

## GENERAL ESTUARY QUESTIONS

### 1.) An estuary is:

- a.) A partially enclosed body of water (such as bays, lagoons, sounds or sloughs) where two different bodies of water meet and mix.
- b.) Where the freshwater rivers meet the saltwater seas.
- c.) A partially enclosed coastal wetland, occurring at a river mouth, where a creek or river meets, mixes, and interacts with a larger water body, such as a Great Lake or Ocean.
- d.) All the above definitions are acceptable and used by national agencies to define estuaries in a variety of government resources, dependent on which kind of estuary they are referencing in a particular region of the country.

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### 2.) Estuaries are classified by their water circulation. Which kind of estuary is found on the Great Lakes?

- a.) Salt-wedge – An estuary with a wedge-shaped layer of saltwater which lies below a fresh water layer. A salt-wedge occurs when a rapidly flowing river discharges into an estuary with weak ocean currents. A sharp boundary is created between the salt and freshwater layers. Fresh water floats on top and a wedge of saltwater lies on the bottom because the saltwater has a higher density than the fresh.
- b.) Fjord – An estuary with restricted flow due to a series of sills and channels carved by glaciers. Glaciers carved deep channels and then melted and left shallow barriers, or sills, at the estuary floor near the ocean. These sills restrict estuary water from circulating between the estuary and the open ocean. Only the lighter freshwater near the surface flows over the sill and out toward the ocean.
- c.) Slightly Stratified – An estuary where saltwater and freshwater mix at some, but not all depths. Lower layers of water near the estuary bottom typically remain saltier than the upper layers near the water surface. Higher salt content (salinity) is greatest at the mouth of an estuary near the ocean.
- d.) Vertically Mixed – An estuary where the saltwater and freshwater mix at all depths. This occurs when a river's fresh water flow is low and the ocean's tidal currents are moderate to strong. The water salinity in a vertically mixed estuary is the same from the top of the water to the bottom of the estuary
- e.) Freshwater - Freshwater estuaries are semi-enclosed areas, where the lake waters become mixed with inflowing rivers or streams.

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3.) Tides greatly affect the water levels of all estuaries around the nation. Please explain how tides in the Great Lakes affect estuaries differently from all other coastal estuaries in the nation:

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- a.) Great Lakes lunar tides are up to 3' tall and either drain or fill the estuaries dependent on whether the tide is high or low.
- b.) While the Great Lakes do exhibit tides, they are extremely small (usually 4 cm or less). Most changes in the water level are due to seiches, wind-driven waves which act like tides, exchanging water between the river and the lake.
- c.) Only Tsunami events can cause lunar tides to form in the Great Lakes. Thus tidal effects occur only once every 600 years in the Great Lakes Region. This very rare event could flood the estuaries and destroy their plant communities.
- d.) None of the above are correct statements.

4.) Estuaries and, wetlands in general, provide which of the following functions and values?

- a.) Wetlands purify water and reduce the pollution that enters Lake Erie, a drinking water source for 11 million people. Wetlands can retain up to 80% of nitrates and 92% of phosphorus in surface water, can reduce the impact of sedimentation on water quality and can degrade and remove contaminants such as pesticides and medications.
- b.) Wetlands store flood waters. For example, research on the Old Woman Creek wetland in Huron, Ohio showed that the wetland volume expands by 20% after a major storm event and holds run-off for several hours.
- c.) Wetlands are home to plants and animals, especially those that are rare. Over 40 species of Lake Erie fish use Old Woman Creek estuary at some point in their life cycle, including for spawning and as nurseries for young fish. Ohio's portion of the Lake Erie fishery is valued at \$800 million.
- d.) All of the above.

