# Exploring Eelgrass Meadows in Channel Islands National Marine Sanctuary

## Lesson Specifications

### Age

8 - 12

### Timeframe

3-5 hours

### Materials

Lesson:

- Computer (and projector with screen if available)
- Internet connection
- Poster paper and markers
- One per group: graph paper, pencils, clipboard
- Sidewalk chalk

Scuba:

- All required scuba gear
- Weighted and waterproof replica of eelgrass meadow
- Three 10m measuring tapes
- One slate with attached recording tool and waterproofed data sheet per group
- Two quadrats per group
- Completed map of the eelgrass bed
- One per group: Small floating buoy and line
- One underwater GoPro camera per group
- Three water collection sample vials per group
- One water testing kit per group
- Real water samples
- All printables for the lesson for each group

### Key Words

Eelgrass meadow, inhabitants, ocean acidification, pH scale, monitoring

### Standards

Ocean Literacy Principles 1, 5, 6, 7
Climate Literacy Principle 7

A kayaker in Channel Islands National Marine Sanctuary. Photo: Tim Hauf

## Activity Summary

This lesson introduces students to NOAA's Channel Islands National Marine Sanctuary. Students will explore an eelgrass meadow, which is an essential fish habitat and an important marine resource within this marine protected area. Students will learn about several tools and techniques used by scientific research divers to measure and document an eelgrass meadow, as well as test water samples from the meadow for pH levels to determine healthy levels for marine life. Students will discuss how eelgrass meadows may help to provide a refuge from ocean acidification and the importance of these marine plants in maintaining and restoring healthy ocean ecosystems.

## Learning Objectives

Upon completion of this lesson, students will be able to:

- Identify the characteristics of an eelgrass meadow habitat and its inhabitants, the creatures that live in the habitat.
- Explain what ocean acidification is, what causes it, and how it affects marine life in this habitat. Identify a healthy pH level for marine life.
- Explain how an eelgrass meadow may provide a refuge from ocean acidification and may help restore the ocean waters to a healthy pH, which supports marine life.

## Essential Questions

1. What is an eelgrass meadow? Where are eelgrass meadows found? Identify and quantify marine creatures and plants that live in an eelgrass meadow habitat.
2. What is ocean acidification? How does ocean acidification affect marine life in an eelgrass meadow? Identify the pH levels that support a thriving and healthy eelgrass ecosystem.
3. How can eelgrass meadows provide a refuge from ocean acidification and restore ocean waters to a healthy pH for marine life?

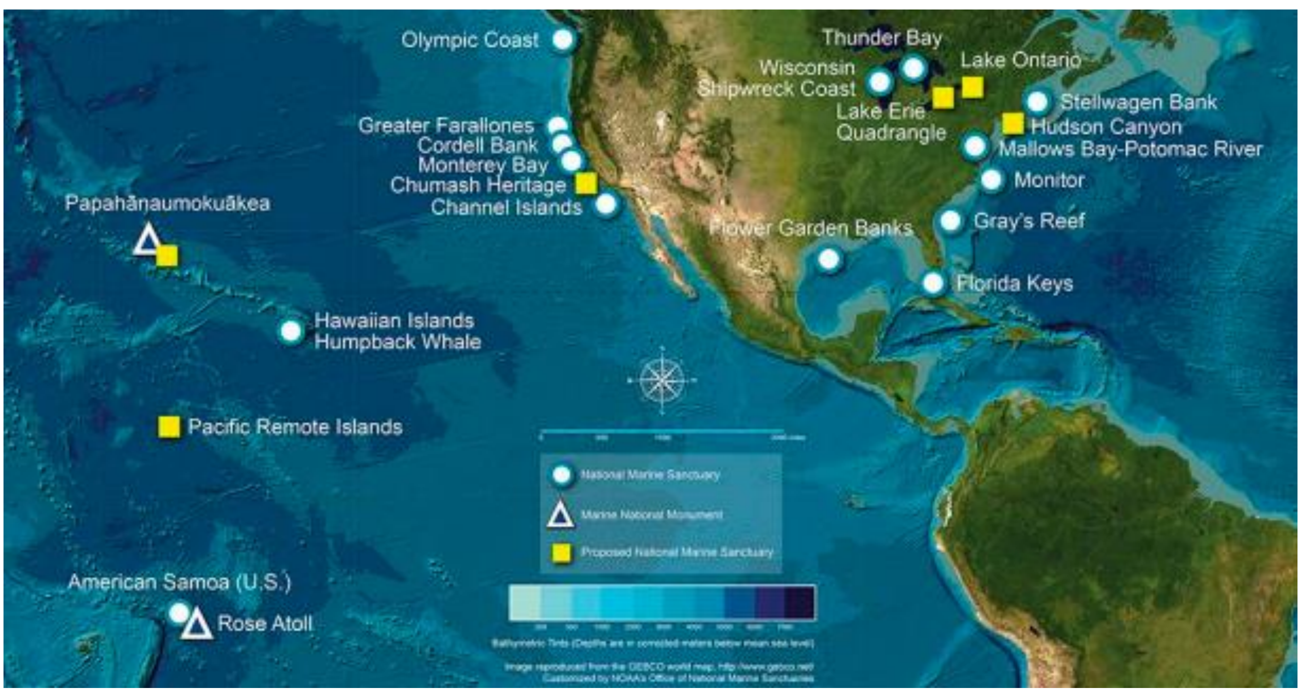
## National Marine Sanctuary Diver Performance Requirements

