CLIMATE EDUCATION FOR A CHANGING BAY

The Chesapeake Bay National Estuarine Research Reserve (CBNERR) is one of 28 protected areas that make up the National Estuarine Research Reserve System established to promote informed management of the Nation's estuaries and coastal habitats. CBNERR is located at the Virginia Institute of Marine Science (VIMS), part of the College of William and Mary. CBNERR received a National Oceanic and Atmospheric Administration (NOAA) Bay Watershed Education and Training grant to work with 9th grade students at Gloucester and Mathews High Schools. The program, entitled *Climate Education for a Changing Bay (CECB)* will engage audiences with meaningful Chesapeake Bay field experiences that are deeply integrated into the classroom and with teacher professional development, sharing results from the project through outreach event and conferences. The overall objective of *CECB* is to improve climate literacy within local high schools by advancing the use of locally relevant environmental data and information in classroom curriculum, field experiences, and professional teacher training. Throughout the school year, each school receives classroom lessons given by CBNERR education staff, a field experience on their school grounds, and a field experience to VIMS and CBNERR facilities.

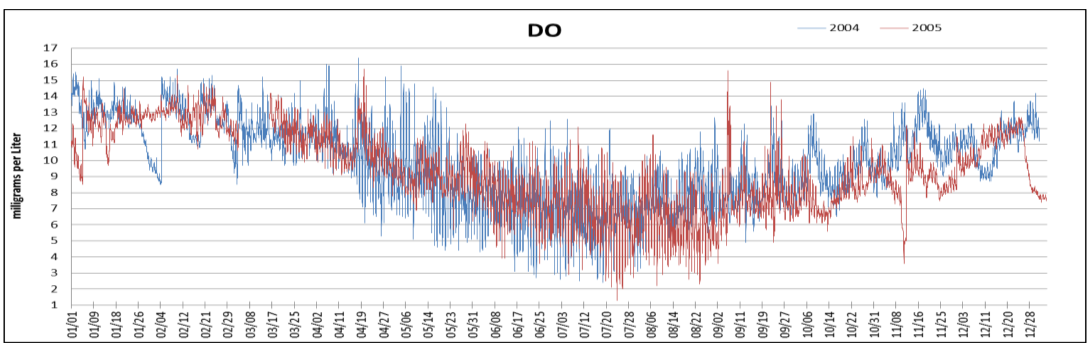
We hope you take the time to read about the lesson presented to the 9th grade Earth Science students at Gloucester High School. Enjoy the information, pictures, and examples of the activities presented below!

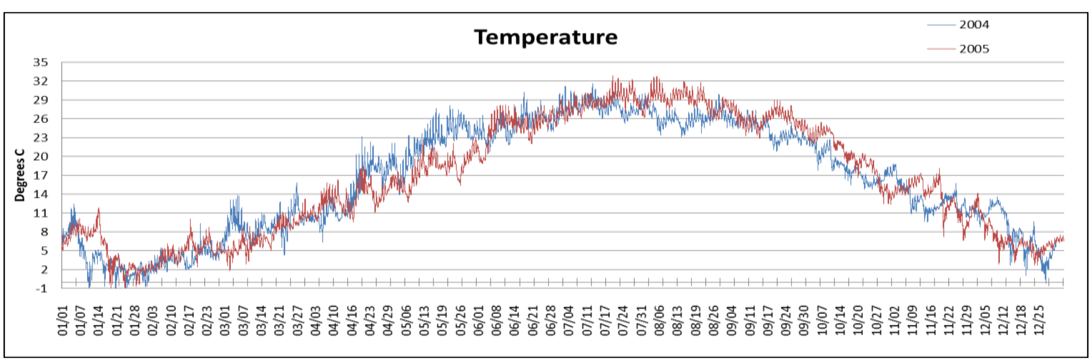
On February 13th 2014, CBNERR educators attended Gloucester High School to give the first lesson of the *CECB* program to one of Mr. Scalf's and Mrs. Haydon's classes. The two classes were chosen by the teachers as pilot classes for this year, testing out the newly created activities and program. The classroom visit was the students' initial exposure to CBNERR educators and the *CECB* program where they were introduced to the NERRS system, the program outline, and climate change science. The first visit was the preparation phase for their Meaningful Watershed Educational Experience, where-by subsequent outdoor field experiences will build upon the knowledge gained from the classroom lesson.

After briefly reviewing some basic concepts of the Chesapeake Bay estuary, students examined local topographic maps to understand elevation. A topographic map is the representation on a flat surface, of part of Earth's surface drawn to scale; it indicates relief which is the difference in elevation between two points. Students were tasked with finding high and low points on their maps, as well as looking at different slopes to determine if they were steep or gentle slopes. To build upon this concept, students also completed a Play-doh activity, where they created small topographic maps by generating contour lines on their piece of paper, representing the different elevations of their Play-doh mountain. The topographic maps were used as a tool to have students start thinking about elevation with the goal of identifying some areas on the map that could be impacted by climate change and sea level rise.

