

2011 West Virginia Envirothon

5th Topic Scenario- "Estuaries"

Background:

Historically, estuaries have been defined as places where fresh water from streams mix with the saltwater from the ocean. There are no two identical estuaries. They are partially enclosed bodies of water. Most estuaries in the United States are found where rivers empty into the Oceans.

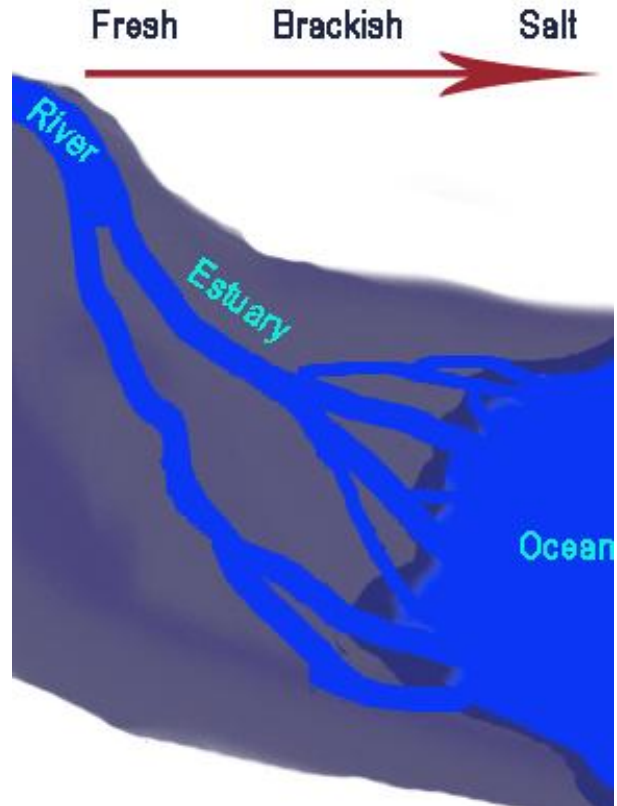
Examples are the Chesapeake Bay and the Mississippi Delta region. Some, especially in northern latitudes, may have been carved out by glacial action on river beds near the coastline.

Saltwater estuaries have an interesting mixture of freshwater and saltwater that varies from place to place in the estuary. The salt content or salinity of the estuary constantly changes. When freshwater mixes with saltwater, it is called brackish water.

Although saltwater estuaries are influenced by the tides, they are protected from the full force of the ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand that surround them.

Saltwater estuaries provide commercial, recreational, cultural, and environmental benefits. These estuaries provide habitat for over 75% of the United States commercial sea catch. Estuaries provide jobs and are important centers of transportation and commerce. Recreational benefits of estuaries include fishing, boating, beaches, and tourism. The areas surrounding them benefit culturally because they are usually centers of trade. They are valuable sources of food, and they also buffer communities from storm surges.

A great divergence of species relies on the various habitats afforded by estuaries. This makes them important environmentally. Estuaries also help with water filtration and habitat protection. Saltwater estuaries are important to the environment and need to be protected.



More recently, some scientists have recognized areas where river water mixes with water from large lakes (The Great Lakes for example) as freshwater estuaries. These water resources are important components of surrounding communities. They support abundant fish and wildlife, offer recreational opportunities, contribute to water quality, and provide economic benefits. Freshwater estuaries are unique combinations of river and lake water that possess three common characteristics: 1) a drowned river mouth, 2) a zone where lake and river water mix, and 3) influence from seiche or wind tides. Unlike brackish estuaries that are tidally driven, freshwater estuaries are storm-driven. In freshwater estuaries the composition of the water is often regulated by storm surges and subsequent seiches (vertical oscillations, or sloshing, of lake water). Most changes in the water level are due to seiches, which act like tides, exchanging water between the river and a large lake. Stratification and mixing of water in freshwater estuaries is also due to changes in temperature differences between stream water and large lake waters. The shallow waters of streams respond quicker to changes in temperature changes than deeper lake waters. These changes affect the temperature of the water, its pH, dissolved oxygen and the salinity of the two water bodies, thus influencing the chemistry of this type of estuarine system.

