Grades K-5

Common Core ELA:
.SL.K.6

www.MaineAgintheClassroom.org

Introduction to Aquaculture

Developed by the Island Institute, Rockland, Maine
Revised and formatted by Maine Agriculture in the Classroom

Activity Description:
Through class discussion, examination of resources, a game and YouTube video, students will explore aquaculture and identify areas that they would like to study in depth. Estimated time: 30 minutes

Learning Objectives:
Students will

- share prior knowledge of aquaculture
- list topics for possible study
- explain the importance of chosen topics

Materials:
List of Questions/statements for Part I (see Spectrum game).

Teacher Preparation:
Familiarize yourself with aquaculture basics, so you can facilitate discussion with participants in Parts II and III. Quick resources for this are Climate of Change Film #4 (http://www.islandinstitute.org/media/climate-change-pt-4) and the Introduction to ***Aquaculture in Maine*** fact sheet.

Procedure:
Part I: Spectrum Game
Ask students the degree to which they agree or disagree with statements made by a moderator. They demonstrate their agreement/disagreement by standing along a continuum. Designate one point in the room as the agree area and another as the disagree area. Students can stand anywhere between the two points based on the statement. There are no right or wrong answers in this activity. It is a conversation starter. Encourage students to elaborate on answers or share opinions in an organized way.

This activity is a modified version of the School Reform Initiative protocol titled ***Continuum Dialog.***

Possible statements:
• I like to eat seafood.
• Someone in my family goes fishing or works on a boat.
• I have been fishing (fish, lobster, clams, etc.).
• I know a lot about seaweed. (Follow up: What do you know?)
• I think seaweed is gross.
• I have eaten seaweed. (Remind them that nori, used in sushi, is a type of seaweed. See if anyone changes their answer.)
• I can name a type of seaweed. (Follow up: What type of seaweed can you name?)
• I think it would be fun to grow seaweed.

Part II: YouTube Video and Discussion

Before watching the video, ask "What do you know about aquaculture?" Discuss. Watch the video and then ask students what they learned about aquaculture from the video. Feel free to pause the video as important points come up.

Part III: Seaweed-Specific Discussion

As you discuss each of these questions, use a Smart board or projector to show relevant pictures or YouTube clips to spark the conversation.

You are encouraged to familiarize yourself with some basic facts about the organism you have chosen to focus on so you can facilitate an introductory discussion. We chose seaweed with an emphasis on sugar kelp. You may find the following ***Kelp Aquaculture*** fact sheet helpful. More suggested reading material can be found on the Resources page. Some questions you might ask about seaweed are:

- What do you know about seaweed?
- Where can we find it?
- What does it need to grow?
- Is it a plant or an animal? (Neither! It's an algae.)
- What is seaweed used for?

Aquaculture in Maine Fact Sheet: http://www.islandinstitute.org/sites/default/files/July6_2016AquaIntro_LETTER.pdf
Continuum Dialogue: http://schoolreforminitiative.org/doc/continuum_dialogue.pdf
Kelp Fact Sheet: http://www.islandinstitute.org/sites/default/files/July6_2016_Kelp_8x11.pdf

Aquaculture in Shared Waters

Aquaculture in Maine

Dana Morse[1] ; James Crimp[2] ; Rebecca Clark Uchenna[3]

Photo: Stephanie MacLagan

So you are interested in aquaculture. Well you are in luck! There is tremendous potential for starting new aquaculture farms throughout the United States, especially in the northeast.

This series of "Aquaculture in Shared Waters" fact sheets is intended to help fishermen or others in Maine's coastal communities interested in starting a small-scale aquaculture business as we move towards achieving this potential in a way that is best for our people and the environment.

Why Aquaculture?