Understanding changes in sea level and inundation, and the associated responses of critical habitats and coastal communities are key to the Chesapeake Bay region. Students brainstormed to list a variety of factors which could be impacted by climate change. The named responses such as sea level rise, warming of ocean temperatures, and ocean acidification were discussed in more detail leading to an activity where students interacted with water quality graphs created from data collected at Goodwin Island, one of CBNERR's 4 reserve sites located along the York River. Students compared graphs and then thought about how marine organisms could be impacted as water conditions changed. Students hypothesized that some organisms may be able to migrate with changing sea temperatures or that some organisms and plants may be able to adapt to the changes at their given location. Water quality data is readily available to the public and students were shown where to get historic and real-time data at locations such as the Virginia Estuarine and Coastal Observing System (VECOS) and the Chesapeake Bay Interpretive Buoy System (CBIBS).

These are two of the four graphs that the students had to interpret. Can you see any relationship between dissolved oxygen and water temperature?





As the temperature of the water increased the amount of dissolved oxygen in the water decreased, these two factors have an inverse relationship. Water temperatures are expected to increase as a result of climate change. Why should we care about the amount of dissolved oxygen in the water?

To conclude the lesson, students briefly discussed coastal community impacts and why it is important to think about elevation when considering land use, climate, and development. It was emphasized that humans can take action to reduce the impacts of climate change. Can you think of some ways to reduce your impact on climate change?

In the next lesson students will focus on wetlands and will participate in a mock marsh transect on their school grounds. Student will learn how to run a transect line and will then focus on the importance of wetlands and examine how they respond to sea level changes.

For more information about CBNERR please visit our website at http://www.vims.edu/cbnerr/. Please find below examples of the activity sheets completed by the students.

Thank you to all of the students and teachers participating in the pilot year of *CECB*!

Rules of Contour Lines- Some basic rules about contour lines are listed below.

1) Where a contour line crosses a stream or valley, the contour bends to form a "V" that points upstream or valley. In the upstream direction the successive contours represent higher elevations.
2) Contours near the upper parts of hills form closures. The top of a hill is higher than the highest closed contour.
3) Hollows (depressions) without outlets are shown by closed, hatched contours. Hatched contours are contours with short lines on the inside pointing downslope. The bottom of the hollow is lower than the lowest closed contour.
4) Contours are widely spaced on gentle slopes.
5) Contours are closely spaced on steep slopes
6) Evenly spaced contours indicate a uniform slope.
7) Contours do no cross or intersect each other, except in rare case of an overhanging cliff.
8) All contours eventually close, either on a map or beyond its margins.

Becoming familiar with your Topographic map. Please use the provided topographic map to answer the following questions.

1) What is the quadrangle shown on your topographic map?

   Achilles. VA

2) What is the contour interval?

   5

3) What is the scale of your map? One inch on your map equals how many feet?

   1 inch equals 2,000 Ft Scale - 1:24 000

4) What is one of the highest contour lines on your map? What is one of the lowest contour lines on your map?

   the highest is ~~15~~ 35 and the lowest is 5

5) Where on your map is there gentle slope? Does this indicate a hill or relatively flat land?

   Campground indicates relatively Flat land

6) Where on your map is there a steep slope? Does this indicate a hill or relatively flat land?

   Coleman Swamp indicates hilly land

7) What is the elevation of one of the benchmarks on your topographic map?

   7

8) Why is it important to think about land elevation in relation to land development, land use, and potential climate impacts?

   One may need to farm, and slope/elevation affects water runoff through land

Extreme Conditions at Goodwin Island

For each graph determine the lowest and highest value of each abiotic factor. Then determine the approximate time (in days) that elapsed between these two measurements

	2004			2005		
Factor	High	Low	Time Between	High	Low	Time Between
temperature	31°C	-1°C	6mo.	33°C	-1°C	7mo.
salinity	20.25	12.75	2mo.	22	10.5	7mo
pH	9	7.4	4mo.	9.1	7.4	5mo
dissolved oxygen	16.5	2.5	3 mo	15.5	1.5	3mo

1) Why do you think the salinity at Goodwin Island was so much higher in the summer of 2005 than the summer of 2004?

not as much rainfall in summer of 2005, causing sal to be greater

2) Do you notice any other trends in the data or relationships between abiotic factors?

as T ↑ D ↓ ; T↑ in Summer

3) How are the listed abiotic factors expected to change as a result of Climate Change?

T↑, salinity could change depending on where you are

DO↓ if T↑ , pH↓ more CO_2 in water

4) What strategies and adaptations do you think aquatic species use to cope with changing abiotic conditions at Goodwin Island?

- migrate , - shelled structure , retreat