

Draft exercise for share fair at Bozeman workshop only.

This exercise is not ready for distribution.

Please send helpful suggestions to

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Cape Shoalwater and Washaway Beach

May 18, 2012

Cape Shoalwater is on the Washington Coast south of Ocean Shores. This area is home to the communities of North Cove and Tokeland. This exercise looks at the regional setting and investigates both long- and short-term changes that have taken place (Figure 1). We will use topographic maps, aerial photos and nautical charts for this investigation.



Figure 1. Trailer that has fallen off the cliff edge as a result of being undercut, at North Cove. Photograph taken April, 2012.

Regional context

Location of Cape Shoalwater

Figure 2 is a regional map of the Washington coast, showing Cape Shoalwater at the north side of Willapa Bay. Three rivers feed Willapa Bay: North River, Willapa River, and the Naselle River. Drainage from all of these Rivers is through the mouth of Willapa Bay.

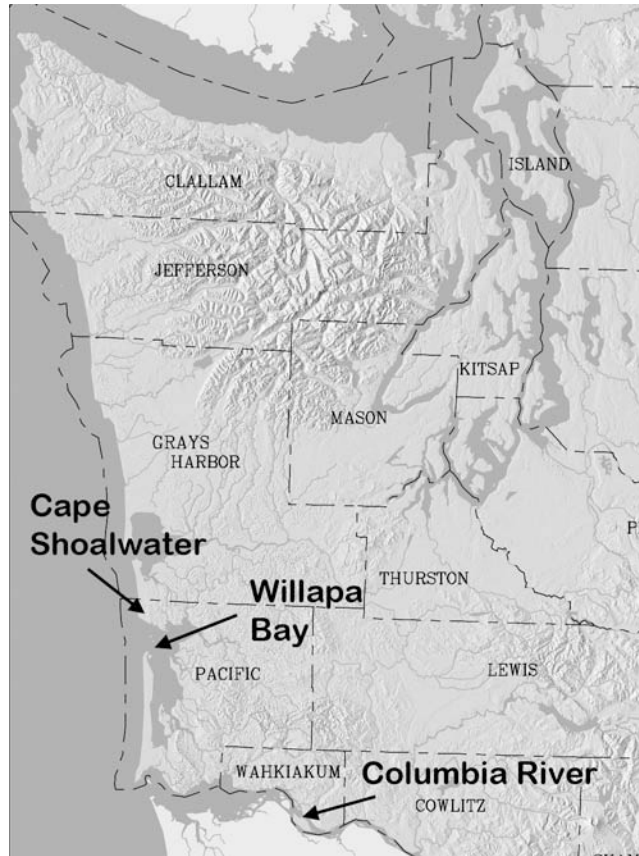


Figure 2, western Washington showing the coast. The study area for this exercise is located along the coast at the north edge of Willapa Bay. Image from <http://www.ecy.wa.gov/services/gis/maps/state/topo.pdf> (downloaded May 10, 2012)

The mouth of Willapa Bay is a geologically complex area, influenced by water and sediment input from the rivers, ocean shore processes, and Columbia River littoral cells. The Columbia River forms the western part of the southern boundary of Washington as shown in Figure 1.

Willapa Bay and its watershed are not heavily industrialized. There is logging in the hills that surround the bay and form its drainage basin. There are no major dams on any of the rivers feeding the bay, and there is little heavy industry along its shores. This is a cranberry growing region, and it also supports subsistence, recreational, and commercial fishing. North Cove, which is at the north edge of Willapa Bay, is home to the Shoalwater Indian Reservation and numerous rural homes. The small community of Grayland is just north of this area.

Nautical Charts

Two nautical charts are provided for this section of the exercise. One is from 1912 (Figure 3), and the other is almost a century later in 2006 (Figure 4). Although nautical charts are intended for navigation purposes on water, we can still learn a lot about shore area processes and changes from them. The numbers in water areas represent depths to the bottom of the water (or top of the substrate, if you prefer). The deepest water represents the main channel of the rivers as they empty into the ocean.

1. Study the 1912 chart (Figure 3). Sketch below the general area of the deepest water in relation to the north shore of the bay. It may help to start your sketch at the tic mark that indicates intersection of 124 degrees west longitude and 46 degrees 42 minutes north latitude.

2. Now look at the 2006 chart (Figure 4). Sketch below the region that has the deepest water, from the right side of the map to the mouth of the bay. Once again, it may help to start your sketch at the tic mark that indicates intersection of 124 degrees west longitude and 46 degrees 42 minutes north latitude.

