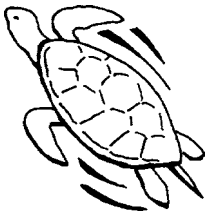


Activity #3

Causes and Consequences of Coastal Erosion

● ● ● In Advance *Student Reading and Questions*

- As homework, assign the Student Pages "Beaches on a Budget: Why Do Beaches Come and Go?" (pp. 42-45) and "Beaches on a Budget: Questions About the Reading" (pp. 46-48).

● ● ● Class Period One *Coastal Erosion Projections*

Materials & Setup

For each lab group of three to four students

- "Baldwin and Kanahā Beach Aerial Photo" acetates (master, pp. 40-41)
- Baldwin and Kanahā "Beach Study Maps and Graphs" (legal-size masters included with this curriculum). Each lab group should have the information that corresponds to its assigned beach.
- Two copies of the Student Page "Coastal Erosion Projections" (pp. 49-51)
- Overhead projector
- One sheet of legal-size or larger paper
- Colored pens or pencils
- Masking tape

For each student

- Student Page "Beaches on a Budget: Why Do Beaches Come and Go?" (pp. 42-45)
- Student Page "Beaches on a Budget: Questions About the Reading" (pp. 46-48)
- Student Page "Beach Management Alternatives" (pp. 52-53)

Instructions

1) Review student questions and responses to the homework, especially question #7 in which they explained the impact of shoreline armoring and longshore currents on beach erosion and accretion. This question is designed, in part, to help students understand how longshore currents transport and deposit sediment along coastlines, and how disrupting this current can lead to changes in the normal patterns of beach erosion and accretion.

2) Divide the class into lab teams of three to four students. Give each team a copy of the Beach Study Map and Graph for *either* Kanahā or Baldwin beach.

3) Explain that the black-and-white photos and maps are excerpts from a study published in 1991. The study looked at coastal erosion by comparing aerial photos taken in 1950, 1964, 1975, 1987,

and 1988. At each of several transects, the authors calculated the rate of coastal erosion during intervals between photos. They looked at the changing location of the coastal vegetation line to track erosion and accretion. The results are presented in the graphs that accompany each map.

4) Project the "Baldwin Beach Aerial Photo" and "Kanahā Beach Aerial Photo" acetate onto the groups' legal-sized or larger papers taped to the wall. Have each group trace its assigned beach from this image, including the water line and the vegetation line, along with any shoreline armoring that appears on the map and important reference points such as roads or large, recognizable facilities. Students can use the line-drawn maps from the 1991 study as a guide for which features could be useful to include on their tracing. When they have finished tracing the color image, they should add and number the transect lines from the corresponding "Beach Study Map and Graph."

5) Have students complete the steps and answer the questions on the Student Page "Coastal Erosion Projections."

6) After lab groups finish their work, have a class discussion to compare results and talk about how these kinds of projections can contribute to coastal management decisions.

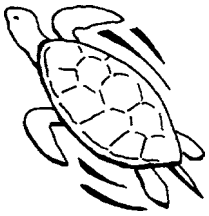
7) Assign the Student Page "Beach Management Alternatives" as homework.

Journal Ideas

- How should projections for future shoreline erosion affect people's decisions about where and how to build houses, hotels, condominiums, roads, and other structures?
- How far into the future do you think people should look when weighing the benefits and drawbacks of shoreline armoring such as seawalls and groins?

Assessment Tools

- Student Page "Beaches On a Budget: Questions About the Reading" (teacher version, pp. 35-37)
- Traced paper maps (evaluate for neatness and accuracy)
- Student Page "Coastal Erosion Projections" (teacher version, pp. 38-39)
- Short paper describing how Baldwin or Kanahā beaches should be managed
- Participation in group work and class discussion
- Journal entries



Teacher Version

Beaches on a Budget: Questions About the Reading

1) What is an active beach?

The part of the beach where sediment transport occurs

2) What is the opposite of shoreline erosion?

