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The Mystery of the Oyster: What's in the Bag?

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Grade Level
7th Grade

Subject Area
Life Science / Biology

VA SEA is a collaborative project between the Chesapeake Bay National Estuarine Research Reserve, the Virginia Institute of Marine Science's Marine Advisory Program, and Virginia Sea Grant. The VA SEA project is made possible through funding from the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.

Title: The Mystery Oyster: What's in the Bag?

Focus: Use measurements and graphing to examine and assess how husbandry strategies and business decisions can impact the Eastern Oyster shape.

Grade Level Life Sciences, Biology; target 7th grade.

VA Science Standards

LS.1 The student will demonstrate an understanding of scientific and engineering practices by

- **B.** planning and carrying out investigations
  - independently and collaboratively plan and conduct observational and experimental investigations; identify variables, constants, and controls where appropriate and include the safe use of chemicals and equipment
  - evaluate the accuracy of various methods for collecting data
  - take metric measurements using appropriate tools and technologies including the use of microscopes
- **C.** interpreting, analyzing, and evaluating data
  - identify, interpret, and evaluate patterns in data
  - construct, analyze, and interpret graphical displays of data
  - compare and contrast data collected by different groups and discuss similarities and differences in their findings
  - consider limitations of data analysis and/or seek to improve precision and accuracy of data
  - use data to evaluate and refine design solutions
- **D.** constructing and critiquing conclusions and explanations
  - construct explanations that include qualitative or quantitative relationships between variables
  - construct scientific explanations based on valid and reliable evidence obtained from sources (including the students' own investigations)

LS.7 The student will investigate and understand that adaptations support an organism's survival in an ecosystem. Key ideas include

- **B.** physical and behavioral characteristics enable organisms to survive within a specific ecosystem.

Learning Objectives

- ✓ Students will make observations about husbandry and business decisions and how those relate to oyster shape
- ✓ Students will plot measurements and compare graphs to visualize differences in oyster shape
- ✓ Students will use the plots and data to determine which market each farmers oyster should be sent to
- ✓ Students will discuss the importance of husbandry decisions and how this can impact oyster growth and different business strategies

Total length of time required for the lesson

75-85 minutes total; Advance preparation of lab materials – 10 minutes, Lab setup – 5 minutes, Introduction – 15 minutes, Activity – 30-40 minutes, Discussion – 10 minutes, Breakdown and clean-up – 5 minutes.

Keywords, vocabulary:

- **Aquaculture**: the growing of aquatic organisms in manipulated aquatic environments for any commercial, recreational or public purpose.
- **Husbandry**: that manner in which farmers care for and manage their animals.
- **Keystone Species**: a species that other species heavily rely on, meaning that if the species were removed, the environment would dramatically change.

Background information

Aquaculture. The word aquaculture means fish farming. Farmers grow organisms in the water. The aquaculture industry is growing fast. By 2024, farmers will likely grow more fish than those caught in the wild. As more and more people live on Earth, there will be a greater need for more seafood options, and aquaculture can fill this need. Researchers are trying to help farmers grow more fish that taste and look better. Farmers that understand tradeoffs tied to different farm choices can harvest a better product and meet the needs of the growing population while also taking pressure off wild fish populations.

Oysters. Oysters are a keystone species that help humans and the environment. Oysters give fish and crabs a place to live and hide. Wild and farmed oysters can help limit flooding and the impacts of high wave and tidal action. Oysters filter feed and can make the water better. A single oyster can filter up to 50 gallons of water daily. Oysters help the economy by giving local people jobs. Healthy oysters are a resource for the environment and coastal communities.

Commercial Shellfish Aquaculture. The Eastern Oyster, *Crassostrea virginica*, is grown on the East Coast of the United States from Maine down to the Gulf of Mexico. Because of this wide geographic range, there are many ways to grow and take care of oysters. Farmers choose gear types and farming practices based on how they want to run their farm. Some decisions farmers make include whether to grow oysters on the bottom or off the bottom, if they will have employees, and where to sell their oysters. These decisions can affect the way oysters physically look. Running a successful farm means understanding how each decision fits into the bigger picture.