Defined as the breeding, rearing and harvesting of animals and/or plants in all types of aquatic environments, aquaculture has several key advantages over wild-harvest fisheries and land-based agriculture that make it attractive to economists, environmentalists, and fishermen alike:

1. **Potential:** World population continues to grow, and with it comes a rise in demand for affordable, healthy food. Aquaculture has become one of the fastest growing food sectors in the world, and its potential is high, as only a small percentage of the oceans are used to grow food.
2. **Sustainability:** Climate change is an increasing concern to food producers, and the amount of energy and fresh water used in modern agriculture may be unsustainable. Aquaculture in comparison uses little to no fresh water, does not require fertilizer, and aquatic animals are on average 10-20% more efficient at converting feed to protein than land animals.
3. **Environment:** The efficiency of aquaculture results in fewer emissions of fossil fuels than traditional agriculture, making it an important way to slow the progress of climate change. Additionally, some aquaculture farms can even improve environmental conditions. Shellfish and seaweed farms, for example, filter the water around them, making for a more pristine environment that can, in some ways, aid wild-fisheries.

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Global Context:

While traditionally the world's supply of seafood has come from wild-caught fish, in the last fifty years, aquaculture has rapidly expanded as a food-producing industry, and now makes up almost half of the seafood consumed in the world. Much of this growth has taken place outside of the United States; however, as a country, we import 85% of our seafood, more than half of which is farmed. While it is hard to know the environmental and social impact of seafood caught and farmed overseas, by growing more of it locally, we can ensure that our morals, taste buds, and pocketbooks are happy.

Baby oysters on North Haven, ME *Photo: Scott Sell*

Aquaculture in Maine:

As a state with one of the longest coastlines in the United States, Maine has tremendous potential for aquaculture within its borders. Factors such as pristine water quality, a history of fishing and farming, a thriving working waterfront, and proximity to a large New England population make it a great fit for a large aquaculture industry.

Surprisingly, aquaculture in Maine is relatively undeveloped compared to both surrounding states and nations. Currently there are fewer than 300 full-time workers employed in the shellfish and seaweed industries in Maine, less than 5% of the number of commercial fishermen in the state.

Mussel rafts at Bangs Island Mussels, Casco Bay, ME
Photo: Stephanie MacLagan

Life of an Aquaculturist

There are many reasons to be excited about becoming an aquaculturist! Existing industry members list a steady income, the flexibility of running their own business, and the ability to make their living on the water as reasons for their high job-satisfaction. Additionally, different species require varying levels of maintenance and have different growing seasons, allowing for aquaculture to be combined with other businesses to fit your desired income and lifestyle.
Below are a few species that are commonly grown in Maine:

1. **Oysters:** seed is hatched in the spring and actively grown on the water surface until winter, when many oyster growers sink their floats to avoid sea/river ice. This leaves a 2-4 month gap in the winter where little maintenance is required.
2. **Seaweed:** each crop is grown between October and April/May, leaving the summer off for most growers.
3. **Mussels:** Grown steadily throughout the year, but only requiring 2-4 days of maintenance per week.

Farming vs. Fishing

Because of its seasonal nature, aquaculture has become more attractive to fishermen who hope to combine it with their traditional employment of lobster/groundfish harvest to obtain a more diversified and complete income. While this model has much potential, it is important to note that aquaculture is not the same as fishing, and many believe it to be more similar to land-based farming.

1. **Risk:** While fishermen rely on the wild to raise their product, only gaining value from their catch at legal size, aquaculturists own their product from start to finish. They must therefore be constantly vigilant as their product matures to keep it growing steadily. Naturally occurring factors such as disease or abnormal weather can result in a large loss of income. Additionally, farmers must wait until their product reaches marketable size before they make any profit, taking up to three years in the case of oysters. With proper planning, however, aquaculturists can generally look forward to a steady business.
2. **Marketing:** Whereas most fishermen can sell their product to a dealer relative easily, the same is not always true for aquaculturists. While wholesalers do exist, many aquaculturists must spend a fair amount of their time marketing their product in order to achieve the best price. Organization and communication skills are some of the best assets an aquaculturist has.

Sugar kelp harvest Casco Bay, ME *Photo: Stephanie MacLagan*

Resources:

For more information about the new Aquaculture in Shared Waters project, please visit the Maine Sea Grant page (link below) where you will find the complete Aquaculture in Shared Waters fact sheet series as well as other information.