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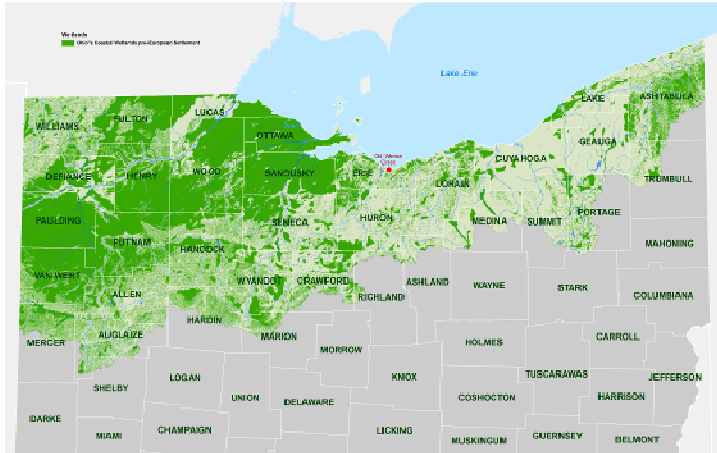
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**5.) An Estuary is one kind of wetland occurring on the coast of Lake Erie. When combining estuary losses with all other kinds of wetlands lost in Ohio, the extent of that loss is:**

(Hint you can use the map provided below to see how many coastal wetlands were here prior to European settlement. Green area on the map indicates that the area was previously wetland.)

- a.) Approximately 90 % lost, Ohio is 2nd only to California in wetland losses.
- b.) Approximately 40% lost, Ohio is 2nd only to Iowa in wetland losses.
- c.) Approximately 10% lost, similar to Hawaii.
- d.) Approximately 2% lost, similar to Texas.



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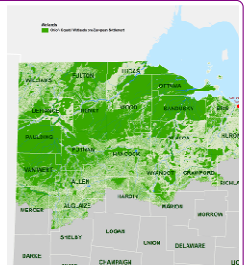
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**6.) One of the main factors stressing Great Lakes freshwater estuaries today include:**

- a.) Invasive plants and invasive animals
- b.) Overactive radiation pollution
- c.) Native fish overpopulating the carrying capacity
- d.) All of the above

**7.) If Climate Science predictions are correct for the future, Great Lakes estuaries water levels may lower; and, Ocean Estuaries may experience...**

- a.) Sea level rise causing their plant communities to be drowned out, thus destroying the marsh habitat in their estuaries
- b.) Sea level drop causing their animal communities to suffer loss of water, thus leaving mussels and other non-mobile estuarine animals high and dry
- c.) No change is predicted.

**8.) A main stressor on all estuaries, whether they are saltwater or freshwater is non-point source pollution. Non-point source pollution includes things such as:**

- a.) Factories whose cooling systems' water pipes empty hot water into the streams feeding the estuaries
- b.) Agricultural run-off such as excess herbicides lost in large rainfall events
- c.) Fertilizers over-applied in urban landscapes
- d.) Answers b and c are both correct

**9.) Many lake fish species utilize the estuaries for at least part of their lives, usually for nursery grounds for young. Using the NOAA Great Lakes food chain (pdf file attached), note which is a correct statement:**

- a.) The invasive Zebra and Quagga mussels are not impacting the phytoplankton in the aquatic food chain; in fact they are added as a food supply for the round goby.
- b.) The native water flea is used by water quality labs frequently as an indicator of the good health of a water supply. If a pollution event occurred and all of these disappeared we would also lose blue-green algae populations as primary producers in the food chain.
- c.) If diatoms, green algae, blue-green algae, and flagellates were eliminated, the food chain of Lake Erie would crash completely.
- d.) None of the above is correct.

**10.) ODNR Division of Wildlife and US Fish & Wildlife work collaboratively to protect endangered, threatened, or species "of concern" animals in coastal wetland areas at state and federal levels. In Ohio, which wetland species listed is a focus for these biologists?**

- a.) Muskrat
- b.) Red Fox
- c.) Red-winged Black Bird
- d.) Lake Erie Water Snake

