KEY

11e

Coastline Inquiry — Activity 15.1

Name: _____ Course/Section: _____ Date: _____

A Refer to the photographs of coastlines in **Fig. 15.1** and the list of Factors Affecting Coastlines on pages 396 and 398.

1. For each of the following coastal areas (see **Fig. 15.1**), describe the type of geologic material(s) that are along the coastline if visible. Then name the two or three most important factors that determine the characteristics of the coastline.

(a) Maryland coastline with salt marsh grasses rooted in clay

Dominated by salt marsh plants, flat topography, land close to sea level so it will significantly impacted by waves, tides, and storms.

(b) San Francisco, California, coastline

Coast line is rocky, made of resistant material that has been sculpted by storms, few beaches, land likely undergoing uplift.

(c) Oregon coastline

this coast has a sandy delta, shoreline affected by the amount of sediment, wave, and storms that affect the shape of the delta.

(d) North Carolina coastline

this coastline is sandy beach that is affect by waves, storms, and especially hurricanes.

(e) Destin, Florida, urbanized coastline

this coastline has been urbanized with homes just above the high-tide line, waves and storms move the sand... and will eventually destroy the houses

(f) Florida Keys coastline with mangrove plants

this coastline is a mass of mangrove roots that normally protect the coast from erosion... but could still be eroded by a powerful hurricane.

(g) Maine coastline (note person for scale)

this coastline is made of ½ to 2 meter rocks indicating high energy, they continually fall from adjacent cliffs.

(h) Caribbean island coastline with fringing reefs (i.e., reefs attached to the island) and a barrier reef

this coastline is fringed and perhaps made of coral, corals may protect the shoreline but can also be damaged by organisms and storms

B **REFLECT & DISCUSS**

1. Which of the eight coastlines shown in **Fig. 15.1** is building out or expanding into the water, and what is causing that to happen?

C is building outward

2. Which coastline gives you the impression that the people who live there are not very concerned about rising sea level?

E, this houses will soon be lost to the sea.

3. Along which coastline(s) will the average position of the coastline on a map change the most when sea level rises by a few meters?

A, E, F, will likely be encroached upon most by rising sea levels.

Activity 15.2 Introduction to Coastlines

Name: _____ Course/Section: _____ Date: _____

A Refer to the photograph of the Po Delta, Italy (**Fig. 15.4**). During Etruscan times around 600 BC, the city of Adria was a busy seaport on the coastline at the mouth of the Po River. Adria was so important that the Adriatic Sea was named after it. The Po River has continued to deposit sediment at its mouth and has extended its delta far beyond Adria, which is no longer located on the coastline.

1. What has been the average annual rate (in cm/yr.) at which the Po Delta has extended toward the Adriatic Sea since Adria was a thriving seaport on the coast? Show your work. Distance Adria to delta = 48 km approx.
48 km ÷ 2600 yr = 0.0185 km/yr = 18.5 m/yr
18.5 m/yr = 1850 cm/yr approx

2. Based on the average annual rate that you just calculated, how many centimeters does the leading edge of the Po Delta move seaward during the lifetime of someone who lives to be 60 years old? Show your work.
60 yr × 1850 cm/yr = 111,000 cm/yr = 1.1 km

3. **REFLECT & DISCUSS** Sea level is rising and submerging coastlines adjacent to the Po Delta, and yet the delta is still extending out into the Adriatic Sea. Why? Because the Po river is supplying adequate sediment to stay ahead of sea level rise.

B Refer to the map and photographs of St. Catherines Island, Georgia (**Fig. 15.5**). Note that on the southwestern and east-central parts of the island there are large areas of salt marsh (**Fig. 15.5A**). Living salt marsh plants are present there as shown on the right (west) in **Figs. 15.5B** and **15.5C**. A sandy beach that occurs on the east side of the island can be seen in **Figs. 15.5B** and **15.5C** bounded on its seaward side (left) by another strip of marsh mud. This is a relict salt marsh consisting of mud from an ancient salt marsh that is eroding along the coastline.

1. What type of sediment is probably present beneath the beach sands in **Figs. 15.5B** and **15.5C**?
modern beach sands are probably deposited over older salt marsh mud.