Student handouts

- The Mystery Oyster: What's in the Bag Worksheet (key provided for the instructor)
- Farmer #1 Profile
- Farmer #2 Profile
- Farmer #3 Profile
- Farmer #4 Profile

Materials & Supplies

- Ruler down to mm capability
- Calculator to calculate percent full and averages
- Computer and projector for accompanying PowerPoint

Classroom Set up

- Students should work in groups of four students; set up however best for this

Procedure

Advance preparation of lab materials – 15 minutes

Prepare lesson activity by printing The Mystery Oyster: What's in the Bag Worksheet and enough farmer profiles for the appropriate number of groups.

Each group should have a copy of:

- The Mystery Oyster: What's in the Bag Worksheet
- 1 of the 4 Farmer Profiles

Ideally, photographs should be printed in color, but are usable in black and white; the instructor may choose to laminate each farmer's profile to ensure their longevity.

Each student should have their own copy of:

- The Mystery Oyster: What's in the Bag Worksheet

Engagement

Begin the PowerPoint, The Mystery Oyster: What's in the Bag

- See slides for specific notes with suggested dialog and discussion
- Questions for students are included throughout the PowerPoint presentation.
    - Slide 2
        - What do you think of when you hear the word farming?
            - Some answers might be cows, chickens, sheep, and various types of crops and flowers and this will begin the lesson about fish farming and aquaculture.

Exploration

- Discuss what aquaculture is and why it is important.
    - Introduce the concept of aquaculture and why it matters
    - Move on to oysters and how they benefit humans and the environment.
    - Ask questions to get students thinking about aquaculture regionally.
        - Have you ever thought about fish farming?
            - Possible answers: yes/no
        - What are some types of fish and shellfish that could be grown?
            - Possible answers: salmon, perch, walleye, shrimp, scallops, and oysters (to name a few things – this is not an extensive list).
        - Any local species that you can name?
            - Possible answers: Midwest –suckers, shiners, yellow perch, tilapia, salmon, trout. Western states: trout, salmon, oysters, mussels, seaweed. Southern States: Catfish, alligators, tilapia, oysters, shrimp. East Coast: oysters, scallops, mussels, Atlantic salmon, kelp.
    - Talk about different gear types
        - On bottom (sits on the bottom seafloor) vs. off bottom cages (floating - floats off at the top of the water column). It is important to note that there are different variations of each gear type (ex. Taylor Floats, Oyster Grow Cages, Australian Longline Systems).

- Talk about the different the two different markets for oysters – where oysters go and how they look.
    - Use the pictures to contrast the two markets for oysters -shucking house and half shell markets and what each oysters sent to either location would look like.

Explanation

- Split the class into groups of 4
- Explain to the class that each group will receive 4 The Mystery Oyster: What's in the Bag worksheets (1 per student) and 1 farmer profile.
- Hand out The Mystery Oyster: What's in the Bag worksheet and farmer profiles.
- Review how to calculate averages and percentages if necessary.

Elaboration

- Have students quantify the percent full of each bag by counting the number of filled holes divided by total number of holes.
    - 1 member from each group should be sent around the room to see what other bags look like. After the gallery walk, students will return to their groups and share their findings.
    - As a group, students should decide if their bags are highly stocked or normally stocked.
- Measure each oyster's length and width, record the values, and calculate an average.
- Have students plot their group's average length and width values and report averages to the teacher.
    - 1 member from each group should be sent around the room to see what the other graphs look like. After the gallery walk, students will return to their groups and share their findings.
- Students should find that more uniform-looking oysters will get sent to the half-shell market while more variable oysters are sent to the shucking house. A half-shell oyster will be round and while a shucking house oyster is more irregularly shaped.
    - Farmer #1: shucking house
    - Farmer #2: half shell market
    - Farmer #3: shucking house and half shell market
    - Farmer #4: half shell market