3. How has the main channel changed between 1912 and 2006? What are geologic processes that could have caused these changes?

4. Sketch below a single simple line that represents the main channel in 2006. If this channel were a river above sea level, where along the river would there be zones of erosion and where would there be zones of deposition? How do the hypothesized zones of erosion and deposition compare to the location of current shorelines?

5. Compare the 1912 (Figure 3) and 2006 (Figure 4) charts. Use the intersection of $124^{\circ} 4' W$ and $46^{\circ} 44' N$ and calculate how far the coast has eroded in the 94 years represented by the two maps. What is the total amount of erosion? What is the annual rate of retreat? Enter these data on the table in question 26.

Topographic Maps

Four topographic maps are provided for this section. They are from 1938, 1956, 1995 and 2011. One question also refers to the 1944 aerial photograph of the area. On the 1938 map, the upper scale is in miles, the middle scale is in yards (on top) and feet (on bottom). The bottom scale is in kilometers.

On the 1938 map, note the right angle bend in Smith and Anderson Road, and the right angle bend in the road by the name T Larken (for reference see the small map below). Also note the intersection where Larken Road joins the main north-south highway. Measure directly south from the road bend for each case discussed below.

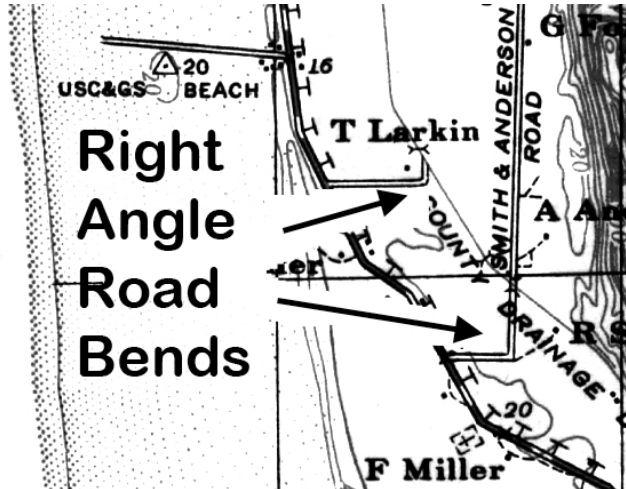


Figure 5, right angle bends for location purposes on topographic maps (1938 base map).

6. On the 1938 map (Figure 6) , how far is the right angle bend in Smith & Anderson Road from the shore?
7. Now compare the 1938 map (Figure 6) with the 1944 aerial photograph (Figure 7).
 - a. Has much change taken place in the depiction of the shore between the time of the map (which was based on mapping and photo interpretation in 1937) and the photograph of the image (which was 1942)?
 - b. What is the amount of overall erosion or deposition that has taken place between the 1938 map and the 1944 aerial image?
 - c. What is the annual rate of erosion or deposition between 1937 and 1942 (the times that the map was surveyed and the aerial photography flown)?

