



Virtual SoundWaters High School Oyster Week Guide

Hello and Welcome to Distance Learning with SoundWaters!

The Oyster Program is a five-lesson, high school level module that focuses on the Eastern Oyster. SoundWaters Educators take your students on a deep dive into the world of the oyster, including its history, biology, role in industry and importance to the environment - especially Long Island Sound. Each lesson begins with a video featuring our Educators introducing key concepts and demonstrating experiments. Supplemental materials are also provided, including worksheets, vocab, and learn more videos. The Oyster Program can be completed by students working independently, and will also fit well into the classroom context.

Because each lesson builds on and references previous units, the material is best viewed sequentially. The results of the experiments are revealed in the Stewardship lesson.

Lesson 1: Oyster History and Physiology

Provides an intro to the History of the Eastern Oyster in the Long Island Sound and an exploration into the anatomy and physiology of the Eastern Oyster.

Lesson 2: Oyster Filtering and Bioremediation

A filtering experiment will be performed and concluded in this video.

Lesson 3: Acidification Effects on Oyster Shells and Reefs

An introduction to acidification and how it affects the oyster. An acidification experiment on oyster shells will be performed. The conclusion of this lab is found in lesson 5.

Lesson 4: Oyster Farming

A peek into the life of an oyster farmer. Students are presented a project on Virtual Oyster Farming. Students will write a proposal and budget plan to an investment company and learn about different culturing methods, environmental conditions best for an oyster.

Lesson 5: Stewardship

This lesson introduces stewardship and provides a tool, Conversation Mapping. At the end of this lesson the acidification experiment will be wrapped up.



Objectives

Students will be able to:

- Identify important physiological features that help the oyster transition from plankton to sessile benthic organism
- Evaluate the effects of an acidic environment on oyster growth stages
- Analyze differences between filtration rates of oysters
- Develop an oyster farm through comparing different variables
- Give examples of the benefits of oysters to the Long Island Sound environment

Instructional Materials

Topic Video

Vocabulary Flash Cards

Assessment Materials

Oyster overview questions (pdf answer key)

Oyster filtration lab report (pdf answer key)

Oyster acidification lab report (pdf answer key)

**this lab report will be used across 2 days (acidification & stewardship)*

Oyster farming narrative

Oyster reef conversation map

Related Materials

Links to videos and reading material that provides additional information on topics.

NOAA Resources

The National Oceanic and Atmospheric Administration (NOAA) is a partner of SoundWaters. These are additional resources you may use in addition to the other materials included above.

High School curriculum

<https://oceanservice.noaa.gov/education/oysters-in-the-chesapeake-bay/highschool.html>

<https://aamboceanservice.blob.core.windows.net/oceanservice-prod/education/oysters-in-the-chesapeake-bay/highschool/hs-module1.pdf>

<https://aamboceanservice.blob.core.windows.net/oceanservice-prod/education/oysters-in-the-chesapeake-bay/highschool/hs-module3.pdf>

<https://aamboceanservice.blob.core.windows.net/oceanservice-prod/education/oysters-in-the-chesapeake-bay/highschool/hs-module4.pdf>

Restoration

<https://seagrant.noaa.gov/News/Article/ArtMID/1660/ArticleID/191/Promoting-Oyster-Restoration-Through-Schools>



Aquaculture in Long Island Sound

<https://coastalscience.noaa.gov/news/models-highlight-benefits-aquaculture-long-island-sound/>

Nitrogen removal by oysters

<https://coastalscience.noaa.gov/news/nccos-and-nefsc-scientists-join-industry-and-community-partners-for-lab-and-field-experiments-to-confirm-bioextractive-removal-of-nitrogen-by-oysters/>

Ocean acidification

<https://ioos.noaa.gov/project/ocean-acidification/>

[https://www.pmel.noaa.gov/co2/story/Ocean+Acidification's+impact+on+oysters+and+ot
her+shellfish](https://www.pmel.noaa.gov/co2/story/Ocean+Acidification's+impact+on+oysters+and+other+shellfish)

