2020

Old MacDonald Had an Aquaculture Farm

Shantelle Landry
Virginia Institute of Marine Science

OLD MACDONALD HAD AN AQUACULTURE FARM

Shantelle Landry
Virginia Institute of Marine Science

Grade Level
6th Grade

Subject Area
Earth Science

The 2019/2020 VA SEA project was made possible through funding from the National Estuarine Research Reserve System Margaret Davidson Fellowship Program which supports graduate students in partnership with research reserves where fieldwork, research, and community engagement come together. VA SEA is currently supported by the Chesapeake Bay National Estuarine Research Reserve, Virginia Sea Grant, and the Virginia Institute of Marine Science Marine Advisory Program.

Title: Old MacDonald had an Aquaculture Farm

Focus: The importance of aquaculture and how it can be used to manage a resource

Grade Levels/Subject: 6th grade/Earth Resources

VA Science Standard addressed:

SOL 6.9 – Earth Resources which focuses on "understanding that humans impact the environment"

- Specifically covering key concepts of
    - "natural resources are important to protect and maintain"
    - "renewable and nonrenewable resources can be managed"

Learning Objectives/Outcomes:

- Teachers will give examples of aquaculture in the Chesapeake Bay
    - Students will compare the yields of soft-shell clams from aquaculture and wild-caught
    - Students will recognize the benefits and importance of aquaculture (e.g. food source, restoration) and discuss ways aquaculture can be impacted (e.g. hurricane, disease)
- Students will play the role of an aquaculturist or waterman in the Chesapeake Bay and count their clam yield from their farm/harvest on a data sheet
- Students will work in pairs to create a bar graph of their clam yield to be shared with the class
- Students will participate in a discussion on which method (aquaculture or wild-caught) they believe can result in the greatest yield, discuss how their "job" was impacted by different variables (hurricanes, disease, policies), and conclude that aquaculture is vital for human seafood production and can be used to restore marine species populations

Total length of time required for the lesson

~ 45-50 minutes

Key words, vocabulary - definitions adapted from Google

Aquaculture - raising aquatic organisms (clams) for food instead of capturing them in the wild

Restoration - the action of returning something to its former condition (like a population)

Yield – to produce or provide (from a natural, agricultural, or industrial product point)

Overharvest - harvesting a renewable resource to the point of diminishing returns (animal cannot reproduce fast enough to keep up with harvesting rate)

Background Information

The role of the teacher during this activity is to provide the background information on aquaculture, soft-shell clams (history and importance to the Chesapeake Bay), and soft-shell clam aquaculture, and facilitate and supervise the group discussion. The main areas of importance are that aquaculture is the main source of seafood in the world and that it also has the potential to restore populations of organisms. Students' grasping these main topics is important for the rest of the exercise in order for them to relate the benefit of aquaculture. A couple slides in the PowerPoint are there in order to discuss the importance of aquaculture (Slides 3 – 5) and the history of soft-shell clams in the Chesapeake Bay (Slide 8).

The aquaculture background and soft-shell clam history and aquaculture are necessary to get to the heart of the activity; the management of soft-shell clams through aquaculture. Aquaculture, or the farming of aquatic organisms, including both freshwater and saltwater, produces over 50% of the seafood used for human consumption. Aquaculture occurs all over the world with China, Indonesia, and India as the top producers. As mentioned previously, aquaculture includes both fresh and

saltwater organisms, but the main organisms raised through aquaculture include finfish (e.g. salmon), mollusks (e.g. snails), and crustaceans (e.g. lobsters). Within Chesapeake Bay, the main organisms that are raised through aquaculture include oysters, striped bass, and hard- and soft-shell clams. There are a lot of factors that can affect the yield of aquaculture, including storm events

(hurricanes), disease, overharvest, policy changes (implementing catch limit), and simply, good harvest years. These problems also affect watermen in terms of their wild harvest, and this is something that students will learn. Both aquaculture and wild harvests are affected by the same

factors, but since aquaculture has a much greater population size than wild caught populations (due to protection from predators) and a shorter growing time, the total yield of soft-shell clams from aquaculture will be greater than the wild caught clams.

