

How Fast Can a Shoreline Change?

Shoreline and bluff erosion has been identified by shoreline residents as a critical problem along some parts of the Great Lakes. Land losses of up to 10 feet per year have been estimated for some areas. Property damage totals millions of dollars. Land loss and property damage are caused by the conflict between natural forces and human activity along the shoreline.

Ohio's Lake Erie shoreline consists of wetlands, low bluffs, and gently sloping shore in the western one-third of the state and glacial till and soft shale bluffs in the eastern two-thirds of the state. The rate of shore erosion is affected by the kind of land and rock materials and the use of protective structures.

OBJECTIVES

When you have completed this investigation, you will be able to:

- Recognize some shoreline features on aerial photos.
- Observe changes in a shoreline over time.
- Observe the effects of shoreline devices on rates of erosion.

Materials

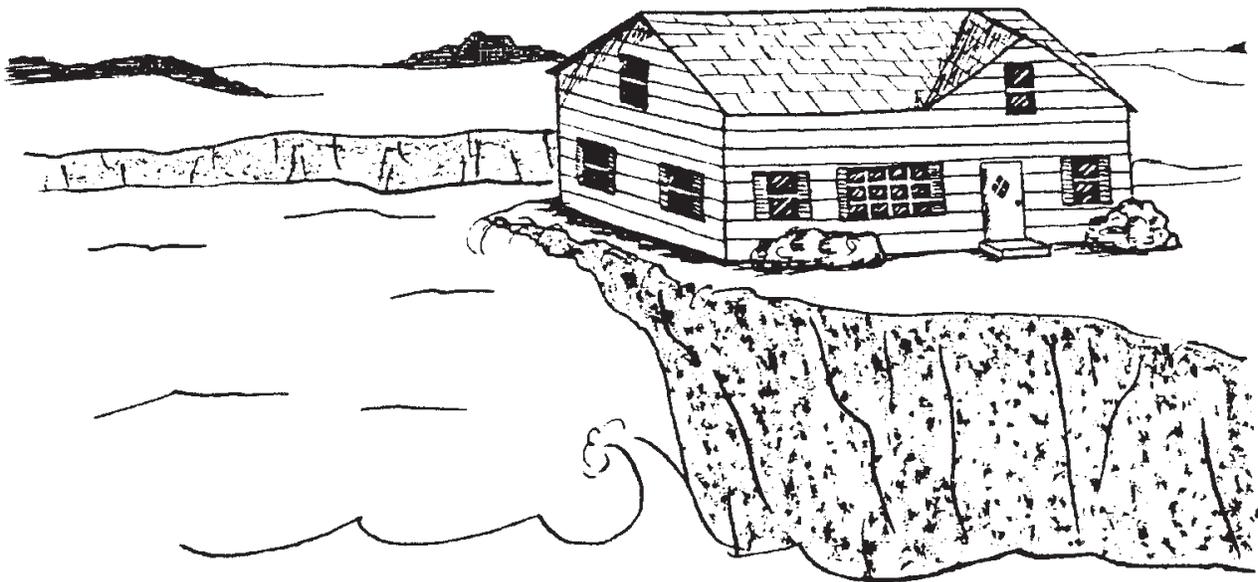
- Ruler.
- Tracing paper.
- Pencil and colored pencils.
- Paper clips.
- Aerial photos of Painesville Township Park.

Source

Modified from OEAGLS EP-6, "Erosion along the Great Lakes," by Beth A. Kennedy, Newark Public Schools, and Victor J. Mayer, The Ohio State University.

Earth Systems Understandings

This activity considers the effects of erosion protection devices on shorelines, ESU 2 (stewardship) and ESU 3 (science methods and technology) and ESU 4 and 5 (analyzes observable changes resulting from coastal processes over time).



Suggested Approach

You might introduce the investigation by using the film, *The Beach: A River of Sand*, from the AGI Earth Science Series, available through Encyclopedia Britannica Films, Inc. 425 North Michigan Avenue, Chicago, Illinois 60611. The film effectively illustrates the development and effects of longshore currents on shorelines, and some of the problems created by harbors and other features that interrupt the littoral drift.

For those schools along one of the Great Lakes, a field trip would be an effective follow-up to the investigation (i.e., Carter, 1973, describes locations along Lake Erie where the effect of erosion processes can be observed).

Answers

1. Students should observe the groins at the center of the photo, the sand beaches to the west, and the slumping bluffs to the east of the groins.
2. In the second photo, the beach has largely disappeared, and the bluffs have retreated southward. A part of the highway has been removed as well as several buildings.
3. Additional erosion has taken place, as noticed for example in the area to the east of the groins.
4. There are six rather prominent groins. In the 1954 photo, students may see several other small structures built out from the beach. These may be small groins or perhaps piers. Of the three largest groins, one has become very faint in the 1973 photo. Other groins seem to have disappeared. They have been submerged by the higher lake level. The general level of the lake increased over the decade from 1960 to when the 1973 photo was taken. This is the major reason that the beach is not as wide and that the groins seem less prominent. In the 1981 photo, two groins are recognizable with the other appearing faint.

