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Understanding Changes in Seagrass Communities

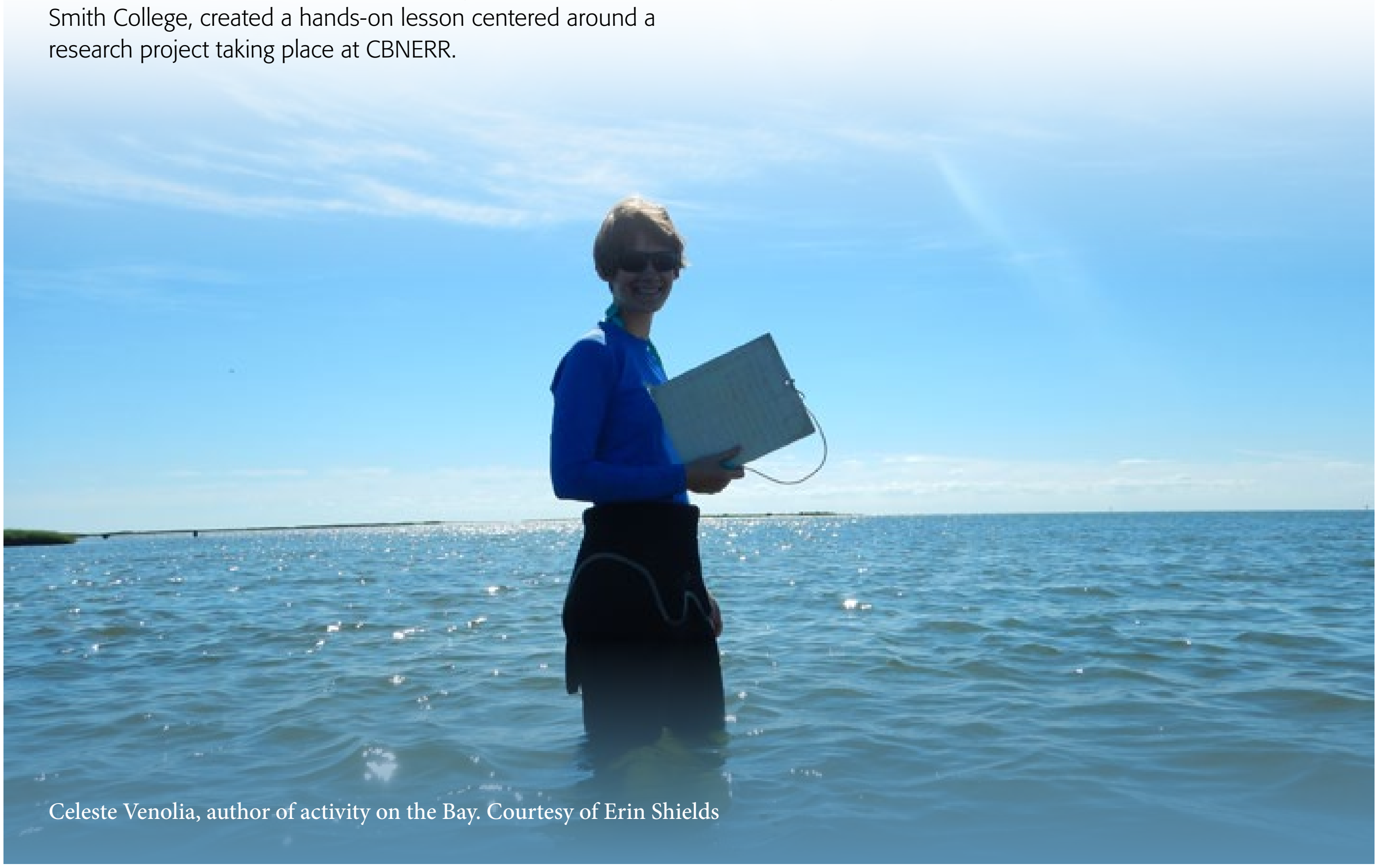
BY SARAH NUSS AND CELESTE VENOLIA

ABSTRACT

Seagrass is an incredibly valuable habitat in the Chesapeake Bay. Students will use mock seagrass patches, modeled after a research transect along Goodwin Island, Virginia, to analyze change in seagrass percent cover during, and following, a major die-off event in 2010. Students also analyze water quality graphs from the same time period to help them determine why the die-off may have occurred.

The Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR), located at the Virginia Institute of Marine Science (VIMS), coordinates many informal science programs for K-12 students, teachers, and the general public. Over the past five years, CBNERR has hosted the National Oceanic and Atmospheric Administration (NOAA) Ernest F. Hollings undergraduate interns to participate in education and research activities. In 2016, Celeste Venolia, Hollings intern from Smith College, created a hands-on lesson centered around a research project taking place at CBNERR.

CBNERR scientists, led by Dr. Kenneth A. Moore, have monitored seagrass communities along fixed transects around Goodwin Island and the VIMS campus from 2004 to the present. The data used in this exercise is from a 700 meter transect branching out from Goodwin Island. Monitoring methods include taking the water depth every 10 meters along the transect line. Every 20 meters, percent cover of seagrass is estimated visually. A quadrat is then thrown three times randomly and with each throw, the scientists estimate percent cover of each species within the quadrat. A plastic circle is also placed around the densest patch of eelgrass, one of the more prominent species of seagrass, and the number of shoots within the circle is counted. This number allows for an estimation of density. The length of the longest eelgrass strand within the quadrat is also recorded. This methodology was simplified for this lesson plan.



Celeste Venolia, author of activity on the Bay. Courtesy of Erin Shields

BACKGROUND

Submerged aquatic vegetation (SAV) refers to angiosperm species that live underwater with a rhizome, a root-like system, buried in the sand. SAV species are often confused with algae, but algae lack advanced characteristics such as veins to carry molecules around the plant. Seagrass refers more specifically to SAV species that are found in marine or higher salinity brackish waters. Despite the word "grass" in seagrass, seagrass is more closely related to gingers and terrestrial lilies than terrestrial grasses (McKenzie and Campbell 2002). SAV species lack the waxy cuticle that keeps land plants from drying out. SAV blades contain specialized cells that retain gases and allow the blades to float up in the water column ("Submerged Aquatic Vegetation"). SAV species can reproduce both sexually and asexually. In asexual reproduction, the rhizome spreads along under the sand and new genetically identical shoots sprout upwards. In sexual reproduction, the SAV plants produce reproductive shoots with flowers (Eriksson 1989).

SAV is limited to water shallow enough to allow for adequate light absorption ("Submerged Aquatic Vegetation"). Epiphytes, such as algae and sponges, grow on the blades of seagrass. Algal epiphytes are normally kept in balance with the actions of grazers and predators, but in high nutrient conditions, they can seriously reduce the amount of seagrass surface area available for light absorption (Duarte et al. 2006).

Seagrass ecosystems are incredibly valuable in estuaries such as the Chesapeake Bay. Some key ecosystem services of seagrass include enhancing regional biodiversity, sequestering and exporting carbon, stabilizing sediment, mitigating the effects of eutrophication, absorbing wave energy, and serving as a nursery or food source for important fauna (Orth et al. 2006). Seagrass meadows are currently declining around the world due to both direct and indirect anthropogenic threats (Short et al. 2011). Examples of threats are high levels of nutrient and sediment run-off, elevated water temperatures, dredging and other detrimental fishing practices, and boat traffic (Orth et al. 2006). These valuable ecosystems are especially susceptible to reduced water clarity because of their high light requirements (Dennison et al. 1993). Understanding patterns of seagrass community change could help in analyzing the overall health of the saline portions of the Chesapeake Bay.

The two species of seagrass found in the brackish waters of the far downstream York River, a major tributary of the Chesapeake Bay in Virginia, are eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) (Moore et al. 2014). The Chesapeake Bay is the southernmost limit of eelgrass distribution, as the species thrives in cool water and cannot survive temperatures above 25°C for extended periods of time ("Submerged Aquatic Vegetation").

ACTIVITY

Students will work in groups to visually estimate percent cover of two seagrass species on mock seagrass patches, and then compile their data as a class. Students will use water quality data to interpret trends and their potential significance for the survival of seagrass. Finally, groups of students will present their hypotheses on the decline and transition of seagrass species in 2010-2011. This activity fits well with the National Science Content Standards for Life Science students in grades 6-12. The activity also addresses the concept that the ocean supports a great diversity of life and ecosystems, one of the literacy principles outlined by the Ocean Literacy Framework. The activity highlights three Climate Literacy principles: life on Earth depends on, is shaped by, and affects climate; human activities are impacting the climate system; and climate change will have consequences for the Earth system and human lives.