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a.) We worked with the water department to install devices to screen out the pills floating down the stream.¶  
b.) We worked with the health department to ask for restrictions in amounts of pharmaceuticals that the local pharmacies could supply their customers.¶  
c.) We worked with local legislators to try to educate the community in general and are seeking to have collection points installed for common unused pharmaceuticals so that they are not disposed of into watercourses.¶  
d.) All of these make sense to implement¶  
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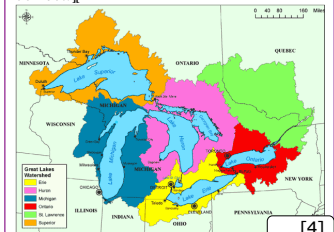
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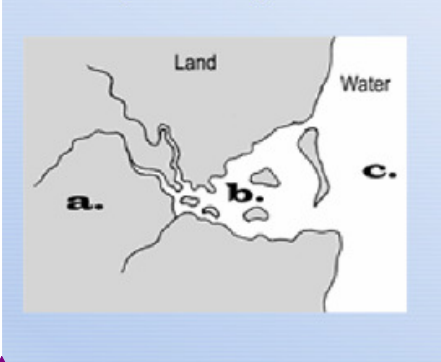
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11.) Interpret the diagram and indicate which statement is correct.



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- a.) The estuary is located in zones a, b, and c; water meets and mixes in all zones.
- b.) The estuary is located in zone b where two water bodies meet and mix, while zone a indicates the freshwater system that is inputting freshwater into the estuary, and zone c indicates either the lake or the ocean.
- c.) The estuary is located in zone c; we know this is due to the barrier beach separating zones b and c.
- d.) Neither a, b, nor c is an estuary; this system is not indicative of an estuary system at all because a partially enclosed water body is not represented.

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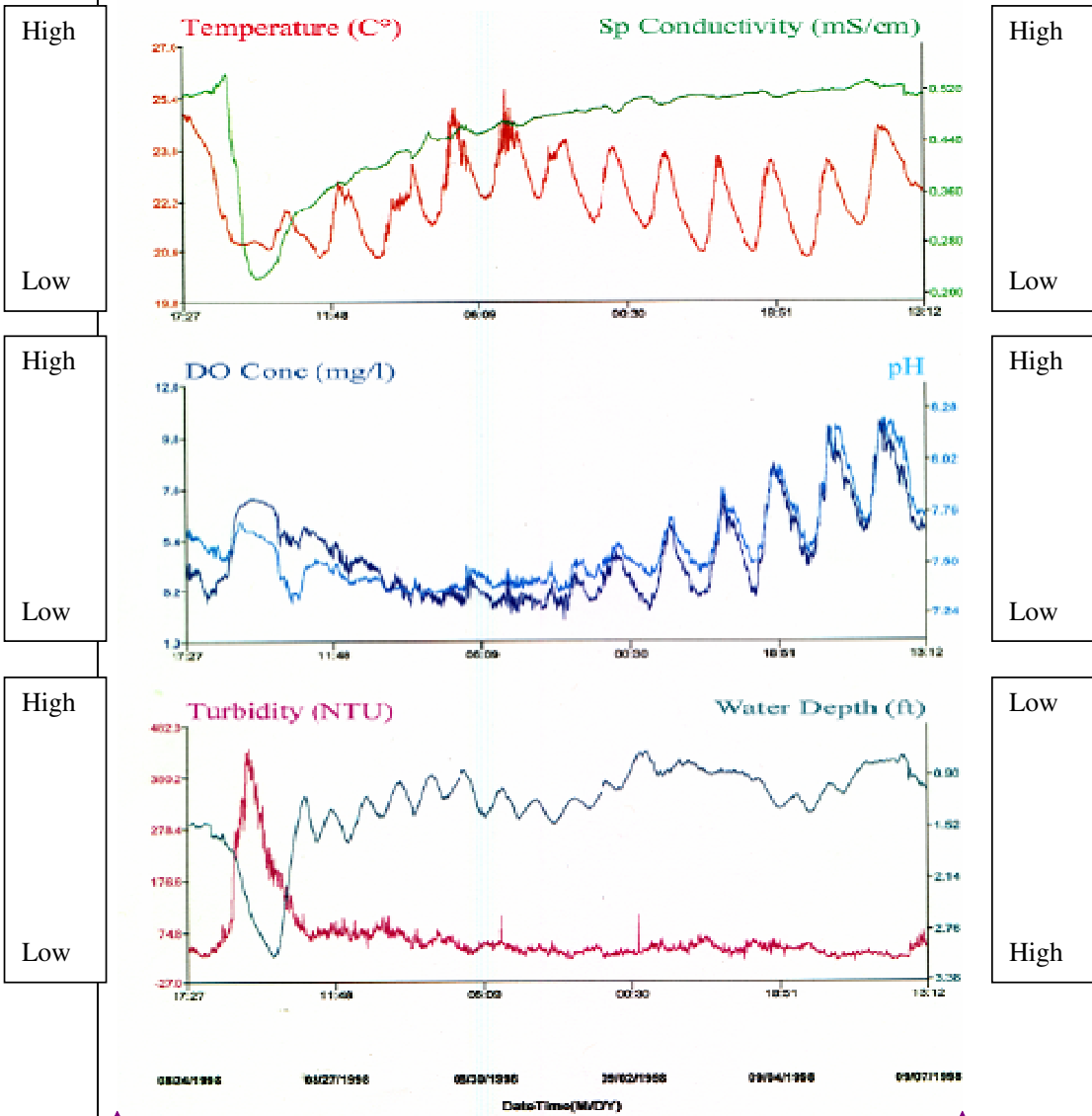
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For questions 12-14: Use the graphs below to interpret the water quality data taken at Old Woman Creek Estuary. Data is collected multiple times over the course of a day at the Reserve until the ice freezes the water during the winter months.

