Beach Profiling Science Protocol

Grade: Grade 5/6
Place of Focus: Boston Harbor

Massachusetts Curriculum Framework for Science and Technology/Engineering Standards

- **4-ESS2-1.** Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion.
- **3-ESS3-1.** Evaluate the merit of a design solution that reduces the damage caused by weather.

Lesson Overview

In this experience at Constitution Beach in East Boston, students will recall the concepts of Lesson 2 and engage in a scientific protocol to apply the concept of measuring slope in the real world.

Students will then explore how environmental changes caused by climate change may accelerate the natural evolution of a coastline. Students will discuss why measuring change over time is important, and how changes may impact Constitution Beach in the future.

Essential Question

How do we know something is changing?

Guiding Question

- How do we measure the slope or profile of a real beach?
- Why might it be important to measure a beach profile?
- What factors are causing change at Constitution Beach over time?
- Based on our observations, how might Constitution Beach change in the future?
- *Extended:* How might the effects of climate change be impacting Constitution Beach?

Learning Objectives

By the end of the lesson, participants will be able to:

- Take measurements along a beach and graph the data to show slope
- Engage in conversation about the importance of data collection to document baseline conditions and change
- Explain how research and documentation is necessary to observe long-term trends in change
- List the possible causes for a changing profile at Constitution Beach
- Brainstorm how Constitution Beach might change in the future, incorporating discussions of climate change effects as appropriate

Lesson Preparations

Time

2 hours, on-site at Constitution Beach in East Boston

Materials and Supplies

Numbered for two classes of ~15 students each

- 2 x 3.5' whiteboards (x2)
- Assorted whiteboard markers (x2 sets)
- Buddy Bison or Bean Bag (x1)
- Beach profiling equipment (x13 sets) *see instructions below
- Data collection sheets
- Profiling worksheet
- Measuring tape

Lesson Outline

Lesson Motivation / "The Hook"

This is the third of four lessons centered around coastal erosion. The goal of this lesson is to apply what the students have learned over the past two lessons in real-world, local context. Students will learn why it is important to measure change, and learn an authentic protocol to measure slope on Constitution Beach.

Introduction

Group Norms and Safety Rules

1. Stay out of the water – we won't be swimming or going in the water, but there will be plenty to do up on the beach
2. Sight and Sound – explain that we are remaining near the area we are currently standing unless you are accompanied by an adult to the restroom. If you can't "see or hear" an adult, you are too far.
3. Call and Response – review the class' call and response or attention signal if they have one, and establish one if they don't
4. Track the Speaker or PROPS (People Respecting Other People Speaking) – respect others when they are speaking so everyone can participate and learn

5. If students seem particularly interested in rock skipping or throwing, explain that we cannot throw/skip rocks, however, if there is good behavior and expectations are met, a rock skipping session will be allowed before leaving the beach.
6. Taking care of equipment - ensure students treat the beach profiling equipment carefully, emphasizing it is scientific equipment. Remind students to be mindful of others around them when carrying the equipment.

Also to note: If you have time, or can plan for extra time, we have observed that students often value time for some free exploration of the beach environment. Of course, you know your students best and how to foster healthy and safe boundaries with them.

Activity Introduction: Beach Profiling

How do we know something is changing? (5 minutes)

- Explain that change to a beach, for a variety of reasons, will also impact how we can use the beach.
- Tell students that today we will talk about why it is important to measure change, brainstorm some solutions to beach damage and erosion, and contribute to research that tracks change on Constitution Beach as scientists

Importance of measuring change (10 minutes)

- Recall Lesson 2: What did we do last time? How did we do it? Refresh memories by having wave tank with sand, water, and line-drawn profile present
- Discuss with a partner
  - Why might it be important to measure how waves change a beach's shape or profile?

Lesson Activity: Beach Profiling and Data Collection

How do we measure slope or profile on a real beach? (40 minutes)

- Slope demonstration (5 minutes)
  - Ask for two volunteers to help define slope through a physical demonstration
  - Have students stand about 5-10 feet apart, one student standing up tall and the other student either kneeling or crouching fully
  - Explain that if the two students' heads represented ground level at two different points, and you connected those two points with the tape measure (as you're explaining, have one student hold the tape measure at the top of their head, stringing the tape to the other student to hold on the top of their head), the ground would be sloped.
  - Explain that the distance between these two elevations is what determines the **slope.**
  - Measure the current distance between the two students and have the rest of the class physically observe how steep the **slope** of the measuring tape is.
  - Then have the students move twice the distance apart, and ask the class to observe how the **slope** has changed. Students will be able to physically observe that the slope is now more gradual.
  - You can experiment with variations of student height and distance apart to observe the effect on slope.
  - Make the connection between visually assessing the slope between the two volunteer students as observing a **profile.**
  - Explain to students that through a scientific protocol to measure the elevation of the beach at fixed intervals, they will now be able to **profile**, or measure the **slope**, of the beach

