



University of Maine
Cooperative Extension
Maine 4-H Science

Sea Vegetables: The Science of Seaweeds (Grades: 3-5)



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Learning Targets:

- Categorize a seaweed as red, brown, or green.
- Identify the different parts of a seaweed.
- Use a biological key to identify a seaweed.

Length: 45 - 60 minutes

Essential Questions:

1. What are seaweeds?
2. How do seaweeds differ from plants?
3. What are the functions of each seaweed part?
4. How are seaweeds classified?

Enduring Understandings:

1. Seaweeds are marine plants also known as algae. They are found in a marine environment and have specialized parts that allow for photosynthesis.
2. Plant parts are stems, roots, and leaves. Corresponding seaweed parts are stipe, holdfast, and blade or frond.
3. Holdfast: anchors seaweed to the surface.
4. Blade or frond: gives surface to absorb sunlight.
5. Stipe: acts like a stem in plants.
6. Float: air-filled bladder to keep seaweed afloat, not present in all seaweeds.
7. Seaweeds are classified by color: red, brown, or green.

Background for Facilitator:

This exercise familiarizes youth with the photosynthetic organisms of the Maine coast, and also introduces them to taxonomy and classification of organisms. Seaweeds can be broadly categorized based on growth form, shape, or color. The youth will examine epoxy seaweed specimens to make observations and categorize the seaweeds on their own. Once the youth are familiar with the structures and vocabulary, they will identify seaweeds through the use of a guide. A species guide has been included for the facilitator to aid in accurate student identification. Each seaweed sample is numbered on the epoxy frame (and is provided in this toolkit), and the number corresponds to the species number on your facilitator's guide.

If readily available, use of live, real seaweed would add another level of authenticity for scientific exploration and discovery. If you are planning to collect seaweed, be sure to be aware of local regulations for seaweed harvesting. <http://www.seaweedcouncil.org/wp-content/uploads/MSC-Field-Guide-Aug-2014-FINAL-reformatted-new-url.pdf> (Harvester's Field Guide to Maine

Seaweeds): includes details on where to find seaweed, appropriate times to harvest seaweed, how to harvest seaweed, and how to handle seaweed.

Vocabulary List:

Blade: Flattened part of a seaweed that resembles a leaf.

Holdfast: Base of a seaweed that attaches it to a rock; this resembles roots.

Stipe: Stalk of a seaweed between holdfast and blade; this resembles a stem.

FronD: Term used to refer to stipe and blade together.

Float: Air-filled bladder to keep seaweed afloat, not present in all seaweeds.

Seaweed: Marine plants that grow in the sea and do not have true roots, stems, or leaves; also known as “algae.”

Habitat: Place where a plant or animal lives (its home).

Photosynthesis: a process used by plants and other organisms to convert light energy from the sun into energy that can be stored for later use.

Materials:

- 4-6 wooden framed, epoxy seaweed samples (with 10 different species)
- 5 Gulf of Maine Seaweed Guides
- Seaweed Sample Answer Key
- 10 Portable microscopes

Methods:

Engage

1. Engage youth in a discussion about identifying seaweeds: *Note: you may have to explain what a seaweed is. See vocabulary list above.
 - a. **Who can describe what seaweed looks like?**
 - b. **How do you recognize seaweed when you see it?**
 - c. **What are the differences between seaweeds and land plants?**
2. Ask youth to spend 10 minutes drawing a picture of a seaweed. They can draw the first seaweed that comes to their mind, even if it's not accurate.
3. As they draw, walk around and ask youth to discuss the following things with their neighbor:
 - a. **Where does your seaweed live?**
 - b. **What color is your seaweed?**
 - c. **Describe the shape of your seaweed.**
 - d. **How does your seaweed stay attached to the shore? Or does it float free?**
 - e. **What makes your seaweed different from a plant on land?**
 - f. **What else should we know about your seaweed?**
4. After approximately ten minutes, tell the youth to finish up their drawings and ask for 2-3 volunteers to describe their seaweeds out loud to the group.
 - a. **Everyone should listen carefully as the volunteers describe their seaweed to us.**
5. Explain that they will now explore the different types of seaweed that are common on the Coast of Maine.

Explore

6. Divide the group into 4-5 cooperative learning groups.
7. Pass out 2-3 portable microscopes to each group.
 - a. **Scientists often use microscopes to get a closer look at seaweeds when identifying them.**
 - b. **First, let's learn how to use the microscopes.**
8. Aid the youth in using the microscopes. They can practice by looking at the table, their hands, a piece of paper, etc. *Note: it helps to practice this yourself before facilitating the activity.
9. Once everyone has been introduced to the microscopes, pass an Epoxy Seaweed Sample to each group.
 - a. **These are samples of real seaweeds that have been collected by researchers at the University of Maine.**
 - b. **They have been preserved by allowing them to air dry, and then set in epoxy to help keep the color and shape longer. Another way to preserve seaweed is by pressing and drying, similar to how leaves can be pressed and dried.**
10. Encourage the youth to explore the different seaweed specimens in front of them using their microscopes.
11. Let each group get a chance to see the different samples and see if they can separate them into groups based on any criteria of their choosing. Each category must share a similar characteristic.
 - a. **Which of these samples would you group together based on similarities?**
 - b. **What makes the samples similar to each other?**
 - c. **What makes the groups different from each other?**

Explain

12. Ask each group to share the criteria they used to categorize their seaweed.
 - a. **Listen carefully as we hear from each group.**
13. After each group shares, explain that scientists categorize seaweed in many different ways, and one of the easiest ways is sorting by color.
 - a. **What color seaweeds do we have in these samples from the coast of Maine?**
14. The youth should be able to identify the three major colors: red, brown and green.
15. Explain to the youth that there are important parts of each seaweed that make them very different from plants on land.
 - a. **Point to the part of your seaweed that looks most like a leaf. In seaweed, this is called a "Blade."**
 - b. **Point to the part of your seaweed that looks most like a stem. In seaweed, this is called a "Stipe."**
 - c. **Point to the part of your seaweed that looks most like roots. In seaweed, this is called a "Holdfast," and they help attach the seaweed to rocks.** *Note: not all samples have holdfasts since they are difficult to press and laminate. You may have to point out the holdfasts in the next part of the activity.
 - d. **Point to a part of your seaweed that allows it to stay afloat. These are air-filled bladders called floats. Not all seaweeds have floats.**

- e. **Why do you think these seaweed structures have different names than the structures of land plants?**

Elaborate

16. Now that the youth are familiar with the three major colors and the parts of a seaweed, they will work in groups to identify the names of their seaweeds using the Gulf of Maine Seaweed Guide.
17. Pass out a Gulf of Maine Seaweed Guide to each group.
18. Have youth record all observations in their Seaweed Journals. Draw a picture of your seaweed in your journal as you would if you were a scientist in the field.
- Can you identify the common and scientific name of your seaweed?**
 - What color is this seaweed?**
 - What is this seaweed used for?**
 - Where does this seaweed live?**
 - What is your favorite thing about this seaweed?**
19. Each group will then introduce their seaweed species to everyone else. They will discuss what characteristics they used to determine the name of the species, describe what it looks like, and share the facts that they learned about that species.

Evaluate

20. Engage the youth in a discussion of their experience:
- Which was your favorite seaweed species and why?**
 - What seaweed fact was most surprising to you?**
 - How do you think the seaweed structures help them to function in their environment?**
 - Why do you think it is important to be able to identify organisms?**
 - Why are seaweeds really not weeds?** (Seaweeds have many benefits – they act as food and habitat for marine creatures; they provide vitamins, minerals, and fiber to people; used as a thickening agent; used as fertilizer, etc.)
 - Have students go back to their original drawings and explain any differences between their first drawing and final drawing. They can now label the parts of their seaweed.

Extension Ideas:

- If you have access to the coast, collect some fresh seaweed for comparison and examination. <https://www.youtube.com/watch?v=RvDalUK5M2w> Video from CA. (Explains edible vs nonedible sea vegetables and how to harvest and store them.)
- <http://www.seaweedcouncil.org/who-owns-the-seaweeds-of-maine/> Maine Seaweed Council. (Laws related to seaweed harvesting in Maine)
- If you have fresh seaweed, you can facilitate a seaweed pressing activity! Encourage youth to get creative with their designs. A quick internet search will lead to some resources for how to press seaweed.
- A fun alternative to seaweed pressing is to create solar prints using fresh seaweed. Purchase solar paper and follow the directions on the box for making prints. We recommend using a

piece of Plexiglas to assemble seaweed designs on top of, in order to prevent the solar paper from becoming too wet.