Differentiate for different skill sets and time available

- Consider the following as modifications based on classroom and time for activity:
    - Graphing can be done in a group to speed up the graphing where only one set of graphs is produced, or as individuals where each student graphs each variable.
    - Eliminate the gallery walk to save time and tell students what each stocking density looks like (high vs. normal)

Evaluation

- Suggested wrap up questions and answers:
    - What variable(s) determines how an oyster will physically look?
        - Answer: stocking density, gear type, and labor availability/amount.
    - What types of oysters are sent to the shucking house and which types are sent to the half-shell market?
        - Answer: larger oysters that are usually misshapen are sent to shucking houses while the pretty oysters that are uniform in size and shape are sent to

restaurants for the half-shell market. Oysters for canning or jarring are sent to the shucking house and those to be eaten on the half-shell are sent to the half-shell market.

- Why might an oyster sold to the half-shell market be worth more than an oyster sent to the shucking house?
  - Answer: Oysters sold to the half-shell market need to have a clean-looking, durable shell, which takes more time and effort to produce. Restaurants only want the best of the best. Customers of the half-shell market care about what the oyster looks like, while it does not matter what the oysters look like when they are canned and jarred (since it is without a shell). Restaurants will pay more to have oysters that look and taste a certain way.

- Have students work through the real-world application questions at the end of the worksheet either in class or as homework

13. Assessment

Students will be assessed based on their performance on the data tables, graphs, and follow-up worksheet questions.

14. Acknowledgments

Support for the lesson plan was provided by Virginia Scientists & Educators Alliance.

The Mystery Oyster: What's in the Bag?

You make decisions every day, like what to eat for lunch and what to wear to school. Oyster farmers are no different. These farmers must decide how to care for their oysters through everyday decisions. Each decision leads to different outcomes that can impact their oysters.

There are many ways to grow and take care of oysters. Farmers choose gear types and farming practices based on how they want to run their farm. Some decisions farmers make include whether to grow oysters on the bottom or off the bottom, if they will have employees, and where to sell their oysters. These decisions can affect the way oysters physically look. Running a successful farm means understanding how each decision fits into the bigger picture.

Your teacher talked with four farmers who each have different business models. Each farmer wants to know which market he should sell his oysters to based on how his oysters physically look. Review the data and live oysters each farmer sent the class. Form groups with four students in each group and discover how different decisions affect oyster shape.

PART 1

Quantify percent full. Observe the pictures of the bags on the Farmer Profile and fill out the corresponding table based on how full the bag is. Number of filled holes = how full the bags is with oysters. Count the squares in a single column up the bag to where the oysters stop. Total number of holes = number of holes in a single column up the entire bag. Percent full = (FH/TH)*100. Calculate the average percent full = add percent full for each bag, then divide by the total number of bags. Multiply your value by 100.

Bag Number (n)	Number of Filled Holes (fh)	Total Number of Holes (th)	Percent Full (%f)
1			
2			
3			
Average	------	------	

Send one group member to walk around the classroom and review what the other group's bags look like and their measurements. Also, view what each group's oysters look like. Take special note of shape and size. Compare what you saw with what your group decided. Circle the answers that best fit your data. My bags are stocked at which density?