Fact sheets on topics including husbandry, water quality, running a small aquaculture business and kelp aquaculture:

http://www.seagrant.umaine.edu/Resources-and-news

Conducting Aquaculture in Maine Fact Sheet:
www.maine.gov/dmr/aquaculture/documents/CONDUCTINGAQUACULTUREINMAINErev6-20-16.pdf

Oyster farm (left) and mussel raft (right) on the Damariscotta River, ME *Photos: Rebecca Clark Uchenna*

The goal of these fact sheets is to inform readers about the possibilities of integrating aquaculture with current fishing and seafood businesses, and to diversify incomes along Maine's working waterfront.

This document was produced courtesy of funding though the NOAA Sea Grant Aquaculture Research Program 2012, Award #NA10OAR4170081, for the project "Aquaculture In Shared Waters" - Teresa Johnson, Principal Investigator, Univ. of Maine (Orono) and D. Morse, Co-Principal Investigator, Maine Sea Grant and Univ. of Maine Coop. Extension.
http://www.seagrant.umaine.edu/aquaculture-in-shared-waters.

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Continuum Dialogue

Developed by Marylyn Wentworth and expanded and enriched by many facilitators.

Purpose
The Continuum Dialogue is a provocative yet non-threatening way to get to know the people one works with: their perspectives, beliefs, opinions on hard issues, how they think about themselves and others, and what they think about teaching and learning. It is also useful to see where people stand on difficult issues that need decisions and to hear them out with respect and interest.

Time
From 30 minutes to an hour and a half.

Description
The Continuum Dialogue requires the participants to choose a place to physically stand along a continuum arc between 2 polar statements that form the beginning and end of the continuum. The continuum is in an arc rather than a straight line so people can see one another as they speak and listen.

The facilitator of a Continuum Dialogue is generally a neutral person who is not part of the group doing the activity. As a group gets more experienced with this process, an "insider" can effectively facilitate. The reason for an outside facilitator is that it is important for every person in the group to stand on the continuum arc.
The facilitator establishes norms for the Continuum Dialogue, which are:

- Listen with respect and interest
- Speak with candor
- No one's comments will be challenged or argued
- Thoughtful reflection on others' responses is okay
- The facilitator is responsible for the process until she/he steps back
- When the facilitator steps back, everyone is responsible for the process

The statements that establish the ends of the continuum must allow for differences without there being a right and wrong place to stand. For example, a continuum that addresses the length of the school day goes from "I think our school day is too long for elementary students" to "I think our school day is too short for elementary students." That is a reasonable continuum as neither end is right or wrong. However, the topic "Who should teach?" with the extremes being, "I think it is okay for people who dislike children to teach," to "I don't think anyone who dislikes children should be teaching," wouldn't work as the "dislikes children and can teach" end could be assumed to be a bad place to stand by most people.

.When the topic and the 2 ends of the continuum have been established, the facilitator stands in the open side of the arc and asks people at different points in the continuum why they chose to stand where they did. People explain why they chose to stand there with no interruptions or questions. There is no need to ask everyone unless it matters to hear from every person for some reason. Generally there will be a series of continuums that make up the dialogue, and everyone should be called on at some point to respond. Sometimes, "Why did you choose to stand there?" isn't the right question to ask. For examples of different questions, see the practice rounds in the steps below.

After several Continuum Dialogues, or when a group of people is accustomed to them, the facilitator can step back and people in the continuum can ask others why they chose to stand where they did. The facilitator would step forward and intervene should there be any confrontational questions asked, disrespect shown, or any rebuttal to the person who explained why they chose to stand where they did. When the dialogue progresses to the point of the facilitator stepping back, secondary questions or comments may come forth after the initial "Why did you chose to stand there?" such as, "I expected that you would have stood further toward this end. It is interesting to me to see how much I assumed about you without asking you what you really thought." Or, "I had no idea you had gone through all of that. It explains so much!" Or, "I hadn't thought of it that way. In fact I think I have to move around the continuum closer to you." The dialogue portion happens at this point, always centered around the question, "Why did you choose to stand there?" and with respectful listening. Sometimes there are no comments, only careful listening to people as they state their reasons for standing where they are, and that is fine.