<https://www.fisheries.noaa.gov/insight/understanding-ocean-acidification>

<https://www.fisheries.noaa.gov/feature-story/how-will-changing-ocean-chemistry-affect-shellfish-we-eat>

<https://oceanacidification.noaa.gov/WhatWeDo/BiologicalResponse.aspx>

NGSS Standards

Ecosystems: Interactions, Energy and Dynamics: HS-LS2.C, HS-LS2-7

Biodiversity and Humans: HS-LS4.D

OYSTER UNIT OVERVIEW QUESTIONS

Answers will vary slightly, but these are main ideas



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1. What clues does the outside of this oyster give us to what is inside

The oyster is a bivalve mollusk so the 2 shells protect a soft inner body. The size of an oyster suggests that the organs are all pretty compact and any sensory functions occur from within the oyster because the animal does not leave the shell

2. Does the oyster have a heart, ears, nose, mouth?

Heart - yes, small and beats to pump blood/oxygen

Mouth - yes, but is not used to bring in food, that happens from the gills

Nose - no, since this animal lives underwater permanently, it breathes with gills

Ears - no, they are able to sense their surroundings with the mantle

3. How does the oyster choose its food?

The oyster brings water into its shells and is able to sort materials based on size and density.

Phytoplankton are light/small enough to be passed to the mouth. Larger debris and sediment is removed as pseudofeces

4. What function(s) does the shell serve?

The shell protects the soft inner body from its surrounding and opens to bring in water

5. Do oysters look the same their entire life?

Oysters are born as plankton, swimming in the water column. They land and begin growing on the bottom and remain sessile the remainder of their life

6. What are some ways a predator could eat an oyster?

Seastars are able to use their arms/tube feet to hold the oyster open while they use their stomach to digest the oyster inside its body. Birds drop the oyster to crack the shell.

7. How do humans impact oysters?

Human development can increase sedimentation in areas that negatively affect their ability to feed.

Dredging would remove stable habitat on the bottom so they cannot land. Ocean acidification can cause a weakening of their shells. Over harvesting can reduce the total population of oysters'

8. Can oysters move?

Oysters only move when they are plankton, which are swimming microscopic organisms

9. How does the presence of oysters in Long Island Sound affect humans?

Oysters filter the water, making it cleaner for the remaining organisms to thrive. Oysters are part of commercial and recreational industries (fish, oysters). Oyster reefs stabilize the coastline from wave action and prevent erosion

10. How do you know if an oyster is alive?

Oysters are alive if they are closed within their 2 shells. If they are open for too long in the water, they may be eaten. If they are open too long in the air, they will dry out



The purpose of this experiment you will be learning how oyster filter the water around them

Question: How does the number of oysters in an area affect the filtration rate?

Hypothesis: If the number of oysters in an area is increased, then the filtration rate will increase as well since the oysters are able to pull more water inside their bodies and process it.

Experimental Setup

<u>Tank 1</u> # of oysters: 0	<u>Tank 2</u> # of oysters: 3	<u>Tank 3</u> # of oysters: 18
Amount of plankton: 200 ml	Amount of plankton: 200 ml	Amount of plankton: 200 ml

Data - Filtration Time *(based on a 3 hour experimental timeframe)*

<u>Tank 1</u> Estimate: Actual: none	<u>Tank 2</u> Estimate: Actual: more than 3	<u>Tank 3</u> Estimate: Actual: 3 hours
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Conclusion:

Dependent on their hypothesis

Why did we add the same amount of plankton to all three tanks?

Changing the amount of plankton in each tank would add another variable so we would not be able to conclude the exact reason for the difference in how fast they filter

What is the purpose of a control in an experiment? Which tank was your control and why?

A control demonstrates what will happen if nothing is changed and provides a comparison for the variable you are testing. The control tank was the one with no oysters.

Oyster Filtration Calculation Guide

How do we calculate the filtration rate for one oyster? We will use Tank 2 (the tank with 3 oysters) as an example.