HIGH **NORMAL**

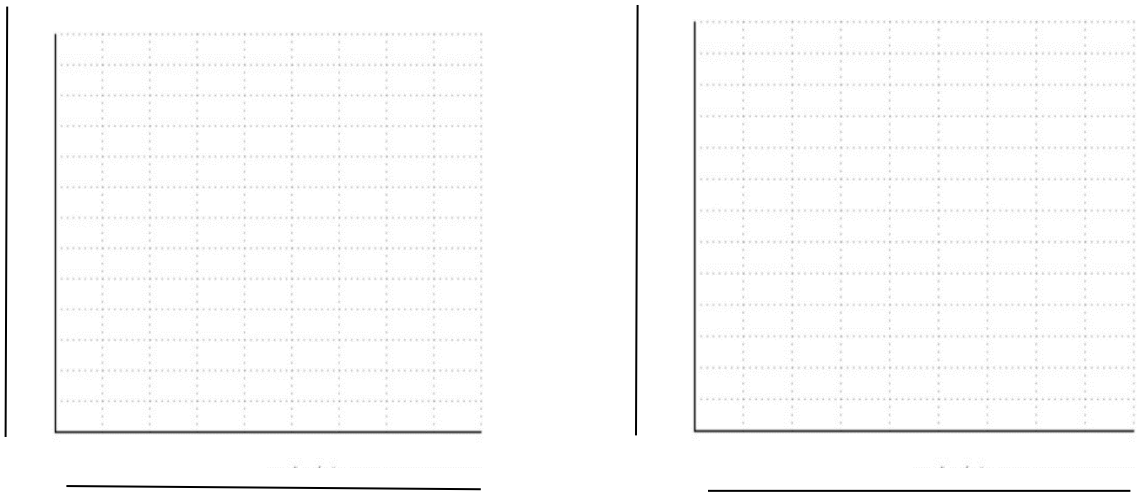
Why might a farmer keep his bags at a high stocking density?

PART 2

1. **Measure the oysters.** Use a ruler to measure the length and width of each oyster from your farmer profile and record the averages for each parameter. Report your averages to your teacher to record on the board.

Oyster Number	Length (mm)	Width (mm)
1		
2		
3		
Average		

2. **Graph your findings.** Each group should graph oyster length and width using a bar graph to include each farmer profile.
    a. Create a title for each plot.
    b. What are the independent variables?
    c. What are the dependent variables?



3. **Use the graphs.** Compare your findings to the rest of the farmer profiles.
    a. How do your oysters compare (size and shape) with the other groups, especially one that does not have your stocking density?
    a. List reasons why stocking density could affect the length and width of oysters.
    b. What market should your farmer target and why?

4. **Real-world reflection and application.** Think about how this lesson connects back to your life.
    a. Do you know if your region or state has any aquaculture operations? Look online to see if there are any farms in your region and what types of species the farm produces.
    b. Next time you go to the store, check out the seafood counter and see where the fish and shellfish come from. Are they coming from local farms, someone in the United States, or are they imported from another country?

The Mystery Oyster: What's in the Bag? – Instructor Key

You make decisions every day, like what to eat for lunch and what to wear to school. Oyster farmers are no different. These farmers must decide how to care for their oysters through everyday decisions. Each decision leads to different outcomes that can impact their oysters.

There are many ways to grow and take care of oysters. Farmers choose gear types and farming practices based on how they want to run their farm. Some decisions farmers make include whether to grow oysters on the bottom or off the bottom, if they will have employees, and where to sell their oysters. These decisions can affect the way oysters physically look. Running a successful farm means understanding how each decision fits into the bigger picture.

Your teacher talked with four farmers who each have different business models. Each farmer wants to know which market he should sell his oysters to based on how his oysters physically look. Review the data and live oysters each farmer sent the class. Form groups with four students in each group and discover how different decisions affect oyster shape.

PART 1

Quantify percent full. Observe the pictures of the bags on the Farmer Profile and fill out the corresponding table based on how full the bag is. Number of filled holes = how full the bags is with oysters. Count the squares in a single column up the bag to where the oysters stop. Total number of holes = number of holes in a single column up the entire bag. Percent full = (FH/TH)*100. Calculate the average percent full = add percent full for each bag, then divide by the total number of bags. Multiply your value by 100.

Bag Number (n)	Number of Filled Holes (fh)	Total Number of Holes (th)	Percent Full (%f)
1	Farmers 1, 3: 8 Farmers 2, 4: 3.2	Farmers 1, 3: 10 Farmers 2, 4: 10	Farmers 1, 3: 80% Farmers 2, 4: 32%
2	Farmers 1, 3: 7 Farmers 2, 4: 4	Farmers 1, 3: 10 Farmers 2, 4:10	Farmers 1, 3: 70% Farmers 2, 4: 40%
3	Farmers 1, 3: 7.5 Farmers 2, 4: 3.2	Farmers 1, 3: 10 Farmers 2, 4:10	Farmers 1, 3: 75% Farmers 2, 4: 32%
Average	------	------	Farmers 1, 3: 75% Farmers 2, 4: 35%

Send one group member to walk around the classroom and review what the other group's bags look like and their measurements. Also, view what each group's oysters look like. Take special note of shape and size. Compare what you saw with what your group decided. Circle the answers that best fit your data. My bags are stocked at which density? High is 75-80% while normal is 30-40%.