In a Continuum Dialogue that will address a hard issue, it is generally best to have several continuums prior to the "big" question to establish norms of response and to learn about each other in helpful ways. An example might be a difference of opinion as to whether a high school should go to block scheduling or stay with a 7 period day. Possible questions for a series of continuums:

- How do students learn best? "Students this age learn best through a variety of shorter learning experiences," to "Students this age learn best when they can focus on a few in-depth learning experiences at a time."
- How do students learn best? "Students learn best when they have a full schedule of daily classes," to "Students learn best when they have space between classes for reflection and synthesis."
- Time for in-depth work. "I think our students have plenty of opportunities to do in depth work," to "I don't think our students have adequate opportunities to do in-depth work."
- What are the gains and losses in block scheduling? "There's a lot to lose by going to block scheduling," to "There's a lot to gain by going to block scheduling."
- How is my teaching affected? "I do my best teaching in smaller, consistent blocks of time," to "I do my best teaching when I have fewer students for a longer time."
- How does this affect me personally? "I am unsure how to teach in longer blocks of time," to "I have some ideas about how to teach in longer blocks of time."

A Continuum Dialogue should never be a vote, or even consensus. It wouldn't work to say "At this point, I want to change to block scheduling," to "At this point, I don't want to change to block scheduling." All those standing somewhere in the middle make it a useless attempt at decision-making. One could state the topic as, "Let's see where we are on the topic of block scheduling," then ask the questions and listen to everyone's reasons for standing where they are. Thus it becomes a learning experience that can lead to a good decision. People calmly listen to other perspectives and grow in understanding their colleagues. Solutions even rise as the Continuum Dialogue unfolds.

As people get accustomed to the Continuum Dialogue, it is possible to take 3 more steps:

1. At the end of a continuum, the facilitator can invite anyone who has changed their mind one way or the other and wants to move to do so, and explain why they chose to move.

2. The facilitator can ask if anyone in the group has a continuum they would like to propose. That person sets up the continuum and facilitates the discussion with the support of the regular facilitator. This gives participants the opportunity to go deeper than the facilitator might. It requires trust to do this well, although sometimes people want to ask fairly simple questions that just didn't occur to the facilitator. It is the facilitator's responsibility to be sure the continuum is productive and not a hidden question to get at something or someone.

3. The facilitator can give anyone in the continuum permission to move anyone else to the place they think they should be and tell the whole group why they moved that person there. The person moved can respond and either stay there or go back to where they were. This process gets to the differences between what we know of ourselves and what we project to others. For example, on a continuum like "I think I am a capable leader," to "Leadership is not my strongest attribute," a surprising amount of moving goes on as many very effective leaders do not perceive themselves that way, and learn a lot about how their colleagues perceive them.

Process

1. The facilitator describes the process:
   - How statements representing the extreme of a topic mark the 2 ends of the continuum
   - Where the continuum will be by physically walking from one end to the other
   - Explains the norms
2. The facilitator gives the group one or more practice rounds. Below are possibilities:
   • The importance of time:
   Always on time.....Time doesn't mean anything
   (A secondary question might be, "What does time feel like to you?)
   • Your desk at school (or at home):
   Neat and orderly nearly all the time.....Utter chaos
   (A better question here is, "What role does your desk play for you?")
   • Time of day you do your best work:
   Dawn.....Deep in the dark night
   • Tolerance for ambiguity:
   Like detailed, written plans.....Go with whatever comes
   • Size of group you work best with:
   Alone.....The whole school, even the district, maybe the world
   • Physical proximity boundaries — How close people can stand and talk with you? (Practice this one and you'll see exactly where boundaries are as people back up when you get to the boundary.)
   2 inches.....2 feet
   (Another question here is "What happens when people cross your boundary?")

3. The facilitator begins the Continuum Dialogue by stating the first question/topic and physically walking off the continuum, stating the 2 end preferences that mark the continuum.

4. Participants go and stand in the place that best represents their preference/opinion/belief.

5. The facilitator asks a variety of people at a variety of points on the continuum why they chose to stand where they did.

6. After enough people have been asked, the facilitator either invites people to move if they have changed their opinion (stating why), opens the dialogue by stepping back and allowing participants to ask one another questions or comment on their new understandings, or moves on to the next question. As Continuum Dialogues have their own pace, the facilitator has to judge when to move on and when to extend the dialogue. Use as many continuums as are appropriate to the topic at hand or to the time allotted.

