

Lesson 8: Habitat Requirements for Mariculture Species

Objectives:

By the end of this lesson, students will be able to:

1. Evaluate habitat characteristics most favorable to successful marine aquaculture ventures in land-based, nearshore and offshore environments.
2. Explain the biotic and abiotic factors required for at least one mariculture species.

Overview:

About half of the seafood eaten around the world is produced by aquaculture. The increase in global aquaculture production during the last half-century has been dramatic, expanding from fewer than 5 million metric tons (mmt) in the mid-1970s to 60 mmt in 2010. As aquaculture production rapidly increases, where should operations be sited?

Key to siting are the habitat requirements of the cultivated species. In this lesson, students will consider the biotic and abiotic factors that influence successful production of a mariculture species. Mariculture — another term for marine aquaculture — is the cultivation, or farming, of species that live in salt water.

Science Standards:

- EEn.2.8.2
- Critique the advantages and disadvantages of traditional agriculture/aquaculture techniques and compare with sustainable agriculture/aquaculture techniques. Include the economics and environmental impacts in this comparison.
- EEn.2.8.3
- Explain carrying capacity.
 - Infer limiting factors to human population growth.
 - Summarize the impacts of a growing population on the natural resources in North Carolina.

Grade Level: 11-12

Duration: 2 class periods

Vocabulary:

- abiotic:** not involving or originating in living organisms; inorganic, abiogenic
- anthropogenic:** of or relating to the study of human origins or human development; originating in or caused by human activities
- biological response:** adaptation or change in response to changes in an organism's environment
- biotic:** of or relating to living organisms; caused by living organisms



Activity:

Student teams of two will receive a scenario (found at the end of this lesson) describing a North Carolina-based mariculture farm and its business goals. Based on their given scenarios, students will choose a specific site on which to locate the farm. They will also decide which species to produce, based on the species' habitat needs and site conditions. Students will identify their site using GIS coordinates from Google Earth. They should use a class map of the N.C. coast to report out their findings by placing a pin, sticker or Post-It note that shows the location of their farm.

When choosing a species to produce, students should consider the following factors. Keep in mind some factors are not important to every species.

- Salinity and temperature
- Phytoplankton abundance and types
- Sediment types
- Water depth and velocities
- Water supply
- Production system
- Protection from severe storms, winter ice and boat wakes
- Water quality acceptable for harvest of product for human consumption
- Accessibility to business operations on land, including docks, processing facilities, etc.
- Accessibility to markets
- Other uses of public trust waters (e.g., navigation, fishing)

For example, an ideal site for oyster aquaculture must have sufficient tidal flow to move the oyster's food source — phytoplankton — to the growing area. Where offshore finfish aquaculture is concerned, strong currents can damage moored pens. For a review of aquaculture production methods, teachers can share the PowerPoint presentation from Lesson 5.

Students can use the following resources to research ideal mariculture farm site conditions:

1. Aquaculture Fact Sheets. 2019. Food and Agriculture Organization of the United Nations. <http://www.fao.org/fishery/culturedspecies/search/en>
2. Shellfish Sanitation Maps. 2019. North Carolina Division of Marine Fisheries. <http://portal.ncdenr.org/web/mf/proclamations-polluted-areas>

Click on the “Shellfish Sanitation Maps” links at the center of the webpage. You can view a map of permanent shellfish harvest closures and an interactive map of temporary closures. Shellfish can only be harvested from approved (open) shellfish waters.

3. Aquaculture in North Carolina: Inputs, Outputs, and Economics. North Carolina Department of Agriculture and Consumer Services. <http://www.ncagr.gov/MARKETS/AQUACULTURE/pubs.htm>



Extension:

Students will explain how the mariculture farm and site they selected are doing in the community 10 years later. Each student should take into consideration an opportunity or disturbance that has affected their aquaculture farm, such as (a):

- Hurricane
- Dense housing development built in view of the farm
- Tripling of the population of the nearest city
- Positive regulatory environment and community support for marine aquaculture
- Local seafood restaurants demanding more aquaculture products
- Disease outbreak in the aquaculture species being farmed

References:

1. Ferreira, J.G., Hawkins, J.S., and S.B. Bricker. 2007. Management of productivity, environmental effects and profitability of shellfish aquaculture- the Farm Aquaculture Resource Management (FARM) model. *Aquaculture* 264: 160-174.
2. Hosack, G.R., Dumbauld, B.R., Ruesink, J.L., and D.A. Armstrong. 2006. Habitat associations of estuarine species: comparisons of intertidal mudflat, seagrass (*Zostera marina*) and oyster (*Crassostrea gigas*) habitats. *Estuaries and Coasts* 29 (6): 1150-1160.
3. Nelson, K.A., Leonard, L.A., Posey, H., Alphin, T.D., and M.A. Mallin. 2004. Using transplanted oyster (*Crassostrea virginica*) beds to improve water quality in small tidal creeks: a pilot study. *J. Exp. Mar. Biol. Ecol.* 298 (2): 347-368.
4. Peterson, B.J. and K.L. Heck, Jr. 2001. Positive interactions between suspension-feeding bivalves and seagrass – a facultative mutualism. *Mar. Ecol. Pro. Ser.* 213: 143-155.

Aquaculture Question Cards

Cut along the dotted lines.



Scenario 1:

Your family wants to buy a unique former bed and breakfast called Frying Pan Tower, which is located 34 miles off of the N.C. coast in Frying Pan Shoals, near Wilmington. You are considering it, but you also want to start a marine aquaculture business that could benefit from this unique offshore location. What would you farm there and why?

Scenario 2:

The NC State University Marine Aquaculture Research Center in Marshallberg is partnering with entrepreneurs to grow marine finfish using recirculating aquaculture systems. You have decided to take advantage of this opportunity. What would you grow there and why?

Scenario 3:

A non-profit environmental organization that works to protect water quality wants to establish a pilot mariculture operation. They want to test whether mariculture could help improve water quality in Stump Sound, specifically surrounding Permuda Island. The area historically has been home to commercial oyster harvesters, but tourism and development are more common now. Where should they farm, what should they farm there and why?



Scenario 4:

A commercial fisherman who is frustrated with changes in fishing rules and regulations is considering starting a mariculture operation to diversify his income streams. He lives and has a dock near Swansboro and wants his farm to be within easy boating distance from the dock. Where should he farm, what should he farm there and why?

Scenario 5:

A restaurant chef wants to grow some of her own seafood, and owns some inland property near Grantsboro in Pamlico County. She hopes to sell a local product and avoid purchasing imported seafood. What should she produce and why?

Scenario 6:

Hatteras Island is somewhat isolated from the mainland, and residents value sourcing local foods to defray transportation costs of shipping in food. The island schools are partnering with local fishers to start an aquaculture operation. They have start-up funding from a community organization in Buxton. Where should they set up operations, what should they produce there and why?

Scenario 7:

Low salinity levels in the water bodies around Currituck County have kept oyster farmers from starting up businesses in the area. The local high school has an education program that has been teaching students how to grow marine aquatic plants. Where should the students grow marine aquatic plants, what kind of plants should they grow and why?