- Many of the pressed species are cultivated and available for purchase. Having “store-bought” samples alongside the pressed or fresh samples could inspire some great discussion about how to process seaweed that will be sold in stores. These can be found in many major grocery stores and health food stores.
- Even students who live near the ocean may not realize that seaweed is an important health food source. Seaweed is now being made into forms like Kelp Crunch Bars in order to promote eating healthy seaweeds. <https://www.youtube.com/watch?v=WAMxRMtjicc>



Microscopes are most stable when placed on top of a sample resting on the table.

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Learning Targets:

- Recognize the differences between seaweeds and land plants
- Identify the parts of a seaweed (blade, stipe, holdfast, and sometimes float)
- Identify the most common species of seaweed in Maine (“The Maine Ten”)

Length: 45-60 minutes

Key Concepts:

- Seaweeds do not have roots, stems, or leaves, or flowers. They have holdfasts, stipes, and blades, and sometimes floats.
- Seaweeds have different structures than land plants because they live in the water rather than on land.

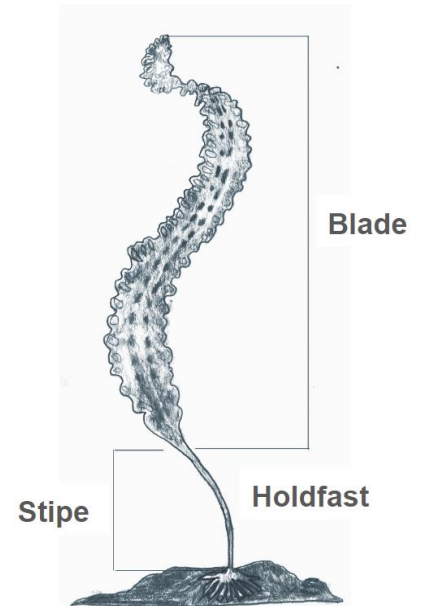
Essential Questions:

- Concepts in the Venn diagram described in the *Evaluate* section.

Background for Facilitator:

"Seaweed" is the common name for countless species of marine algae that grow in the sea. They produce oxygen by photosynthesizing energy from the sun, just like plants do on land. But, seaweeds differ from land plants in many important ways:

- Seaweeds can photosynthesize in all of their tissues. Most land plants photosynthesize only in their leaves.
- Seaweeds absorb water and nutrients in all of their tissues. Land plants have complex systems of roots, specialized tissues, and leaves that help them move water and nutrients around their body.
- Seaweeds are typically supported by the water they live in. Land plants need structures to help hold them up against gravity.
- Seaweeds can reproduce by simply breaking apart, releasing eggs and sperm, or releasing spores. Land plants typically reproduce by spreading their seeds.
- Seaweeds do not have flowers. Land plants can have flowers.
- Seaweeds can have **holdfasts** that help them cling to rocks. (Holdfasts do not transport nutrients or water, they just hold the base of the seaweed in one place). Land plants have



roots that anchor the plant in the ground and uptake nutrients and water that then gets transported around their body.

- Seaweeds have **blades**. Land plants have leaves.
- Seaweeds have **stipes**. Land plants have stems.

Vocabulary List:

Blade: Flattened part of a seaweed that resembles a leaf.

Holdfast: Base of a seaweed that attaches it to a rock; this resembles roots.

Stipe: Stalk of a seaweed between holdfast and blade; this resembles a stem.

Float: Air bladder that allows seaweeds to float closer to sunlight.

Species: the largest group of organisms from which two individuals are capable of reproducing fertile offspring (ex. dogs, humans, chickadees).

Materials:

- 4 species of “Seaweed vs. Plant” Clue Cards
- “Seaweed vs. Plant” answer key
- 4 sets of “Go Fish for Seaweed” Cards

Methods:

Engage

1. Ask youth to recall some of the information they learned in Activity 1:
 - a. **How is seaweed different from a plant?**
 - b. **What clues do you need to tell them apart from each other? On chart paper, begin with the word “Seaweed”. Have youth list as many terms, facts, ideas, and definitions that they can remember from the previous activity. Alternative -- have small groups come up with focused lists. The entire group can then look for similarities between lists. What is readily remembered? Is any concept missing which is critical to understanding?**¹

Explore

2. Divide the groups into 3-4 cooperative learning groups and begin by playing a game of “Seaweed vs. Plant” to refresh their memory of seaweed:
 - a. **The object of the game is to determine whether your species is a plant or a seaweed based on the clues given on the card.**
 - b. **There will be five rounds, and each group will receive one clue card per round.**
 - c. **Read the clue card aloud to your group, and decide whether you think the species described is a SEAWEED, PLANT, or NOT SURE based on the information given on the card.**

- d. **Each round, you will receive another clue card with more information about your species.**
 - e. **The next round doesn't begin until each group has chosen: SEAWEED, PLANT, or NOT SURE. Raise your hand when your group is ready. We won't move on until all groups have their hands raised.**
3. Distribute "Round 1" of the "Seaweed vs. Plant" clue cards. Each group should have a different species.
 4. Proceed with rounds 2-5 until all groups have come to a decision.
 5. At the end of round 5, prompt the youth to share their ideas, one group at a time:
 - a. **Read through all of the clues, in order, and tell us what you decided; is your species a SEAWEED or PLANT?**
 - b. **What clues led you to believe that?**
 6. Following each presentation, address the rest of the youth:
 - a. **Do you agree with this group's decision? Why or why not?**
 7. After the discussion, reference the answer key and tell the youth the name of the species and if it is a plant or a seaweed.
 8. Be sure to point out the clues that help the youth understand the differences between plants and seaweeds.
 - a. **For example: Species 1, Clue 4 says that this species never has any flowers. Seaweeds do not have flowers; only land plants have flowers. Similarly, Species 2, Clue 5 references "my flowers."**
 - b. **Another example: Species 4, Clue 5 says "my holdfasts are used to hold on tight to rocks, not take up water or nutrients, like roots do," indicating that this species is a seaweed.**
 - c. **Another example: Species 1, clue 1 says "Love the sun", which applies to both.**
 - d. **Another example: Species 4, Clue 4 says "surrounding water supports me."**

Add new understandings to the posted Focused List.

Explain

9. Now that the youth have refreshed their memory of the differences between seaweeds and plants, it's time to play "Go Fish for Seaweed!"
10. Review the vocabulary words: holdfast, blade, stipe. Draw a diagram if necessary.
 - a. **Does anyone remember these 3 important parts of seaweed?**
11. Tell youth they will be assembling these structures of seaweeds in a game similar to the card game "Go Fish."
12. Read the following rules aloud:

Game Rules

This variation of the popular card game, "Go Fish", is designed to help you compare the different structures of seaweed and plants. If you already know how to play "Go Fish," this variation may not be the same as you are used to, so listen carefully to the rules:

Objective: The object of the game is to collect as many complete species as possible. A complete species is a set of three cards with different structures that make up one species. For example, “Kelp Blade,” “Kelp Stipe,” and “Kelp Holdfast” is one complete species (***show an example from the deck***).

Dealing and Setup: The game can be played by 2-5 players. If there are 2-3 players, they are each dealt 7 cards. If there are 4-5 players, they are each dealt 5 cards. Once the dealing is done, the rest of the deck is placed in a random pile on the table in the center of the players, face down. If the players have any complete species in their hand at this time, they can put them on the table in front of them, face up, to reveal the “catch.” This counts as one point.

Fishing: You can decide who goes first through a game of rock, paper, scissors. The first player starts by asking one of the other players for a particular species and structure that they need to build a seaweed. For example, if you have a kelp blade in your hand, you might ask another player: “Do you have a kelp stipe?”. You may **only** ask for a species that you already have at least one card of. For example, if you are not holding any kelp cards in your hand, you can’t ask for kelp from another player. If the player being asked for a kelp stipe has that card, then they **must** give them to you, and you get another turn. If they don't have any kelp stipes then they will tell you to "Go Fish", which means that you will draw one card from the pile on the table. If you get a kelp stipe, then you show it to the other players to reveal your “catch” and get another turn. If you get something else besides a kelp stipe from the pile, you are finished with your turn and the player to your left plays next.