A wild population of soft-shell clams were once very abundant in the Chesapeake Bay, to the point where a fishery was established in both Maryland and Virginia in the 1950s. Numbers of soft-shell clams dwindled due to overharvest and hit an all-time low in 1972, when Tropical Storm Agnes hit the Bay and caused so much sediment to be deposited into the Bay. This storm lead to the closure of the Virginia fishery and significantly reduced harvests in Maryland. As the soft-shell clam is a benthic animal (lives in the ocean floor), the increased sediment essentially smothered much of the wild population. Numbers of soft-shell clams remain low to this day due to predation from the blue crab, the main predator of the soft-shell clam. It is possible that aquaculture could be the answer to bring the soft-shell clam fishery back to the Bay.

It is important for students to understand what role they will be playing, and additional information regarding their roles is given on slide 12. Two important notes should be made clear when going through the background PowerPoint. The first is that aquaculture is not a perfect situation (as seen in slide 11). There are positives and negatives to aquaculture and for the sake of time, we only focus on two negatives of aquaculture. The second important note is that watermen are still vital to society as explained in slide 17. While aquaculture may be a solution to restoring soft-shell clams in Chesapeake Bay, there are still many marine animals that are only harvested from watermen, so they are just as important as aquaculturists.

Student Handout

- Excel worksheet is supplied to aid students in the data log process so they can calculate their soft-shell clam yields.
- The first attached document contains a blank graph with x and y axes pre-labeled for students to create a bar graph of their initial and final clam yields.

- The second attached document contains the scenarios with details for each job on the event and how it affects their soft-shell clam yield.

Materials and Supplies

- Each group will require a data log sheet
- The second attached Word document contains the different scenarios (7) that students will encounter during the activity
- Each scenario will have an explanation of how their soft-shell population will be affected (losses or gains).
- ***Optional addition**- for a more hands-on experience, teachers can use beans to aid in the math portion of this lesson plan. Each pair would start with 20 beans and there should be a bowl of at least 40+ beans with each scenario/table for students to add or subtract to their yield.

Classroom Set-Up

The teacher should arrange the classroom so that there are 7 stations that students will visit. A different scenario should be placed at each station. The students will rotate between stations in sequential order of the scenarios. Watermen can start from any scenario and move in sequential order. For the aquaculturists, they must start at a "double your population" scenario (1, 4, or 7) in order for their yield to be greater than the watermen's yield. After starting at either scenario 1, 4, or 7, students can continue through the scenarios in sequential order. The example graphs given in the PowerPoint are for students that start with scenario 1.

Procedure

The background and introduction PowerPoint of the topic (10-15 minutes)

Prior to the start of the first class:

- The teacher should print out (or create copies) the supplied scenarios and explanations of each scenario.
- The teacher should print out the data log sheet provided to aid students in calculating their total yield of soft-shell clams as well as the blank graphs for students to graph their results
- ***Optional addition**- teacher should set up bowls of beans for each pair and each scenario

Background:

- The lesson should start with teachers asking students if they/their families eat seafood at home (refer to Slide 1 of the PowerPoint), followed by where they get their seafood from (grocery stores, farmers markets, personally caught). Before moving onto the next slide, introduce the word "aquaculture" by asking students what they already know about aquaculture to get an idea of their level of knowledge. This will lead the part of the lecture that goes over some of the basics of aquaculture and the history of soft-shell clams within the Chesapeake Bay.

- The slide that explains aquaculture (slide 11) is the last background slide that teachers will go through to set up the knowledge needed for the activity. Slide 12 goes over the actual activity and explains how students will go through the activity.

