Lesson 11: Oysters and Estuarine Water Quality

Focus question:
Are oysters effective in filtering particles from water?

Objective:
- To observe the filtering capacity of oysters.

SC Science Standards:
7-1, 8-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Purpose: This lab-based activity engages students in observational research. It builds on their experiences with an estuarine organism, the oyster. It also introduces one of the environmental issues facing estuarine areas—increased turbidity caused by (1) too many nutrients leading to algal growth and/or (2) sediment. Both lead to decreased water clarity.

Time Duration: 1 – 2 hours, but spread over a 4-5 hour period

Materials:
Teacher Preparation:
Read Background on Oyster Filtration and Turbidity (Appendix 1)
KWL Chart
3 similar, 1-gallon jars, prepared in three ways to engage students as a "hook": (1) water from a pond/lake kept near natural light, but at room temperature (avoid heating by sun or radiators) to which was added a small amount of garden fertilizer about 1-2 weeks prior to this activity. (2) Tap water with handful of dirt, stirred in just prior to the activity (3) Tap water with about ¼ cup of table salt dissolved prior to the activity.

Per Student Group:
- Two single, live oysters in their shells
- 2 similar glass containers, such as small, 5-10 gallon aquariums, clear baking dishes, etc.)
- 4 tablespoons of corn starch
- Turbidity Observational Disks & Scoring Card (Appendix 2)
- Student Worksheet (Appendix 3)
- Saltwater (artificial seawater or natural estuarine water with salinity at 14-21 ppt)
- Tape
- Permanent marker
- Timer or clock

Fresh, unshucked, live oysters can be purchased at most seafood markets and many grocery stores. Freshly harvested oysters can live several days if kept cool and moist in a cooler or refrigerator.

SAFETY CONCERNS: Have students wash their hands in warm soapy water after handling oysters (in or out of the shell). Students should not eat class oysters due to potential shellfish allergies and sanitation.

Vocabulary:
Filter-feeder: a plankton eating organism, such as a barnacle, clam or oyster, that filters its food from the water.
Nutrients: phosphates, nitrates and other minerals that fertilize plant growth
Dissolved: Compounds, such as salt and suger, which split into ions with water. These compounds do not settle out on the bottom.
Suspended: particles, such as dirt or plankton, that when mixed in water may settle out or be filtered out of the water.
Turbidity: suspended matter or particles in water in that reduce the transparency of water, block some light penetration; turbid water looks cloudy or murky. Turbidity reduces water clarity.

Hooking Students:
a. Compare the three jars (pond water, dirt water, salt water). Ask the student to "guess" what is in each jar just by observations.
b. The jar with the fertilized pond water should be green with algae after sitting in sun over a period of time. Ask what has happened to pond water jar. (There is a bloom of single celled plant. If you have microscopes, you can have students look for algae in the water).
c. The jar with the stirred dirt in it should be cloudy. Ask them to observe what is happening in the jar over time—minutes to hours. They should observe that some of the sediment has settled to the bottom of the jar.
d. The jar with salt or sugar should look be clear. Ask what they think is in this jar just by looking. (They should say they don't have any evidence for an answer.)
e. Hold the Observation Disks (Appendix 2) behind each jar and have students practice ranking the turbidity using the Turbidity Scoring Card (Appendix 2.) This is a skill for their investigation.
f. Lead the discussion to understand the differences in the terms--dissolved and suspended, based on their observations. Introduce the term, Turbidity.

Student Engagement:

A. Use a KWL Chart to organize the students' ideas.
<u>"K" What do you know?</u>
Discuss the pond water jar and the dirty water jar. Brainstorming with students how estuaries become turbid. (Farms and towns lose sediment, run off from roads and construction sites during storms carry sediment and increased fertilizers to estuaries. This leads to algae growth. Salt marsh grass decays to become "detritus". These organic particles add to turbidity in estuary). Ask them about some of the bad effects of too much turbidity. Answers can include sediment clogs filtering gills of oysters, cloudy water prevents bottom grasses from getting sufficient sunlight to photosynthesize. Ask them how oysters feed (filter particles from the water with their gills that are then moved to the stomach). Write their answers in the "K" Column.