Both saltwater estuaries and freshwater estuaries face many challenges; one of which is over-population of the area surrounding them. More than half of the people in the U.S. live within 100 miles of the coast. Communities in these areas are growing three times faster than other parts of the country. Another challenge is pollution of water and habitat. These challenges can contribute to unsafe drinking water, algae blooms, loss of habitat, reduction of species, and other natural resource problems.

Plants and animals need nutrients, such as nitrogen and phosphorus, in order to grow. However, if an estuary has too many nutrients, too much algae will grow, creating algae blooms. The blooms block sunlight and can suffocate fish and plant life by using up oxygen from the water. Because estuaries receive water from rivers, all the nutrients that are transported by those waters eventually reach the estuary. These nutrients can enter estuaries from sewage treatment plants, septic systems, city water runoff, fertilizers, and polluted air.

Sedimentation is a natural process, but it can be greatly accelerated by human action. Sediments can interfere with fish feeding and breeding mechanisms. Their eggs can be smothered by sediment, and silt can erode the gills of fish. Habitats have been destroyed by sediments, because they can prevent organisms from growing, breathing, and feeding.

Although West Virginia is a land -locked state, activities in the Mountain State affect two main estuaries: the Chesapeake Bay and the Mississippi Delta. **[The focus of the 2011 WV Envirothon Fifth Topic is the Mississippi Delta estuary.](#)**

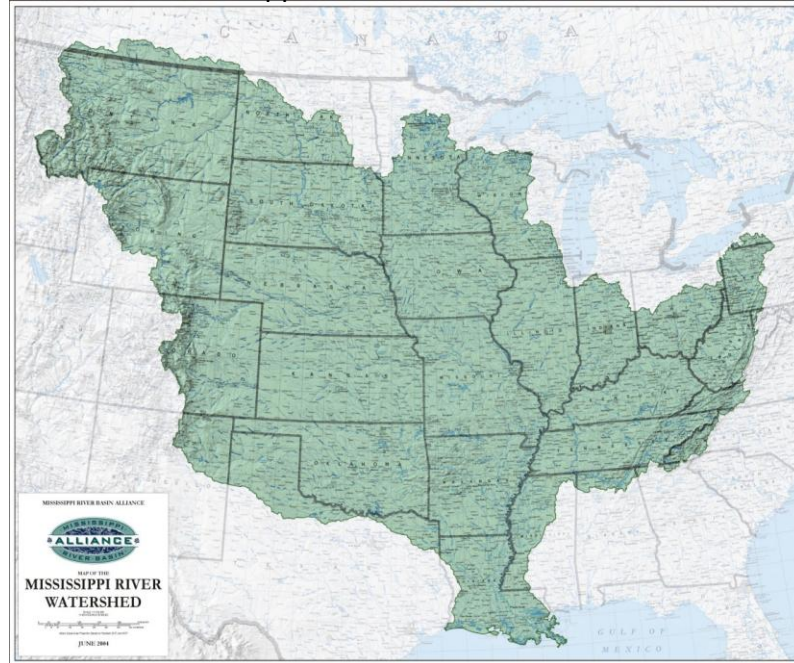
The Mississippi Delta is located off the coast of Louisiana, at the end of the Mississippi River. The Mississippi River's Watershed consists of 1,245,000 square miles, which is

796,800,000 acres, making it the fourth largest drainage basin in the world. West Virginia contributes to the Mississippi River as part of the Ohio River drainage basin. West Virginia is one of 14 states contributing to the Ohio drainage basin, which has an area of 189,422 square miles, or 121,230,080 acres.

Ohio River Watershed



Mississippi Delta Watershed



With the information provided and your own research, the State of West Virginia needs your team to develop a social marketing campaign to encourage and convince residents within the Mississippi River Watershed (most of West Virginia) to reduce the nitrogen and sediment load our rivers contribute to the estuaries in the Mississippi River Delta.

Flatwoods WV, the site of the 2011 State Envirothon, is located within the Mississippi Delta Watershed. The presentation of your marketing campaign must address, but is not limited to, addressing the following items:

1. Results and analysis of a survey conducted by your team measuring the public's knowledge of the following:
 - a. Nitrogen and sediment pollution in your own local major watershed.
 - b. Methods those residents may take to decrease this nitrogen and sediment pollution load. * If your team is in the Potomac Watershed, your survey of the public's knowledge in your area can be applied to the Flatwoods area as well to complete part 2 and 3.