Adaptation Note: There can be an alternate version of this activity, where they just have to match the species and not the 'kelp, blade, and holdfast' of those species.

Scoring: If you have a complete species (3 cards of the same species), put them on the table in front of you, face up, to reveal the “catch”. This counts as one point.

Drawing new cards: You can finish all the cards in your hand, either because someone else asked you for the last cards that you had, or you used up all your cards by making a complete species. If you have no cards left in your hand, you may draw new cards from the pile on the table. You may take the same number of cards as you were dealt at the start of the game. If you have no cards left in your hand and there are no more cards left in the pile to draw from, you are “out” and will wait until the other players finish the game. You will still keep all of the points you gathered during the game.

Evaluate

13. Engage the youth in a discussion of their experience:

- a. **Why do seaweeds have different structures than plants? Construct a Venn diagram: in the shared portion - produce oxygen through photosynthesis; need sunlight. In the Plants portion - found on land; need structure to hold them up; parts are root, stem, leaf, flower: photosynthesis in leaves. In the Seaweed portion - found in the ocean; supported by water; parts are holdfast, stipe, blade, bladder; photosynthesis throughout the entire plant.**
- b. **What is the function of each seaweed part? What purpose does a holdfast, blade, stipe, or float serve? What purpose does a leaf, stem, roots, or flower serve in a plant?**

Annotated Student Drawing:² Draw a seaweed and land plant side by side. Label parts and purpose of each.

¹ Focused Listing – review technique from Science Formative Assessment by Page Keeley, NSTA Press 2008, page 95.

² MTV: Making Your Thinking Visual from Page Keeley, Page 53 (see source 1).

Seaweed vs. Plant Answer Key

Species 1: Sea Lettuce (SEAWEED)



Species 2: Dandelion (PLANT)



Species 3: Blueberry (PLANT)



Species 4: Kelp (SEAWEED)



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Learning Targets:

- Understand that seaweeds are edible plant-like organisms that people consume in processed food products.
- Recognize and/or identify seaweed-based ingredients when reading product ingredient lists.
- Observe how seaweed acts as a binding/thickening agent in food.

Length: 45 - 60 minutes

Essential Question:

- Why is seaweed added to the foods we eat?

Enduring Understandings:

- Seaweed is added to foods to help keep our bodies healthy and to thicken foods and to keep them from separating.

Key Concepts:

- Seaweed can be used in many ways.
- Seaweed is found in many products we use every day.
- Adding seaweed to products can thicken/bind/stabilize/emulsify the ingredients.
- We can use the unique properties of seaweed to help us solve problems (such as protecting ice cream from freezer burn).

Background for Facilitator:

Seaweed is used in many products we use and eat because the properties of seaweed make it useful as an **emulsifier**, **thickener**, and **stabilizer**. It is an emulsifier because it keeps ingredients like mayonnaise, salad dressing, and chocolate milk in suspension. It is a thickener because it absorbs water and keeps things like pie filling from softening the pastry crust. It is a stabilizer for things like ice cream to keep them from forming large ice crystals when frozen. Seaweed stabilizes the emulsion and prevents breakdown of the emulsion. These properties are useful in other products like toothpaste. They are also important in the textile industry to thicken pastes containing dye. In this activity, we search the ingredients labels of common products and investigate how seaweed can emulsify, thicken, and stabilize the ingredients in the products we use.

We will explore one of these seaweed products, alginate, to investigate the “slimy” properties of seaweed that allow it to emulsify, thicken, and stabilize the ingredients in the products we use. Depending on the seaweed species and the extraction process, the alginate powder may have different properties for use in different kinds of products. For example, *Macrocystis* (a type of kelp) can give either a medium-viscosity alginate, or a higher viscosity alginate when extracted at a lower temperature. *Sargassum* (a free-floating brown algae) usually gives a low viscosity alginate. These are

some of the reasons why alginate producers prefer to have a variety of seaweed sources. Different seaweeds match the needs of the particular application.

Vocabulary List:

Emulsifier (ih-muhl-suh-fahy-er): promotes the formation and stabilization of a mixture of liquids. Emulsifiers are used to keep liquids from separating and to bind liquids together.

Stabilizer: a substance added to another substance to prevent it from altering its physical state. Stabilizers prevent the breakdown of emulsions and keep them stable.

Thickener: a substance that makes something thick or thicker.

Alginate (al-juh-neyt): a substance derived from marine brown algae (such as Kelp) used especially as a stabilizing, emulsifying, or thickening agent in foods (such as ice cream), pharmaceuticals, and cosmetics.

Carrageenan (kar-uh-gee-nuhn): a gelatinous substance extracted from various red algae (such as Irish Moss) and used especially as a stabilizing or thickening agent.

Beta Carotene (bey-tuh kar-uh-teen): a natural substance that is found in dark green and dark yellow fruits and sea vegetables that helps your body grow and be healthy.

Hypothesis (hahy-poth-uh-sis): an idea or theory that is not proven but that leads to further study or discussion.

Materials:

- 5 “Seaweed in your cupboard” data sheets (1 per group)
- 15 Dry erase markers
- 25 Laminated photos of common products (1 set per group)
- 3-5 bags of different types of dried seaweed (enough for each group to have one of each sample type)
- 5 aluminum trays (1 per group)
- 5 containers of Sodium Alginate powder (1 per group)
- 15 Craft sticks (not-dyed or colored)
- 15 Mini cups
- 5 Alginate experiment data sheets (1 per group)
- 2 Tablespoons
- Paper towels
- Pitcher/water bottle for water transport
- Water [not included]

Methods:

Engage

1. Ask youth to recall the information they learned about cooking with seaweed in the previous activity:
 - a. **What are some things that humans can do with seaweed? Refer back to Gulf of Maine Seaweed guide in Activity 1: as a food in salads, soups, wraps; as fertilizer; in skin care products**
 - b. **Do you remember which seaweed species can be used for cooking? Rockweed: clambakes for steaming food, added to soup; Kelp: noodles, salad, sushi wrap; Dulse: chips; Irish Moss: pudding)**

2. Explain that you are going to start this activity with a guessing game called “Seaweed or No Seaweed?”
 - a. **The object of the game is to guess which of these common products have seaweed ingredients in them.**
 - b. **I will show you the products one at a time, and ask “Seaweed or No Seaweed?”**
 - c. **If you think the product has seaweed in it, put your THUMBS UP.**
 - d. **If you think the product does not have seaweed in it, put your THUMBS DOWN.**
3. Show youth the laminated seaweed products, one at a time, while also describing the product in case the photo is hard to see from their seats. For example:
 - a. **This common product is ICE CREAM. Seaweed or No Seaweed?**
4. Encourage the youth to write down their guesses, and/or ask for a volunteer to keep track of the number of “thumbs up” and “thumbs down” for each product.

Explore

5. Tell the youth that they will now have the opportunity to figure out whether or not these products have seaweed ingredients.
6. They must look for one of three seaweed names in the ingredients list of each product: **ALGINATE** (al-juh-neyt) (sometimes referenced as **ALGIN**), **CARRAGEENAN** (kar-uh-gee-nuhn), and **BETA CAROTENE** (bey-tuh kar-uh-teen). They will be given a data sheet with these ingredients spelled out for them, so they can look for them in the products.
7. Divide into five cooperative learning groups of 2-3 youth per group.
8. Distribute one set of laminated “products” and one “Seaweed in your cupboard” data sheet to each group.
9. Ask each person in the group to read the definitions of the three seaweed ingredients aloud.
 - a. **One person reads the description on the datasheet for “Alginate” aloud. Another person reads the description for “Carrageenan.” A third reads the description for “Beta Carotene.”**
 - b. **These are the names you will look for in the ingredients list for each product.**
10. Tell the youth to keep track of which products have “Seaweed” or “No Seaweed” on their data sheet.
11. Encourage the groups to discuss with each other:
 - a. **How do your findings compare with your “Seaweed or No Seaweed” guess in the beginning of this activity?**
 - b. **Why do you think seaweed has been added to these products?**
Answer: Either to help bodies be healthy or to thicken foods and keep them from separating.
 - c. **Which product with seaweed ingredients was most surprising to you?**
12. Encourage the groups to exchange “products” so everyone has a chance to determine “Seaweed or No Seaweed?”