- Explain profiling protocol (10 minutes)
  - *See beach profiling instructions and video tutorial attached below*

- Measure and record beach profiles (25 minutes)

Lesson Activity: Beach Profiling and Data Collection

Conclusion and Reflection

Clean Up

- Have each beach profiling team collect rods and strings and place them in a designated spot

Reflection

- Ask students to reflect on our essential question: *"How do we know something is changing?"*
  - We can learn about how something is changing by observing the conditions of the environment around us, both through real-world observation and data collection, and through modeling of these conditions
- Ask students: "Can we see change from a single day of observations? How could we track change over time?"
- Knowing what we have seen in our model of water affecting beach via erosion, ask students, "What predictions could we make about the slope of Constitution Beach over time?"
- This lesson was focused on one specific beach in Boston Harbor. For our final lesson, we will be observing how waves and water are impacting many places and islands around Boston Harbor on a harbor cruise.

Optional Post-Visit Activity

After discussing the observations documented at the conclusion of the Field Visit to Constitution Beach, you can have students plot the elevation either beginning at sea-level (0ft, their last data point) ***or*** *beginning at their first data point (starting location). Through plotting the data points, you can better visualize, or model, the slope of the beach and discuss with students. This is also a good opportunity to compare the starting elevation obtained via a GPS or the iPhone Compass app with the recorded elevation obtained via the measurement protocol. If there is a discrepancy, hypothesize and discuss why that might be the case.*

Beach Profiling Instructions

This protocol uses the Emery Method for beach profiling

Have students decide roles: recorder, person holding unmarked rod, person holding and reading measuring rod.

Step 1: Pick a starting point at the top of the beach, making sure that you can see the horizon.

Step 2: Record air temperature and tide data on your datasheet.

Step 3: Record the elevation of the beach at your starting point (e.g. Compass app on iPhone).

Step 4: Begin your profile. Set the measurement rod right at the start of your **transect** (invisible line you will be measuring down the beach), with the numbers facing the reader and away from the water. This rod is 6 feet tall and has measurement markings in decimal feet.

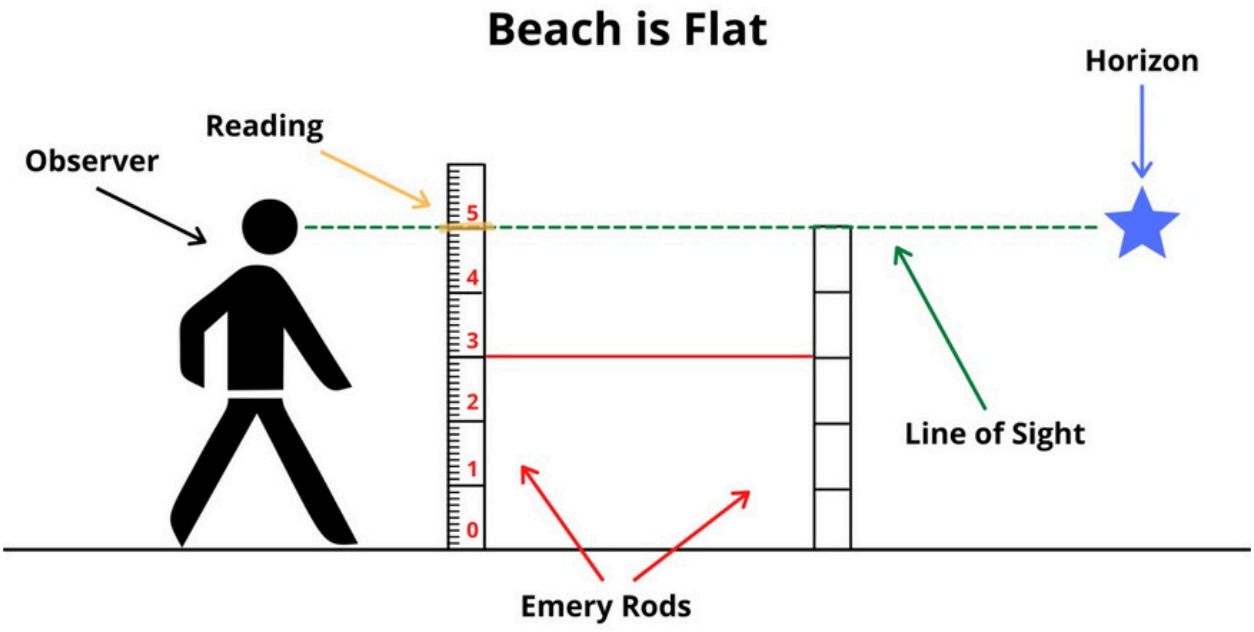
Step 5: Set the unmarked rod down 6 feet (2 meters) away from the measurement rod along the straight rope line towards the water. Typically, the unmarked rod is 5 feet tall and has no numbers. However, you can use a shorter unmarked rod (e.g. 4 feet) if it better accommodates student height. The rope connecting the two rods should be taut and as level as possible.

