Grades: 6-8 **Length**: 90 min

Oysters are Shoreline Protectors

Summary: In this hands-on lesson, students design and build a structure that can break wave energy before it hits land. They collaborate through the engineering design process, figure out that there are many possible ways to solve the problem, and reflect on the role that oysters play as natural breakwaters.

Outline

- **Observe changes to New York Harbor (15 min)**
- **Plan and build a breakwater structure (30 min)**
- **Test each group's structure (30 min)**
- **Discuss and reflect (15 min)**

LESSON OVERVIEW

Objectives (Students will be able to…)

- Design and build a structure that models how oysters break wave energy in order to evaluate competing design solutions for shoreline protection in New York Harbor

Standards

- MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

BOP Connections

- Standalone Lessons: Pairs well with "Oysters are Keystone Species" which provides overview of the ecosystem functions oyster provide.
- ORT / ORS: Supplements the Oyster Research Tank or Oyster Research Station by modeling an important ecosystem function of oysters, that isn't as easily visible

BEFORE YOU GET STARTED

Supplies

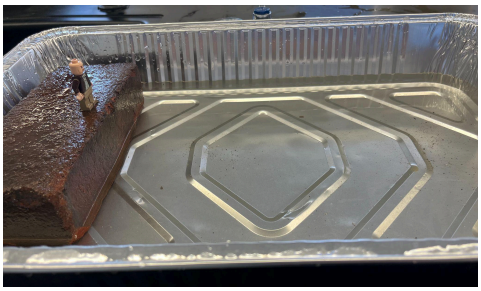
- Grade 6-8: Slides
- Grades 6-8: Handout (for each student)
- Building materials (for each group):
  - Things to build with (e.g. recyclables, sponges, legos, shells, gravel, etc.)
  - Duct tape
  - Scissors
- Testing materials:
  - Water source
  - "Waves" (e.g. plate, cup)
  - "Harbor" (e.g. large bin or aluminum pan filled with water)
  - "Land" (e.g. brick or a tall tupperware filled with water)
  - Ruler

Tips for Teachers

- Review with students:
  - Norms (what it may look like and sound like) for teams to work together productively
  - Steps of the engineering design cycle
- Decide:
  - How will students get building materials (e.g. distribute identical sets to each table, students choose from a "store", one student selects for the group, etc.)?
  - How many groups will test at a time (e.g. one group or multiple testing stations)?
- Heads up:
  - Students can get excessive with materials - consider giving each group a pre-measured amount of items (e.g. pre-cut duct tape stuck to the side of their table).
  - Check out the additional resources available for Grades 9-12: Source Library

Materials Preparation

- Collect enough varied materials for each group to build structures - consider what is easily accessible, and what students may be able to help collect (e.g. bringing in recyclables)
- Identify where you'll test designs - fill up a large pan/bin with water, and place a figurine on the "land" flush against the bin.
  - Identify where to get water (e.g. use pitchers, use sink, take students outdoors and use hose)
  - Identify where to put wet structures after testing
  - Gather towel(s) to clean up any spilt water.



Vocabulary

- Wave attenuation: The process of decreasing energy carried by waves.
- Erosion: The process by which water, wind or ice moves land (quickly or slowly).
- Breakwater: A structure, which can be natural or built by humans, that is built near a shoreline and attenuates wave energy.

INSTRUCTION PLAN

OPENING:
Observe changes to New York Harbor. (15 min)

1. **Show:** Display images of 2 similar shorelines with differing features. [slide 2]
    - **Ask:** *What do you notice about the shorelines? What do you think caused this?*

2. **Explain:** This is an example of erosion.
    - **Ask:** *Based on the photos, how would you define erosion?* [slide 3]

3. **Define:** Erosion is the process by which water, wind or ice moves land. In this case, the water eroded the land. [slide 4]
    - **Ask:** *Do you think erosion happens quickly or slowly? Why?* [slide 5]

4. **Explain:** Erosion can be very slow and gradual, like a river slowly chipping away at rock or soil over time. Or, it can happen very quickly, like during catastrophic events like hurricanes or superstorms, like Hurricane Sandy in 2012. Erosion, particularly during these storms, can be a big problem because it can cause a lot of damage to shorelines and habitat. Plus, big waves during storms are becoming increasingly frequent and powerful due to climate change. Keeping that in mind…

5. **Compare:** Take a look at 2 images of the New York Harbor: one historical (pre-1600 colonization) and one present day. [slide 6]
    - **Ask:** *What do you notice is different about these photos?* (fewer trees, more buildings and roads, smaller water bodies, land masses have changed shape, etc.)

