Waterfront Puzzle: A look at the pieces that make up our beaches

TOPIC

Marine Ecology

GRADE LEVEL

9th through 12th grade

SUBJECT AREAS

Marine Science, Earth Science, Ecology, Biology, Geology, Math

DURATION

Preparation Time: 15 minutes
Class Set Up & Introduction: 10 minutes
Activity Station Rotation: 25 minutes per station
Conclusion: 10 minutes

SETTING

Waterfront Area, preferably Intertidal Zone*
(*See *Setting Adaptations* for alternate setting recommendations)

SKILLS

Gathering information, organizing data, graphing data, identifying organisms, using an identification guide, data analysis

VOCABULARY

Biodiversity, deposition, intertidal zone, desiccation, vertical distribution (zonation), biotic/abiotic factors, habitat, tidal range, wrack line, erosion, littoral drift, substrate, sediment, transect, tide, current

SUMMARY

Students use a variety of scientific tools to collect and record data at unique sections of the waterfront area (beach or dock pilings) and analyze aggregate data to better understand the inter-complexity of environmental components.

OBJECTIVES

Students will:

- Use *water quality* kits to analyze health of the local waterway.
- Use *seine nets* to collect organisms from the coastline and identify the organisms using field guides.
- Use *substrate sieves* to analyze sediment sorting on the beach.
- Use *quadrats and transect lines* to understand zonation of species and biodiversity.

MATERIALS

- Clipboards and pencils
- Waterfront Puzzle data sheets (included)

Station 1:

- Small location flags or markers
- LaMotte Water Quality Kit or digital equipment for temperature, dissolved oxygen, salinity, pH and nitrates
- Container or bucket for water sample
- Tape measurer or ruler

Station 2:

- 1 set of substrate sieves
- Small spade or trowel (shovel)
- mm rulers or calipers
- Clear packing tape and scissors

Station 3:

- 3 half meter² quadrats
- >50ft measuring tape
- Field guide or local species key

Station 4:

- Seine net(s)
- 2 pairs of waders per seine net
- 5-gal bucket or kiddie pool
- 2 life jackets (or as many needed for seiners)

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PROCEDURE

Class set up and introduction (10min):

1. Divide students into four groups (4-10 students per group)
2. Distribute Estuary Exploration data sheets, one per group
3. Review data sheets and explain that each group will collect its own data. At the completion of all four stations, the groups will share data with other groups to complete their own sheet and create a "master" data sheet.
4. Provide overview of each station and explain that students will be following procedures and collecting data at each station.
5. Assign each group a station to start at: 1) Tidal Change & Water Quality; 2) Substrates; 3) Quadrat Study; 4) Seining. Determine a station rotation so that each group visits each station once.

Accessing prior knowledge, making predictions, forming inquiries:
What environmental components make up our waterfront? As we take a closer look, what will we find? How does our beachfront environment change over time? Why is it important to understand those changes?

Station Rotation (25min per station):
Each station is designed to be led by an instructor. It is possible to develop student-guided stations with minimal adaptations. To do so, create a procedure card for each station to be included with data sheets.

Station 1: Tidal Change & Water Quality

Objective: Students will measure tidal change, conduct water quality tests, and record data.

Brainstorming & Hypothesis Making: What is tide? How fast do you think our tide changes? What effects do you think we'll see in an ecosystem with a changing tide? Why is it important for us to understand tidal effects in our area? What defines water quality? What factors affect the quality of seawater globally? Locally?

Activities:
A) Measuring Tidal Change:

1. Place a flag or marker (must be visible vertically in event of rising tide) at the water's edge. Record the time.
2. Conduct Water Quality Tests (B).
3. Upon completion of Water Quality Tests, place a second flag or marker at the water's edge. Record the time. Measure and record the distance between Marker 1 and Marker 2.
4. Each subsequent group will mark and record the time their station begins. They will also mark, record time, and measure the distance at the station's conclusion.

B) Testing Water Quality:

1. Read kit instructions and review the contents of the kit.
2. Using a sample jar or collection vessel provided, collect a water sample from surface of water and record the time.

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3. Instruct two students to begin the Dissolved Oxygen (DO) test.
4. Continue to break the students into groups of two. Have each pair work on one of the following tests: Temperature, Salinity, pH, and Nitrates tests.
5. Record all data onto the data sheet.
6. If there is enough time for a second sample, instruct students to take a sample from deeper water to compare with surface water.