Explain

13. When the groups are finished with their investigations, play the “Seaweed or No Seaweed?” game again, and ask another volunteer to keep track of the number of “thumbs up” and “thumbs down.”
14. Use this opportunity to clarify any confusion over whether a product has Seaweed or No Seaweed.
15. Besides the fact that seaweed is healthy for our bodies, it can also be added to help thicken foods. Explain to the youth that there are three ways that seaweed is used in this way.
 - a. **Seaweed is used in many products we use and eat because its properties make it useful as a thickener, stabilizer, and emulsifier.**
 - b. **It is a thickener because it absorbs water and keeps things like pie filling from softening the pastry crust.**
 - c. **It is a stabilizer because it absorbs water in things like ice cream to keep it from forming large ice crystals when frozen and prevents the breakdown of emulsions.**
 - d. **It is an emulsifier because it keeps ingredients like mayonnaise, salad dressing, and chocolate milk in suspension so the ingredients do not separate.**
16. Explain that the youth will be performing some seaweed experiments to understand how seaweed is useful as a thickener, stabilizer, and emulsifier and why it is added to many common food products.

Elaborate

17. Divide into five cooperative learning groups of 2-3 youth per group. Give each group a few pieces of dried seaweed.
 - a. **Do you remember the name of these seaweeds from the previous activities?**
 - b. **What does this seaweed feel like?**
 - c. **How might it be different from live seaweed?**
 - d. **How do you think this seaweed became so dry?**
 - e. **What if we were to wet this piece of seaweed? What would you expect it to feel like then?**
18. Distribute an aluminum tray containing about 1 inch of water to each group.
19. Encourage youth to play with the dried seaweed in the tray of water and discuss their observations within their groups, and/or write them down.
 - a. **What happened to the dried seaweed?**
 - b. **What does it feel like? What does it look like?**
 - c. **What are some differences between dried seaweed and wet seaweed?**
20. Explain that seaweed is often dried and ground into a fine powder before it is added as an ingredient to food products.
 - a. **What do you think would happen if we took dried seaweed, ground it into a fine powder, and then added water?**
 - b. **In your groups, brainstorm what would happen to the powdered seaweed using your observations of what happened to the dried seaweed when it was added to the tray of water.**
21. Ask each group to make a **hypothesis** and write it down.
 - a. **We will test your hypotheses by experimenting with seaweed powder and water.**
22. Distribute 1 mini cup and 1 stirring stick to each person.

23. Distribute 1 alginate experiment datasheet to each group.
24. Introduce the alginate:
 - a. **Alginate is powdered brown seaweed for sale in gourmet food stores. In fact, this product is often made from Maine seaweed!**
 - b. **Each person in the group is going to mix different amounts of alginate and water to test your hypothesis.**
 - c. **Circle the amount of alginate and water you would like to test. Everyone should have different amounts of alginate and water so you can compare the effects of water on the alginate.**
25. Walk around to each group with the alginate and water; have the youth measure the amount of alginate and water they requested. *Note: Use your discretion to determine if youth can measure ingredients themselves, or if the facilitator should walk around and measure for them.
26. If time allows, continue changing the proportions of alginate and water and encourage youth to describe their observations and evaluate their hypothesis.

Evaluate

27. Engage the youth in a discussion of their experience:
 - a. **What happened to the powdered seaweed when water was added?**
 - b. **How does your cup differ from others in your group?**
 - c. **What can you say about the effect of water on powdered seaweed?**
 - d. **Was your hypothesis correct? How do you know?**
 - e. **What would your next seaweed experiment look like?**
 - f. **Can you describe how this mixture is helpful for products like ice cream, toothpaste, and pudding? Keep in mind what it feels like and what happened to the water.**

Extension Ideas:

Additional Resource: <https://www.youtube.com/watch?v=7I8GXmpKrVg> Explains in kids' language what an emulsifier is. (note, the narrator has a British accent)

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This activity is supported by National Science Foundation award #1355457 to Maine EPSCoR at the University of Maine.



Learning Targets:

- Understand that nitrogen cycles indefinitely through the Earth system.
- Name the places that nitrogen is found on Earth.
- Describe how the cycle travels between living things and the physical environment.
- Understand the role of seaweed in the marine cycle of nitrogen.

Length: 45 - 60 minutes

Key Concepts:

- Nitrogen cycles around and around. It is always recycled and never disappears from our environment.
- Nitrogen doesn't follow the same path all of the time.
- Even though nitrogen is essential for all life, there can still be too much of it sometimes. Seaweeds need a lot of nitrogen to grow, so they take up nitrogen in areas where there is too much.

Essential Questions:

1. Why is nitrogen important?
2. How is nitrogen taken into living organisms?
3. What is the nitrogen cycle?
4. When there is too much nitrogen in the ocean, what role does seaweed take?

Enduring Understandings:

1. Plants and animals use nitrogen to build proteins.
2. Nitrogen cannot be absorbed directly from the air. First, bonds are broken and then bacteria processes nitrogen into nitrates. Then nitrogen is fixed so it can be used.
3. The nitrogen cycle is the process of nitrogen being fixed, then used by plants and animals, and later being returned to the atmosphere to cycle again. Nitrogen takes varied paths in the atmosphere, soil, and waters.
4. Seaweed takes up nitrogen and uses it to grow.

Background for Facilitator:

Nitrogen is an element found in living things such as plants and animals; in dead things such as fallen leaves and dead animals; and in non-living things such as air and water. The nitrogen cycle is very important for ecosystems because it is an important element for ALL life on earth. Nitrogen goes through its cycle slowly, and is stored in the atmosphere, in living organisms, in soils, and in oceans along its way through the cycle. Nitrogen in its gaseous form is unusable to life forms and must first be converted, or “fixed”, by specialized bacteria so it can be used. Other bacteria do the reverse and return nitrogen to its gaseous form.

In this game, youth will play the role of nitrogen atoms traveling through the nitrogen cycle. They will gain understanding of the varied pathways through the cycle and the relevance of nitrogen to living things. Seaweed picks up nitrogen in a process called nutrient bio extraction. Many plants and animals cannot survive when there is too much nitrogen in the water, but seaweed takes in the nitrogen.

Fun Facts:

- Nitrogen is the seventh most abundant element in the universe.
- Approximately 78% of the atmosphere is nitrogen.
- Nitrogen has no color, odor, or taste.
- Nitrogen is used in fertilizer for farms and gardens.
- The human body contains about 3% nitrogen.

Vocabulary List:

Nitrogen: An important element of the periodic table. It does not have a color or an odor. Nitrogen is essential for growth and reproduction of all living things.

Materials:

- 10 six-sided dice
- 14 Nitrogen Station Signs
- 10 Nitrogen Cycle Passport Datasheets (1 passport per group)
- 15 Nitrogen Necklaces
- 14 Emoji Stamps (a **different** stamp for each game station)
- Pens/Pencils
- Masking Tape
- Paper Towels

Methods:

Engage

1. Introduce this activity by asking youth what types of things they eat on a regular basis. The goal is to determine if they eat one thing all the time or if they eat a variety of foods.
 - a. **Seaweeds produce sugar during photosynthesis, but is that enough for them to survive?**
 - b. **What would happen if humans ate nothing but sugar? Is that good or bad? Example to help understanding: Would you eat candy and pudding for every meal? What if humans ate only broccoli all the time? What would the result be for your overall health?**
 - c. **Seaweeds need a variety of nutrients just like humans need a variety of vitamins and minerals to be healthy.**
2. Explain to the youth that one of the nutrients seaweed needs is called **NITROGEN: Let's learn more about nitrogen. What is nitrogen? A gas in the air. Animals and plants, including seaweed, need it as a nutrient to live. Is it absorbed directly from the air like oxygen? No. Nitrogen must be broken down to nitrates by specialized bacteria. The process of breaking nitrogen down is referred to as "fixing nitrogen." Then it travels through varied paths called a cycle. Let's play a game to see how the nitrogen**

cycle works and how seaweeds get nitrogen.

3. Point to the nitrogen station signs around the room and explain that these signs represent the places to which nitrogen can travel.
4. Ask for a few volunteers to read aloud how nitrogen travels from station to station.
 - a. **What are the names of the Nitrogen stations around the room?**
 - b. **What are some ways Nitrogen can travel from station to station?** Read a few of the descriptions next to the image of dice.