6. **Show:** What is not visible in the image is that 400 years ago, oyster reefs surrounded the soft, marshy shorelines of New York City. Oysters grow in reefs, which naturally would have been able to break up some of the wave energy during big storms to prevent erosion. [slide 7]
    - **Ask:** *Looking at the reef structure, what do you think these reefs could do to waves that crash into them?* (break up waves, slows down waves, reduces crashing onto the shoreline, etc.) [slide 8]

7. **Explain**: Because the reefs were so big and wide and sturdy, it would attenuate (decrease) the wave energy before it hits the shore. Now, without oyster reefs, and with our paved roads and buildings, water comes crashing onto land and isn't slowed down or absorbed. Human activities have changed the natural landscape of New York Harbor so much that the effects of big storms and erosion are stronger than they would've been 400 years ago. [slide 9]

- **Ask:** *What could we do to solve this problem (prevent erosion and help protect our shorelines)?* (sea wall, rebuild soft shorelines, restore oysters, etc.) [slide 10]

ACTIVITY:
Plan and build a breakwater structure. (30 min)

1. **Frame:** There are many ways we can look to prevent erosion. Today, you will work in groups to create a structure that will help attenuate (reduce) the energy of waves before they hit the shoreline. [slide 11]
    - **Share:** Review the steps of the engineering design cycle.

2. **Facilitate:** Provide handout for each student and invite them to record notes in Part 1.
    - **Ask:** *What problem are we trying to solve?* (big waves hit NYC with a lot of energy, damage the natural and built environment, etc.)

3. **Share:** To attenuate wave energy, designs must meet the following criteria: [slide 12]
    - Be at least partly submerged (underwater) in the "harbor" - like an oyster reef
    - Slow down the "wave" before it hits the "land" - to break up wave energy
    - Stay intact when 10 big "waves" come - since storms last a long time
    - Prevent person on "land" from getting knocked over by "waves" - structure successfully prevents damage on land

4. **Share:** Given the materials, there are some constraints to the designs: [slide 12]
    - Materials: only use materials provided
    - Team members: work in groups
    - Time: 25 minutes to plan and create
    - Size: fit inside the "harbor"

5. **Facilitate:** Provide time frames for students to design and build their structures, while completing each part on their hand out. Prompt groups to move onto the next step in their handout as they are ready.
    - Students independently jot or sketch initial ideas for a design. [Part 2 - Imagine]
    - Students gather with a small group to share their ideas, and create one team plan for building a prototype on Part 3 of the handout labeling the materials they plan to use. [Part 3 - Plan]
    - Groups collect their materials and build a prototype based on their team plan. [Part 3 - Create]

- Suggested end of Class 1 -

Test each group's structure. (30 min)

1. **Share:** Outline the procedure for how students will test their designs, including normalizing that some structures may break and need redesign - that is okay! [slide 15]

2. **Facilitate:** Invite groups to test their structures at the set testing site. [slide 15]
    - Group describes their materials and design choices
    - Group places structure in the bin, in front of the "land" that as figurine on top
    - Use plate to push 10 big "waves" toward land
    - **Ask:** *Did the design meet the criteria? What specific aspects of the design helped break the wave energy? How is this design different from the previous one?*
    - Remove structure, replace figurine, and repeat with the next group.

DEBRIEF:
Discuss and reflect. (15 min)

1. **Discuss as a whole group**: [slide 16]
    - *What aspects of the designs helped attenuate wave energy and prevent erosion?*
    - *Was there only one right way to solve the design problem? How can you tell?*
    - *What were some limitations of our model? How might this work differently in real life?* (no representation of erosion, in real life waves crash constantly with various sizes and timing, damage can look differently than a figurine falling over, scale is larger in real life, etc.)

2. **Recall:** Just like how there wasn't one right way to build your model structures, engineers have designed many different types of solutions to attenuate wave energy, such as by building a seawall, restoring the natural soft shoreline ecosystem to absorb water, and creating breakwater structures with living things. [slide 15]

3. **Show:** One notable project is the "Living Breakwaters". This restoration project started after Hurricane Sandy caused a lot of flooding, erosion and damage off the coast of Staten Island. It is a big, complex set of rock barriers, designed to attenuate wave energy before it hits Staten Island. Billion Oyster Project is restoring one billion oysters to New York Harbor, and has added living oysters to this rocky structure [slide 16]
    - **Ask:** *What might be the benefit of putting live oysters on a breakwater, when a seawall can also attenuate waves?* (revitalize lost habitat, support ecosystem functions that oysters provide like clear the water, restore habitat, develop foundation for food web, etc.) [slide 17]

4. **Reflect:** Students write independently on Part 4 of the handout: [slide 18]
    - If you could redesign your group's structure, what would you change? Why?