ACTIVITY 15.1 Coastline Inquiry

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

A. Refer to the photographs of coastlines in **FIGURE 15.1** and the list of Factors Affecting Coastlines on page 376.

1. Describe what each shoreline is made of (if visible). Then name the two or three main factors that are primarily affecting the coastline and describe how they combine to shape the coastline.

a. Maryland coastline with saltmarsh grasses rooted in clay.

b. San Francisco, California, coastline.

c. Oregon coastline.

d. North Carolina coastline.

e. Destin, Florida, urbanized coastline.

f. Florida Keys coastline with mangrove plants.

g. Maine coastline (note person for scale).

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

B. **REFLECT & DISCUSS** **FIGURES 15.1C** and **15.1D** are both sandy coastlines. Which one is building out into the water and what is causing that to happen? Which one seems to be receding landward, and what seems to be causing that to happen?

ACTIVITY 15.2 Introduction to Shorelines

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

A. Refer to the Space Shuttle photograph of the Po Delta, Italy (**FIGURE 15.4**). The city of Adria, on the Po River in Northern Italy, was a thriving seaport during Etruscan times (600 B.C.). Adria had such fame as to give its name to the Adriatic Sea, the gulf into which the Po River flows. Over the years, the Po River has deposited sediment at its mouth in the Po Delta. Because of the Po Delta's progradation, Adria is no longer located on the shoreline of the Adriatic Sea. The modern shoreline is far downstream from Adria.

1. What has been the average annual rate of Po Delta progradation in centimeters per year (cm/yr) since Adria was a thriving seaport on the coastline of the Adriatic Sea? (Show your work.)

2. Based on the average annual rate calculated above (A1), how many centimeters would the Po Delta prograde during the lifetime of someone who lived to be 60 years old? (Show your work.)

3. **REFLECT & DISCUSS** Sea level is rising and submerging coastlines adjacent to the Po Delta. Why do you think the delta prograding out into the Adriatic Sea?

B. Refer to the map and photographs of Saint Catherines Island, Georgia (**FIGURE 15.5**). Note that on the southwestern and east-central parts of the island there are large areas of salt marsh. Living salt marsh plants are present there, as shown on the right (west) in **FIGURES 15.5A** and **B**. Also, note the linear sandy beach in **FIGURES 15.5A** and **B**, bounded on its seaward side (left) by another strip of salt marsh mud. However, all of the living, surficial saltmarsh plants and animals have been stripped from this area. This is called **relict** salt marsh mud (mud remaining from an ancient salt marsh).

1. What type of sediment is probably present beneath the beach sands in **FIGURES 15.5A** and **B**?

2. Explain how you think the beach sands became located landward of the relict saltmarsh mud.

3. Portions of the living saltmarsh (wetland) in **FIGURE 15.5C** recently have been buried by bodies of white sand that was deposited from storm waves that crashed over the beach and sand dunes. What is the name given to such sand bodies?

4. Photograph 15.6C was taken from a landform called Aaron's Hill. It is the headland of this part of the island. What will eventually happen to Aaron's Hill? Why?

5. Based upon your answer in part 4, would Aaron's Hill be a good location for a resort hotel? Explain your answer.

6. **REFLECT & DISCUSS** Based upon your inferences, observations, and explanations above, what will eventually happen to the living salt marsh in **FIGURES 15.5B** and **C**?

ACTIVITY 15.3 Shoreline Modification at Ocean City, Maryland

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

Ocean City is located on a long, narrow barrier island called Fenwick Island. 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. The island south of Ocean City Inlet is called Assateague Island. It has remained undeveloped, as a state and national seashore.

Rising sea level at Ocean City has increased the risk of beach erosion there. Therefore, Ocean City constructed barriers to trap sand. Examine the portion of the Ocean City, Maryland, topographic quadrangle map provided in **FIGURE 15.7**. Purple features show changes made in 1972 to a 1964 map, so you can see how the coastline changed from 1964–1972. Also note the black and red outlines of the barrier island as it appeared in 1849 and 2010 according to the U.S. Geological Survey.

A. After the 1933 hurricane carved out Ocean City Inlet, the Army Corps of Engineers constructed a pair of jetties on each side of Ocean City Inlet to keep it open. The southern jetty is labeled "seawall" on the map. Sand filled in behind the northern jetty, so it is now a seawall forming the straight southern edge of Ocean City on Fenwick Island (a straight black line on the map). 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.

B. Notice that Assateague Island has migrated landward (west), relative to its 1849 position (**FIGURE 15.7**). This migration began in 1933.

1. Why did Assateague Island migrate landward?

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 1933–1972 in feet/year and meters/year? (Show your work.)

3. Based on your last answer above (B2), and extrapolating from 1972, in what approximate year should the west side of Assateague Island have merged with saltmarshes around Ocean City Harbor? (Show your work.)

4. Notice from the 2010 position of Assateague Island (red outline on **FIGURE 15.7**) that it has not merged with saltmarshes of the mainland. What natural processes and human activities may have prevented this?

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

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

2. What effect could these groins have on the beaches around Ocean City's Municipal Pier (southern end of Fenwick Island)? Why?

D. Hurricanes normally approach Ocean City from the south–southeast. In 1995, one of the largest hurricanes ever recorded (Hurricane Felix) approached Ocean City but miraculously turned back out into the Atlantic Ocean. How does the westward migration of Assateague Island increase the risk of hurricane damage to Ocean City?

E. Compare the position of Assateague Island in **FIGURE 15.7**, from 1972 (purple position of the island) to 2010 (red outline of the island). The northern two kilometers of the island remained in a relatively stable position from 1972–2010, but the rest of Assateague Island did not. Explain what happened to the southern three kilometers of Assateague Island on **FIGURE 15.7** from 1972–2010 and infer why it may have happened.

F. **REFLECT & DISCUSS** The westward migration of Assateague Island could be halted and probably reversed if all of the groins, jetties, and sea walls around Ocean City were removed. How would removal of all of these structures place properties in Ocean City at greater risk to environmental damage than they now face?

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 front door of the property was four feet above mean sea level in 2010.

1. According to the U.S. National Oceanic and Atmospheric Administration, the historic rate of sea level rise here since 1975 has been 5.48 +/– 1.67 mm/yr. Using the "plus or minus" error, what has been the minimum rate and the maximum rate of mean sea level rise here in mm/yr?

   a. _____ mm/yr minimum rate **b.** _____ mm/yr maximum rate

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

   a. _____ mm minimum **b.** _____ inches minimum

   c. _____ mm maximum **d.** _____ inches maximum

3. Mean sea level is the average position of sea level between low and high tides. High tides occasionally reach 2.9 feet (0.88 m) above mean sea level here, and storm surges often raise sea level an additional foot (0.3 m). When Hurricane Sandy passed offshore of Ocean City in 2012, the storm surge caused a total storm tide of 3.59 feet. 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.

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: 4–5 feet

   Category 2 hurricane: 96–110 mph winds, Storm Surge: 6–8 feet

   Category 3 hurricane: 111–130 mph winds, Storm Surge: 9–12 feet

   Category 4 hurricane: 131–155 mph winds, Storm Surge: 13–18 feet

   Category 5 hurricane: 156 mph + winds, Storm Surge: more than 18 feet

5. **REFLECT & DISCUSS** Given the fact that most existing topographic maps of coastal areas have contour intervals of 5 feet, what would you suggest as the contour line below which construction of the living/working floor of homes should not occur along the Ocean City coast? Explain.