Make a table with the information from our experiment (we've added in a couple numbers to help you):

Time to filter (tank 2)	21
Time to filter (tank 3)	3
# Oysters (tank 2)	3
# Oysters (Tank 3)	18
# Gallons per tank	3

Now you have all of the information you need to calculate a SoundWaters oyster's filtration rate!

We know that 3 oysters filter 3 gallons of water in 21 hours. We show this as a fraction:

$$3 \text{ oysters} = \frac{3 \text{ gallons}}{21 \text{ hours}} \quad \text{which we can simplify as:} \quad 3 \text{ oysters} = \frac{1 \text{ gallon}}{7 \text{ hours}}$$

Our next task is to calculate how many oysters it would take to filter 1 gallon per hour. We do this by multiplying both sides of our equation by 7, and we get:

$$7 * 3 \text{ oysters} = \frac{1 \text{ gallon}}{7 \text{ hours}} * \frac{7}{1} \quad \text{after multiplying both sides, we get this:} \quad 21 \text{ oysters} = \frac{1 \text{ gallon}}{1 \text{ hour}}$$

From here, we can easily calculate 1 oyster's filtration rate! All we have to do is divide 1 gallon per one hour by 21!

$$\frac{1 \text{ gallon}}{1 \text{ hour}} = 1 \quad \text{therefore} \quad \frac{1}{21} = 0.048$$

Voila! One oyster from tank 2 filters **0.048 gallons of water per hour!**

Now it's your turn!

Based on the filtration data for tank 3, what is the filtration rate in gallons per hour for a single oyster? Hint: each tank is 3 gallons

$$18 \text{ oysters} = \frac{3 \text{ gallons}}{3 \text{ hours}}$$

$$18 \text{ oyster filter } 1 \text{ gallon/hr}$$

$$1 \text{ gallon}/18 \text{ hours} = 0.056$$



The purpose of this experiment you will be learning how oyster filter the water around them

Question: How will oysters be affected by pH during different stages of their life?

Hypothesis: The oyster spat has the smallest shell, which is also the thinnest, so it should be most susceptible to the acid in the water. AS oysters get older, their shell size increases

Experimental Setup:

You will be comparing the reaction of three oyster life stages (spat, juvenile, adult) under different pH conditions that include, Long Island Sound Water and vinegar. The experiment will occur over several days.

Conclusion:

- 1) Which of the shell life stages was most affected?
 - 2) Why is that significant?
 - 3) What effect does it have on the formation of oyster reefs?
 - 4) Based on your results, what other animals would be most affected by a change in the pH of the water in the ocean or Long Island Sound?
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- 1) The oyster spat was affected the most
 - 2) Spat are the stage of oyster that are first attached to a hard surface. If their shell breaks down as they are starting to grow, they will be too brittle before they get to be adults
 - 3) Any animals with a shell would be most affected including other bivalves (clams, mussels, etc). If the acid affects the outside of a hard surface, then it would certainly affect the soft bodies of other animals as well.

SHELL ACIDIFICATION LAB REPORT



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Data

pH of Long Island Sound = 8		pH of Vinegar = 2-3	
<u>SPAT IN LONG ISLAND SOUND</u>		<u>SPAT IN VINEGAR</u>	
Pre Weight	0.19 grams	Pre Weight	0.06 g
Post Weight	0.22 grams	Post Weight	0.00 g
Pre description	Small rounded shell, flat and thin	Pre description	Small rounded shell, flat and thin
Post description	no change to appearance	Post description	Dissolved completely
<u>JUVENILE IN LONG ISLAND SOUND</u>		<u>JUVENILE IN VINEGAR</u>	
Pre Weight	2.57 g	Pre Weight	0.95 g
Post Weight	2.71 g	Post Weight	0.06 g
Pre description	Larger shell than spat, beginning to have some ripples on top of shell, becoming thicker	Pre description	Larger shell than spat, beginning to have some ripples on top of shell, becoming thicker
Post description	no change to appearance	Post description	Shell almost completely dissolved
<u>ADULT IN LONG ISLAND SOUND</u>		<u>ADULT IN VINEGAR</u>	
Pre Weight	26.09 g	Pre Weight	18.00 g
Post Weight	26.40 g	Post Weight	13.25 g
Pre description	Largest shell, much thicker and rough on the surface. Developing additional layers, wavy look	Pre description	Largest shell, much thicker and rough on the surface. Developing additional layers, wavy look
Post description	No change to appearance	Post description	Shell thinner than when experiment started