OBJECTIVES

- Describe basic seagrass biology, values of seagrass, and threats to seagrass
- Determine the interactions between water quality and seagrass
- Simulate an estuarine research method
- Evaluate community change with actual trends in seagrass cover from the Chesapeake Bay

MATERIALS

- 16 coated wire or plastic mesh squares (example shown in this article uses coated wire mesh with 1 inch by 1 inch squares, but this exact type of mesh is not necessary)
- Green ribbon (to represent *Zostera marina*)
- Green yarn (to represent *Ruppia maritima*)
- Clear tape
- Masking tape
- Marker

SEAGRASS SQUARES PREPARATION

1. Cut wire or plastic mesh into 16 squares of about a foot by a foot in size. Exact size is not important as long as you adjust the amount of ribbon and yarn you are using to create the correct percent covers. If using wire mesh, you may want to use rubber cement to cover up any sharp bits created in the cutting process.

2. Use the data in the table below when setting up the seagrass on the 16 mesh squares. For each month and year combination, there will be four squares, representing samples taken at 4 different distances from shore.
    - Use tape and a marker to create a label, which includes the month, year, and distance from the shore of the seagrass patches.
    - Tie ribbon (*Z. marina*) and yarn (*R. maritima*) of varying lengths to the mesh to reach the percent covers of *Z. marina* and *R. maritima* listed in the table below. Clear tape was used around the bases of the tied ribbons and yarn. The knot should be placed in the middle of the ribbon or yarn so that it more accurately mimics multiple blades coming out of the same shoot. The same species should generally be found close together on the mesh, as multiple shoots will branch out of the same rhizome.

An example of a finished product can be seen below (Figure 1).

PROCEDURE

1. Lay down mock seagrass patches in a grid according to the respective dates and distances from shore (Figure 2). Each table should also have a data sheet (see Example Student Worksheet on page 29).
2. Compile the data the students collect into a comprehensive table, in a space viewable by everyone that allows for easy comparison of the percent cover of the two species at different points in time and distances from shore.
3. Divide students into four groups. Explain to students that the four different transects are all the same fixed transect, but at four different time periods. Clarify that the distances from shore are provided since the seagrass patches cannot be laid out to scale due to space constraints.
4. Give students tips on how to most effectively visually estimate percent cover:
    - Percent cover is usually less than you think.
    - Suggest dividing the larger area into smaller areas, so that it is easier to focus (with the 1 inch by 1 inch wire

FIGURE 1. Example of a seagrass square used in this lesson. Courtesy of Celeste Venolia

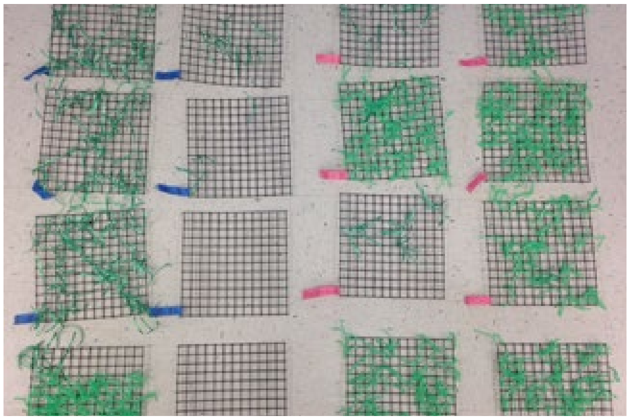


FIGURE 2. Transect set up example used in this lesson. Courtesy of Celeste Venolia

TABLE 1.

Month / Year	Percent Cover at 20m from shore	Percent Cover at 100m from shore	Percent Cover at 180m from shore	Percent Cover at 260m from shore
June 2010	*Z. marina*: 5 *R. maritima:* 75	*Z. marina*: 50 *R. maritima*: 0	*Z. marina*: 50 *R. maritima*: 0	*Z. marina*: 40 *R. maritima*: 0
August 2010	*Z. marina*: 0 *R. maritima*: 0	*Z. marina*: 0 *R. maritima*: 0	*Z. marina*: 2 *R. maritima*: 0	*Z. marina*: 5 *R. maritima*: 0
June 2011	*Z. marina*: 0 *R. maritima*: 70	*Z. marina*: 10 *R. maritima*: 0	*Z. marina*: 2 *R. maritima*: 70	*Z. marina*: 15 *R. maritima*: 0
August 2011	*Z. marina*: 0 *R. maritima*: 75	*Z. marina*: 2 *R. maritima*: 40	*Z. marina*: 0 *R. maritima*: 80	*Z. marina*: 2 *R. maritima*: 35

mesh, look at squares that are 2 inches by 2 inches).
- Explain to students how they can use these divisions to set up a fraction of sections with seagrass over the total number of sections to get a percent cover.