"W" What you want to know? Record any questions that students have about oysters and estuaries. (For examples, can an oyster discriminate good and bad particles? How much water they can filter? How does excess fertilizer decrease the water quality of estuaries. How do oysters feed?)

"L" What have you learned? Complete this column at end of lesson.

B. Student Challenge

Design an experiment that will allow you to investigate if oysters can remove particulates from the water.

What is your research question? What data do you want to collect to answer this question? What instruments or tools will you need to collect data? Set up your reporting table on the Student Worksheet.

Sample Research Questions: How do oysters filter food from water? Can oysters remove particulates from water?

Part 1: Doing the investigation

1. Student Background to learn how an oyster feeds. Use Figure 1 to trace the path of particles that are captured on the surface of the gills, enter through the palps, move through the stomach and exit as wastes near the muscle.
2. Obtain 2 live oysters.
3. Set up your two containers. Label one container **control** and one **experimental**. Pour in sufficient seawater to cover two oysters by a couple of inches of water(See Figure 2).
4. Cut out & tape the Turbidity Disk card to the back side of each container below the water level.

Figure 1. Oyster Anatomy

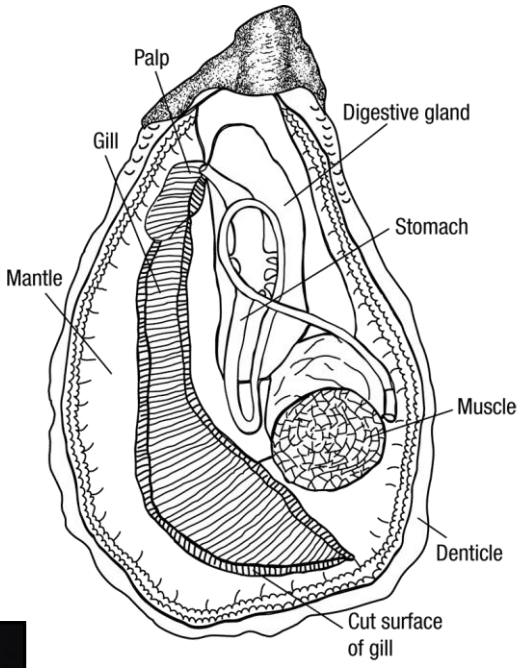

Figure 2. Container setup

5. Sprinkle a thin layer of one tablespoon of cornstarch over the water surface of each container, stir gently.
6. Add 2 oysters to the Experimental container; no oysters to the Control container
7. Record the time and record the turbidity of each container, by comparing the Turbidity Disk to the Turbidity Scoring Card and ranking the turbidity 1 (cloudy); 2 (clearer); 3 (clear) as appropriate. You should report your observations of both containers in addition to the ranking in the Data Table on your Student Worksheet.
8. Check after 30 minutes to see if your oysters beginning to open their valves a little to filter. Record the turbidity and your observations in both containers. Repeat at 30 minute intervals for no more than 6 hours.
9. Remove oysters and end the experiment before the end of school, as oysters will be stressed and die. Discard oysters in an outside container or return them to tidal creek.

Note: Healthy oysters should begin filtering within an hour, if not sooner.

Part 2: Understanding what you did

10. Write up Results from your Data Table on your Student Worksheet.

11. Write up conclusions from your results on your Student Worksheet.

C. Student Reflection:

In many estuarine areas, agencies are trying to restore and increase oyster populations to increase the water quality in the estuary or bay. What would they be filtering? Lead students in a discussion on if this is a good idea based on your experiment?

Appendix 1 Background on Oyster Filtration & Turbidity

Oysters are filter feeders which remove food particles, such as plankton, detritus and other small materials, from the estuary's water through their gills. Oysters can pump and filter 100 gallons of water each day! (The USGS estimates that this volume of water is nearly the same amount as most Americans use in one day!) Oysters filter algae for food. However, overharvesting and diseases have reduced oyster populations by over 50 to 80% in many East Coast esturaries.

