From the Mountains to the Estuary:
From the Schoolyard to the Bay

Meaningful Watershed Experiences for High School Students

With grant support from the
NOAA Bay Watershed Education Training (B-WET) Program

In partnership with:

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Acknowledgments

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Along with the teachers and students who provide their ongoing insights to its continual improvement.

Meaningful Watershed Experiences

As part of the Chesapeake 2000 Agreement, the Commonwealths of Virginia and Pennsylvania along with the State of Maryland, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency, reaffirmed their long-term commitment to "protect and restore the Chesapeake Bay's ecosystem."

In co-signing, Virginia agreed to accomplish specific goals, including the following regarding public education:

> Beginning with the class of 2005, provide a meaningful Bay or stream outdoor experience for every school student in the watershed before graduation from high school.

- Provide students and teachers alike with opportunities to directly participate in local restoration and protection projects and to support stewardship efforts in schools and on school property.

A meaningful watershed experience should:

- Be investigative or project oriented.
- Be an integral part of the instructional program.
- Involve sustained activity.
- Be enhanced by natural resource personnel.
- Involve sharing and communication.
- Consider the watershed as a system.
- Be for all students.
- Be richly structured and of high quality design.

In April 2005, the Virginia Department of Education began collecting data on Virginia's progress toward meeting educational goals related to watersheds and related educational programs.

This high school program presented here was compiled to assist earth science and environmental science teachers in providing meaningful watershed experiences for their students. The curriculum is designed to support relevant Virginia Standards of Learning, the Chesapeake 2000 Agreement, and our students' own discovery of how they can make a real difference in saving the precious ecosystems of our Bay watershed.

For on-line access to all materials included or referenced herein, please visit:
http://school2bay.pbworks.com/High-School

For more information on Meaningful Watershed Experiences please visit:
http://www.deq.state.va.us/vanaturally/pdf/c2k.pdf

For more information on the Chesapeake 2000 Agreement please visit:
http://www.chesapeakebay.net/content/publications/cbp_12081.pdf

Virginia Earth Science Standards of Learning

ES.1 The student will plan and conduct investigations in which
- a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;
- b) technologies including computers, probeware, and global positioning systems (GPS), are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
- c) scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted;
- d) variables are manipulated with repeated trials; and
- e) a scientific viewpoint is constructed and defended (the nature of science).

ES.2 The student will demonstrate scientific reasoning and logic by
- a) analyzing how science explains and predicts the interactions and dynamics of complex Earth systems;
- b) recognizing that evidence is required to evaluate hypotheses and explanations;
- c) comparing different scientific explanations for a set of observations about the Earth;
- d) explaining that observation and logic are essential for reaching a conclusion; and

ES.3 The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include
- a) maps (topographic)
- b) imagery (aerial photography and satellite images);
- c) direction and measurements of distance on any map or globe; and
- d) location by latitude and longitude and topographic profiles.

ES.7 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include
- a) fossil fuels, minerals, rocks**, water,** and vegetation;
- d) making informed judgments related to resource use and its effects on Earth systems; and
- e) environmental costs and benefits.

ES.9 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include
- d) identification of other sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;
- e) dependence on freshwater resources and the effects of human usage on water quality; and
- f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries.

ES.11 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include
- b) importance of environmental implications;
- e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

ES.13 The student will investigate and understand that energy transfer between the sun and the Earth and its atmosphere drives weather and climate on Earth. Key concepts include
- a) observation and collection of weather data…

Boundaries of Our Watershed

Using Models

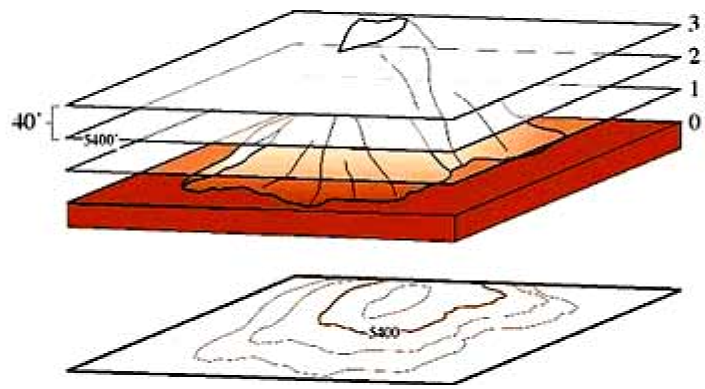
Understanding Topographic Maps

Overview:

Using a model, students will create their own topographic map. They will use it to investigate and understand how to read and interpret topographic maps. Students will use a GPS unit to record latitude, longitude, and elevation in their schoolyard.

Background:

- A topographic map shows elevation change in an area. It is a two-dimensional surface that represents 3-dimensional objects like hills, mountains, and valleys, as shown in the diagram below.