At the surface, students will:

- Determine if they have the necessary gear to complete the task underwater.
- Streamline gear prior to entry.
- Demonstrate proper descent techniques and awareness of the environment.
- Review hand signals necessary for the dive.

Underwater, students will:

- Dive to identify the boundary of the eelgrass meadow.
- Dive along a transect line to record scientific data.
- Count and measure the size and number of inhabitants of the eelgrass meadow and record the data on slates. Take photos and videos to document the eelgrass meadow.
- Take water samples to test for the pH level after the dive.




A map of the National Marine Sanctuary system in the U.S. and its territories.

## Background Information

Channel Islands National Marine Sanctuary, located off the coast of Santa Barbara and Ventura counties in California, is one of 14 federally designated national marine sanctuaries administered by the National Oceanic and Atmospheric Administration (NOAA), within the Department of Commerce. The sanctuary encompasses 1,110 square nautical miles (1,470 square miles) of water from Santa Barbara, Anacapa, Santa Cruz, Santa Rosa, and San Miguel islands.

The sanctuary is adjacent to metropolitan Los Angeles — one of the largest U.S. population centers — and is therefore impacted by a large range of human activities and pressures. Due to its offshore location, human activities in the Channel Islands face different driving pressures than inshore or mainland activities.

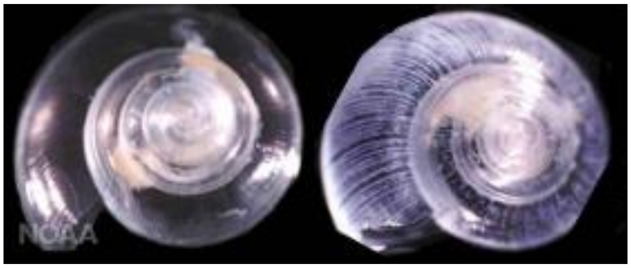
The sanctuary is a special place for species close to extinction, sensitive habitats, shipwrecks, and maritime heritage artifacts. Many valuable commercial and recreational activities, such as fishing, shipping, and tourism, occur in the sanctuary.

The physical and biological oceanographic characteristics of this region are unique because of the sanctuary's remote and isolated position. Two major currents meet at the east-west oriented northern Channel Islands, making it a transition zone where surface temperatures shift from warm in the east, to cool in the west. There is notable seasonal variation of surface temperatures, currents, nutrients, pH, and dissolved oxygen levels. These factors combine to support one of the most productive and biologically diverse marine ecosystems in the world that includes a myriad of sea life from microscopic plankton to blue whales.

There are two different types of seagrass found at the Channel Islands and support the marine life there. The first is surfgrass which grows on rocky substrate in shallow water, and the second is eelgrass which grows only in protected, sandy areas where it is sheltered from wave action. Both types are photosynthetic and are true plants that have evolved to live completely immersed in seawater (but are not seaweeds). Eelgrass is especially sensitive to disturbance as it is shallow-root- ed and is also at risk from anchoring and large storms.

Some of the many species that can be found in eelgrass beds include snails, sea stars, anemones, crabs, and clams. Sand stars, bat stars, and wavy top snails are common in certain spots around the Channel Islands. Kelp bass, senoritas, and many kinds of perch are among the most common fish.