2. A marketing campaign with the following message: “How can the Individual Landowner Reduce Nitrogen and Sediment Load in the Mississippi Delta Estuaries?”
 - a. How can radio, television, or other media advertisements be used to spread your message?
 - b. Create a logo or symbol for your Marketing Campaign.
 - c. Elaborate on details regarding other marketing strategies that may be effective.
 - d. Elaborate on how to get Flatwoods WV residents to buy into saving the Mississippi Delta Estuaries when WV only contributes a small percentage of nutrient and sediment pollution to them.
3. An explanation of how this campaign will demonstrate nitrogen and sediment reduction within the Mississippi Delta Estuaries and how that will help to relieve the hypoxic zone in the Gulf of Mexico.

<http://freshwaterestuary.uwex.edu/estuary.html>

Freshwater Estuaries Defined

Estuary science has, for the most part, been historically focused on areas where *freshwater* from a river mixes with *saltwater* from the ocean. The concept of another estuary-type system occurring at the intersection of a *freshwater* river and large *freshwater* lake has become increasingly recognized by a wide range of scientists and organizations. For example, Great Lakes freshwater estuaries have been addressed and recognized by the Wisconsin Department of Natural Resources, National Oceanic and Atmospheric Administration, and numerous other state and federal natural resource agencies. These systems have also been described and studied in numerous articles and represent an ecological system with important relevance to the Great Lakes region.

What exactly is a freshwater estuary? A variety of definitions exist, and, not surprisingly, the definitions vary. However, three common characteristics are frequently used to define these systems: 1) a drowned river mouth; 2) a zone where lake and river waters mix; and 3) influence from seiche or wind tides. A fourth characteristic that some, but not all, freshwater estuaries have, is a bar or spit that partially encloses the river mouth.

1) Drowned River Mouth

The term “drowned river mouth” may seem a bit odd the first time you hear it, but the term becomes less strange once we understand what it is describing. Simply put, it is a river mouth (the end of a river where it enters another waterbody like one of the Great Lakes) that becomes submerged or flooded. How can a river become flooded? To answer that question, we have to look back into Wisconsin’s history about 10,000 years. At the end of the most recent Ice Age, massive amounts of ice as much as several hundred feet thick retreated from much of the Great Lakes Basin. As the ice retreated, the earth’s crust, which had been pushed down by the incredible weight of the ice, started to very slowly rebound. The rebounding of the earth’s crust is still occurring today.

This rebounding of the earth’s crust has caused the outlet of the Great Lakes to rebound, sometimes faster than areas downstream. The rise in the outlet level of the Great Lakes causes a condition similar to a dam and floods ancient river valleys with Great Lakes water, thereby creating drowned river mouth systems. In fact, the U.S. Geological Survey has found that water levels in the southwestern portions of Lake Superior have risen approximately 15 to 18 feet over the past 2000 years! They estimate that the lake level rise in

those areas is occurring at a rate of one inch per decade, and that rising Lake Superior water levels associated with the rebounding of the earth's crust will continue to flood low-lying river mouths and expand wetlands.

Sources of Additional Information:

Great Lakes estuaries, Estuaries (journal), C. Herdendorf, 1990.

Rapid submergence of Lake Superior shorelines, U.S. Geological Survey, 1995, available at <http://water.usgs.gov/wid/html/wi.html#HDR11>

2) River-Lake Transition Zone

Freshwater estuaries have a zone of transition from stream water to lake water. The mixing of water in this transition zone creates unique characteristics. For example, stream water typically has a higher temperature and more suspended solids than Great Lakes water. The mixing of river and lake water in a freshwater estuary can affect water temperature, turbidity, and chemical composition. Those affects can, in turn, impact water density; currents; and sediment, nutrient, and contaminant transport, all of which influence important ecological processes.