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**12.) Dissolved oxygen (DO) and pH:**

- a.) Are linked. Thus, as Oxygen goes up, pH goes up.
- b.) Fluctuate oppositely. Thus, as Oxygen goes up, pH goes down.
- c.) Are not linked. Thus, do not show any similarities in trends.
- d.) None of the above.

**13.) Dissolved oxygen (DO) and temperature:**

- a.) Warmer temperatures in the water yield more ability to hold more dissolved oxygen.
- b.) Colder temperatures in water yield more ability to hold more dissolved oxygen.
- c.) Are not linked. Thus, do not show any similarities in trends.
- d.) None of the above.

**14.) Turbidity and water depth:**

- a.) As water level drops, turbidity increases. As water level increases, turbidity decreases.
- b.) As water level drops, turbidity decreases. As water level increases, turbidity increases.
- c.) Are not linked. Thus, do not show any similarities in trends.
- d.) None of the above.

**15.) Ohio is divided in terms of drainage patterns (or watersheds). Portions of Ohio drain north to the Lake with river systems each having an estuary environment prior to the water getting to the lake itself, while the rest of Ohio's watercourses drain toward estuaries in which NERR state?**

- a.) Mississippi
- b.) Oregon
- c.) Delaware
- d.) Florida

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19.) Using the map of the reserves provided, answer this question. Which of the NERR Reserve Regions w... [5]

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16.) Reference the map of Great Lakes Major Estuaries to answer the next question. Which of the following statements is correct?



- a.) The lessons learned from research completed at Old Woman Creek National Estuarine Research Reserve are intended to help all Great Lakes estuaries.
- b.) The lessons learned from research completed at Old Woman Creek National Estuarine Research Reserve could only apply to Old Woman Creek Estuary, and it would not be proper to apply this information elsewhere.
- c.) Ohio has estuaries at every major river system entering into the lake. Many of these have been altered for shipping and/or development, thus they are no longer considered estuaries, and thus are not indicated on this map.
- d.) None of the above are correct statements.

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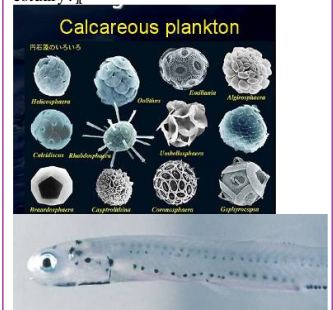
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Reef Building Coral will suffer who need calcium to make their shells.¶  
Calcareous plankton will suffer who use calcium to form their protective ... [6]

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**17.) There are only two relatively undisturbed estuaries left on Lake Erie; they are Old Woman Creek Estuary on Ohio's north central coast and Arcola Creek Estuary in the northeastern region. All other estuaries on the Lake Erie coast have been altered to allow for shipping, recreational boating, or urban development. These areas still have estuarine environments where water mixing occurs, but they do not possess all the functions and values of the natural estuaries.**