HIGH **NORMAL**

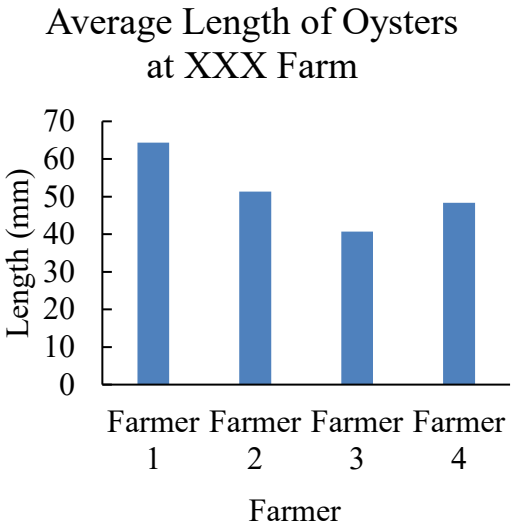
Why might a farmer keep his bags at a high stocking density? The farmer might not have enough labor or gear to spread out the oysters into more bags or they might not know what a good stocking density is.

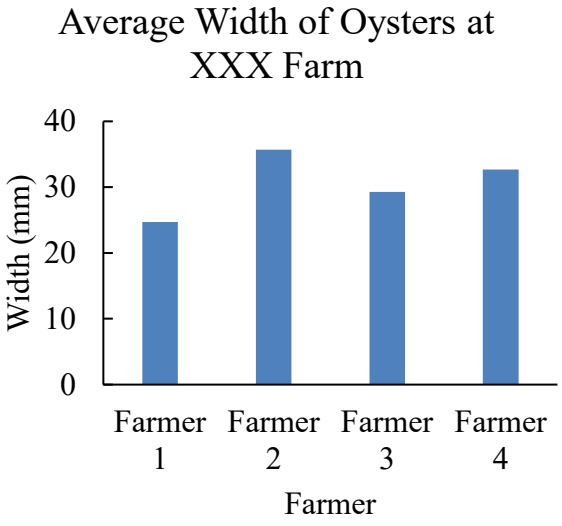
PART 2

1. **Measure the oysters.** Use a ruler to measure the length and width of each oyster from your farmer profile and record the averages for each parameter. Report your averages to your teacher to record.

Oyster Number	Length (mm)	Width (mm)
1	Farmer 1: 77 Farmer 2: 47 Farmer 3: 39 Farmer 4: 47	Farmer 1: 37 Farmer 2: 37 Farmer 3: 33 Farmer 4: 32
2	Farmer 1:63 Farmer 2: 54 Farmer 3: 61 Farmer 4: 51	Farmer 1: 21 Farmer 2: 36 Farmer 3: 36 Farmer 4: 36
3	Farmer 1:53 Farmer 2: 53 Farmer 3: 22 Farmer 4: 47	Farmer 1:16 Farmer 2: 34 Farmer 3: 19 Farmer 4: 30
Average	Farmer 1: 64.3 Farmer 2: 51.3 Farmer 3: 40.7 Farmer 4: 48.3	Farmer 1: 24.7 Farmer 2: 35.7 Farmer 3: 29.3 Farmer 4: 32.7

2. **Graph your findings.** Each group should graph oyster length and width using a bar graph to inlcude each farmer profile.
    a. Create a title for the plot. Average Length and Width of Oysters from XX Farm
    b. What are the independent variables? Farmer #
    c. What are the dependent variables? Length/Width (mm)