3) Seiche and Wind Tides

The Great Lakes exhibit an interesting natural phenomenon called a "seiche." A seiche is an oscillation, or periodic back-and-forth movement, that occurs in large waterbodies. One way to visualize a seiche is to imagine a bowl of water that you gently shake. After shaking the bowl, the water moves back-and-forth. The same phenomenon happens in the Great Lakes, only the factors "shaking" the Great Lakes are atmospheric disturbances such as winds or changes in barometric pressure. In waterbodies as large as the Great Lakes, the back-and-forth movement never actually stops and seiche effects can be observed on a daily basis. The intervals, or periods, between seiche peaks on the Great Lakes can range from minutes to more than eight hours. Seiches can cause changes in water surface elevations of a few inches to several feet depending upon atmospheric conditions. Freshwater estuaries experience frequent wet and dry periods, especially near the water margins, due to seiche effects.

A wind tide, or storm surge, is a vertical rise in water level on the leeward, or downwind, side of a waterbody as a result of strong winds. Storm surges on the Great Lakes can produce a change in water level of up to eight feet under extreme conditions. Given their association with storms and high winds, the effects of a wind tide are often more dramatic than the effects of a seiche. Wind tides can also be a contributing factor to seiche effects.

Sources of Additional Information:

Living on the coast: Protecting investments in shore property on the Great Lakes, P. Keillor, University of Wisconsin Sea Grant, 2003, available at

http://www.lre.usace.army.mil/coastalprocesses/Publications/Living_on_the_Coast.pdf

4) Barrier Spits and Baymouth Bars

Freshwater estuaries are commonly separated from the adjacent main body of water by a barrier spit or baymouth bar. Spits and bars are accumulations of sand and gravel that can form entirely or partly across the mouth of a river. Many, although not all, freshwater estuaries are partially enclosed by bars or spits.

For a more traditional definition of estuary...Wikipedia

The word “estuary” is derived from the Latin word *aestuarium* meaning tidal inlet of the sea, which in itself is derived from the term *aestus*, meaning tide. There have been many definitions proposed to describe an estuary. The most widely accepted definition is: “a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with freshwater derived from land drainage.”^[1] However, this definition excludes a number of coastal water bodies such as coastal lagoons and brackish seas. A more thorough definition of an estuary would be “a semi-enclosed body of water connected to the sea as far as the tidal limit or the salt intrusion limit and receiving freshwater runoff; however the freshwater inflow may not be perennial, the connection to the sea may be closed for part of the year and tidal influence may be negligible.”^[3] This definition includes classical estuaries as well as [fjords](#), [lagoons](#), [river mouths](#), and [tidal creeks](#). Estuaries are a dynamic [ecosystem](#) with a connection with the open sea through which the [seawater](#) enters accordingly to the rhythm of the [tides](#). The seawater entering the estuary is diluted by the [freshwater](#) flowing from rivers and streams. The pattern of dilution varies in different estuaries and is dependent on the volume of freshwater, tidal amplitude range, and the extent of evaporation from the water within the estuary.^[2]

Dr Anna Redden
Director, Acadia Centre for Estuarine Research (ACER)

"Education is not the filling of a pail, but the lighting of a fire." Yeats

NOAA - National Oceanic & Atmospheric Administration

www.noaa.gov

Estuaries



Estuarine habitats are typically found where rivers meet the sea. **Mouse over the image** to see some of the estuarine areas highlighted in this tutorial. **Click on image** for more details and a larger image.

Estuaries are bodies of water and their surrounding coastal habitats typically found where rivers meet the sea. Estuaries harbor unique plant and animal communities because their waters are brackish—a mixture of fresh water draining from the land and salty seawater.

Estuaries are some of the most productive ecosystems in the world. Many animal species rely on estuaries for food and as places to nest and breed. Human communities also rely on estuaries for food, recreation, and jobs.

Of the 32 largest cities in the world, 22 are located on estuaries (Ross, 1995). Not surprisingly, human activities have led to a decline in the health of estuaries, making them one of the most threatened ecosystems on Earth. NOAA's National Estuarine Research Reserve System (NERRS), in partnership with coastal states, monitors the health of estuaries, educates the public about these ecosystems, and helps communities manage their coastal resources.



Estuaries are both beautiful and ecologically bountiful. Their natural expanses provide habitats for a wide range of animal and plant species. **Click on image** for more details and a larger image. (Photo: Old Woman Creek NEERS site)



New York City, with a population of over eight million people, is one example of a major urban area located on an estuary. **Click on image** for more details and a larger image. (Photo: Stanne/NYSDEC)