isopod*** *Paradella dianae*	Dorsally compressed, isopods look as if that have been squished. Expert hiders, isopods look similar to land based sow bugs or pill bugs, *3-5 mm
	**Atlantic Mud Crab** *Panopeus herbstii*	This is the largest crab found within the mud, with the exception of the stone crab. Its claws have black extensions, with "teeth" at the base. *2 cm
	**Oyster Pea Crab** *Zaops ostreum*	Lives in the gills of the oyster as a parasite, feeding on food filtered by the oyster, *1 cm
	**Marsh Crab** *Sesarma reticulatum*	This crab lives in the low, muddy areas of the marsh. It lives in burrows surrounded by mud "chimneys" above the high tide line. It is a purplish-black or brown color. *3 cm
	**Fiddler Crab** *Uca sp.*	Easily identifiable due to the male's significantly larger claw, these crabs demonstrate herding behaviors. This crab lives on sandy areas of the saltmarsh and creek banks. Its color is pinkish-purple, *5 cm

Images provided by Southeastern Regional Taxonomic Center & USGS

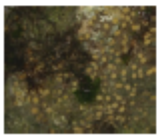
Annelida includes segmented worms, like earthworms, and marine worms, like Polychaetes. They have bristles, called "chaetae," on their bodies. Some species build tubes made of mud or calcium while others are free-swimming.

	Polychaete (no common name) *Dipolydora socialis*	These worms are generally surface deposit-feeders, meaning that they feed mostly on organic matter found in the surface sediment. *1 cm
	**Spaghetti Worm** *Amphitrite ornata*	This worm lives hidden in a tubes made of mud and uses its sticky spaghetti-like head extensions to search out food and bring it back to its mouth, *5 cm
	**Green Oyster Worm** *Nereiphylla fragilis*	This worm appears as a fragile yellow or green thread with a sticky texture. It lives in mucus-lined burrows in the mud among oyster shells, *15 mm
	**Scaleworm** *Lepidonotus sublevis*	The broad and flat bodies of the scaleworm are transparent cream with green stripes. It mostly feeds on organic material in the mud. *1 cm
	**Clam Worm** *Nereis succinea*	This polychaete is the most common Annelida found in oyster bags. a fierce predator that has extendable, muscular mouth parts with sharp jaws that shoot out to grab prey, *12 mm

Bryozoa are marine invertebrates that resembles plants and moss more so than animals. They filter plankton from the water.

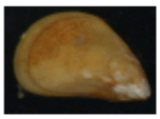
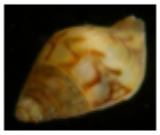
	Bryozoa (no common name) *Bugula neritina*	This is one of the most easily recognized branching bryozoans found on our coast. It appears as reddish-purple, bushy colonies.

Porifera *are sessile (attached) organisms without definite symmetry . They filter food from water that passes through their pores. and live mostly in marine environments.*

	**Redbeard Sponge** *Microciona prolifera*	Red to orange in color, these sponges grow on oysters in oyster reefs filtering out plankton through the pores. *up to 12 inches wide and 8 inches tall.
	**Boring Sponge** *Cliona celata*	This nearly featureless orange or yellow sponge is commonly found in the bottom of holes and tunnels which it tunnels (up to 3mm in diameter) in oyster shells and of other mollusks. You probably won't see a boring sponge, but you will see their tunnels.

Images provided by Southeastern Regional Taxonomic Center & USGS

Mollusca: Mollusks are a diverse phylum of organisms that all have soft bodies which include a "head" and a "foot." Most mollusks have a hard calcareous shell secreted by a mantle to protect their soft bodies, like snails and clams while nudibranchs, octopus, and squid have other defense mechanisms and have their mantles contained within their soft body.

	**Northern Quahog Clam** *Mercenaria mercenaria*	These clams have a characteristic heart shape to their dorsal area. These are also known as chowder clams. Their shell is a large, dense, grey or brownish in color, texture and size, *6 cm
	**Scorched Mussel** *Brachidontes exustus*	This mussel uses strong threads, known as a "byssus" to attach to hard surfaces. Its coloration is dark black, yellow green or brown with teeth on the outside margin of the shell, *2.5 cm
	**Lemon Drop Nudibrach** *Doriopsilla pharpa*	This slug gets its color from its primary food source, the yellow colored boring sponge, *2 mm
	**Lunar Dove Snail** *Astyris lunata*	Tiny and fat, these snails are smooth and brown. Their shell has a zigzag pattern with dark lines or bands that wrap around it from the base to the tip, *2 mm
	**Ribbed Mussel** *Geukensia demissa*	This is one of largest mussels, reaching up to 10 cm in length. Its shell has a yellowish-brown or greenish-brown color with strong lines, known as "ribs" on the outside. *8 cm
	**Atlantic Oyster Drill** *Urosalpinx cinerea*	This gastropod feeds on the oyster by using its radula as a drill a hole in the shell, *5 cm
	**Eastern Oyster** *Crassostrea virginica*	These mollusks live in dense clusters along banks of tidal creeks and rivers, which are exposed at low tide twice daily, *15 cm