Activity (30 minutes):

- The teacher should go over the two different jobs that students will have in the activity; aquaculturist and watermen. The class should be separated into two groups (corresponding with the two jobs) and students should work in groups of 2 - 3. Students within each group will have the same job, so one group of 2 – 3 students will be all aquaculturists, another group will be watermen.
- Students will move through the classroom with their assigned job and keep track of the gains and losses of clams on their data log sheets.
- Once all the data are collected, teachers should bring the class back together and hand out the blank graphs for students to fill out their initial and final clam yields.
- Once the graphs are completed, teachers will lead a discussion on the results by asking each group what their final yield was and discussing the various scenarios and their outcomes. Slide 15 shows a graph comparing the two different yields which brings the entire lesson back together to emphasize the benefits of aquaculture.

Assessment

The graphs and the student's ability to understand the differences between the results from the aquaculturists and watermen are forms of assessment that the teacher can use to assess understanding of the topics presented. If desired, the teacher could have each student research other aquaculture examples (in the U.S. or elsewhere in the world) with different animals as a homework assignment.

An important follow-up question to ask at the end of the activity is "why did we (students) observe that aquaculturists had a higher yield than watermen" (Slide 16)? The main reason for the difference is that aquaculturists can control much of the system or farm that they have created whereas watermen do not have such control. There are some things such as storm events, that are out of an aquaculturists control and would affect both aquaculturists and watermen equally however, there are many things (like food, number of animals, growth) that aquaculturists can control.

Answer Key

The two graphs that students will create will demonstrate that aquaculture will result in a greater yield for soft-shell clams. The examples below show what students should have produced.

Aquaculturists

- Start with 20
- Scenario 1: 20 x 2 = 40
- Scenario 2: 40 – 10 = 30
- Scenario 3: 30 – 15 = 15
- Scenario 4: 15 x 2 = 30
- Scenario 5: 30 + 0 = 30
- Scenario 6: 30 + 0 = 30
- Scenario 7: 30 x 2 = 60

Watermen

- Start with 20
- Scenario 1: 20 + 10 = 30
- Scenario 2: 30 – 10 = 20
- Scenario 3: 20 – 5 = 15
- Scenario 4: 15 + 10 = 25
- Scenario 5: 25 - 10 = 15
- Scenario 6: 15 + 10 = 25
- Scenario 7: 25 + 10 = 35

References

Beal, B. F., & Kraus, M. G. (2002, January 8). Interactive effects of initial size, stocking density, and type of predator deterrent netting on survival and growth of cultured juveniles of the soft-shell clam, *Mya arenaria L.,* in eastern Maine. Retrieved from https://www.sciencedirect.com/science/article/pii/S0044848601009000.

Beal, Brian. (2006). Biotic and abiotic factors influencing growth and survival of wild and cultured individuals of the softshell clam (*Mya arenaria L.)* in Eastern Maine. Journal of Shellfish Research. 25. 461-474. 10.2983/0730-8000(2006)25[461:BAAFIG]2.0.CO;2.

Glaspie CN, Seitz RD, Ogburn MB, Dungan CF, Hines AH (2018). Impacts of habitat, predators,recruitment, and disease on soft-shell clams *Mya arenaria* and stout razor clams *Tagelus plebeius* in Chesapeake Bay. Mar Ecol Prog Ser 603:177-133. https://doi.org/10.3354/meps12706

Scenario 1:

Hooray! You have a **good growing year/ harvest**!

Aquaculturists: double your population

Watermen: add 10 to your population

Scenario 2:

A **hurricane** comes through and deposits so much sediment (mud/sand at bottom of Bay) that it smothers your soft-shell clams.

Everyone: lose 10 soft-shell clams

Scenario 3:

Oh no! One of your soft-shell clams becomes infected with a **disease** and spreads it to its neighbors.

Aquaculturists: lose 15 soft-shell clams

Watermen: lose 5 soft-shell clams

Scenario 4:

Hooray! You have another **good growing year/ harvest**!