Step 6: Record the distance of the unmarked rod from the measurement rod on the data sheet in feet (should always be 6 feet).

Step 7: Take care that both rods are as straight as possible. From behind the measurement rod, look towards the water. You will be using the 5-foot line on the measurement rod to compare to the height of the unmarked rod, which is 5 feet tall. If using a 4-foot unmarked rod, use the 4-foot line on the measurement rod. Find the line of sight where the top of the unmarked rod is level with the horizon. See where that lines up on the measurement rod. You will see one of three scenarios: no elevation change, a negative elevation change, or a positive elevation change.

Scenario 1: No Elevation Change

If the top of the unmarked rod and the horizon aligns at 5 feet on the measurement rod, the beach is flat and there has been no elevation change. Mark down 0 decimal feet on your data sheet.



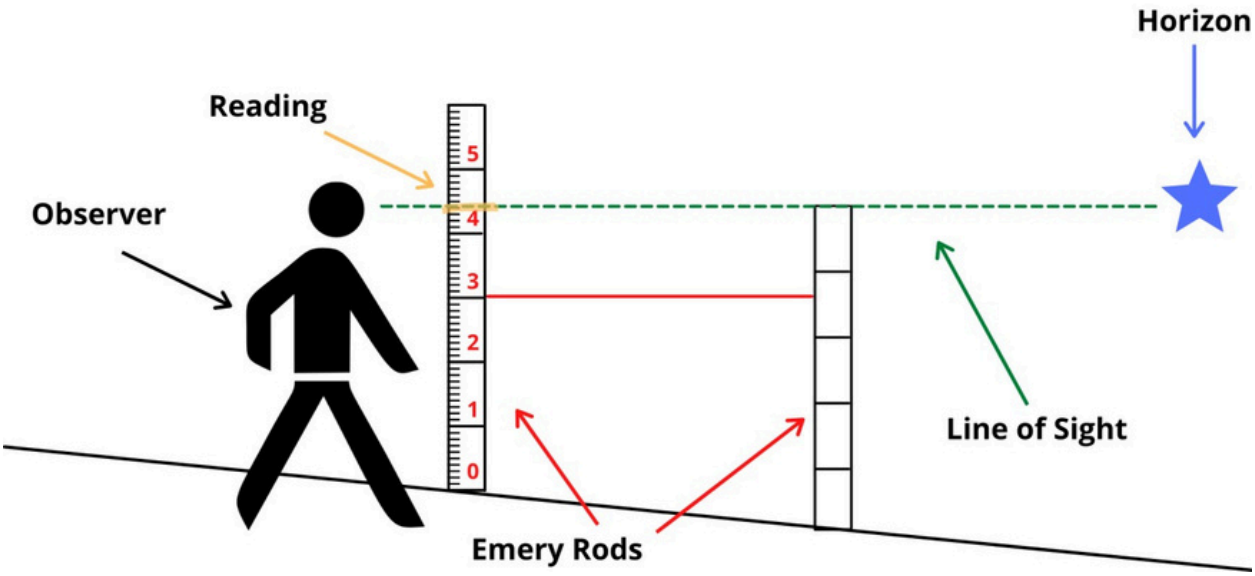
Scenario 2: Negative Elevation Change

If the reading is below 5 feet on the measurement rod, the beach is sloping down and there has been a negative change in elevation. Subtract the reading on the measurement rod from 5 feet and mark down the change as a negative number. For example, if the horizon and 5 foot mark on the unmarked rod both align at 4.4 decimal feet on the measurement rod, there has been a – 0.6 ft change in elevation.