Images provided by Southeastern Regional Taxonomic Center & USGS

Cnidaria is based on a Greek word meaning stinging nettle. A diverse phylum, Cnidaria range from corals and anemones to box jellies and man-of-wars.

	Anemone *Bunodosoma cavernata*	Found o nrocks and oyster reefs in the intertidal zone, these anemones filter plankton from water with their tentacles. *2-4 cm.
	Sea whip ***Leptogorgia virgulata***	Sea whips are colorful Cnidarians, ranging from white to orange to yellow to pink. They have a flexible skeleton covered with polyps armed with stinging cells that catch food floating by in the water, but their nematocysts, stinging cells, are potent enough to harm humans. * 10 inches tall

Echinodermata typically have symmetry based on 5 and are called pentamorusly symmetrical. The actually can up to 40 "arms" and aggressive predators preying on mollusks, other echinoderms, and dead organisms on the estuarine floor.

	Brittle star *Ophiophragmus sp.*	A fragile looking Echnoderm with 5 long lanky arms. Hard to see in oyster clusters as they are masters of camouflage. *8cm.
	Sea Star *Asterias forbesi*	Moving by thousands of tube or drifting with the tides, these sea stars are commonly found on our coast in jetties or oyster reefs. Tightly wrapped around a bivalve, a sea star will tire out the adductor muscle of its prey until the sea star can insert its stomach into the bivalve and eat the fleshy animal. *4 inches

Images provided by Southeastern Regional Taxonomic Center & USGS

Oyster Bag Data Sheet

Oyster *Cluster (Circle):* *Aged Oyster Bag* *Young Oyster Bag*

Phylum Mollusca	**Number**
Northern Quahog Clam	
Scorched Mussel	
Lemon Drop Nudibranch	
Lunar Dove Snail	
Ribbed Mussel	
Atlantic Oyster Drill	
Eastern Oyster	
Other:	

Phylum Porifera	**Number**
Redbeard Sponge	
Boring Sponge	
Other:	

Phylum Cnidaria	**Number**
Anemone	
Sea Whip	
Other:	

Phylum Arthropoda	**Number**
Blue Crab	
Acorn Barnacle	
Green Porcelain Crab	
Grass Shrimp	
Amphipod	
Snapping Shrimp	
Isopod	
Atlantic Mud Crab	
Oyster Pea Crab	
Marsh Crab	
Fiddler Crab	
Other:	

Phylum Bryozoa	**Number**
Bugula neritina	
Other:	

Phylum Cnidaria	**Number**
Anemone	
Sea Whip	
Other:	

Phylum Ecinodermata	**Number**
Sea Star	
Brittle Star	
Other:	

Phylum Annelida	**Number**
Dipolydora socialis	
Spaghetti Worm	
Green Oyster Worm	
Scaleworm	
Clam Worm	
Other:	

Oyster Cluster Data Summary:
Total # of Individuals Counted:
Total # of Species Represented:
Total # of Phylum Represented:
Notes:

APPENDIX 3 Student Worksheet (Teacher copy)

1. What Phylum was the most plentiful in the "young" oyster bag?
   Answers will vary

2. What Phylum was the most plentiful in the "aged" oyster bag?
   Answers will vary

3. If you would have been given an entire bag of oyster shells to sift through, would you expect to find more species or less in the sample? Explain your answer.
   Sample answer: I would expect the number of species to stay the same but there would be more individuals to count.

Focus Question: What animals use oyster reefs for habitats?

APPENDIX 3 Student Worksheet

1. What Phylum was the most plentiful in the "young" oyster cluster?

2. What Phylum was the most plentiful in the "aged" oyster cluster?

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Focus Question: What animals use oyster reefs for habitats?

Appendix 4: Background information

In southeastern estuaries, most of the intertidal area consists of soft sediment (mud or pluff mud). Hard substrate or surfaces, like shells or rocks, are common near oyster reefs or manmade structures like docks or jetties. Oyster reefs are formed by spat settling and growing on layers of living, dead or discarded oysters.