PROCEDURE

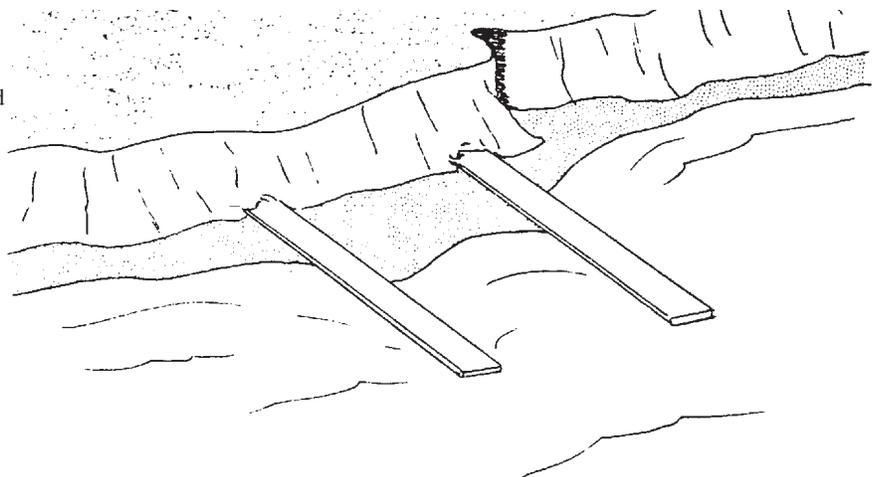
You will be studying a portion of the Lake Erie shoreline in Lake County, Ohio. You will determine how fast erosion has occurred in the area and how much sand and clay has been removed by the waves and currents of the lake.

You will be using photographs taken from an airplane flying over the area at three different times, one in 1954, one in 1973, and again in 1981. The photos represent the same area of the shoreline. When using the photos, be sure that the large area of water (Lake Erie) is at the top of each photo. Then it will be oriented just like a map. The top will be north; the left side of the photo, west; and the right side, east.

1. Examine the 1954 photo. Describe the shoreline.
2. Now examine the 1973 photo. How has the shoreline changed? What features have been destroyed?
3. View the third photo from 1981. What changes do you see?

You should have noticed some straight objects jutting out into the water in the west central part of the photos. These are **groins**. They are structures designed to protect the shoreline by trapping sand.

4. How many groins are there in the 1954 photo? In the 1973 and 1981 photos?



5. Cover the 1954 photo with a sheet of tracing paper and secure it with paper clips.
6. Starting 1 inch in from the left border of the photo, draw 8 parallel N-S lines at one-inch intervals. Label the lines A through H starting at the left line.
7. Using a pencil, trace the base of the bluff on the paper. Label this line “1954.”
8. Now draw in and label the groins.
9. Outline two or three major road intersections. These will help you to position the paper on the other photo.
10. Now place the tracing paper on the 1973 photo. Match the road intersections.
11. Using a different colored pencil, trace in the base of the bluff. Label this line “1973.” Draw in and label the groins.
12. Notice that you have two different shorelines. Lightly shade in the area between the two shorelines.
13. Why are there two different shorelines?
14. What does the shaded area between the two shorelines represent?
15. What differences do you note between the area of shoreline east of the groins and that to the west of the groins?
16. What caused these differences?
17. Repeat the same procedure with the 1981 photo, comparing it to the 1973 photo. Note that the time elapsed between the 1954 and 1973 photos is more than twice that between 1973-1981. Observe the rates of erosion to see if there is a related relationship to time, i.e., did twice as much erosion take place between the first two photos as between the latter two? How can you tell?

Answers

5. The base of the bluff is used as an indicator of the position of the shoreline. The beach itself varies considerably in size because of normal processes such as longshore currents and periodic changes in lake level. It, therefore, is not a good indicator of the position of the shoreline.
6. For questions 6-12, see Appendix A. The scales of the two photos are not exactly the same. Therefore, students will not be able to get a perfect match on road intersections. But they can match close enough to get a good idea of the changes that have occurred to the shoreline.
13. The two shorelines are the result of erosion processes and the consequent retreat of the shoreline to the south. **ONE CAUTION; LINE A WILL CROSS A CLAY PIT.** On the 1973 photo, clay has been removed to the beach. Therefore, there is a broad white stretch on the photo. Students may interpret this as cliff recession.
14. The shaded area represents land removed by erosion.
15. A greater amount of erosion has taken place to the east. Because of the presence of the clay pit, students may not arrive at this conclusion. You should discuss this with them.
16. The groins protected the portion of the shoreline they were connected to. The new beaches, once formed, provide a place for waves to expend their energy. This energy is not used to erode the upland areas; consequently, the recession rate of the shoreline is considerably reduced. Beyond the groins on the downcurrent side, currents will pick up a new load of sediment, and there will be more erosion than occurring upstream of the groins.