Reading on measurement rod – Height of unmarked rod = Change in elevation

4.4 feet – 5 feet = - 0.6 feet

Beach Slopes Down



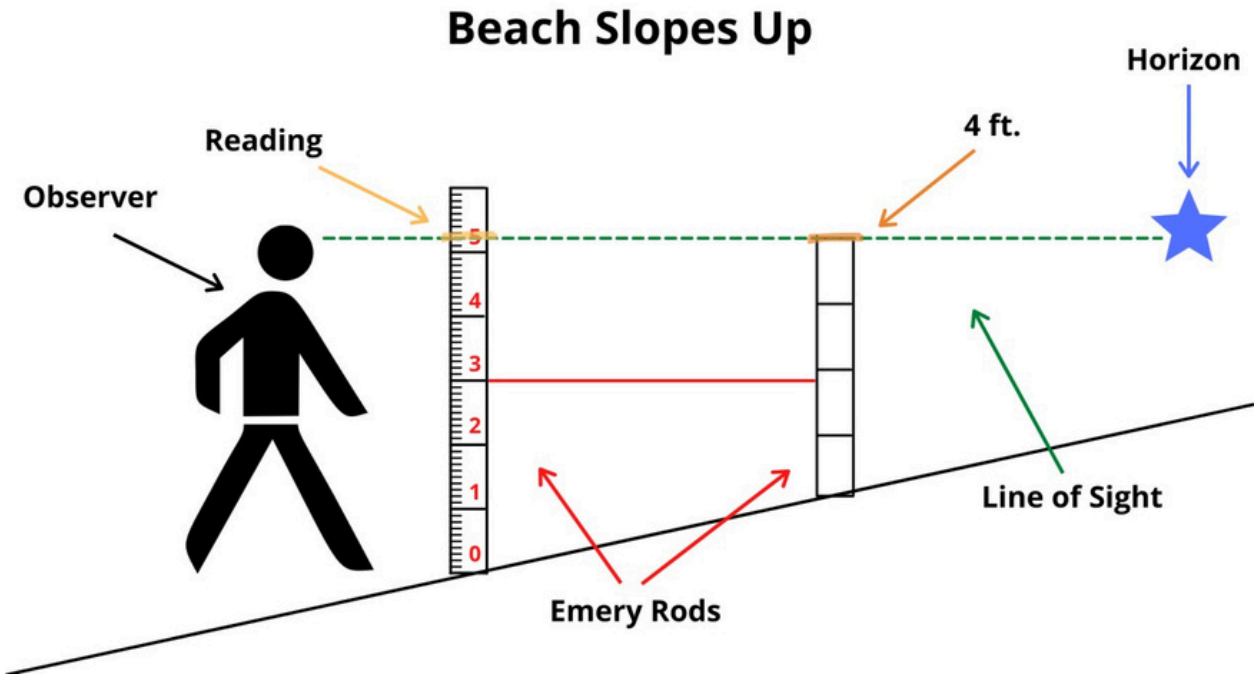
Scenario 3: Positive Elevation Change

If the reading is above 5 feet on the measurement rod, the beach is sloping up and there has been a positive change in elevation. If the reading is between 5 and 6 feet, there is no need to adjust the height of the unmarked rod. For example, if the horizon and **5 foot mark** on the unmarked rod both align at 5.5 decimal feet on the measurement rod, there has been a + 0.5 ft change in elevation.

Reading on measurement rod – Height of unmarked rod = Change in elevation
5.5 feet – 5 feet = 0.5 feet

The reading from the measurement rod now represents a positive change in elevation. If the horizon and **4-foot mark** on the unmarked rod both align at 5.3 decimal feet on the measurement rod, there has been a + 1.3 ft change in elevation.

Reading on measurement rod – Height of unmarked rod = Change in elevation
5.3 feet – 4 feet = 1.3 feet



Step 8: Record the elevation change in decimal feet on the datasheet.

Step 9: Move the measurement rod into the “footprint” of the unmarked rod and set the unmarked rod down 6 feet closer to the water. Follow the line of the rope that you set down at the beginning of your transect.

Step 10: Repeat Steps 6-9 until you reach the water line. Make sure to record your end time for your transect.

Step 11: Repeat the entire process for your remaining transects.

Beach Profiling Tutorial: https://vimeo.com/539425881

Stone
Living Lab

Beach Profiling Equipment

- **Measuring rods (preferred unit: decimal feet).** Suggested brand: Firecore aluminum grade rod.
- **Unmarked rods.** Suggested brand: Sunnyglade adjustable tarp poles.
- **6 foot / 2 meter length string.**
- **Data sheets, clipboards, and writing instruments.**

Optional:

- **Bubble levels**
- **Transect strings / marking flags**
- **Infared thermometers**

Stone Living Lab

BEACH PROFILING DATA SHEET

SITE INFORMATION					
Name					
Site Name					
Date		**Start Time**	: AM/ PM	**End Time**	: AM/ PM
Temperature	F	**Tide**	High Intermediate Low		
Weather	Clear Rainy Overcast				

SET UP	Transect	# _____ of _____	**PHOTOS**	Beginning of Transect	☐
	Stake Height	(decimal ft)		End of Transect	☐
	Visible Horizon	☐		Side of Transect	☐
	Starting Point Located	☐		Other Photos (Optional)	☐

BEACH PROFILING DATA					
Point	**Distance from previous point (ft)**	**Slope**	**Height of Unmarked Rod (ft)**	**Measurement Rod Reading (decimal ft)**	**Elevation Change (decimal ft)**
	Rope length	Flat, Up, or Down	Measurement Rod Reading – Height of Unmarked Rod = Elevation Change		
Start					
2					
3					
4					
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COMMENTS