What's that smell!?

The case of the sinking salt marsh - What can we do to help restore our submerging marshes?

Salt Marsh Restoration Activity Lesson Plan & Teacher Background

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Activity Information

Grade Level: 7-12	*Topics Addressed:* • Threats and pressures of ecosystems • Habitat restoration • Biotic/abiotic interactions
Time Required: 2-3 class periods	
Learning Objectives • Recognize that as an estuarine habitat, salt marshes are dynamic and play an important role in biological, chemical, physical and geological cycles, such as food webs, hydrologic cycles and nutrient cycles. • Explore plant and animal adaptations that enable success in this changing environment and brainstorm ideas to help protect salt marshes and their inhabitants from the impacts of climate change and sea level rise	

Overview

While sea level rises and humans continue developing coastal regions such as those around our estuaries, salt marshes have no way to recede and remain capable of providing the ecosystem services for which they are known. Students will be introduced to techniques being implemented by coastal managers to restore sinking and shrinking marshes and will evaluate what goes into the decision making process.

Teacher Background/Links:

- Beneficial Use of Dredged Material for Salt Marsh Restoration and Creation in Connecticut
- Videos of dredging of Shinnecock Channel (Long Island, NY):
- Replenishing The Bowl
- Dredging at Shinnecock Inlet 11/23/19
- Dredging at Shinnecock Inlet 2/19/20
- Huge Dredge Inside Shinnecock Inlet Shinnecock Inlet Dredge - Drone Footage - 02.17.2020

Procedure for Activity

Phenomena

Before handing out any materials for the activity or discussing the activity, show the photo below and play this video.

Discuss as a class what students think is happening and why. Students may not know the answer, but they will get a more detailed description in the activity that follows.

Part 1.
Set students up in groups of 3 - 4.

Create enough copies of the **Salt Marsh Restoration Activity Student Read & Reflect** pages for each group to use.

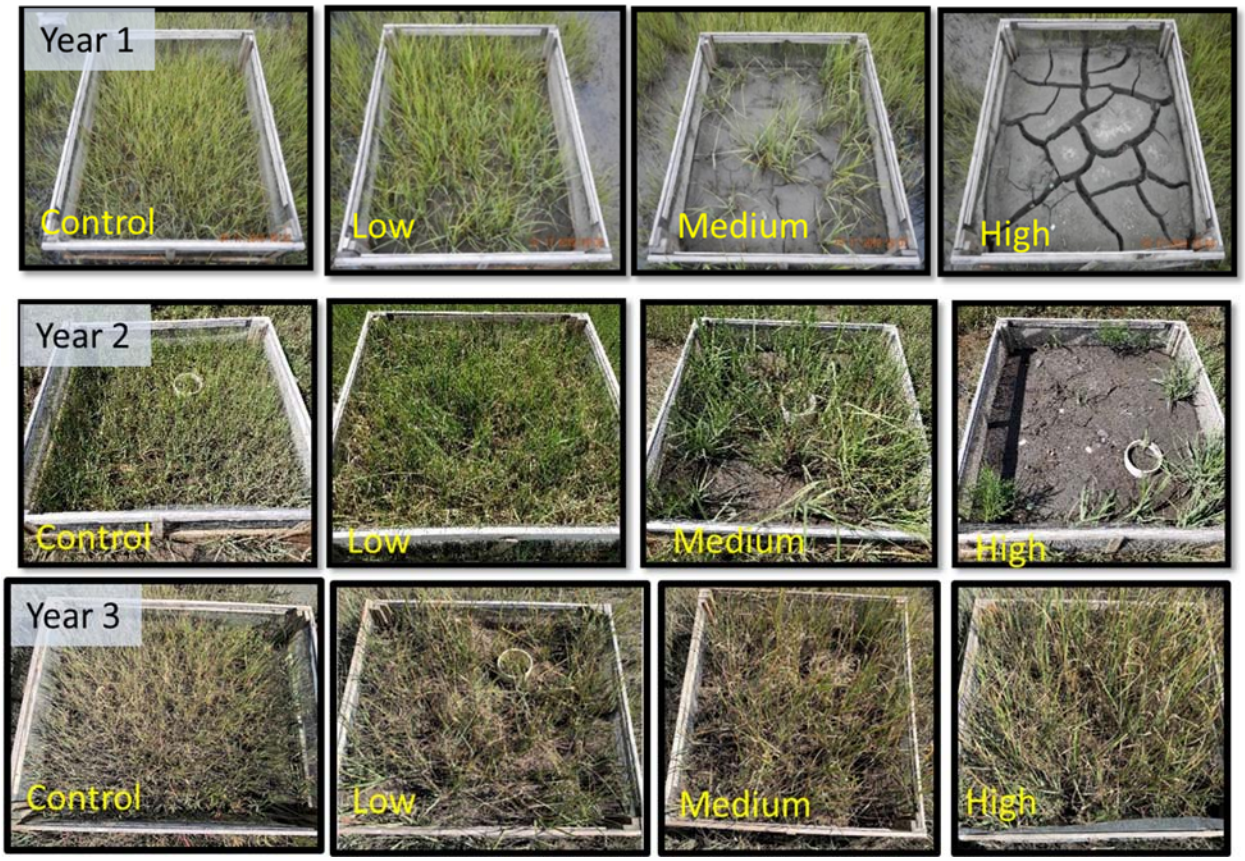
Ask students to read the story on the Student pages (they may wish to view the photo and/or watch the video again at this point) with their group and then answer the questions posed.