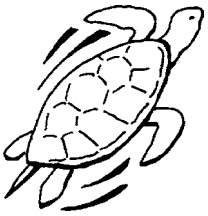
Accretion

3) Explain the term "littoral budget," using at least two examples of sources and sinks.

A littoral budget is the amount and movement of sediments to and from the shoreline—between different parts of the active beach, onto the beach from elsewhere, and away from the beach to another location offshore or down-current.

Sources include
- skeletal material from coral reef ecosystems,
- offshore deposits of sand that may be transported onshore by waves and currents,
- other beaches from which longshore currents and wind can transport sediments,
- erosion of headlands and coastal uplands,
- materials from new volcanic eruptions and lava flows, and
- sediments carried from inland by streams and rivers.

Sediment sinks include:
- loss of sediments to deep water;
- harbors and channels, which trap sand moving along or across the near-shore area;
- transport of sediments offshore or along the shoreline to other beaches by currents and waves;
- impoundment (trapping) behind seawalls, revetments, and other structures;
- over-wash by high storm waves and surges; and
- wind loss inland due to strong onshore winds.



4) Describe the cycle of sand dune building, scarping, and rebuilding that happens during and after large storms.

High waves during storms and large swells erode the beach. And they erode the dune, too. This process, known as scarping, releases sand that was stored in the dune to the active beach. The influx of sand from the dune is often carried offshore where it accumulates into sandbars. These sandbars intercept large waves before they reach shore, lessening their impact on the coastline.

When the high-wave event subsides and normal wave patterns return, the waves dismantle the offshore sandbars and rebuild the beach. Although some sand may have been permanently washed away from the beach system into deep water by the storm, eventually the beach and the dunes regenerate to their prestorm profile. Most of the sand transported offshore during storms and stormy seasons eventually is reincorporated into the dune.

5) Name two reasons why coral reefs are important to healthy beaches.

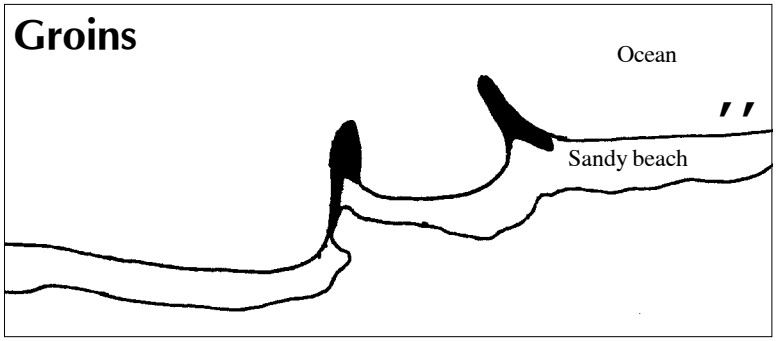
- They act as natural breakwaters, absorbing wave energy and helping protect the shoreline from wave erosion.
- They are important sources of sand production.

6) Describe two human activities that aggravate coastal erosion and reduce the amount of sand available to the beach.

Activities include
- Shoreline armoring,
- Sand mining,
- Grading dunes, and
- Maintaining and expanding harbors and navigational channels.

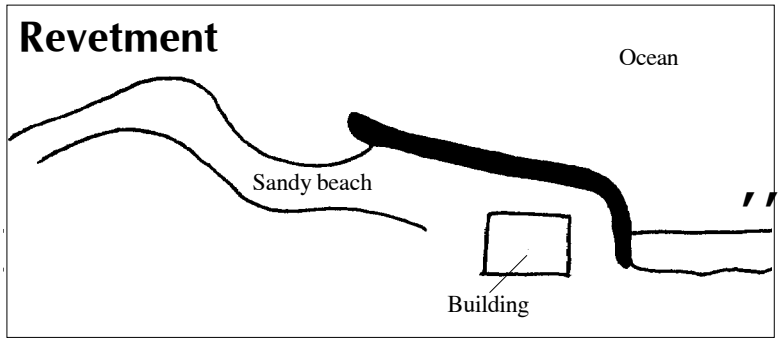
See Student Page “Beaches on a Budget” (p. 44) for descriptions of each activity.