Reflection: What did we learn about our local tidal change? How do you know if the tide is incoming or outgoing? How will your understanding of tidal change and water quality affect how you use the beach?

Setting Adaptions: If the site does not have enough or any beach front to identify tidal change, complete Part A of this station using dock pilings. Complete Part B dockside or alongside a sailboat.

Station 2: Substrates

Objective: Students will observe naturally occurring sediment sorting on the beach by measuring the amount of cobble, gravel, and sand at four different tidal level locations: 1) Upper Beach - above the wrack line; 2) Wrack Line; 3) Mid Beach - halfway between the wrack line and shoreline; 4) Shoreline. Students will follow up this study by reading Chart P.

Brainstorming & Hypothesis Making: What forces of nature affect the beach and cause changes to the shoreline hourly, daily, over time? What materials make up our beach or waterfront area? How do these materials change over time? Where do you think the water table is? How will we find the water table?

Activities:

A) Quantifying Sediment & Locating the Water Table

1. Choose a tidal level location – one group per location as described above
    - Note: in the event of an ebb tide, begin sediment observation at the upper beach. In the event of a flood tide, begin at the shoreline.
2. Using a trowel or shovel, dig down one foot. Diameter of hole does not matter.
3. Fill the top sieve (largest holes) with a fair representation of the sample and sift the substrate through to the lowest level, adding water to the sediment to make it flow better, if necessary.
4. Estimate the amount of sediment collected in each sieve using the guide and record.

    Sediment Guide:
    - cobble = ≥64mm
    - large gravel = 30 mm to 64 mm
    - small gravel = 2 mm to 30 mm
    - sand = .06 mm to 2 mm
    - silt = .002 mm to .06 mm
5. As substrate changes (type of sediment) or water appears, measure and record the depth at which it first appeared.
6. If the substrate type changes as students dig deeper, record the depth of the change and describe the change.

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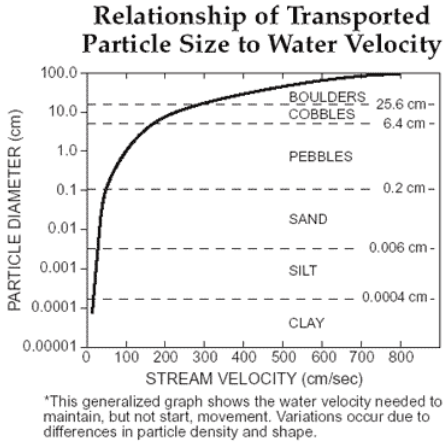
7. After the substrate has been sorted, cut four 1.5-2 inch squares of packing tape. Apply one piece of tape to each level of substrate in the sieves – a layer of sediment should stick to the tape. Place the tape onto the data sheet.

B) Comparing Collected Data to a Published Chart

1. Take a moment to review the types of sediment collected, using this to gain an understanding of the term "substrate."
2. Study Chart P *Relationship of Transported Particle Size to Water Velocity*. Draw conclusions about the relationship between the tidal level location and Chart P.

CHART P:



Reflection: How did your tidal location impact your sediment findings? As seasons and tidal patterns change over time, how is the waterfront area affected? What causes beach erosion and what are some ways to prevent it?

Station 3: Quadrat Study

Objective: Students will use quadrats to quantify biodiversity and vertical zonation of organisms within a specific habitat. Students will identify biotic and abiotic factors that influence species zonation. (Hints: dessication, predation, temperature, water exposure and retention, etc.)

Brainstorming & Hypothesis Making:

What types of organisms do you expect to find at the shoreline? The intertidal zone? The upper beach? What types of characteristics do these organisms share and what makes them different?

Activity:

1. Make a Transect Line: If the tide is high or outgoing, start at the wrack line. If the tide is low or incoming, start at the shore line. Using the tape measurer, create a dividing transect line starting from the shoreline (0'0") to the upper beach (50' or as far as the beach front extends.) Students may leave the transect line on the ground for all groups or have each group create one as they rotate to this station.
2. Divide the group into three sub-groups and assign one data recorder.