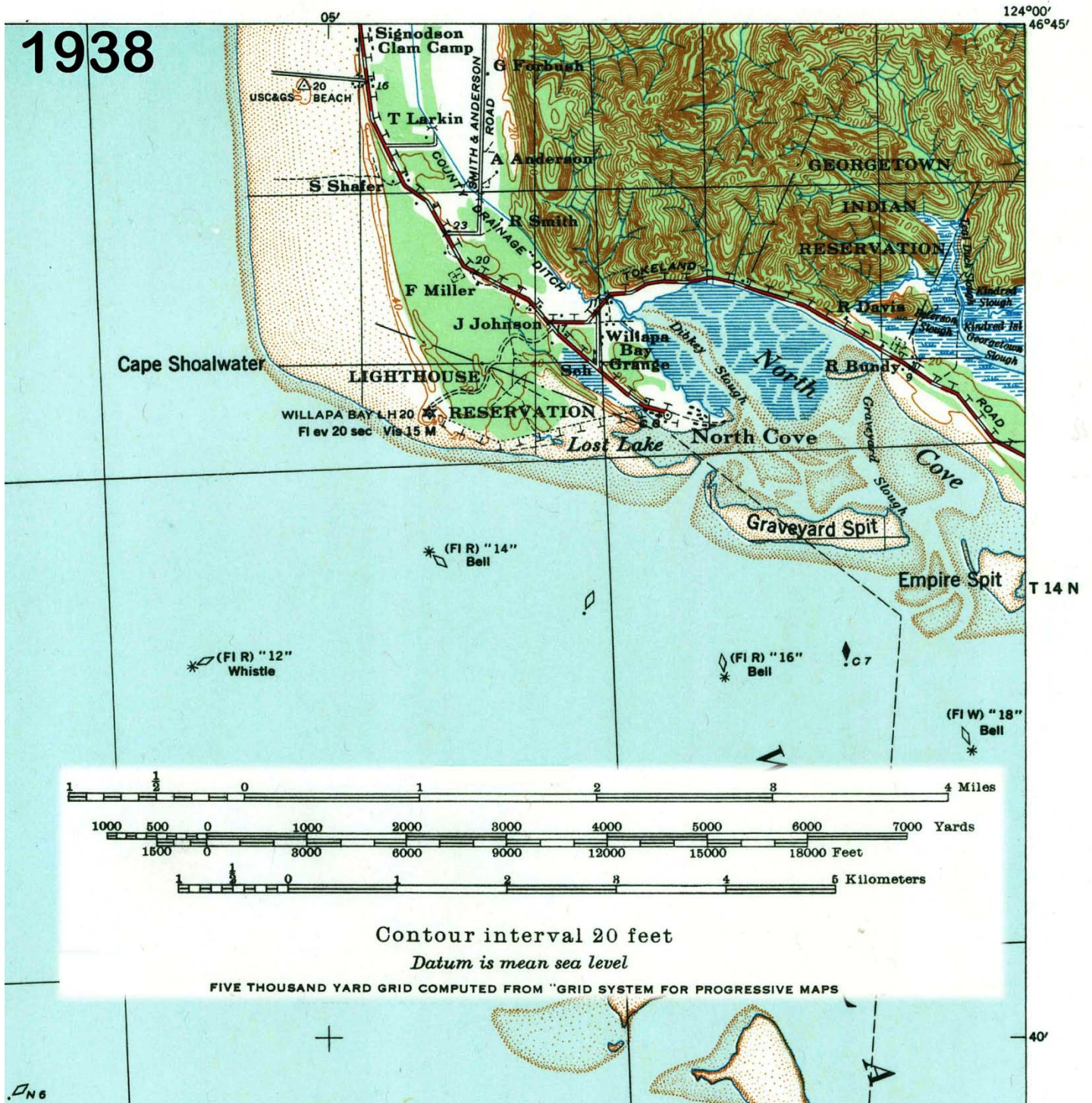


Figure 6. 1938 topographic map.



Figure 7. 1944 aerial image.

8. Refer to the 1956 map (Figure 8). How far is the right angle bend in Smith Anderson Road from the shore?
9. Based on these data and the map data from question 6 above, what is the annual rate of retreat of this shoreline between 1938 and 1956?
10. Refer to the 1995 map (Figure 9). How far is the right angle bend in Smith Anderson Road from the shore?
11. Based on these data, what is the annual rate of retreat of this shoreline between 1956 and 1995?
12. Now refer to the 2011 map (Figure 10). Where is the right angle bend in Smith Anderson Road?
13. Based on these data, what is the annual rate of retreat of this shoreline between 1995 and 2011?
14. Enter your calculated amounts and rates of erosion in the table in question 26 below.

Now let's look at the lighthouse story.

15. Use the 1938 map (figure 6).

- a. Determine the latitude – longitude of the lighthouse at the cape. What is it?
- b. How far is the lighthouse form the shore?
- c. What is the highest elevation of land near the lighthouse? Based on the 1938 map, speculate on the types of soils and sediments that might exist at the lighthouse and their potential for erosion.
- d. Plot the location of the 1938 lighthouse on the 2011 topographic map (Figure 10).