The Channel Islands region is also affected locally by climatic short-time scale events, such as El Niño- related sea surface temperature anomaly and upwelling variability, and decadal-scale variability such as the Pacific Decadal Oscillation. Changes in upwelling driven by climatic alteration can impact zooplankton productivity and food web integrity and have cascading effects on ecosystem health. Other possible threats from climate change include changes in ocean chemistry (for example ocean acidification) and sea level rise. The impacts are expected to be intense and widespread – particularly at the bottom of the food web where trophic processes are tightly coupled to environmental chemistry.




Shell building organisms are harmed by ocean acidification. Photo: NOAA.

So what exactly is ocean acidification? As humans, we release carbon dioxide ($CO_2$) into the atmosphere and have been doing so in large quantities since the Industrial Revolution. Carbon dioxide is released during combustion, when we drive our cars, power our houses and factories, use electricity, burn things, cut down trees, etc. The ocean acts as a sponge and absorbs about 30 percent of the carbon dioxide from the atmosphere. However, as levels of $CO_2$ rise in the atmosphere, so do the levels of $CO_2$ in the ocean. This is not great news for our ocean or the organisms that make their home there. When $CO_2$ mixes with seawater, a chemical reaction occurs that causes the pH of the seawater to lower and become more acidic. This process is called ocean acidification. Even slight changes in pH levels can have large effects on marine organisms, such as fish and plankton. Ocean acidification also reduces the amounts of calcium carbonate minerals that are needed by shell-building organisms to build their shells and skeletons. The damage to these shell-building organisms, including many types of plankton, oysters, coral, and sea urchins, can have a negative ripple effect throughout the entire ocean food web.

| **Vocabulary** | |
|---|---|
| Eelgrass meadow | A bed, or an area, on the soft seafloor that is covered in a type of marine, flowering seagrass found in temperate zones around the world, typically in shallow bays and estuaries. |
| Inhabitant | A living organism that occupies a particular place regularly, routinely, or for a period of time. |
| Ocean acidification | A reduction in the pH of the ocean over an extended period of time, caused primarily by uptake of carbon dioxide ($CO_2$) from the atmosphere. |
| pH scale | A pH scale is a scale to measure how acidic or basic a liquid is. |
| Monitoring | Documenting and measuring something over time. |

## Preparation – *Classroom*

Before the activity, the instructor creates the “on deck eelgrass meadow” by using sidewalk chalk to draw an “eelgrass meadow” with the x and y axis. Use the “Pool Diagram” as an example of how to draw the eel- grass meadow on the deck. Have measurement materials on hand for each group: dive slates, buoy with line, underwater camera with video capability, quadrats, and water collection vials.