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3. Instruct the first subgroup to place a quadrat randomly on an area of beach at the shoreline close to the transect line.
    a. Measure and record the distance of the quadrat from the shoreline.
    b. Count and record the number and type of each living item found in the quadrat, including animals and plants. Use a field guide or local species key to identify organisms. If an organism cannot be identified, sketch or take photos to be reviewed and identified at a later time.
4. The next subgroup will place a quadrat square on the opposite side of the transect line, further up the beach away from the shoreline. Measure and record the distance from the shoreline and count and identify all living organisms.
5. Repeat step 4 for remaining subgroups.

Reflection: What did you learn about species zonation? How can this theory be applied to other ecosystems? How does human bias play a role in marking and choosing quadrat locations?

Setting Adaptions:
If the site does not have enough or any beach front to identify zonation and species banding, complete this station using dock pilings at low tide or mooring lines.

Station 4: Seining

Objective: Students will use seine nets to collect, identify, and catalogue species in shallow water (ideally performed in times of low tide).

Brainstorming & Hypothesis Making: What types of organisms do you expect to find in shallow water? Why do these organisms live close to shore? How does the tide affect the organisms in shallow water?

Activity:
1. Unroll the seine net at the shoreline parallel to the water's edge and explain how a seine net works.
2. Instruct two students to don waders or hip boots and demonstrate how to use the seine net.
3. Perform a seine:
    a. Seiners enter the water perpendicular to the beach with the taller person (the out-seiner) in deeper water and the shorter person (the in-seiner) closer to shore. The out-seiner should go no farther into the water than just below chest level or to the height of their waders. Be sure everyone who enters the water is wearing a properly fitting lifejacket.
    b. Seiners pull the net smoothly as they walk backwards, parallel to the beach as they keep the net perpendicular to the beach. Technique: Each pole should be held at a slight angle so the bottom of the pole is close to the sand near the seiner's feet, and the top of the pole is tipped away from the seiner. This position is optimal for catching sea creatures, and prevents the creatures from swimming out under the net.
    c. When the seine net has been pulled for at least 3 minutes, the in-seiner "plants" the pole and holds it in place. The out-seiner then pulls the net toward the shore, forming a horseshoe shape.

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   d. When the two seiners are an even distance from the shore, pull the net toward the beach, moving at the same speed and closing the net slightly if necessary, continuing to keep the poles tipped.
   e. As the seine net reaches the shoreline, instruct remaining group members to help lift the lower edge and stretch the net across the beach and lay it down flat.
4. Gently collect plant and animal specimens from the net and place them into collection bucket or pool.
5. Using a field guide or local species key, identify, count, and record all organisms on the data sheet.
6. One person from each group is responsible for recording on his/her data sheet the approximate number and types of organisms found in the seine net hauls.

Reflection: What shared characteristics did you find in your organism collection? Why are "bait fish" important to the ecosystem? Why do fish exhibit schooling behavior? What water quality or seasonal factors may change your seine net findings?

CONCLUSION

Discuss and review all activities (10min):
These activities provide a small but thorough view of the very complex world of the intertidal zone. What makes Marine Ecology and Marine Biology amazing is that each component of the environment is so intricately related and intertwined. By examining specific substrates, quadrats and shallow water ecology we can better understand each element in depth. Then, as we take a step back and reflect on the role of each of these pieces in the larger puzzle, we gain a greater understanding of the waterfront ecosystem. Through these reflections, students are encouraged to do more than simply enjoy the beach for leisure, and, instead, to have an awareness and appreciation of all of the life and energy of an ever-changing shoreline.

RESOURCES

- Water Quality Kit - LaMotte Earth Force® Low Cost Water Monitoring Kit – (10 tests per kit) – Purchase at Amazon or Carolina Biological
- How to make a PVC Quadrat- http://limpets.org/rocky-intertidal-monitoring/ri-equipment/make-quadrat/
- Hubbard #3076 Four screen sieve kit item # 53716 (five screen available)
  Sand gauge item # 77332
- Background information on the Intertidal Paradigm - http://www.cosee-se.org/files/southeast/HomeSweetHomeintheIntertidalZone_Lesson6.pdf

Books:

- Peterson Field Guides – Atlantic Coast Fishes, Atlantic Seashores
- Pollock, Leland W.1998. A Practical Guide to the Marine Animals of Northeastern North America
- Weiss, H. M. 1995. Marine Animals of Southern New England and New York: Identification keys to common nearshore and shallow water macrofauna. Hartford, CT, State Geological and Natural History Survey of Connecticut Department of Environmental Protection