Explore

5. Ask the youth to work in groups of 2-3 for this game.
6. Give a nitrogen necklace to each person, and tell the youth they will play the role of a nitrogen atom during this game:
 - a. **You will travel as nitrogen atoms with your partners based on the roll of the dice.**
 - b. **You will carry your own dice and a nitrogen passport. You will stamp your passport each time you arrive at a nitrogen station. Every station has a different stamp to help you keep track of where you have been.**
Note: It does not matter which stamp you put at each station!
 - c. **You will also stamp the nitrogen station sign itself to prove that you were there.**
 - d. **Roll the dice and follow the directions on the sign to determine which station you will travel to next.**
 - e. **At the end of the game, you will share your individual journey and we will determine which nitrogen station had the most visitors.**
7. Demonstrate the game by traveling from one station to the next, describing your actions aloud.
8. Direct each group to begin at a different nitrogen station, and record the “start” station on their passport.
9. Walk around to the groups during the game to clarify any questions and remind them to fill out their passports and to stamp the signs.
10. Play the game for approximately 20 minutes, or more if necessary. Repeat the game multiple times if needed to ensure understanding. Repetition may help reinforce key concepts.

Explain

11. When you stop the game, tell youth to remain at the nitrogen station where they ended up and record the number of stamps on each sign.
12. Direct the groups to walk around to empty stations and record the number of stamps on each sign, too. Eventually, all of the stations should be counted between all of the groups.
13. Engage the students in a discussion of their experience:
 - a. **Which nitrogen station was most visited?** (*Note: they will need to compare calculations among groups to answer this question).
 - b. **How many stops did you make on your trip?**
 - c. **Was everyone’s journey the same? Why or why not? Visual maps can be made**

by each group and shared with the whole group.

Elaborate

Let's look more closely at seaweed.

14. Explain that seaweed needs a lot of nitrogen to grow.
 - a. **Nitrogen is an important nutrient for seaweed. Without nitrogen, seaweed couldn't grow.**
 - b. **Oftentimes, seaweed is grown right next to fish farms because the waste from the fish is full of nitrogen.**
15. Explain that fish farming creates a large amount of fish waste.
 - a. **How do you think this affects the nitrogen cycle?**
 - b. **Let's find out by having everyone start from the "Marine Animal Waste" station at the same time.**
16. The nitrogen cycle signs need to be cleaned off. Ask each youth to wipe one sign down with a damp paper towel.
17. Explain that you will now play another round of the game. This time, have all of the groups start at the "Marine Animal Waste" station and roll the dice one group at a time.
18. Direct the youth to record their travel on the back of their passport datasheet.
19. Continue the game for 15 minutes or more.
20. Direct the youth to count the total number of stamps on each station.

Evaluate

21. Engage the youth in a discussion of their experience:
 - a. **What happened when everyone started at the Marine Animal Waste station?**
 - b. **How was this journey different from the first journey?**
 - c. **Where did the nitrogen travel?**
 - d. **Knowing that seaweed uses a lot of nitrogen, how do you think farming seaweed and fish together might benefit the environment?**
 - e. **How do you think growing seaweed can help in areas where there is too much nitrogen?**
 - f. **How do you think humans factor into the nitrogen cycle?** (Youth need to connect humans with farm runoff, fertilizer, accidental forest fires, animal wastes from farms, human wastewater pollution, etc.).

Extension Ideas:

- Discuss the human impacts on the nitrogen cycle (farming, burning fossil fuels, sewage waste, deforestation, marine pollution, etc.). Ask youth to expand upon the nitrogen cycle game to include human impacts, and perhaps suggest solutions to any issues.
- Introduce aquaponics: a system of aquaculture in which the waste produced by farmed fish or other aquatic animals supply nutrients for plants or seaweeds grown hydroponically, which in turn purify the water. Have youth draw and label their own "nitrogen cycle" for an aquaponics system.

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Learning Targets:

- Understand the role of kelp, urchins, and wolffish in the New England ecosystem.
- Understand how a population of one organism can affect the population of another in the same food web.
- Model human impacts on a fragile food web.

Length: 45 - 60 minutes

Essential Questions:

1. Small changes can set off a chain of reactions that can affect an entire ecosystem.
2. Organisms in an ecosystem depend on each other in many ways.
3. Humans can negatively or positively impact the food web.

Background for Facilitator:

The waters of New England are home to abundant and diverse kelp forests, where large species of kelp provide habitat for countless marine organisms. The Atlantic Wolffish is an important resident of the kelp beds. They prey upon Sea Urchins that graze upon the kelp. Wolffish protect kelp from predation and allow kelp forests to flourish, which is good news for that fragile marine ecosystem.

The loss of a predator, such as the Atlantic Wolffish, would result in an increase of herbivores (urchins, in this case), which leads to a decrease in the abundance of kelp that provides habitat for many species in New England waters. Protecting important predators will build resilience for our ecosystems in more ways than we can count. For more information, visit: newenglandoceanodyssey.org/tag/kelp/

Vocabulary List:

Herbivores: An animal that eats only plants.

Materials:

- 1 set of Web of Life necklaces
 - 2 Wolffish
 - 5 Sea Urchins
 - 7 Kelp
 - 1 Sun
- 1 Ball of twine
- 5 Jenga sets
 - 24 green blocks (kelp)
 - 15 pink blocks (urchin)
 - 9 blue blocks (wolffish)

- 6 uncolored blocks (ocean surface)
- 5 decks of “Environmental Changes” cards
- 5-10 Dry erase markers

Methods:

Engage

1. Begin by asking the youth to stand up and spread out in a circle.
 - a. **You will each be playing the role of an important organism in the waters of New England.**
2. Distribute the Sun, Kelp, Urchin, and Wolffish necklaces randomly among the circle until each youth has their own. *Note: if you have more than 15 youth, they will need to work in pairs.
3. Explain this particular food chain:
 - a. **In this marine ecosystem, there are KELPS, SEA URCHINS, WOLFFISH, and the SUN.**
 - b. **Raise your hand if you are a Kelp.**
 - c. **Raise your hand if you are a Sea Urchin.**
 - d. **Raise your hand if you are a Wolffish.**
 - e. **Raise your hand if you are the Sun.**
4. Ask youth to recall information from the photosynthesis discussion in Activity 2:
 - a. **Raise your hand if you get your energy from the sun.**
 - i. The Kelps should raise their hands.
 - b. **Raise your hand if you get energy from eating another creature.**
 - i. The Urchins and Wolffish should raise their hands.
5. Explain the relationships between the organisms in this ecosystem:
 - a. **In this ecosystem, Kelp gets its energy from the sun;**
 - b. **Kelp is eaten by the Sea Urchins;**
 - c. **Sea Urchins are eaten by the Wolffish.**
 - d. **We are going to model these connections using a ball of twine.**

Explore

6. Pass the ball of twine to the “Sun” to begin the web of life and demonstrate the first connections:
 - a. **The Sun begins by holding the end of this twine - the Sun should not drop this end. Hold on to it for the entire game!**
 - b. **Since the Sun provides Kelp with energy, they are connected.**
 - c. **Let’s demonstrate this connection by having the Sun pass the ball of twine to a Kelp, but not letting go of the end of the twine.**
 - d. **Now that a Kelp has the ball, you can see that these two things are connected in the ecosystem.**
 - e. **What is Kelp connected to?**
 - i. SEA URCHINS (eat kelp) and SUN (provides energy for photosynthesis).
 - f. **The Kelp can pass the string to anything that it is connected to.**
 - i. Have the Kelp pass the string to a Sea Urchin for this demo.
 - g. **Now that a Sea Urchin has the ball, you can see how these three things are connected to each other.**
 - h. **What are Sea Urchins connected to?**
 - i. WOLFFISH (eat urchins) and KELP (is food for sea urchins).
 - i. **The Sea Urchin can pass the string to anything that it is connected to.**

- i. Have the Sea Urchin pass the string to a Wolffish for this demo.
 - j. **Now that the Wolffish has the ball, you can see how all of these things are connected to each other.**
7. Direct the youth to keep passing the ball of twine until everyone in the circle is holding a piece of it.
 - a. **You may pass the twine to any organisms that you are connected to, whether you get your energy from them, or they get it from you.**
 - b. **Be sure to pass the twine to someone who hasn't had it yet.**
 - c. **Be sure to hold on to your end of the twine before you pass the ball!**
8. When the twine has been passed to everyone, there will be a large "Web of Life".
9. Take the opportunity to emphasize how every organism in an ecosystem is connected to each other.
 - a. **What do you notice about this ecosystem?**
 - b. **What would happen to the food web if we removed one of these organisms?**
10. Demonstrate a "stress" on the food web by asking 1-2 volunteers to take a few steps back while everyone else stays in place. Make sure everyone holds on to their twine.
 - a. **Who felt a tug on their twine?**
 - b. **This represents how each organism is connected to each other in an ecosystem.**
11. Explain to the youth that they will be playing a game that demonstrates these connections between organisms in the Kelp Forest.