Between 1954 and 1973, a portion of the shoreline eroded away. Between 1973 and 1981, an additional amount was removed. Shore erosion occurs through the combined effects of waves and currents. Waves, especially during storms, will attack the bluffs along the shore, causing them to collapse. Currents moving along the shore will pick up the sediments and carry them away. These currents flow in a predominant direction. Any obstruction will trap the sediment carried by the currents on its upcurrent side (the side from which the current is coming). On the downcurrent side of the obstruction, the currents will pick up a new load of sediment. Because of these processes, the groins slow down erosion upstream and cause additional erosion downstream.

Answer

18. Groins will cause deposition on their upcurrent side, and increased erosion on the downcurrent side. Therefore, it appears that the predominant direction of the longshore currents is from west to east.

You have heard that "energy can neither be created nor destroyed." As wave energy is taken in by the shoreline, the shore deposits are changed. Energy is transformed from the wave to the shore.

Teacher's Note

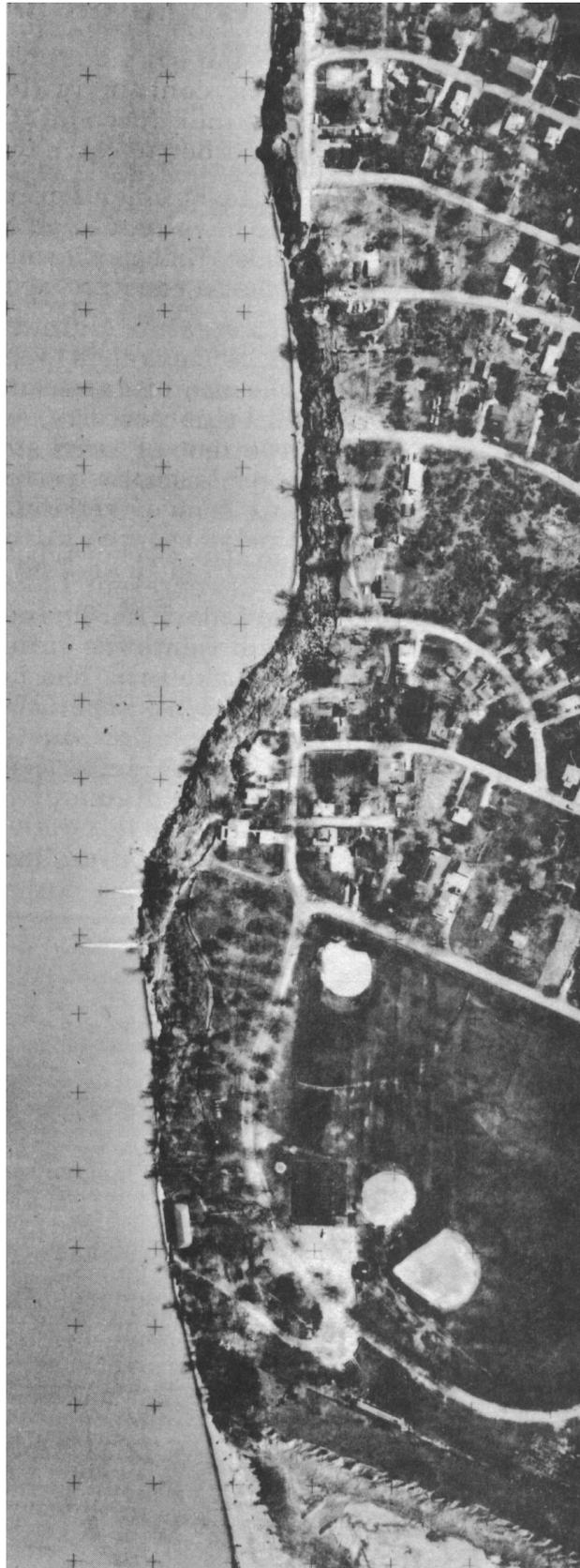
For the second extension activity, refer to the Great Lakes Atlas for land use and erosion maps. Note the erosion of shoreline areas near large cities.

18. In what direction do the currents along this section of the shore move?

EXTENSIONS

1. How do you think lake shoreline erosion is different from inland erosion, as into a stream or river? Which do you think is more costly in economic terms? Which is more critical in environmental terms? How could erosion affect water quality and activities along a shoreline such as fishing and swimming? Offer a discussion of different perspectives to support your answer.
2. Refer to the activity "How well do you know the Great Lakes?" Determine the density of population per Great Lakes shorelines. On which lake would you assume population density to have the most impact regarding erosion? On which the least?

Painesville, 1973



Painesville, 1954





Appendix A.
 Teacher's Page: Example of student comparison of 1954 and 1973 photos.