Estuaries, such as the Chesapeake Bay, have had a lot of nutrients dumped into the water from land-based farms and suburban run off. In some cases, this caused algae to grow. The waters look green.

After a rainstorm, sediment is carried from farms and towns to streams and estuaries that increased turbidity. Sometimes, oyster's gills can get clogged with sediment particles. If the sediment load lasts for many days, oysters cannot feed and may die.

Turbid water blocks light from reaching the bottom. Sea grasses or Submerged Aquatic Vegetation (SAV) that are important habitat for scallops, shrimps and fish cannot photosynthesize in turbid water.

Scientists and citizens can measure turbidity by lowering a device called a Sechi (pronounced seh-key) Disc into the water. It is a round metal disc, painted black and white. Turbidity is determined from the depth in which the disc is lowered and "disappears" from view. In estuaries, the Sechi Disc may only be lowered four or five feet before it disappears from view. In the Gulf Stream with few particulates, the Sechi Disc may be lowered 100 ft.

Sources:

Of Sand and Sea, by Paula Keener-Chavis and Leslie Reynolds Sautter SC Sea Grant Consortium http://www.scseagrant.org/Content/?cid=290

NOAA/NOS Monitoring Estuaries: Turbidity http://oceanservice.noaa.gov/education/kits/estuaries/estuaries10_monitoring.html

Maryland Sea Grant: Learn more about Oyster anatomy and feeding: http://www.mdsg.umd.edu/issues/chesapeake/oysters/education/anatlab/lab_i.htm

Turbidity Observation Disks

Turbidity Comparison Scoring Card

1= Little Filtering/ Highly turbid

3=Some filtering/ Less turbid

5=High filtering/ Not turbid

Appendix 3: Student Worksheet (Teacher's copy)

1. What is your research question?

Answers will vary: Can oysters remove particulates from water?

2. Describe your experimental Design.

Set up an experimental and a control tank to see if oysters are responsible for filtering out the cornstarch.

3. Describe your set up and the materials you used

Answers will vary.

4. Methods

a. What data do you want to collect to answer this question?

Sample answer: Information on if cornstarch particles are removed from the water and how long it will take.

b. What instruments or tools will you need to collect data?

Sample answer: I used the turbidity card and ranked the clarity of the symbol when I looked through the water..

5. Results: Complete Data Table

Data Table:

Time		Turbidity Score		Other Observations
		Control	Experimental	
Start Time:		*1*	*1*	*Both containers were cloudy with the cornstarch suspended in the water*
1st Observation after 30 min:		*1*	*2*	*The oysters have opened their shell valves a little. I could see some currents moving the cornstarch in the water.*
2nd Observation after 30 min:		*1*	*2*	*I could still see some currents moving the cornstarch in the water with the oyster. Corn starch was still on the bottom of the control container*
3nd Observation after 30 min:		*1*	*2*	*Currents moving cornstarch getting fainter and I saw some corn starch on the bottom of the control container*
4nd Observation after 30 min:		*2*	*3*	*The oysters seem to have removed most of the cornstarch*
5nd Observation after 30 min:		*2*	*4*	*Very clear water in experimental. Oysters really filter!*

6. Conclusion:

a. What did you learn about oyster and their filtering capacity?

I learned that oyster filter water and remove cornstarch particles.

Focus question: Are oysters effective in filtering particles from water?

Student Worksheet

1. What is your research question?

2. Describe your experimental Design.

3. Describe your set up and the materials you used

4. Methods
    a. What data do you want to collect to answer this question?

    b. What instruments or tools will you need to collect data?

5. Results: Complete Data Table

Data Table:

Time		Turbidity Score		Other Observations
		Control	**Experimental**	
Start Time:				
1st Observation after 30 min:				
2nd Observation after 30 min:				
3nd Observation after 30 min:				
4nd Observation after 30 min:				
5nd Observation after 30 min:				

6. Conclusion:

a. What did you learn about oyster and their filtering capacity?

Focus question: Are oysters effective in filtering particles from water?