Explain

1. Explain to the youth that they will be playing a tower building game.
 - a. **This game is all about how small changes can impact the stability of a whole ecosystem.**
 - b. **The system is made up of organisms and their habitat, and all of the parts depend on each other.**
2. Introduce any unfamiliar vocabulary at this time to ensure understanding of the terminology used on the cards.
3. Divide the youth into 5 cooperative learning groups of three to four.
4. Distribute a set of blocks to each group.
5. Ask each group to set up the game by placing three green blocks side by side. Continue alternating layers of green blocks in a crisscross fashion. Once the green blocks are used up, stack the pink blocks, then the blue blocks, then the uncolored blocks until they are all stacked up in crisscrossed layers of three.
6. Remind everyone to listen carefully as you read the rules aloud.



Game Rules

- The first player picks a card, reads all of the information aloud and follows the instructions in the same order in which they are written on the card. For example, if the card says "Remove 1 kelp block, add 2 urchin blocks"; the player must first remove 1 kelp block (green), and then add 2 urchin blocks (pink) if available to stack. They place the card into a discard pile when they are finished.
- Only the block being removed or returned may be touched. Holding the tower together while removing blocks is not allowed.

- The player may touch a block to see if it is loose before removing it, but must return the block to the original position if he/she chooses to remove another one instead.
 - Players may only use **one hand** to remove and place the blocks.
 - When a block is removed from the tower, it must be placed in a discard pile. ***Note: the removed block does NOT get placed on the top of the tower.**
 - When a block is added to the tower, it must be placed on the same level it came from (Kelp [green] on the bottom, Urchins [pink] in the middle, Wolffish [blue] on the top).
 - The unpainted blocks are not to be removed from the tower, they are only there to represent the ocean “surface”.
 - If a player cannot go on their turn (for example, if the card says to add 2 kelp blocks, but there is only 1 kelp in the pile), then that player must hold on to that card, skip their turn, and try to play the card when it is their turn again.
7. Play a practice or demonstration round to ensure that each group understands the rules.
 8. Shuffle the playing cards and stack them with the photos facing up.
 9. Continue taking turns until the tower falls and the ecosystem collapses.
 10. If the tower is still standing and the players have used up all of the cards, reshuffle the discard pile and keep playing until the tower falls.

Elaborate

11. Instruct each group to set up their tower to play on their own as many times as desired.
12. Be sure to encourage youth to read each card aloud, and to think about the consequences of the environmental change described on the card.
13. Walk around to each group while they play the game to clarify questions and ensure the youth are following the rules.

Evaluate

1. Engage the youth in a discussion of their experience:
 - a. **If the ocean is so large, why do small changes make a difference?**
 - b. **In what ways did the organisms in this food web depend on each other?**
 - c. **What surprised you when playing the game?**
 - d. **What role do you think humans play in this food web?**

Extension Ideas:

- Play the game again with one to four blocks added for humans.

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Learning Targets:

- Understand the value of aquaculture in Maine.
- Apply their creativity and imagination to create biological and business models.
- Develop an engineering solution prototype that will meet a societal demand for food.
- Design an engineering solution given constraints on cost and materials.

Length: 60-90 minutes

Key Concepts:

- Seaweeds have adaptations that cause them to survive well, less well, or not at all in certain habitats.
- Just like vegetables, seaweed is a crop that can be farmed. It requires different methods because of the marine environment.
- Engineers work together to share ideas.

Essential Questions:

1. Why is aquaculture important?
2. What are the benefits of aquaculture farms over land farms for the production of food?
3. How does a marine environment affect sea vegetable production?
4. Who works to create aquaculture farms?

Enduring Understandings:

1. Aquaculture provides food and fuel. It also helps the environment. Sea vegetables contain nutrients and iodine. They are used as a thickening agent in substances like toothpaste. They are also used in skin care and cosmetic products.
2. Aquaculture does not require fresh water, fertilizer, pesticides, or land space. It does not cause land erosion or deforestation. Aquaculture is renewable and low cost. Aquaculture is an alternative to overfishing. Sea vegetables remove nitrogen and toxins from seawater and absorb CO² as they grow.
3. Sea vegetables need different adaptations and ways to grow than land plants. The marine environment provides sea vegetables with the proper nutrients they need to grow.
4. Scientists and engineers work together to create aquaculture farms.

Background for Facilitator:

Aquaculture is an important part of Maine's economy and produces resources for the community. Seaweed farming, a type of aquaculture, is the practice of cultivating and harvesting seaweed. Modern seaweed farmers are pioneering new designs in "sea vegetable" aquaculture. Farmers grow

high quality and abundant food, while also improving the environment. In comparison with other agricultural and aquaculture operations, seaweed farms are extremely sustainable because they don't rely on freshwater, fertilizer, or deforestation. Since seaweed is a great source of food, fuel, and environmental remediation, it is important that we continue to innovate new and exciting ways to cultivate these species.

This activity is designed to be done in a longer session. If extended time is not available, you may consider delivering Part 1 and Part 2 into two activity sessions.

Vocabulary List:

Sea Vegetable: An edible seaweed.

Aquaculture: The cultivation of aquatic organisms (such as fish, shellfish, sea vegetables, etc.) for food or other purposes.

Materials:

- Scrap paper [not included]
- Poster board or 15 sheets of newsprint
- 1 box of colored pencils
- 1 set of play money
- 1 ball of wax cord
- 1 roll of mesh fabric
- 30 straws
- 30 coffee stirrers
- 100 toothpicks
- 30 craft sticks
- 50 paper clips
- 30 clothespins
- 30 cups
- 50 rubber bands
- 1 roll of aluminum foil
- 5 "Seaweed Farm Materials Cost" sheets

Methods:

Engage

1. Access youth's prior knowledge about the common seaweed species found in Maine:
 - a. **Who can remember the names of some common seaweeds in Maine?**
 - b. **What do they look like? Describe their characteristics.**
 - c. **Where do they live? Describe their habitat.**
 - d. **What do they need to survive?**
 - e. **What are some ways humans use these seaweeds?** food, fuel, thickening agent in things like toothpaste, skin care and cosmetic products.
2. Introduce this activity by announcing that they will be given an opportunity to create and farm their own species of seaweed. Introductory video on kelp farming in Maine:
<https://www.youtube.com/watch?v=Zw4IiPujXWo>
3. They will need to determine:
 - a. What their seaweed species needs to survive

- b. What habitat their seaweed species lives in
- c. How humans will use their seaweed species

Explore Part 1

4. Divide into 5 cooperative learning groups.
5. Distribute paper and/or newsprint and colored pencils to each group.
6. Encourage each group to work together to create a detailed illustration of their new seaweed species. Have them consider:
 - a. **What is the name of your seaweed species?**
 - b. **What does it need to survive?**
 - c. **Where does it live?**
 - d. **How do other organisms interact with your seaweed?**
 - e. **What adaptations does it have that help it to survive?**
 - f. **What product does it make that is useful to humans?**
 - g. **Why would anyone want to buy it?**
7. When they have addressed all of the points above, distribute another piece of newsprint paper and/or poster board to each group.
8. Direct them to create an advertisement, flier, fact sheet, brochure, commercial, or public service announcement to advertise their new seaweed species.
9. Encourage youth to use labels, pictures, bold text, and other visual features to describe their species to people who have never seen it before and to convince them to buy it.