Provide students with examples, on an overhead, of grids with a percentage of the squares filled in with a color. Students should try a few examples to estimate percent cover as a group before working with the seagrass squares.

5. As the students work through the steps, check-in with each group to make sure the percent coverage data they are collecting is reasonable. For example, 100 meters from shore in August of 2011, they should find about 2% eelgrass cover and 40% widgeon grass cover.

6. Have students add their group's data to the larger table. Discuss the trends in the percent cover data they have just collected:
   - The June 2010 data reflects a standard zonation pattern when *Z. marina* is present in high densities. *R. maritima* dominates close to shore and *Z. marina* dominates farther away from shore.
   - There is a major loss of seagrass from June to August of 2010.
   - *Z. marina* remains in the region in 2011, but at greatly reduced percent cover.
   - In 2011, *R. maritima* colonizes the space previously occupied by *Z. marina* in June 2010 and recolonizes inshore space that it had disappeared in August of 2011.

7. Have the students split into pairs and give each pair the temperature and turbidity data. Ask the students to look for trends in the water quality data, which could explain the major loss of *Z. marina* in 2010. Explain to the students that they have been given 2009 in addition to 2010 and 2011, so that 2009 can serve as further evidence of what normal conditions might be. Remind them that finding no trend is still an important result in the scientific process.

8. Come together as a group and discuss the trends found and their potential to explain the patterns of change in the seagrass:
   - There are no major trends in turbidity that should have an influence on a long enough time scale to make a difference in the big picture trends.
   - The primary trend students should notice in the temperature data are that there were hotter temperatures in June of 2010 than in June of 2009 or 2011.
   - In general, the influences of high temperatures and high turbidity can have a compound negative effect (Moore et al. 2012), but for the purposes of this time period, temperature is the more important variable.

9. Below are some potential discussion questions:
   - Why was widgeon grass able to colonize the substrate after the eelgrass had died-off?
   - In the typical zonation pattern present in the Chesapeake Bay, widgeon grass dominates the near shore waters. If widgeon grass was artificially excluded, do you think eelgrass could grow there?
   - Within its Chesapeake Bay range, do you think eelgrass has been disappearing equally from all regions, or more in its upriver or downriver sections?
   - Do you think, based on the physical shape of the two seagrass species, that one might be more valuable as a habitat?

EXTENSION

Rising temperatures are a result of anthropogenic climate change. Since the Chesapeake Bay is currently the southernmost point of eelgrass distribution along the East Coast of the U.S, it could potentially be lost from the Bay as temperatures continue to rise. Activities dealing with global climate change and increases in ocean temperatures would be a good follow up to this activity. Please visit http://www.vims.edu/cbnerr/_docs/education_docs/SAVLessonPlan.pdf for the full activity.

Students participating in the activity. Courtesy of Kristen Sharpe

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Close up image of SAV. Courtesy of Erin Shields

EXAMPLE STUDENT WORKSHEET

GROUP 1: 20 METERS FROM SHORE

Group Members: ____

You are a team of marine scientists surveying seagrass along a fixed transect off of Goodwin Island in the York River, VA. Repeat steps 1-3 at all four locations in space and time that are found in your data table below.

1.) Visually estimate the percent cover of the *Zostera marina* (ribbon).

2.) Visually estimate the percent cover of the *Ruppia maritima* (yarn).

3.) Combine these numbers to get overall percent cover of seagrass.

4.) Once you have completed steps 1-3 at all four sites, add the data you have just collected to the larger table on the board.

	Z. marina **percent cover**	***R. maritima*** **percent cover**	**Overall seagrass percent cover**
June 2010 (20m from shore)			
August 2010 (20m from shore)			
June 2011 (20m from shore)			
August 2011 (20m from shore)			

EXAMPLE WATER QUALITY DATA

2011 Data