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- a.) True
- b.) False

**18.) Of all organisms capable of producing oxygen through photosynthesis, algae are responsible for most of the oxygen in the atmosphere.**

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- a.) True
- b.) False

**19.) Water-borne commerce moves millions of tons of cargo (coal, grains, iron ore, cement, chemicals, limestone, etc.) annually through Lake Erie. Shipping is an economically efficient method of transporting raw materials, finished goods and agricultural products. However, shipping is also a vector for non-native species, several of which may be detrimental to the Lake Erie ecosystem.**

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- a.) True
- b.) False

**20.) All of Sandusky Bay would be considered an estuarine environment due to its Barrier Beach forming at the opening of the Bay to Lake Erie giving it the partially enclosed area to mix; while Maumee Bay is not considered estuary due to it not being a partially enclosed bay and the fact that the currents of Lake Erie form the sand barrier beach at the mouth of the river rather than the mouth of the bay.**

a.) True¶  
b.) False¶

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- a.) True
- b.) False

**OHIO SITE SPECIFIC QUESTIONS:**

**21.) The macro invertebrates in this lab tray were collected here at this site. Use the chart below, used by volunteer stream monitors throughout Ohio, to decipher if this collection means for the quality of the water in the creek.**

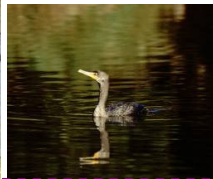
- a.) The water is poor quality, and likely very polluted. Restoration efforts need to take place.
- b.) The water is medium quality, and some pollution exists. Minimum restoration efforts could enhance this area.
- c.) The water is high quality, with very little pollution. Do not focus on restoration efforts; rather focus on keeping the watershed surrounding this creek in a similar manner, possibly through conservation easements.
- d.) There is not sufficient information to make any such determination.

**22.) Identify this turtle common in Ohio estuaries and coastal wetlands.**

- a.) Blanding's turtle
- b.) Eastern box turtle
- c.) Snapping turtle
- d.) Midland painted turtle

**23.) Look at the scenes showing animals in the estuaries. Of these four posters, which one shows the animal that was down to only 4 productive mating pairs in 1972, and that rose to 180 productive pairs in 2010. Juveniles can be seen all year long in the estuaries, which provide a rich feeding ground, including eating fish snacks at the ice breaks in the winter, enjoying a buffet lunch at the fish spawning in the spring, and eating small muskrats and fish in the summer and fall. Which of these pictures shows Ohio Division of Wildlife's most successful assistance to an endangered animal?**

- a.) Cormorant
- b.) Great Blue Heron
- c.) Great Egret
- d.) Bald Eagle



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Deleted: 30.) Estuaries are a type of wetland found on the Great Lakes coast and on all oceanic coasts. Estuaries are not possible at the site we are testing at here today because it is not on the coast. However, we do know that wetlands show three common characteristics, even though they may not be estuaries. Study the area (encircled with caution tape) to look for these three characteristics. Indicate which set of flags best tells us that this site could be a wetland: ¶ (Feel free to use the plant guides, or take a soil sample with the probe and use the soil guides as needed to make your determination.)¶ ... [7]

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**24.) Identify this taxidermy using the field guide provided. It is a common species of waterfowl found in the estuary and in wetlands throughout Ohio.**

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- a.) Wood duck
- b.) Mallard
- c.) Pintail
- d.) Redhead

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**25.) Research Reserves have to categorize their habitats and document changes over time. Look at the posters of portions of the reserve. Please classify the habitat.**

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- a.) X and Y are both marsh.
- b.) X is shrub-scrub, Y is marsh.
- c.) X is wet prairie, Y is open water.
- d.) X is swamp forest, Y is marsh.