2. Explain how you think the beach sands were deposited landward of the relict marsh mud.
likely deposited during high tides or storms.

3. Portions of the living salt marsh wetland in **Fig. 15.5C** recently have been buried by white sand that was deposited from storm waves that crashed over the beach and sand dunes. What is the name given to this type of sand body?
"washover fans"

4. **Fig. 15.5D** was taken from a landform called Aaron's Hill. It is the headland of this part of the island. What do you think will eventually happen to Aaron's Hill as sea level rises? Why?
Due to sea level rise, it will eventually be inundated or eroded away.

5. Based upon your answer in part 4, would Aaron's Hill be a good location for a resort hotel? Explain your answer.
No. It will be gone soon.

6. **REFLECT & DISCUSS** Based upon your inferences, observations, and explanations above, what will eventually happen to the living salt marsh in **Figs. 15.5B** and **15.5C**?
It will eventually be covered and killed by wash-over sand.

Coastline Modification at Ocean City, Maryland

Activity 15.3

Name: _____ **Course/Section:** _____ **Date:** _____

Ocean City is located on Fenwick Island, a long, narrow barrier island (**Fig. 15.7**). During a severe hurricane in 1933, the island was breached by tidal currents that formed Ocean City Inlet and split the barrier island in two. Ocean City is still located on what remains of Fenwick Island. The city is a popular vacation resort that has undergone much property development over the past 50 years. South of Ocean City Inlet, Assateague Island has remained undeveloped as a state and national seashore.

Rising sea level at Ocean City has increased the risk of beach erosion there, so barriers have been constructed there to trap sand. Examine the portion of the Ocean City, Maryland, topographic quadrangle map provided in **Fig. 15.7**. Outlines of the coastline as mapped in 1900 (black curves), 1942 (purple), 1964 (orange), and 2011 (blue) are shown on a portion of the USGS topographic map published in 2014, illustrating how this coastline has evolved over time.

A After the 1933 hurricane carved out a tidal channel through the barrier island just south of Ocean City, the Army Corps of Engineers constructed a pair of jetties on each side of the inlet to keep it open. These are labeled *post-1933 jetty* on **Fig. 15.7**. Sand filled in behind the northern jetty, so it is now a seawall forming the straight southern edge of Ocean City on Fenwick Island. Based on this information, would you say that the longshore current along this coastline is traveling north to south or south to north? Explain your reasoning.

North to South based on sand buildup on the Ocean City side of the jetty.

B Notice that since 1933 Assateague Island has migrated landward (west) relative to its 1900 position (**Fig. 15.7**).

1. Why did Assateague Island migrate landward? the jetties blocked its sand supply
2. Field inspection of the west side of Assateague Island reveals that muds of the lagoon (Sinepuxent Bay) are being covered up by the westward-advancing island. What was the rate of Assateague Island's westward migration from 1942–1964 in m/year? Show your work. 8 mm on map. Ratio = 58 mm / 1.5 km

Measure at the '1942' Label

$\frac{210\,m}{22\,yr} = 9.5\,m/yr$ $\frac{58\,mm}{1.5\,km} = \frac{8\,mm}{x}$ $x = 0.21\,km = 210\,m$

3. Based on your last answer in part **B2** and extrapolating from 1964, in what approximate year would you predict that Sinepuxent Bay should cease to exist as the west side of Assateague Island moves westward? Show your work.

490 m ÷ 9.5 m/yr = 52 yr 19 mm = 0.49 km to close waterway = 490 m " " "

4. Notice from the position of Assateague Island in 2011 that it has not merged with salt marshes of the mainland. What natural processes and human activities might have prevented this?

Dredging or currents in the waterway may keep the channel open.

C Notice the short black lines that represent groins that have been constructed on the east side of Fenwick Island (Ocean City) in the northeast corner of **Fig. 15.7**, about 2 km north of the inlet.

1. Why do you think these groins have been constructed there?

to capture sand to make the beach wider

2. What effect could these groins have on the beaches around Ocean City's Municipal Pier at the southern end of Fenwick Island? Why? they may "starve" the beaches to the South by blocking the North-South flow.

D Hurricanes normally approach Ocean City from the south–southeast. In 1995, Hurricane Felix approached Ocean City but turned back out into the Atlantic Ocean before making landfall. How does the westward migration of Assateague Island increase the risk of hurricane damage to Ocean City?