7. Several variations can happen here:
   - Participants can propose the questions/topics, set up the continuum, and facilitate.
   - The facilitator can invite participants to move other participants to spots they think are more representative of that person, and tell why. The moved person can respond and/or choose to move back.

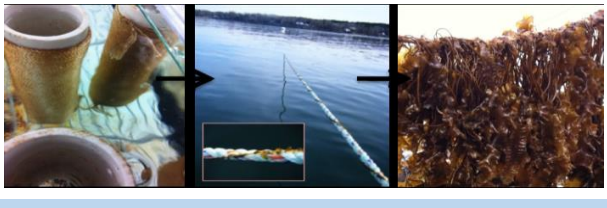
8. The group sits down in a circle to debrief, talking about what they learned and how that might impact the work they do together. Discuss the process – what worked, what didn't and what might be improved for another time.

Aquaculture in Shared Waters
Kelp Aquaculture

Sarah Redmond[1] ; Samuel Belknap[2] ; Rebecca Clark Uchenna[3]

"Kelp" are large brown marine macroalgae species native to New England and traditionally wild harvested for food. There are three commercially important kelp species in Maine—sugar kelp (Saccharina latissima), winged kelp (Alaria esculenta), and horsetail kelp (Laminaria digitata). Maine is developing techniques for culturing kelp on sea farms as a way for fishermen and farmers to diversify their operations while providing a unique, high quality, nutritious vegetable seafood for new and existing markets. Kelp is grown on submerged horizontal long lines on leased sea farms from September to May, making it a "winter crop" for Maine. The simple farm design, winter season, and relatively low startup costs allow for new and existing sea farmers to experiment with this newly developing type of aquaculture on Maine's coast.

"Kelp" can refer to **sugar kelp** (*Saccharina latissima*), **Alaria** (*Alaria esculenta*), or **horsetail kelp** (*Laminaria digitata*). Sugar kelp has been cultivated in Maine for several years, and successfulexperimental cultivation has been done with speciessuch as *Alaria*. These photos are examples of the cultivation stages of sugar kelp.



Microscopic kelp seed

Seeded kelp line

Kelp line at time of harvest

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Q: *Is there a viable market for kelps grown in Maine?*

Maine is home to a handful of companies that harvest sea vegetables from the wild, including kelps and other seaweeds. Over the last 40 years, they have successfully built relationships and markets throughout the US and around the world. These markets have primarily existed within the health food and macrobiotic realms, though sea vegetables are gaining in popularity among the mainstream markets as consumers are looking for healthier alternatives. All of the traditional companies in Maine offer dried sea vegetables with the exception of one company, Ocean Approved, LLC, that offers a ready-to-eat cut and frozen kelp products. Both existing and emerging companies are interested in farmed kelp because of the sustainable production and unique product that it offers. Because kelp farming is a new and emerging industry, the existing producers and marketers are working on building the infrastructure that will be required for new farmed product to enter the market. The Maine Seaweed Council (www.seaweedcouncil.org) is an industry group made up of researchers, harvesters and growers who are working together to build this new industry, and is a good source for more information.

Kelp

Kelp is a healthy and nutritious sea vegetable that is high in fiber, vitamins, and minerals, including vitamin C, vitamin K, iron, calcium, iodine, and magnesium, and has long been an important part of the diet of coastal people. Kelps are great in salads and soups, and can be added to foods and even beer (Marshall Wharf Brewery in Belfast makes a sugar kelp beer called "Sea Belt") to enhance flavor and nutrition. Kelp is also useful in the beauty industry, as it contains alginate and vitamins and minerals, which are nourishing to hair and skin.