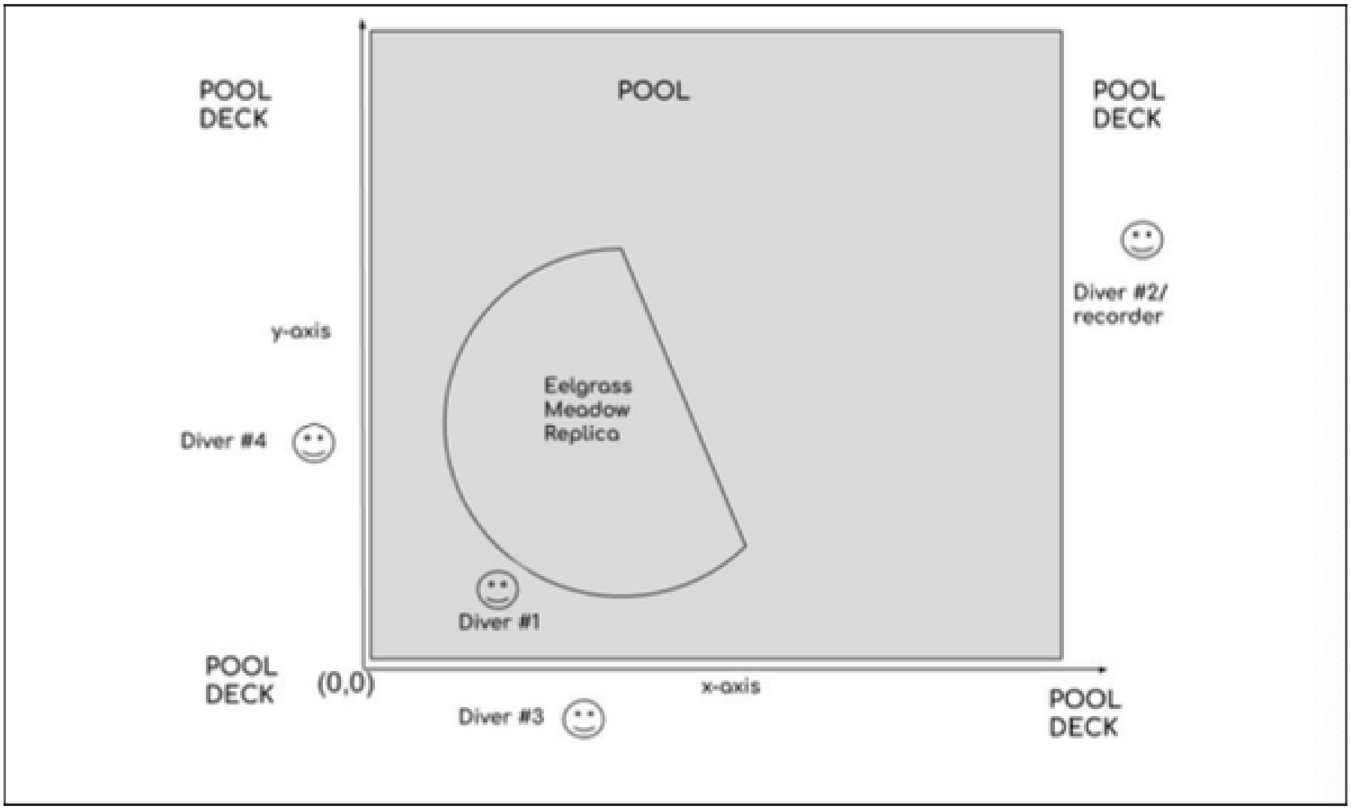
## Procedure – *Classroom*

### *Introduction*

1. The instructor will introduce the Essential Questions and the Student Outcomes to the student group
2. Instructor presents the PowerPoint to the students to introduce Channel Islands National Marine Sanctuary, eelgrass meadows, and the threat of ocean acidification. Instructor asks students what marine life they see during the presentation.
3. Instructor asks the students the essential questions and records answers on poster.
    - What is an eelgrass meadow? Where can it be found? Name marine life that inhabit, or live in, an eelgrass meadow.
    - What is ocean acidification? How does ocean acidification affect marine life in an eelgrass meadow? Identify the pH levels that support a thriving and healthy eelgrass ecosystem.

- How can eelgrass meadows provide a refuge from ocean acidification and restore ocean waters to a healthy pH for marine life?

### *Activity*




Pool set-up diagram.

1. Prior to pool entry, instructor puts the students into groups of four, giving each student a different card to specify Diver #1, Diver #2, Diver #3, and Diver #4 (choose if you want to use the color cards or black and white versions). The instructor explains that they will practice measuring an eelgrass meadow on the deck to prepare for the pool mission. Instructor tells students that they are simulating a water-resistant GPS, which is a tool that scientists and divers use in the field to identify their location accurately.

   The instructor chooses a group to demonstrate. The instructor tells each diver where to stand. Use the pool diagram to arrange students in the right locations.

   Diver #1 with buoy and line stands next to the boundary of the eelgrass meadow "within the pool," Diver #2 stands off to the side away from the axis lines, Diver #3 stands next to the x-axis line, and Diver #4 stands next to the y-axis line. The (0,0) coordinate is at the bottom, left corner of the pool, as shown in the diagram.

An eelgrass meadow. Photo: Robert Schwemmer/ NOAA.

2. Diver #1(with snorkel equipment) does first “swim” (walk around) to gather boundary data while Diver #3 (x-axis) and Diver #4 (y-axis) shout out the position of Diver #1. Diver #2 records the points on the graph. Divers repeat this every 3 to 5 seconds.

   Remind students that the x-axis always comes before the y-axis just like in the alphabet. Diver #3 on x-axis will count every three seconds and shout out Diver #1’s position, for example “3.5” and then Diver #4 on y-axis shouts out Diver #1’s position, “six.” Diver #2, the recorder, plots a point at (3.5,6) on the graph to record that point on the boundary of the eelgrass meadow. Continue until the group understands this procedure for collecting the data for the boundary of eelgrass meadow.

   *Note: Diver #2/recorder could write down the point pairs and plot them on the grid after Diver #1 is done swimming if it’s too fast to plot points on the grid at the same time. Example: (2,.5), (1,3), (1.5,4), etc.

   **Note: Teach students that 1 ½ mm is 1.5m when shouting out Diver #1’s location so it’s easy for Diver #2 to record the point on the graph.