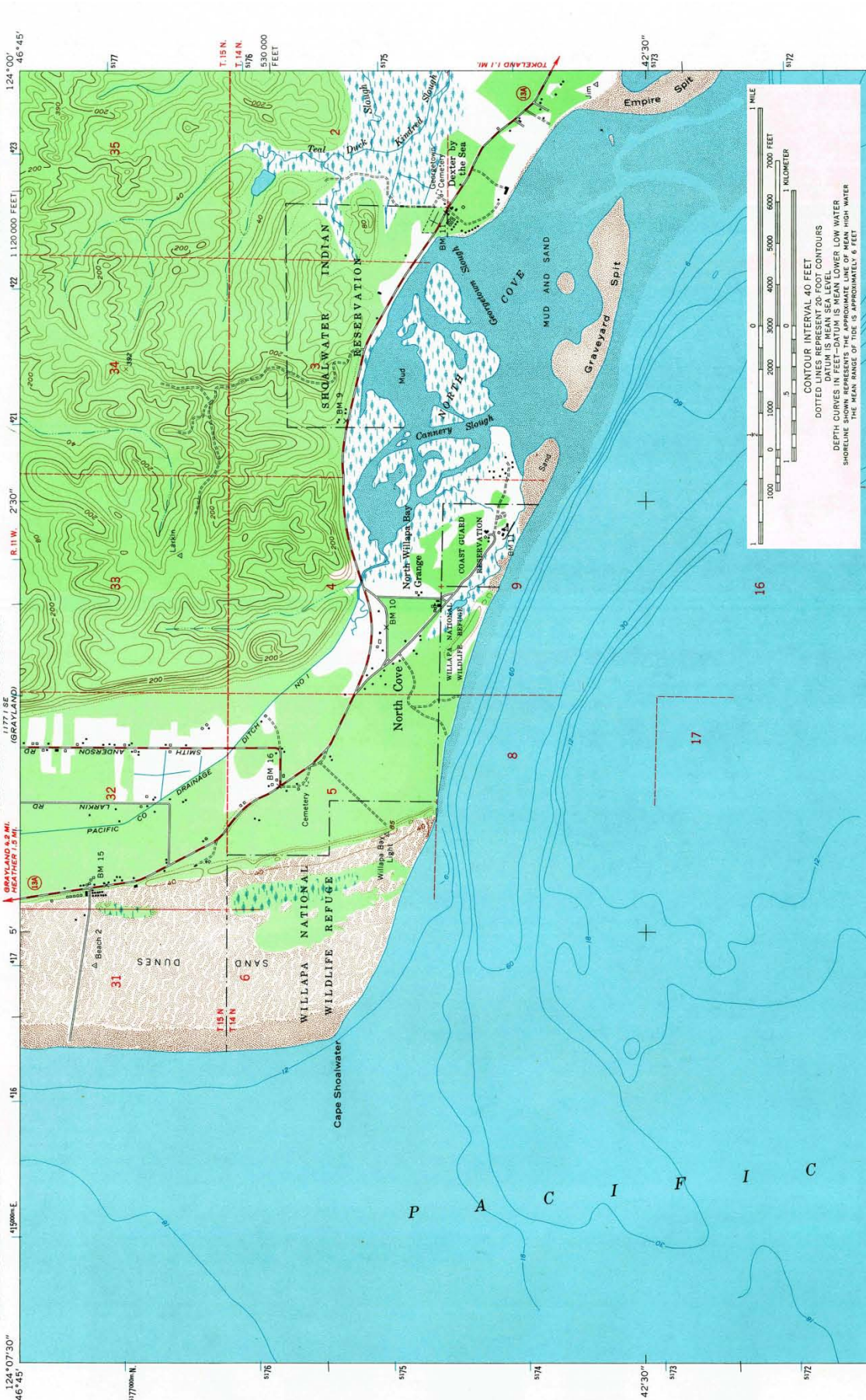


Figure 8. 1956 topographic map.

NORTH COVE QUADRANGLE
WASHINGTON — PACIFIC CO.
7.5 MINUTE SERIES (TOPOGRAPHIC — BATHY)

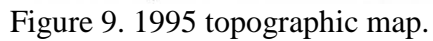




Figure 10. 2011 topographic map.

16. Now use the 1956 topographic map (Figure 8).

a. Determine the latitude-longitude of the light in 1956.

b. Plot the location of the 1956 lighthouse on the 2011 topographic map (Figure 10).

c. What has happened to the lighthouse and light sites between 1938 and 1956? Does this confirm or refute your analysis of erodability in question 15c?

17. Now look at the 1995 map (Figure 9).

a. A light is shown on the 1995 map, southwest of the words “North Cove.” How does the location of the light in 1995 compare with the location of the lights in 1938 and 1956?

b. Plot the location of the 1995 light on the 2011 topographic map (Figure 10).

18. What has happened between 1956 and 1995? In addition to looking at the lighthouse, it may help to look at the location of the highway.

19. Now refer to the 2011 map (Figure 10). \

a. What has happened between 1995 and 2011? How does this compare with your earlier pairs of maps?

b. What suggestions for locating a light (used by boats and ships to mark the entry channel) do you have for this area.