Kelp salad

Dried sea vegetable varieties

Seaweed soup

Frozen kelp

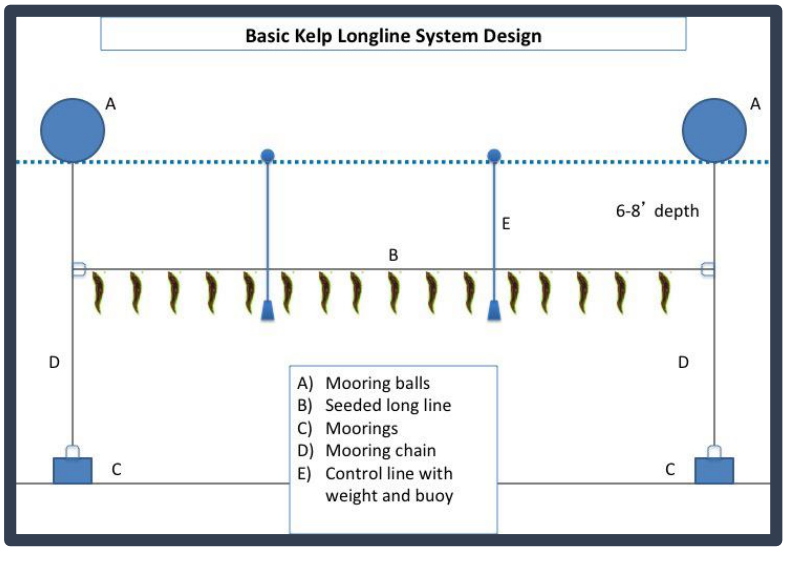
Kelp Soup

Q: *What is the potential for growing kelp in Maine?*

Maine is an ideal place to cultivate kelps, with its clean, cold water, abundant coastline, and knowledgeable watermen. Kelps are cultivated on sea farms, which are leased from the State of Maine through the Department of Marine Resources. Because kelp is a winter crop, it can be grown in the "off-season" in Maine, when most lobster fishing and recreational boating is at a minimum. Winter kelp farms have great potential in Maine to provide a means for diversification and a way to increase seafood production in the State.

Sugar kelp drying after harvest

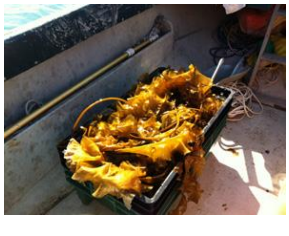
Young kelp growing on longline



Kelp grow-out line set-up

Kelp at time of harvest

Young kelp on line



Harvested kelp

Rolls of kelp seeding line

What is the grow-out time for various kelp species?

The large brown kelps are a cold temperate group of marine macroalgae, able to take advantage of the increased nitrogen availability and reduced competition in the colder months of the season. For these reasons, the growing season for kelp is from fall to spring. Sugar kelp (*Saccharina latissima*) is the main cultivated kelp species so far in Maine, with a season that typically runs from October to May.

Who can I talk to for more information about kelp production?

For more information about growing kelp, contact Maine Sea Grant marine extension associate Sarah Redmond at sarah.redmond@maine.edu. There is also a valuable Manual on Kelp Cultivation, available for free download here: http://www.oceanapproved.com/farming/. For information on leasing and aquaculture regulations, visit the Department of Marine Resources at http://www.maine.gov/dmr/aquaculture/

Resources

New England Seaweed Culture Handbook: Nursery Systems - An online manual that gives an overview of how to set up a seaweed nursery, and covers culture of Kelp, Gracilaria, Irish Moss, and Porphyra.
http://seagrant.uconn.edu/publications/aquaculture/handbook.pdf

New England Seaweed Culture Handbook Video Series: Online Seaweed Culture in New England – YouTube

Maine's Kelp Highway. Article in Maine Boats, Homes & Harbors, Winter 2013, Issue 122. Online at Maine's Kelp Highway - Maine Sea Grant

Business Plan for the Establishment of a Seaweed Hatchery & Grow-out Farm. Online Publication by BIM, Irish Sea Fisheries Board. Online at Seaweed Hatchery & Grow-out Farm

Maine "Seaweed Scene" Annual Meetings
http://www.seagrant.umaine.edu/seaweed/seaweed-scene-2012
http://www.seagrant.umaine.edu/seaweed/seaweed-scene-2013

Maine Seaweed Festival: www.seaweedfest.com

"In Maine, kelp is on the way from Ocean Approved". Article in Portland Press Herald, May 2014.
http://www.pressherald.com/2014/05/01/winning_recipe__frozen_kelp/

"Sea Fare" UMaine Today Article on Sea Vegetables in New England
http://umainetoday.umaine.edu/archives/summer-2012/sea-fare/

Resources for Seaweed Growers: http://www.seagrant.umaine.edu/resources-for-seaweed-growers/

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