3. **Use the graphs.** Compare your findings to the rest of the farmer profiles.
   b. How do your oysters compare (size and shape) with the other groups, especially one that does not have your stocking density? Students should notice that the oysters visibly look different based on stocking density (shape, uniformity, taller, wider). Oysters in bags with a high stocking density are not as round as those in normally stocked bags and also tend to be taller, skinnier or wider, and more irregularly shaped. More size variance of oysters in highly stocked bags.
   a. List reasons why stocking density could affect the length and width of oysters. The oysters could be more crowded. Not enough room to move around in the bag. The oysters are competing against one another in the cages/bags. They are not getting enough food or new water access. The flow of water is not good enough because there is a solid block of oysters. Oysters grow where they can and not in a nice shape.
   b. What market should your farmer target and why?
   Farmer #1: shucking house – irregularly shaped, all different sizes.
   Farmer #2: half shell market – nice shape, good sizing, all uniform.
   Farmer #3: shucking house and half shell market – a mix of oysters that look good and some are not good enough for the half shell market. Some are round and uniform while others are irregularly shaped and too small.
   Farmer #4: half shell market - – nice shape, good sizing, all uniform.

4. **Real-world reflection and application.** Think about how this lesson connects back to your life.
   a. Do you know if your region or state has any aquaculture operations? Look online to see if there are any farms in your region and what types of species the farm produces. Research this based on your location.
   b. Next time you go to the store, check out the seafood counter and see where the fish and shellfish come from. Are they coming from local farms, someone in the United States, or are they imported from another country? Could be a good thing to ask as a follow-up question after the weekend. Larger, chain stores will likely not have local fish options but small markets likely carry local options.

Farmer Profile #1

Shelly from Sunnyside Shellfish (Farmer #1) sent in pictures of her bags and oyster samples for the class to assess. Sally does not have access to labor aside from her own capabilities. She works alone tending to her oysters and is a smaller operation. She grows oysters in cages that sit on the bottom seafloor. She wants to know what market she should target to sell her oysters. Can you help Shelly?

Bag 1

Bag 2

Bag 3

Oyster 1

Oyster 2

Oyster 3

When measuring the oysters, the length is up and down and the width is side to side. Collect the measurement at the tallest and widest sections.

Farmer Profile #2

Pearl from Pearly Oysters LLC (Farmer #2) sent in pictures of her bags and oyster samples for the class to assess. Pearl has 12 people working for her and is the biggest farm in the state. She grows oysters in cages that sit on the bottom seafloor. She wants to know what market she should target to sell her oysters. Can you help Pearl?

Bag 1

Bag 2

Bag 3

Oyster 1

Oyster 2

Oyster 3

When measuring the oysters, the length is up and down and the width is side to side. Collect the measurement at the tallest and widest sections.

Farmer Profile #3

Bill from Bivalve Bonanza (Farmer #3) sent in pictures of his bags and oyster samples for the class to assess. Bill has 2 people working for him and is a small to midsize farm in his region. He grows oysters in floating bags and baskets. He wants to know what market he should target to sell his oysters. Can you help Bill?

Bag 1

Bag 2

Bag 3

Oyster 1

Oyster 2

Oyster 3

When measuring the oysters, the length is up and down and the width is side to side. Collect the measurement at the tallest and widest sections.

Farmer Profile #4

Phil's Fantastic Filterers (Farmer #4) sent in pictures of his bags and oyster samples for the class to assess. Phil has 8 people working for him and is a mid-size to a large-scale operation. He grows oysters in floating bags and baskets. He wants to know what market he should target to sell his oysters. Can you help Evan?

Bag 1

Bag 2

Bag 3

Oyster 1

Oyster 2

Oyster 3

When measuring the oysters, the length is up and down and the width is side to side. Collect the measurement at the tallest and widest sections.

References and further reading:

Fisheries, NOAA. "Oyster Reef Habitat." *NOAA*, 4 Feb. 2022, https://www.fisheries.noaa.gov/national/habitat-conservation/oyster-reef-habitat#:~:text=Oysters%20are%20a%20crucial%20component,and%20protecting%20productive%20estuary%20waters.

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