A map of eelgrass meadows in Prisoners Harbor. Photo: Santa Barbara Channel Keeper.

3. The instructor will show students how to take photos and videos using the underwater camera. Instructor explains to the students that documenting with photos and video is an essential skill so that the scientists can use the data collected and compare it to the photos taken to make sure it is an accurate representation of the eelgrass meadow. The instructor will also show the students how to use the quadrat to count the shoot density, how many shoots are in a given area.

4. After the outside boundary of the eelgrass meadow is recorded, Diver #3 and Diver #4 “with scuba equipment” will figure out which length of the meadow is the longest by looking at the map of the eelgrass meadow on the grid. Then they will get “into the pool” to run the transect line and “take water samples” at each end. Next, the divers will both swim the length of the transect line on opposite sides (port/starboard) going the same direction, and as they swim they will count the major invertebrates within 1m bands from the transect line. Divers will adjust their swim speed to stay together at all times.

5. While Diver #3 and Diver #4 are running the transect line and counting invertebrates, Diver #2 “with scuba

equipment" does 2nd swim around the boundary to document with video(s).

6. Then, after Diver #3 and Diver #4 completed running the transect line, Diver #1 "with scuba equipment" takes "a water sample" from the center point of the transect line. (Prior to the dive, Diver #1 will use the "map" of the eelgrass meadow to estimate at which meter mark on the transect line is approximately the center point to take this sample.)

7. Next, Diver #1 and Diver #2 "with scuba equipment" collect shoot density and marine life data using a quadrat at two predesignated locations on the star-board side of the transect line. Diver #2 will "count and record" the shoot density and marine life data on the dive slate while Diver #1 "takes photos" of the quadrats. Diver #1 will then give the camera to Diver #4. Diver #3 and Diver #4 will work on the port side of the transect line at the predesignated locations. Diver #3 will "count and record" the shoot density and marine life data on the dive slate while Diver #4 "takes photos" of the quadrats. Once all data is collected, Diver #4 will "wind up" the transect tape.

8. Students are now ready to complete this activity in the pool.

## Preparation – *Pool Mission*

Students will:

- Practice dive skills while meeting diving performance requirements and sanctuary learning objectives.
- Work in groups of four to complete the learning objectives.
- Practice snorkeling and diving and use a quadrat to record shoots and marine data.
- Take a video and pictures to record the eelgrass meadow.
- Practice taking water samples to test the pH levels of the water samples.

Prior to the mission, the instructor will set up the underwater environment in the pool. This will include setting up the weighted eelgrass meadow replica in the pool with the x-axis and y-axis tapes along the edge of the pool deck to create the grid. The left corner of the pool is the (0,0) coordinate of the grid.

Also, have measurement materials on-hand for each group: dive slates, buoy with line, underwater camera with video capability, quadrats, and water collection vials. Also, have computer/s set up with a pre-designated place for downloading images and videos after the dive activity is complete.

Also, the instructor has set up a space for water testing with the testing kit and the real water samples to use once the dive activity is complete.

*Optional side activity for SSI Mile Ranger requirement: Have all students put on snorkel gear and swim a mile in the pool. This can be done as a fun side activity either before or after the following in-pool activity.

## Procedure

1. Repeat all steps from the prior activity in the pool with scuba/ snorkel equipment.

2. After completing the steps from the previous activity, divers exit the pool and prepare for photo/video download and water sample testing.

3. Diver #1 and #2, download images and videos to computers. Instructor: Have a predesignated file for divers to upload files to. Instructor explains to students that documenting with photos/ videos is an essential part of the exercise so that the data collected can be compared to the photos take to maintain an accurate map of the eelgrass meadow. Instructor also explains that scientists spend hours after a dive cataloging photos and inputting them into databases for other scientists to have for reference.

4. Diver #3 and Diver #4 assist in comparing water sample data. Instructor explains and demonstrates to Diver #3 and Diver #4 how to use the water testing kit to test the pH level (use slide 16 in presentation to reference pH level). Then the Instructor provides real water samples to Diver #3 and Diver #4 to test and record data on the Eelgrass Meadow Water pH Level Data Chart. Next, all four divers look at and compare their results to the simulated water sample data from six months earlier to see if the pH level returned to a healthy level for marine life.

5. To all students, Instructor shows again the power- point slides #7-10 to explain the pH scale, ocean acidification, how it harms marine life, and how the eelgrass meadow can help. As the instructor goes through each slide again, have the students explain each slide to make sure they understand how each part is related.