Explain

10. Direct each group to present their new seaweed species to the others.
11. Facilitate a reflection of the presentations:
 - a. **Would you want to buy or use any of these seaweed species?**
 - b. **What would happen if we brought these species to Maine?**
 - c. **Is there such a thing as bringing too many new species to Maine? What might be the consequences of that?**

Elaborate Part 2

12. Introduce the next part of the activity by focusing on how their new seaweed species will be farmed:
 - a. **Let's pretend that you all have been given the opportunity to farm your new species in Maine.**
 - b. **Think about what your particular farm would look like.**
 - c. **How does a seaweed farm differ from a farm on land?**
13. Explain the directions for the next part of the activity:
 - a. **Each group will be given \$50 and a list of available materials to build a seaweed farm.**

- b. **You need to work together as scientists and engineers to design a farm within your budget.**
 - c. **You need to consider the following things:**
 - i. **How does your farm support the needs of your seaweed?**
 - ii. **How does your farm protect your seaweed from predators?**
 - iii. **Where is your farm located?**
 - iv. **How does your farm interact with the surrounding environment?**
 - v. **How will sea farmers access your seaweed?**
 - vi. **How will your seaweed be harvested?**
14. Encourage youth to brainstorm on paper before they purchase any materials.
 15. Logistically, this part of the activity is best organized if the facilitator acts as the “banker” or “store”. All of the materials are kept together in one place, and the youth can come to the facilitator to “purchase” or “return” the items.
 16. Encourage youth to calculate the amount of change they will need from the store after they purchase items.
 17. As the youth finish building their farms, encourage them to prepare a brief presentation to give to the other groups. Be sure all scientific and engineering aspects are discussed.

Evaluate

18. Engage the youth in a discussion of their experience:
 - a. **What were some of the challenges in building a farm for your species?**
 - b. **What were some of the things you had to consider when building your farm?**
 - c. **What jobs would people need to do in order for your farm to operate?**
 - d. **What if your seaweed was really popular and you had to expand your farm, what would you do differently?**
19. **Overfishing has occurred in the waters near a town in Maine named (you or youth invent a fictitious name). Write to the local fisherman’s council with the proposal of locating your offshore seaweed farm there. Convince them of the benefits to their community and to people in general.**

Extension Ideas:

- Ask youth to take this activity one step further and build a mechanism for harvesting the seaweed off their farm.

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Activity 7: Rockweed Harvesting Game

Learning Targets:

- Explore the concept of sustainability using a model of Maine's rocky shore.
- Investigate and explore a way to maintain a sustainable rockweed industry.

Length: 45 - 60 minutes

Essential Questions:

1. What characteristics do scientists use to identify seaweed species?
2. What do we mean by sustainable harvesting of seaweed?
3. What is carrying capacity?

Enduring Understandings:

1. Scientists use appearance, adaptations, and location to identify seaweed species.
2. In sustainable harvesting, seaweed is not completely used up and can reproduce over time.
3. Carrying capacity is the maximum population that can be supported in one area.

Background for Facilitator:

Seaweeds are an important marine resource that humans use for wrapping sushi, for thickening ice cream, and for adding to cosmetics, pharmaceuticals, and animal feed. Seaweed is also important to us because it serves as habitat for other sea life that we depend on. Even though most of the global seaweed production is farmed, there is still a large industry based on wild harvesting. In Maine, there is a large rockweed industry that supplies seaweed for fertilizer and livestock feed by harvesting it from the rocky shore. Since rockweeds are long-lived and provide such great habitat for over 100 other species, it is especially important that we don't harvest this species in greater amounts than it can repopulate. Sustainability refers to our ability to preserve the number of resources. We can use these resources, but we can't use them all up or destroy them. The sustainability of a fishery like this one depends both on the area being harvested, and on how much seaweed is being taken. In this game, youth will have an opportunity to demonstrate their response as consumers of a resource (in this case, rockweed). The rocky shore represents the area of potential harvest, and the rockweed represents the resource the consumers want to use.

Vocabulary List:

Sustainable: able to be used without being completely used up or destroyed.

Fishery: the occupation or industry of taking fish or other animals (such as shellfish or seaweed) from the sea.

Carrying capacity: the maximum population that an area will support without deteriorating.

Key Concepts:

- Wild-caught seaweed (and other marine creatures, such as fish) populations have a carrying capacity. That means there are only so many that can live in one place. It is okay to harvest them if we do not go over that number and allow time for reproduction. If we harvest too many at one time, then we can harvest them to extinction.
- Aquaculture is one way to restore wild populations of organisms. Aquaculture is the rearing of aquatic plants or cultivation of plants for food and other uses.

Materials:

- 5 Pressed Rockweed Samples
- 5 Gulf of Maine Seaweed Guides (Find in Activity 1 bag)
- 4 Rocky Coastlines (1 per group)
- 100 Rockweed images (16 per group, with some leftover)
- 5 Rockweed Data Sheet (1 per group)
- Clock or watch [not included]

Methods:

Engage

1. Divide the group into four cooperative learning groups.
2. Distribute one pressed Rockweed sample and one Gulf of Maine Seaweed Guide to each group.
3. Encourage youth to take another look at the rockweed species (Bladderwrack, *Fucus* sp.), which they may recall from the Maine Seaweed ID activity.
 - a. **Who remembers this seaweed, named “Rockweed” or “Bladder wrack”, from the first activity?**
 - b. **How do you recognize it when you see it? How can you tell it apart from other seaweeds?**
4. Prompt the youth to describe Rockweed on a sheet of paper.
 - a. **Using your observations of the rockweed sample in front of you, and the Seaweed Guide, come up with a way to describe this species to someone who hasn’t seen it before but wants to collect some from the coast of Maine.**
 - b. **What are the characteristics of this seaweed that they should know about?**
 - c. **What other information, besides its looks, would be important for this person to know about?**
 - d. **How will you prevent them from collecting another species by mistake?**
Characteristics to distinguish from knotted wrack/rockweed: flattened blade with branching tips and air bladders.
 - e. **How many Rockweeds do you recommend this person take from the coastline?**
 - f. **Record some notes.**
5. Direct each group to present a way they would describe Rockweed to someone who has never seen it before.

Explore

6. After the presentations, tell them that Rockweed is a very important natural resource to Mainers.
 - a. **Rockweed is a long-lived species that provides important habitat for over 100 other species such as fish, crabs, shellfish, and other sea creatures.**
 - b. **Rockweed is harvested from Maine's rocky shores and used in fertilizers and animal feed.**
7. Engage youth in a discussion of sustainable harvesting:
 - a. **Does anyone remember what rockweeds have that help them attach to a rock?**
Answer: **Holdfasts**
 - b. **What do you think would happen if we took all of the Rockweed from the rocky shore?**
 - c. **What would happen to the sea animals that depend on the Rockweed?**
 - d. **What would happen if we ran out of Rockweed to use for fertilizer and animal feed?**
8. Introduce the idea of carrying capacity.
 - a. **A rock can only support a certain number of seaweeds given the space available for each holdfast.**
 - b. **The maximum number of individual seaweeds that can live in one place is called the carrying capacity.**
 - c. **Today, we will be playing a game all about the carrying capacity of Rockweed!**

Explain

9. Distribute one Rocky Coastline with 16 Rockweed images attached to it and one Rockweed Datasheet to each group.
10. Introduce the game with a discussion of the ground rules, supplying only the information needed to get the participants started. A discussion of problems and strategies will surface as the youth play the game.

Ground Rules

- a. **The object of this game is to harvest as much Rockweed as possible from the coastline over the course of FOUR rounds.**
- b. **Count how many Rockweeds are on your group's rock.**
Give them a few moments to do this. Each group should have 16.
- c. **This is the rock's carrying capacity, or the maximum number of seaweeds that can live on this rock. At carrying capacity, there are 16 Rockweeds on each rock.**
- d. **Write this number down on your Rockweed Data sheet under "Carrying Capacity".**
- e. **Each group represents a team of fisher-people.**
- f. **Your team will have four 20-second trials in which to harvest rockweed. We will tell you when each trial starts and stops.**

- g. For each round, your team can either harvest all of the rockweed, some of the rockweed, or none of the rockweed.
 - h. Every Rockweed that remains on the rock after each trial will reproduce, so a new Rockweed will be added. Each round, the number of Rockweeds on your group's rock will double. However, the total number of Rockweeds on the coastline cannot be more than the rock's carrying capacity of 16.
 - i. Use the Rockweed Datasheet to keep track of how many Rockweeds your team harvests.
 - j. Each fisher-person may only use one hand when harvesting Rockweed! Remember, you are a team. You must work together to harvest as much as possible over the four trials.
11. Play all four rounds of the game one time. *Note: if one team chooses to harvest all of the rockweed during the first round, they will not be able to harvest rockweed for the other three rounds. They must wait until the game is over for a chance to play again.
 12. Distribute extra Rockweeds for the groups who leave some on the rock to reproduce.
 13. Ensure that the youth are filling out the Rockweed Datasheet in its entirety.
 14. After four rounds, facilitate a quick debrief of the game:
 - a. How many Rockweeds did each group harvest?
 - b. Why were Rockweeds only replaced if some remained on the coast?