Oyster Budget Sheet

Item	Cost per item	Quantity	Total Cost
Eastern Oysters (500,000/batch)	\$11,000		
Staff (1 person/40 hr week)	\$400 per week		
Additional boat	\$20,000		
Mechanized dredge (per 2 staff)	\$2,000		
Hand tongs (per1 staff)	\$475		
Rack and bag method	\$20 per 150 oysters		
Surface/floating method	\$20 per 150 oysters		
Trays	\$30 per 200 oysters		
TOTAL MONEY SPENT (\$500,000 BUDGET)			

Oyster Business Plan



Safe Reef, an investment company, has decided to invest \$500,000 into your oyster business. As well as investing money into your company, they are also giving you the lease to a plot in the Long Island Sound, a boat, and taking care of all permit costs. Your business is tasked with successfully growing oysters to market size within the next two months. Safe Reef, however, has a few stipulations in order to receive the money. You must send them a completed budget worksheet and a business plan addressing the following questions:

- What are you most concerned about with growing your oysters?
- Why are your decisions going to have the best results?
- What could potentially go wrong with your farm to affect your results?
- What will you do with the oysters that you have grown on your farm? Will you sell them for profit or share them with another agency/group to help the environment?

Summary

- Use \$500,000, Oyster Boat, and plot to start your oyster company
- Choose a oyster culture method based off your oyster plot
- Your group must be prepared to deliver a business plan and completed budget sheet to Safe Reef

Bottom (see budget sheet for cost)

Substrate: rock

Business pro: no grow out method needed, oysters grow directly on the bottom like wild oysters.

Oyster growth pro: most robust shells, hardiest oysters.

Business con: Requires mechanized oyster dredge or hand tongs.

Oyster growth con: more susceptible to predator animals and environmental conditions (water chemistry, pollutants, etc), overcrowding of oysters can lead to die off

Off Bottom Overview (must select grow out method)

Substrate: mud, sand

Business pro: less likely to lose oysters due to weather or predation.

Oyster growth pro: oysters are more uniform in size, faster growth rate due to faster water flow.

Business con: requires more equipment based on number of oysters, weaker shells are harder to open for businesses.

Oyster growth con: shells tend to be more brittle.

Rack & Bag (\$20 per 150 oysters)

Business pro: oysters can be grown in areas that might be too muddy.

Oyster growth pro: oysters are enclosed and protected from predators.

Business con: cleaning regularly to prevent fouling, requires much horizontal space, cannot be grown on top of each other.

Oyster growth con: attached by steel to bottom, can be grown in intertidal zones.

Surface/Floating (\$20 per 150 oysters)

Business Pro: most floating systems can be handled and processed by a single worker.

Oyster growth Pro: oysters are enclosed and protected from bottom dwelling predators, oysters are able access the phytoplankton rich surface of the sound.

Business Con: cleaning regularly to prevent fouling, requires much horizontal space, cannot be grown on top of each other, more of a navigational hazard, takes a lot of time and labor to construct system.

Oyster growth Con: shells tend to be more brittle.

Trays (\$30 per 200 oysters)

Business pro: trays can be stacked vertically depending on space, which increases number of oysters that fit in the cage.

Oyster growth pro: oysters are protected from predators, mud, and silt.