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**26.) Analyze the two trays of sand samples. (Feel free to use the magnifying tools, magnets, and water bottles provided on the table to get a better look.) One of these is from the Barrier Beach of Old Woman Creek Estuary with Lake Erie. The other is from this site where we are currently located. Indicate the correct statement.**

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- a.) Tray Y is from the Barrier Beach. Tray X is from this site here. We know this due to the color variations in the sand indicating presence of Barium, only found on Lake Erie.
- b.) Tray X is from the Barrier Beach. Tray Y is from this site here. We know this due to the presence of zebra mussel shells, which prefer the rocky shores of Lake Erie versus the muddy substrates here in the creek.
- c.) Tray X is from the Barrier Beach. Tray Y is from this site here. We know this due to the magnetic properties shown in the Tray Y (creek) sample.
- c.) These two sands are exactly alike. I see no differences whatsoever, and feel that our instructor has mixed the samples just to confuse us.

27.) Use the probe to determine the reading for the dissolved oxygen for this water sample. Animals need at least 2 part per million (or 20%) Dissolved Oxygen to survive. Based on your reading, you determine what?

- a.) The dissolved oxygen is too low here. We should not expect animals to live in this water.
- b.) This dissolved oxygen level here is good and will support life.

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- a.) Phytoplankton—the primary producers of the aquatic food chain and the source of 60% of the oxygen we breathe.
- b.) Zooplankton—the animal-like microscopic organisms at the bottom of the aquatic food chain.
- c.) Diatom—we know this due to the presence of silica all over its body.
- d.) Blue Green Algae—this is the algae that can be toxic to humans and other animals.

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6.) Through the National Estuarine Research Reserve System, a national collaboration of scientists, funded by NOAA (the National Oceanic and Atmospheric Association) works together to collect data in estuaries. The System Wide Monitoring Program (SWMP) data follows a national protocol to make sure that it can be compared across the country. Which of the following six items are water quality parameters that are the focus of the water quality data collections that occur at fifteen minute intervals daily using electronic instruments deployed in the estuaries (see picture below)?

- a.) Turbidity, salinity/conductivity, temperature, water depth, dissolved oxygen, and wind speed
- b.) Turbidity, salinity/conductivity, evaporation, temperature, water depth, and pH
- c.) Turbidity, salinity/conductivity, temperature, water depth, dissolved oxygen, and pH
- d.) Turbidity, salinity/conductivity, wave height, rainfall, dissolved oxygen, and pH