Elaborate

15. Explain that each team will be given a chance to play again.
16. Encourage each team to improve their strategy.
 - a. Take a few minutes to discuss and improve your harvesting strategy within your groups.
 - b. What will you do differently this time? What will you do the same?
17. Play the game as many times as you have time for, making sure the youth use the Rockweed Datasheet to keep track of their harvest.

Evaluate

18. Engage the youth in a discussion of their experience. Then have them record answers to the questions below.
 - a. What were some ways that you improved your strategy?
 - b. What strategies worked in this game? What didn't work?
 - c. Is it possible to keep harvesting Rockweed forever?
 - d. How can we make sure humans don't over-harvest a species to extinction?
 - e. How do you think aquaculture can help in areas where a species has been overharvested?

Extension Ideas:

- Repeat the demonstration with six participants in each group to simulate population growth. Keep all other factors constant.
- Add other species, such as crabs or fish, to the rocky coastline that will be positively or negatively affected by the rockweed population.

- Add competitors, such as other seaweed species of no commercial value, that may take up space on the rocky coastline and prevent rockweed from reproducing.

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Learning Targets:

- Explore various careers that involve a knowledge or love of seaweed.
- Understand that there are many practical applications of this knowledge in the workforce.
- Summarize the information learned over the course of the Seaweed Aquaculture Toolkit.

Length: 45-60 minutes

Key Concepts:

- There are many interesting ways to stay involved with seaweed and the marine environment.
- A lot of Mainers depend on the health of the marine environment to support their careers. If we protect our natural resources, we protect Maine's people, too.

Essential Questions:

1. What are some careers connected with a knowledge of seaweed?
2. What are some of the important things learned from the activities in this toolkit?

Enduring Understandings:

1. Some careers involved with seaweed include farmer, harvester, chef, business owner, scientific researcher, engineer, nutritionist, and policy maker. There are many career opportunities related to knowledge of the importance of seaweed.
2. Some of the uses of seaweed include: nutritional food source, thickening agent, fertilizer, skin care product. As a benefit to the environment, seaweed removes nitrogen and CO₂ from the atmosphere. saves land space for food production, and aids in avoiding problems created by erosion, fertilizer, and water consumption.

Background for Facilitator:

With all their newfound knowledge about seaweed aquaculture, participants might be wondering how to stay involved with seaweed. There are many ways to turn a love of seaweed into a career! In this activity, youth will explore the various “celebrities” of the seaweed world and gain an understanding of the workforce applications of seaweed knowledge. They will also have an opportunity to review the information they may have learned throughout this toolkit.

Vocabulary List:

Career: a job or profession that someone does for a long time.

Materials:

- 1 set of Seaweed Celebrity cards

- Paper (or whiteboard) for keeping score [not included]

Methods:

Engage

1. Ask youth to brainstorm some jobs that may involve seaweed:
 - a. **Can you think of any jobs that may involve working with seaweed in some way?**
 - b. **What could people do for work that requires knowledge of seaweed?**
 - c. **How does each of those jobs involve seaweed?**
2. Explain to youth that they will be playing a game called “Seaweed Celebrity” where they will be introduced to different careers in the seaweed industry.
3. Split the group into two teams, with approximately the same number of people on both teams. Give youth a few minutes to come up with a team name.
4. Once you have their attention again, direct youth to sit in a circle so that every other person is a member of their team. See “Explore” for examples.



Explore

5. Tell youth that you have a set of cards in the bag that highlight certain people with careers in the seaweed industry. Each card contains clues about the career those people have.
6. Pass the cards around and ask for volunteers to read the cards aloud and show the pictures. Clarify any confusion that the youth may have about each career.
7. Read the game rules aloud and play an example round if necessary:

RULES: This game is similar to charades, where one player from each team will try to get their team to guess the person on their card. However, each round will have a different set of rules, and each person will only have 1 minute to act out as many cards as possible. There are three rounds in total, and each team gets a point for each career that they guess correctly. The team with the most points at the end of all 3 rounds wins the game.

Adaptation: Some groups may benefit from exploring careers prior to Round 1. As a group, or in small groups, talk about the careers and what each career might involve. Have participants work in partners to act out careers together, so they are familiar with the careers prior to guessing.

ROUND ONE: Players can use any words or sounds to describe or give clues about the career, except the name of the career in any form. For example, Player 1 draws a card that says “Mickey Mouse”. They might say to their team, “He is a Disney cartoon character, has big black ears, he has a friend named Minnie,” etc.

- Team 1 picks a player to go first. Player 1 draws a card from the Ziploc bag and has 1 minute to get their team to guess the career on the card. They must give clues according to the round 1 rule.
- Once the team guesses correctly, Player 1 keeps the card by his/her side and picks another one. The player must continue picking cards and describing them until 1 minute is up. When the time is up, the team will keep their cards in a pile to tally later. These cards stay out of the Ziploc bag until the end of round 1. However, if the time is up before the team correctly guesses the card, it goes back in the bag to be guessed again later. No passing is allowed. If

the player accidentally says the name of the career, team 1 forfeits the card, gives it to team 2, and the play goes to team 2.

- Next, team 2 picks a player and follows the same rules as above. They have one minute to get their team to guess as many cards as possible.
- Continue to go back and forth between teams with new players each time until all of the cards in the Ziploc bag have been used up. When there are no more cards left in the Ziploc bag, each team will count the number of cards they guessed correctly and tally it on the board or score sheet. Then the cards are returned to the Ziploc bag.

Explain

8. Engage the students in a discussion of their experience:

- a. **Were you surprised by any of the careers on the cards?**
- b. **Which of these careers do you find the most interesting?**
- c. **If you had to choose one of these jobs to do when you grow up, which one would you choose?**
- d. **Why do you think the people on these cards chose their careers?**
- e. **How does each of these jobs depend on the marine environment?**

Elaborate

ROUND TWO: Players must give clues about the career in **ONE** word only. There is no body gesturing, facial clues, or other sounds allowed. Example: if the card drawn says “Mickey Mouse” again, the player might just say “Disney”.

- All of the cards go back in the Ziploc bag and get shaken up.
- Round 2 begins wherever round 1 left off in terms of the team and the player.
- The key to this round is choosing the one best word to help your team members figure out the career. Once you say a word, you cannot change it. Again, no passing is allowed. If the player accidentally says the name of the career, or uses more than one word, the team forfeits the card, gives it to the other team, and the play goes to the other team.
- Success in this round comes from paying attention in round 1. Remembering what the careers were from round 1, will lead to successful guesses in round 2.
- Players continue to choose names as they get their team to guess until the minute time limit is up.
- Round two ends when all the cards are used up. Each team will count the number of cards they guessed correctly and add it to their tally.

ROUND THREE: No words or sounds are allowed to be spoken at all. Players can only mimic or give gestures to provide clues (like charades). An example for the Mickey Mouse card is the player might gesture big ears on top of their head to represent Mickey Mouse ears.

- All of the cards go back in the Ziploc bag and get shaken up.
- Round three begins wherever round two left off in terms of the team and the player.
- Still, no passing is allowed. If the player accidentally says a word or makes a sound, the team forfeits the card, gives it to the other team, and the play goes to the other team.

- The game ends when all the cards are used up, and each team tallies the total number of cards they guessed correctly.

TIPS:

- If a player is having trouble because they don't know what the career on the card is, they can use the "Career Clues" given on the card to remind them. However, the timer does not stop if they need to do this.
- The key to success is paying attention in round 1.

9. Tell the youth that you will be the official timekeeper and scorekeeper.

10. Play the game until you have completed all three rounds.

Evaluate

11. Prompt each student to quietly think about things they learned that they didn't know before doing all of the Seaweed activities in this science toolkit.

12. Have youth quietly write down the things they learned that they didn't know before. It can be anything related to seaweed. Have them star the ones they found most important and put a question mark before the ones they found most interesting.

13. Engage the students in a discussion of their experience: Make a visual listing of these on the board or newsprint.

a. **Share what you felt was the most important fact learned.**

b. **Share what you found most interesting.**

c. **What was your favorite activity in the Seaweed toolkit?** Have youth record their answer on post it notes so that you can easily make a bar graph.

d. **How will you use your new knowledge of seaweed?**

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