Aerial photos and satellite images

Four images from Google Earth are used in this part of the coastline analysis. These are from June 20, 1990, July 31, 2005, June 25, 2009 and September 25, 2011. There also is an oblique aerial image from 1997.

The image below (Figure 11) is a location map that you can use with the rest of the images. Point X is the intersection of Spruce and Whipple, and is the point from which erosion measuring should be based. The intersections at points Y and Z are useful fixed points for reference.



Figure 11. Location map of North Cove. North is at the top of the map. “X” is at the intersection of Whipple (the E-W road) and Spruce (the N-S road).

20. Use data from the four figures below (Figures 12a-d) to complete the table below the images.

Note that all the images are the same scale, so the scale on the 1990 image can be applied to the other images. North is at the top of all the images.



Figure 12a, 1990



Figure 12b, 2005



Figure 12c, 2009



Figure 12d, 2011

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Image	Distance Point X to shore	
	West along Whipple	South along Spruce
1990		
2005		
2009		
2011		

21. Based on the data above, fill in the table below to indicate how far the shore retreated for each time span.

Years	Total retreat		Annual rate of retreat	
	E-W (Whipple)	N-S (Spruce)	E-W (Whipple)	N-S (Spruce)
1990 - 2005				
2005 - 2009				
2009 - 2011				
1990 - 2011				

Has the annual rate of retreat been the same in E-W and N-S directions? Has the annual rate of retreat remained the same in the 21 years depicted in these images? Explain.

22. About how many houses were lost between 1990 and 2011?

23. About how many roads were lost?

24. The oblique aerial photo below (Figure 13) has two houses indicated on it. Intersection Z is shown for comparison with the earlier images. The image is from <http://apps.ecy.wa.gov/shorephotos/scripts/bigphoto.asp?id=PAC0015>, downloaded May 18, 2012.



Figure 13. Oblique aerial photograph from 1997.

a. Describe method(s) you can use to make distance estimates on an aerial photo for which no scale is given. Is the scale the same everywhere in the photograph?

b. How far from the shore do you estimate House A was in 1997?

b. How far from the shore do you estimate House B was in 1997?

25. The home at site A is relatively new construction. How does its location in the 1997 oblique aerial image compare with its location on the 2011 Google Earth image?

Synthesis and prognostication

26. What is the range of erosion rates that you have calculated from the different data sets? Complete the table below.

Source	Years	Total erosion	Erosion rate (feet per year)
Chart	1912-2006		
Map and photo	1938-1944		
Topo maps	1938-1956		
	1956-1995		
	1995-2011		
	1938-2011		
Photos and images	1990-2005		
	2005-2009		
	2009-2011		
	1990-2011		

27. Describe the changes in erosion rates through time and different data sources.

a. Is the rate of erosion increasing or decreasing through time?

b. Compare the erosion data from the different sources. Are the answers from the different data sets similar or different?

c. Is there a single data set that is more reliable than the others? Explain.

28. Compare the location of House A with the areas of active retreat from the chart, topographic map, and aerial images.

a. Based on your interpretations, do you think that home A is at risk from continued erosion? Explain your analysis.

b. House A has been protected by large rocks, known as rip-rap (see Figure 14, photograph of house A from May 2012). These rocks are now serving as a property-specific seawall to protect the house. On a larger scale, however, they might be serving as either a wide groin or perhaps a small rocky headland. How might the protection of this property be influencing erosion or deposition at adjacent properties?



Figure 14. House A, looking west southwest from shore, May 2012.

29. The owner of house B has been told by “an engineer” that she is safe from erosion at least until 2029. Do you feel, based on your analysis of charts, maps and photos in this lab, that this is correct or not? Explain the basis for your analysis. What additional data would you like to have, if any?

32. Refer to your text or to other resources. Beaches are dynamic zones of moving sand. What do you think are the local sources of sand to these beaches?

33. These beaches are in a zone known as the Columbia River littoral cell. This means that much of the sand along this part of the coast has the Columbia River as its ultimate source. Refer back to the diagram showing all the dams in the Columbia Basin.

a. What impacts could the dams be having on sand supply?

b. What changes along the coast would you expect as a result of these impacts?

34. After your analysis of the data in this lab:

a. What suggestions do you have for local homeowners?

b. What suggestions do you have for local, state and national governmental agencies?

35. This exercise has used historical as well as modern maps. Describe the values of using historical images in analysis of geologic hazards.