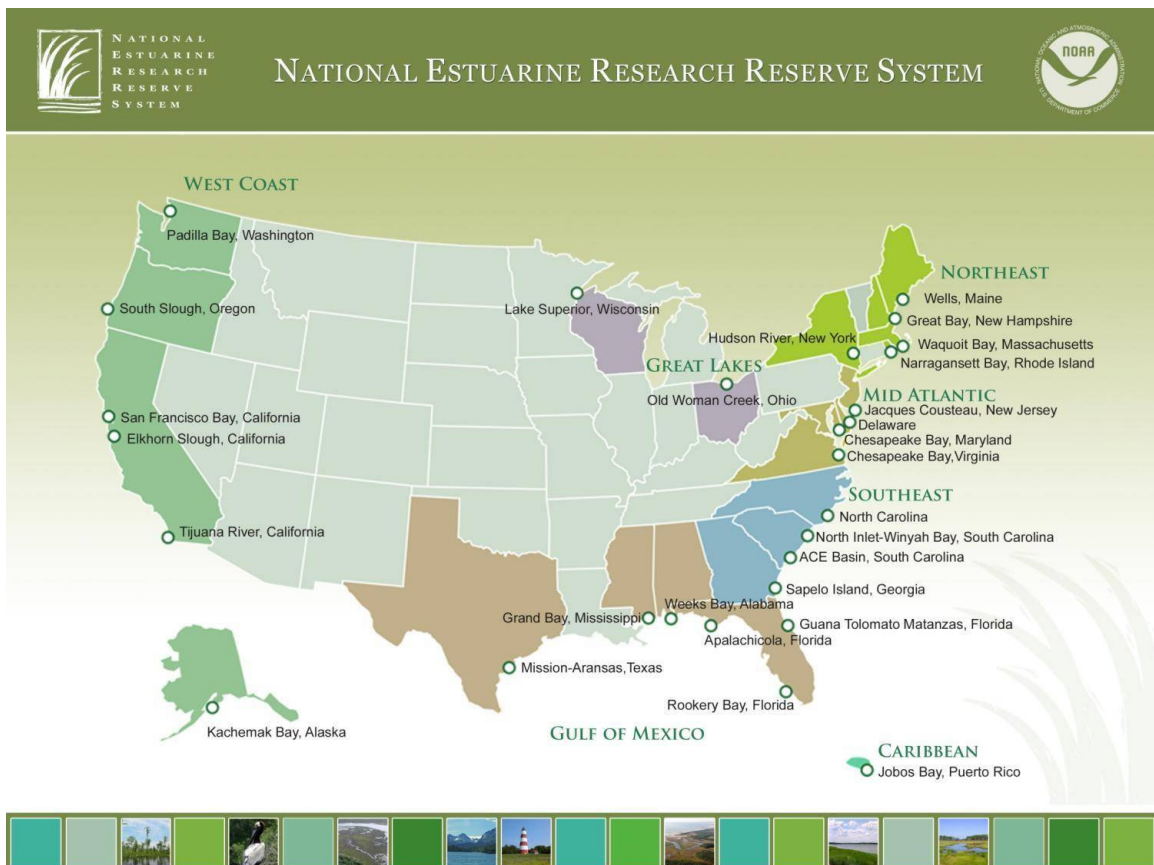
7.) Weather data is collected at each of the National Estuarine Research Reserve estuaries as well, as part of the national protocol. Other NOAA offices, such as the NOAA National Weather Service utilize this data as well. Here is a picture (above) of the Old Woman Creek weather monitoring tower. This instrument measures a variety of weather information necessary to make the Marine Forecasts (alerts) for Lake Erie. Based on your knowledge of what is the most important factor affecting Lake Erie's waves, which factor below do the meteorologists working out of the NOAA National Weather forecast station at Cleveland Airport use the most to determine whether to issue an alert or not?

- a.) Temperature
- b.) Wind speed
- c.) Precipitation/rainfall amounts
- d.) All of the above

14.) The Great Lakes watershed is shown below. Using this diagram, indicate which statement is correct.



- If snow melt is very high in the orange zone and dark blue zone, then it is likely that Ohio estuaries will have relatively high water levels.
- If estuaries in the red zone have high snow melt, then that water will eventually back feed into Lake Erie estuaries.
- Estuary water line Mean Sea Level elevations in the dark blue and pink zones are never anticipated to be the same, as Lake Michigan and Lake Huron are never at the same elevation levels.
- Water from the lakes and coastal estuaries flows in the following pattern: from the yellow zone, to the pink and dark blue zones.



19.) Using the map of the reserves provided, answer this question. Which of the NERR Reserve Regions were most active in helping clean up last summer's catastrophic oil spill?

- a.) West Coast (green)
- b.) Gulf Coast (brown)
- c.) South East Atlantic (blue)
- d.) Great Lakes (purple)

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22.) Ocean acidification has been studied by NOAA, NERRS and EPA scientists working in national estuaries and oceans. The oceans saltwater have absorbed approximately 525 billion tons of carbon dioxide from the atmosphere, thus reducing the pH of the water. What animals do Marine biologists in the saltwater estuaries predict will be severely impacted by decreased pH in the ocean and/or estuary?



Reef Building Coral will suffer who need calcium to make their shells.  
Calcareous plankton will suffer who use calcium to form their protective coverings.  
Marine species, including commercial fish and shellfish, will suffer due to larval forms not being able to withstand or adapt to the pH levels.  
All of the above

23.) Although there are not many native U.S. animals that can live in both freshwater and saltwater, there are a few rare animals that have this ability. One of these frequents the saltwater estuaries of the south, and then swims up large freshwater rivers to have their young. Which animal is it?

- a.) Great white shark
- b.) Blue crab
- c.) Salmon
- d.) Killer whale

24.) Unlike brackish estuaries that are tidally driven, freshwater estuaries are storm-driven.