7) True to their name, "longshore" currents run along or parallel to the shore. These currents are important mechanisms for transporting sediment within the beach system. Sediment transported along shore feeds beaches along the entire coastline. Shoreline armoring interferes with longshore sediment transport. The diagrams below illustrate two different types of shoreline armoring that have been in place for several years. For each diagram:
   a) Draw in the direction of the longshore current, and
   b) Explain how the pattern of beach erosion and/or accretion is related to the armoring structure and the longshore current.



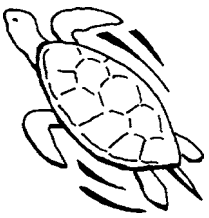
Longshore current

The groins have trapped sand behind them, causing accretion on the up-current side while robbing down-current beaches of their normal source of sediment transported by longshore currents.



Longshore current

The beach area just down-current from the revetment is heavily eroded because the revetment cut off a continuing source of sediment for the longshore current to pick up and deposit there.



Teacher Version

Coastal Erosion Projections

Use your traced paper image of your beach and the space provided on this page to project changes in the coastline over time.

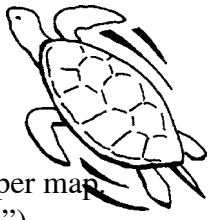
BEACH NAME: _____

1) The 1991 study graphs changes in the vegetation line between 1950 and 1988. For each transect on your beach segment, calculate an average annual rate of change, and record your calculations and answers below:

Transect #	Annual rate of change (+ or -)
Kanahā 5	-1.5 ft/year
6	-4.74
7	-4.08
8	3.53
9 (not on aerial photo)	5
Baldwin 17	.47 ft/year
18	-1.1
19	-2.89
20	-.39

2) You are going to be mapping projected shoreline changes based on the annual rate of change you calculated above. You will do this using the 1997 aerial photo (your traced paper image of it) as a baseline. Before you start mapping, you need to do some more calculations. Using the annual rate of change for each transect line, calculate the total erosion or accretion likely to occur by 2027 and 2057. Calculate these changes using 1997 as your starting date.

Transect #	Change (+ or -) by 2027	Change (+ or -) by 2057
Kanahā 5	-43.5 ft	-87 ft
6	-142.2	-284.4
7	-122.4	-144.8
8	105.9	211.8
9 (not on photo	.13	.26
Baldwin 17	14.1 ft	28.2 ft
18	-33	-66
19	-86.7	-173.4
20	-11.7	-23.4



3) Now mark the 2027 and 2057 vegetation lines on each of the transects on your traced paper map. (Extrapolate the scale on your traced paper map using the "Beach Study Map and Graph.")

   Use these points and any clues you can glean from the existing shoreline features to draw an anticipated vegetation line for 2027 and 2057. (Using different-colored pens or pencils for each line helps make the map clearer.)

   With a dashed line, indicate where you think the water line will be in 2027 and 2057.

   Label your map clearly.

4) Looking at your traced paper map, as well as the photos, maps, and information from the 1991 study, describe any patterns of erosion and accretion that you see. What might explain these patterns?

   Well-reasoned responses are acceptable. The primary patterns are associated with shoreline armoring (e.g., accretion up-current and erosion down-current, or even complete erosion of the beach behind the groin).

5) In 1992, researchers estimated that 62 percent of the Maui shoreline is eroding at a rate of 1.25 feet per year. How do the erosion/accretion rates you calculated compare with that average?

   The average rate of erosion taken across all nine transects is 1.16 feet per year, slightly less than the Maui average. However, in certain places, particularly at Kanahā beach, the rates of erosion are much higher than this average, and in other places the shoreline is accreting.

6) Use your projections to identify areas where you think development should be restricted because of the potential for shoreline erosion, and areas that you think would be appropriate for development. Explain your reasoning for these areas here.

   Well-reasoned responses are acceptable

Baldwin Beach Aerial Photo

Photo: Air Survey Hawai'i

Kanahā Beach Aerial Photo

Photo: Air Survey Hawai'i