After students have a chance to complete Part 1, discuss student answers and then check in to see if there are any misunderstandings about what the dredging process is used for and how it is done.

Part 2.
Students should continue their reading and reflections on the Student pages for the question about what to take into account when considering the use of dredged materials. Some possible answers students may come up with include, but are not limited to…

- Current marsh inhabitants (salt marsh sparrow, plants, mussels, etc)
- Elevation of marsh
- Water flow/currents
- Frequency of inundation (tidal range); variable throughout LIS (~2m on west side of LIS, 0.3m on east side)
- Type of sediment added
    - Texture of added sediment- sand, silt, loam, cobble
    - Chemistry of added sediment- sulfides, heavy metals/contaminants
- Composition of existing marsh sediment (organic vs mineral; plant roots vs silt; adding heavy sediment can actually sink a marsh with organic substrate)
- Time frame- when do managers want plants to establish
    - Public expectations, deeper sediment takes longer for plants to establish and may be susceptible to erosion before plants establish, but may be more beneficial in long-run

Part 3.
Provide students with the photos shown out of order on a separate page and ask the students to help the Madeline place them in the proper order, which should look like this:



Mixed up photo strip ID	***Year after sediment added (1, 2, or 3?)***	***Provide evidence using the photos above (in other words, justify your reason)***
A	*3*	*Answers may include: "Plants take time to grow through the added sediment and plants are most abundant in the high treatment in A"*
B	*1*	*Answers may include: "Plants seem least dense in this year and no plants growing in the high treatment, so its probably the first year"*
C	*2*	*Answers may include: "Plant density is intermediate in this strip compared to the other two, so likely the second year."*

Students have been asked to reflect upon what surprises them about the photos. Discuss their answers. Some may think that more is better and that Year 5 is what it looks like during years 2 - 3.

<u>Part 4.</u>

Students are provided with another piece of the story and asked to complete the next section with their group. Here are some possible answers to the questions posed by Madeline (in blue):

1) Does adding sediment increase aboveground biomass relative to the controls?

Initially no, but over time it seems like the sediment addition treatments increase aboveground biomass, but they vary among treatments, especially in Year 2.

2) Which treatment seems to promote biomass most in Year 2?
The low treatment has the highest biomass in Year 2.

3) What about in Year 4?
The three sediment treatments have similar aboveground biomass estimates in Year 4, because the error bars are all overlapping.

4) What do you think will happen in Years 5 and 6?
It seems like the High treatment is on an increasing trajectory, but the Low treatment is stabilized, so it is likely that the High treatment will surpass the Medium and Low treatments in Y5 and Y6. This makes sense because this treatment added the most sediment and increased elevation the most, so that it is inundated less frequently and making it easier for plants to grow.

5) Extend the lines for the four treatments into Years 5 and 6 on the figure (disregard error bars).
Example lines included in the figure below…

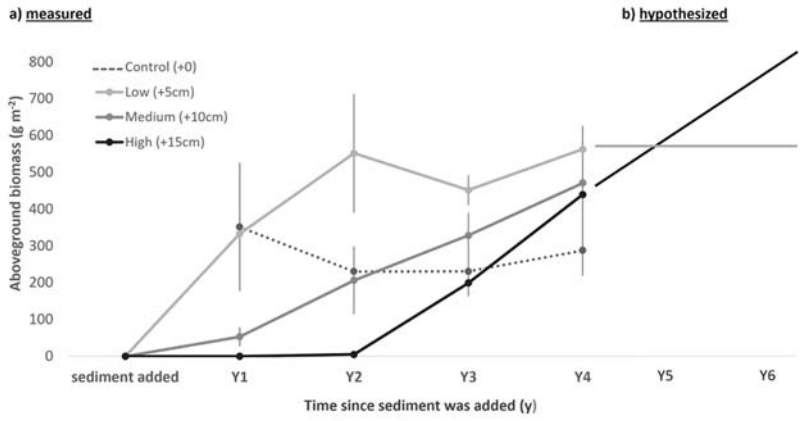


Figure 1. a) UConn scientists measured how different sediment depths (Control, Low, Medium, High) added to a submerging marsh in Guilford, Connecticut affected aboveground plant biomass over four years. Their experiment had six replicates per treatment. The points represent the average aboveground biomass and the vertical lines represent the variability among the six replicates (standard error). b) What do you think will happen in the future?? Draw your hypothesized data points for Y5 and Y6 (disregard error bars).

~Teacher Note: this is a good stopping point and place to start up next class period~

Part 5.

Ask students if they remember what Kate asked Madeline at the end of the last section (about adding sediment with “stinky sulfides” to a drowning marsh) and what they think the answer will be. Why?

Show students the video from Madeline explaining how her research is looking into testing different amendments to reduce acidity for marsh restoration.

~Teacher Note: after students respond, discuss what questions groups have for the scientist. If the students have a list of questions, teacher may wish to forward them to the scientists conducting this research~

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Part 6.

Review the experiment students may do with you in the classroom and ensure that there are safety goggles for any students who may be working with vinegar.

Here is a sample data table for this experiment, but you may wish to have students create their own.

Discuss student conclusions and why their data did or did not support their hypothesis.

Date	***Vinegar***	***Vinegar + Crushed shells***	***Vinegar + whole shells***	***Notes***

Part 7.

Students are tasked with playing the role of salt marsh managers who will use knowledge gleaned from the activities they've completed, background they've learned and their own critical thinking skills to come to consensus about the treatment of salt marshes in photos.