6. Assess student understanding by asking: How does monitoring and restoring eelgrass meadows help marine life, the ocean, and the climate for humans? What changes can you make in your life to help reverse ocean acidification?


A quadrat can be used to monitor eelgrass beds.
Photo: Jessie Altstatt/ NOAA

| **Education Standards** | |
|---|---|
| Dive Industry Standards | This lesson could be paired with:<br>PADI Snapshot Specialist<br>SSI Buddy Ranger<br>NAUI Junior Scuba Diver or Passport |
| Ocean Literacy Principles | 2: The ocean and life in the ocean shape the features of the Earth.<br>5: The ocean supports a great diversity of life and ecosystems.<br>6: The ocean and humans are inextricably interconnected. |
| Climate Literacy Principles | 7: Climate change will have consequences for the Earth systems and human lives. |

## Additional Resources

**NOAA's Office of National Marine Sanctuaries** This site contains information on each of the sites in the National Marine Sanctuary system. https://sanctuaries.noaa.gov/

**Channel Islands National Marine Sanctuary** This site contains information on visiting Channel Islands National Marine Sanctuary. https://channelislands.noaa.gov/visit/

**Channel Islands National Marine Sanctuary, 2016 Condition Report, Executive Summary** This link contains the 2016 Condition Report for Channel Islands National Marine Sanctuary. https://sanctuaries.noaa.gov/science/condition/cinms/

**The Role of Eelgrass Beds As Fish and Invertebrate Habitat 2009 ~ 2010 Final Report** This link contains the Santa Barbara Channel Keeper Report about eelgrass bed habitats. Possibly show students the data tables at the end of this report so they can get an idea of what the data is used for and how it is cataloged. Pages 25 to 37.
https://www.sbck.org/wp-content/uploads/2013/06/Eelgrass-Report.pdf

**What is ocean acidification**? This NOAA site includes a 1:04 video that explains ocean acidification. https://oceanservice.noaa.gov/facts/acidification.html

**Channel Islands National Park** This link contains the National Park Service article about eelgrass meadows in Channel Islands National Park. https://www.nps.gov/articles/eelgrass.htm

**Climate Change and Ocean Acidification, Channel Islands** This site contains information about why there is a concern about climate change and ocean acidification in Channel Islands National Marine Sanctuary. https://sanctuaries.noaa.gov/science/sentinel-site-program/channel- islands/climate-change-ocean-acidification.html

**Can seagrass help fight ocean acidification?** This site includes an article by Carnegie Institution for Science about how seagrasses can help against ocean acidification. https://phys.org/news/2018-07-seagrass-ocean-acidification.html

**Seagrass Restoration video** This link contains a video about seagrass restoration in the Florida Keys. https://floridakeys.noaa.gov/restoration/methods.html

**Web Story: Channel Islands National Marine Sanctuary faring well despite challenging seascape (July 2019)** This link contains the Web Story about the Channel Islands National Marine Sanctuary. https://sanctuaries.noaa.gov/news/jul19/channel-islands-national-ma- rine-sanctuary-faring-well.html

**Ducksters Education** Website provides kid-friendly explanations on many topics. This link provides information about acids and bases as well as the pH scale.
https://www.ducksters.com/science/acids_and_bases.php

**Secret Gardens Under the Sea: What are Seagrass Meadows and Why are They Important?** This link contains an article about the importance of seagrass meadows.

https://kids.frontiersin.org/article/10.3389/frym 2018.00002 Cullen-Unsworth L, Jones B, Lilley R and Unsworth R (2018) Se- ret Gardens Under the Sea: What are Seagrass Meadows and Why are They Important?. Front. Young Minds. 6:2. doi: 10.3389/ frym.2018.00002

**Channel Islands National Marine Sanctuary Featured Teacher At Sea**
This link includes information about the Teacher At Sea program. The explanation about ocean acidification from "Day 2" was cited in the PowerPoint for this Channel Islands National Marine Sanctuary dive lesson. https://channelislands.noaa.gov/education/teachers/teacheratsea.html

**Underwater Meadows Might Serve As Antacid For Acid Seas** by Christopher Joyce, heard on Morning Edition of NPR on July 15, 2014 5:37am ET. This link contains an article from National Public Radio, NPR, about how seagrass meadows can help against ocean acidification.
https://www.npr.org/2014/07/15/330440072/underwater-meadows- might-serve-as-antacid-for-acid-seas

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## For More Information

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