Oysters have a life cycle in which the larval stage is planktonic or free swimming. Oysters at this stage of life are called veliger larvae.

When a shell starts to form, the larval form settles on a hard substance, now the oyster is known as spat.

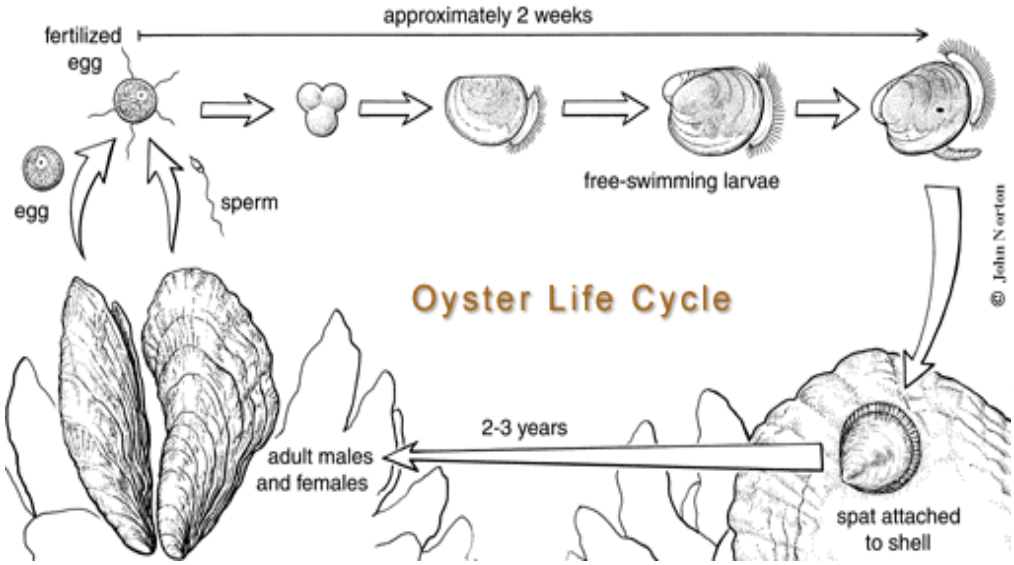

Figure 1 Oyster Life Cycle Credit: MD Sea Grant

In addition to providing hard substrate for young oysters to settle on, the oyster reefs provide habitat for many other estuarine animals to live, feed, and hide. Marine worms, crabs, snails and brittle stars move in and around the dead oyster shells and the living oysters. Other animals such as sponges, sea whips (soft coral) and mussels attach to the reef and filter food from the water that flows past. Tiny animals and juvenile organisms also inhabit the reef, feeding on even smaller creatures or grazing on attached algae or seaweeds.

While exposed at low tide, oyster reefs are invaded by land and air animals. Predators like raccoons, oyster catchers, and great blue herons stalk or pluck food from the oyster reef. At high tide, fish and blue crab investigate the reef for their favorite prey such as smaller crabs and polychaete worms.

Oysters have been important economic fisheries for coastal communities. However, overharvesting, poor water quality and disease have reduced the available oysters. When oysters are removed for sale, the actual habitat is reduced. Good management of this resource suggests that when oysters are removed from the estuary, it is important to return the oyster shell from where the animal was originally collected. By returning the shell material to the estuary, hard substrate is available for new oysters to grow.

Natural Resource agencies, such as SC DNR, help communities return oyster shells to the estuary. In SC, volunteers work with SCDNR scientists to "build" oyster reefs along the SC coast using plastic

mesh bags filled with oyster shells left over from large oyster roasts. These bags are then placed in the intertidal zone where SC oysters grow naturally. The program is known as SC Oyster Restoration and Enhancement or SCORE (http://score.dnr.sc.gov/).

Scientists are interested in the number of different types of animals found in an oyster reef and the actual number of animals living in a designated space. One can use a large scale classification of types on the Phyla level or small scale classification on the specie level.
Many ecologists feel that diversity in an ecosystem is good and provides more stability or resilience in the event of pollution, natural disasters or other impact.

In calculating diversity, do the following. Take a small cluster from the bag or reef and carefully identify the species and count each creature that you identify. This gives a list of species and total animals counted in that cluster, reef or bag.

Example:

You have counted 200 individuals classified into 20 species in an aged oyster bag. So diversity would be calculated as follows: 20/200=.1

If you have 10 species and 200 individuals in the young oyster bag, so diversity would be calculated as follows: 10/200=.05.

The diversity index of .1 is higher than .05. Therefore the aged oyster bag has a higher diversity than the young oyster bag.