Aquaculturists: double your population

Watermen: add 10 to your population

Scenario 5:

Uh oh, looks like the wild population was **overharvested** and the soft-shell clams cannot replenish their population fast enough.

Aquaculturists: no change to your population

Watermen: lose 10 soft-shell clams

Scenario 6:

Yay for legislation! A **new policy** was set in place to limit the number of soft-shell clams that can be harvested.

Aquaculturists: no change to your population

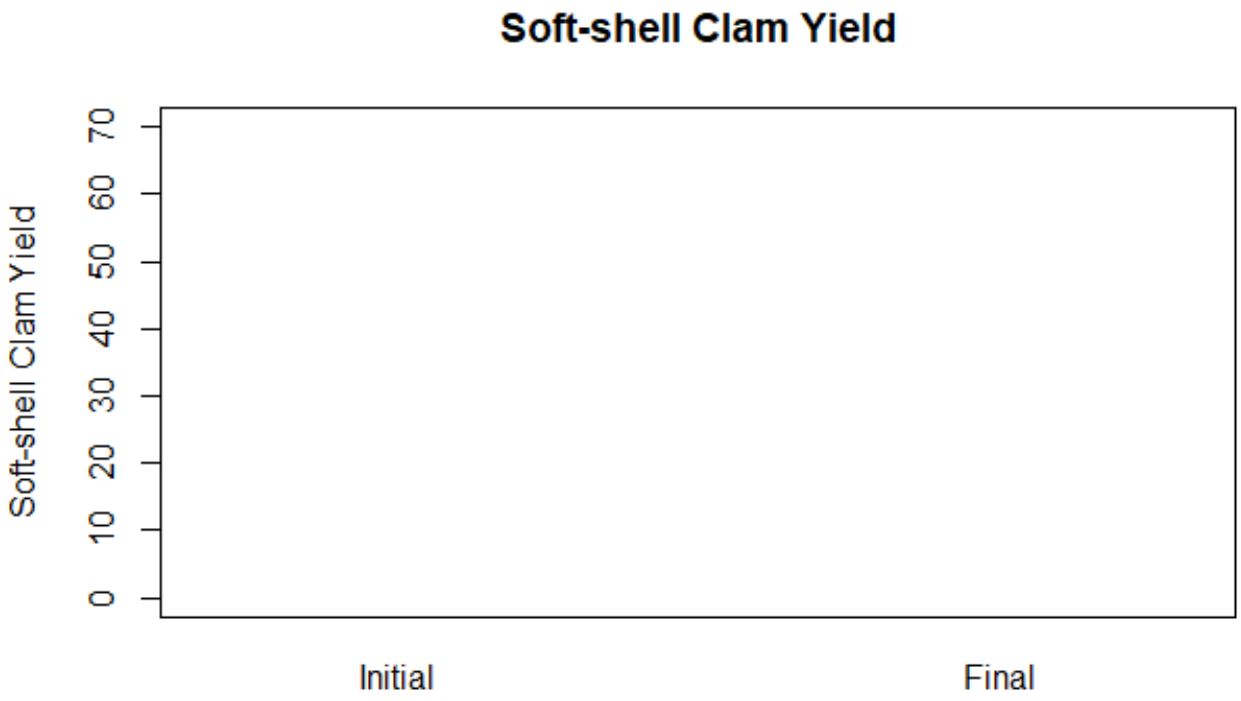
Watermen: add 10 to your population

Scenario 7:

Hooray! You have another **good growing year/ harvest**!

Aquaculturists: double your population

Watermen: add 10 to your population


Soft-shell Clam Yield
Soft-shell Clam Yield
0
10
20
30
40
50
60
70
Initial
Final

Soft-shell Clam Data Log

Student Name(s)

	Initial Yield	Hurricane	Disease	Good Growing Year 1	Overharvest	Policy Change	Good Growing Year 2	Good Growing Year 3	Final Yield
	20								