- a.) True
- b.) False

**30.) Estuaries are a type of wetland found on the Great Lakes coast and on all oceanic coasts. Estuaries are not possible at the site we are testing at here today because it is not on the coast. However, we do know that wetlands show three common characteristics, even though they may not be estuaries. Study the area (encircled with caution tape) to look for these three characteristics. Indicate which set of flags best tells us that this site could be a wetland:**

**(Feel free to use the plant guides, or take a soil sample with the probe and use the soil guides as needed to make your determination.)**

- a.) Flag X is in hydric soils, Flag Y is near hydric plants, Flag Z shows evidence of water at site at least part of the time**
- b.) Flag U is presence of sands and gravels, Flag V is swamp hardwoods, and Flag W is evidence of water at least part of the time**
- c.) All the above indicate that this site is a wetland.**
- d.) None of the above. The sites marked do not meet all the qualifications including hydric soils, water loving plants, and presence of water at least part of the year.**

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**32.) When wetlands are destroyed due to development; developers must pay to have the wetland mitigated (or rebuilt elsewhere in the watershed or in the state).**

**Although we have made many advances in wetland restoration techniques, we still have a lot of mitigated wetlands that do not function as well as the wetlands that were destroyed. Something as simple as how much slope is on the side of the dike or pool (is it a huge drop off or a gentle slope) can greatly influence which amphibians are able to use the site. One common amphibian though, is very resilient and is able to occupy most mitigated wetlands regardless of slope. Listen to the sound on the tape to identify this common amphibian found in natural and restored wetlands around Ohio.**

- a.) Bullfrog**
- b.) Tree toad**
- c.) Spadefoot**
- d.) Spring peeper**

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**33.) Estuaries are determined to end where the first riffle occurs at the intersection of the creek with the estuary. Identify the riffle area and pool area of this site.**

- a.) Riffle is marked with Flag X; Pool is marked with flag Y**
- b.) Riffle is marked with Flag Y; Pool is marked with flag X**

35.) Look at the water quality data graphics along with the tides information and site specific information about the morphology of the sites, provided from NERR sites around various regions of the country. Determine who has the most dissolved oxygen between these sites and why you believe this is the case.

a.) Alaska's Kachemak Bay NERR has the most dissolved oxygen, as it also has the coldest water. Colder waters have more ability to hold oxygen than all the other warmer sites. Also Alaska has a twice daily tide of 28' which causes a lot of mixing to occur, replenishing the waters with oxygen.

b.) California's Tijuana NERR has the most dissolved oxygen, as it is the warmest waters. Also it has very little to no mixing, thus oxygenated water in the estuary is not lost to the ocean waters.

c.) Ohio's Old Woman Creek NERR has the most dissolved oxygen, as on the Great Lakes the estuaries are periodically separated from their lake by a barrier beach. When the barrier beach forms, then the mouth of the estuary closes. Microscopic Algae and Phytoplankton thus are able to build up in the estuary, allowing greater than 100% oxygen to occur.

d.) Alabama's Weeks Bay NERR has the most dissolved oxygen, as in the south less animals are present due to the oil spill that occurred last year. The oil also binds with the oxygen, thus allowing the waters there to have higher dissolved oxygen levels.

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**36.) Dead Zones are large regions of water very low in oxygen that occur along many of the world's coastlines including the central basin of Lake Erie and in the Gulf of Mexico near the mouth of the Mississippi. Dead Zones are caused by excess nutrients in the water that lead to algal blooms. When the algae die, the process of decomposition consumes oxygen in the water, which can kill fish and other organisms. What can be done to fix this problem?**

**a.) Use fewer fertilizers and adjust the timing of fertilizer and manure applications to limit run-off of excess nutrients from farmland; restore wetlands to help trap pollutants.**

- b.) Allow livestock direct access to streams and rivers; install fencing to keep livestock in direct contact with their needed water supply.**
- c.) Discharge septic system overflow waters directly into the streams and rivers: Work with the local health department to assess your septic system and check for potential upgrades needed.**
- d.) Discharge nutrients, organic matter, and chemicals from manufacturing facilities.**

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