Its movement leaves the southern end of Ocean City exposed to hurricanes

E **REFLECT & DISCUSS** The westward migration of Assateague Island might be halted or even reversed if all of the groins, jetties, and seawalls around Ocean City were removed. How might removal of all of these structures affect the risk of environmental damage to properties in Ocean City? Removing these would lead to loss of sand, and leave structures along the shore exposed to erosion

F **REFLECT & DISCUSS** There has been a community of Ocean City on Fenwick Island since before 1900—for more than a century. The highest elevation in Ocean City is about 3 m (10 ft.), and most of the city is below 1.5 m (5 ft.). Do you think Ocean City is sustainable for the next century? Explain your answer.

Not likely. It will be very expensive to protect it from rising seas.

Activity 15.4 The Threat of Rising Seas

Name: _____ **Course/Section:** _____ **Date:** _____

In planning for coastal management and safe and economical coastal development, responsible planning commissions and real estate developers should "play it safe" and assume that sea level will continue to rise. There are many predictions of future rises in global mean sea level, but regional trends should also be considered as in these examples.

A Imagine that you are planning to buy a shorefront property in Ocean City, Maryland, this year. You plan to use the property for family vacation getaways over the next 50 years and then sell the property. The ground floor of the property was 1.2 m above mean sea level in 2010.

1. According to NOAA, the historic rate of sea level rise here since 1975 has been 5.48 +/− 1.67 mm/year. Using the "plus or minus" error, what has been the minimum rate and the maximum rate of mean sea level rise here in mm/year?

   (a) 3.8 mm/yr. minimum rate 5.48 mm/yr − 1.67 mm/yr = 3.81 mm/yr

   (b) 7.2 mm/yr. maximum rate 5.48 mm/yr + 1.67 mm/yr = 7.15 mm/yr

2. Using the minimum and maximum rates above and recalling that 1 in. = 25.4 mm, calculate how much sea level will rise in mm and in. at Ocean City over the next 50 years.

   (a) 190 mm minimum 3.81 mm/yr × 50 yr = 190.5 mm

   (b) 7.5 in. minimum 190.5 mm ÷ 25.4 mm/in = 7.5 in.

   (c) 360 mm maximum 7.15 mm/yr × 50 yr = 357.5 mm

   (d) 14 in. maximum 357.5 mm ÷ 25.4 mm/in = 14.1 in

3. Local mean sea level is the average position of sea level between low and high tides. High tides occasionally reach 0.88 m (2.9 ft.) above mean sea level here, and storm surges often raise sea level an additional 0.3 m (1 ft.). When Hurricane Sandy passed offshore of Ocean City in 2012, the storm surge caused a total storm tide of 3.59 feet. (Further north at Bergen Point tide gauge, Staten Island, New York, the National Weather Service reports a 2.87 m storm surge on top of a 1.57 m high tide, bringing the water level to 4.44 m above local mean sea level during Hurricane Sandy.) Given these natural day-to-day variations in sea level and the prospect of sea level rise calculated above, would it be a wise decision to purchase the shorefront property that you planned to buy? Explain your reasoning.

   No. High tides already nearly reach the front door of the home. Any storm surge will likely flood the first floor.

4. The city of Ocean City expects the following temporary increases in sea level due to storm surges in hurricanes. How would this affect your purchasing decision? Why?

   Category 1 hurricane: 74–95 mph winds, storm surge 1.22–1.52 m (4–5 ft.)
   Category 2 hurricane: 96–110 mph winds, storm surge 1.83–2.44 m (6–8 ft.)
   Category 3 hurricane: 111–130 mph winds, storm surge 2.74–3.66 m (9–12 ft.)
   Category 4 hurricane: 131–155 mph winds, storm surge 3.96–5.49 m (13–18 ft.)
   Category 5 hurricane: >156 mph winds, storm surge >5.49 m (>18 ft.)

   Don't buy. Even a Category 1 hurricane will flood this house.

B **REFLECT & DISCUSS** Based on your analysis of data in part A, what would you suggest as the minimum elevation of the floor of any new house or commercial building constructed along the Ocean City coast? Explain.

(Not assigned)