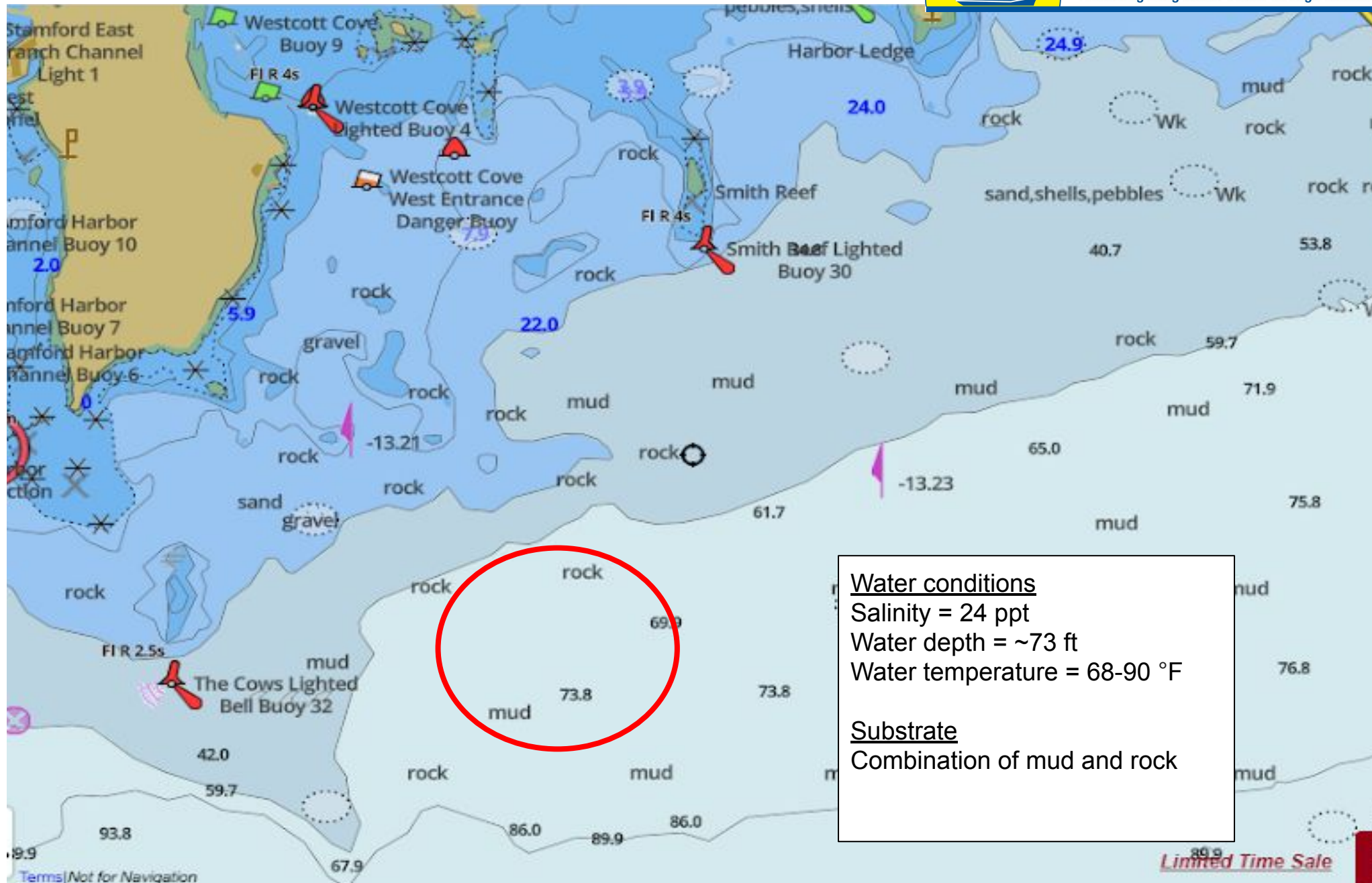
Business con: multiple staff needed to clean cages regularly and operate equipment to remove cages. Tray quantity is dependent on number of oysters.

Oyster growth con: some predators can get in. Oysters are susceptible to silt and environmental conditions.

VIRTUAL OYSTER PLOT



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CONVERSATION MAP: OYSTERS

Use this conversation map about Oysters to spark a conversation with your peers. Ask 5 people in your class to fill in their thoughts, ideas, opinions, and questions regarding each oyster topic.