- Contour lines placed on the topographic map connect points of equal elevation.
- The contour interval of the topographic map shows the difference in elevation from one contour line to the next. The contour interval is indicated at the bottom of the map.
- Topographic maps can be used to determine the size and location of regional watershed systems. Areas of higher elevation, such as ridges or divides, separate watersheds.

Materials:

- Topographic lesson power point at http://www.school2bay.pbworks.com/High-School
- Topographic maps of Washington DC area -
  - 1:250,000
  - 1:100,000
  - county-specific 1:50,000

- Can of play dough
- Ruler
- Pencil
- 30 cm piece of thread or fishing line cut
- Sheet of graph paper
- GPS units (Garmin brand eTrex model used for demonstration below)

Engage:

1. Show the students the landforms power point from the www.school2bay.pbworks.com web site or CD.
2. Discuss differences in landforms shown

Learning Experiences:

A. Explore: Create your own topographic map

1. Group students into pairs and give them a can of play dough. Using the play dough, have students make a model of one of the landforms they saw. Have them put it in the middle of their graph paper.
2. Using the ruler and pencil point, have students put small holes in the landforms in a straight line at vertical 1 cm intervals, from some point[s] on the base of the model to [each of] its peak[s].
3. The students should put an "X" on the paper at the bottom of each line of pencil holes.
4. Trace the bottom of the landform on the paper.
5. Wrap the thread evenly around the landform at the first centimeter mark and pull both ends to cut through the dough.
6. Place the lower separated layer of play dough off to the side.
7. Place the rest of the landform on top on the graph paper, be sure the holes line up with the X's.
8. Again, trace the trace the landform on the paper.
9. Wrap the thread evenly around the play dough at the second mark and pull both ends to cut through the play dough.
10. Place the lower separated piece of play dough on top of the first piece that was placed off to the side, aligning them as they were originally.
11. Repeat steps #7-10 until there aren't any sections left to cut with the thread.
12. On the map they created have the students label the topographic features of their landform (i.e. Hilltops, Valleys, Cliffs, Plains etc..)
13. Have students note the contour interval of their map.

Extensions:

1. Have students exchange the topographic maps that they created. Using the maps, ask students to find the correct play dough models the map represents.

B. Elaborate: Using GPS Units in the Schoolyard

1. Have the students investigate the topographic maps of the Washington area.

2. Let them compare the features found on the 1:250,000 map, to the 1:100, 000 map to the 1:50,000 Prince William County Map.

3. What scales are represented by each of these maps?

4. Using the 1:50,000 Prince William County Map, have the students locate their school.

5. Have them record the latitude and longitude from the map for the location on the schoolyard. Also, have them estimate the elevation.

   Background: Latitude and longitude are in base 60. Each degree contains 60 "minutes of arc" (that's the arc of a cross-section of the Earth). Each minute contains 60 seconds of arc. Use the base 60 hours-minutes-seconds concepts with time to help them understand this. Transfer discussion to base 60 with latitude-longitude degrees-minutes-seconds, and the fact that in latitude-longitude, degrees refers to distance, not temperature, and minutes and seconds refer to distance as well, not time. Many GPS today represent location in terms of degree plus minute, with minute calculated to 2-decimal places. For reference:

   1 minute of arc = 1.86 km (1.15 mi.), about the length of 20 football fields

   1/10th of a minute = about the length of 2 football fields

   1/100th of a minute = about 18 m (61 ft.), just past a football field's 20 yard line

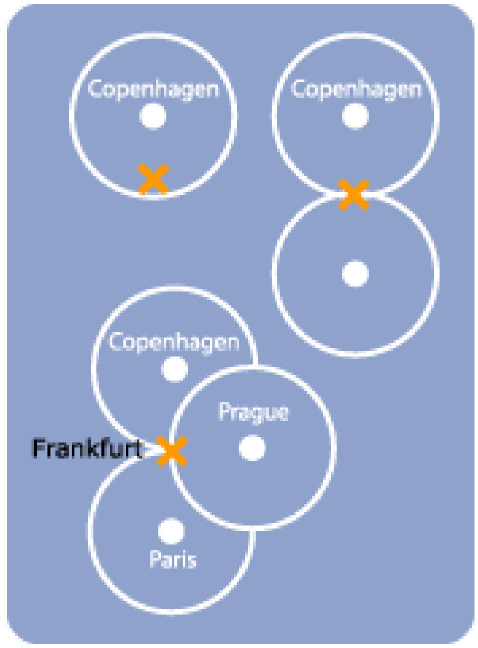
   1 second of arc = about 30 m (100 ft.), just past the 30 yard line

6. What technologies exist to help people determine position on earth? *Global Positioning System satellites or GPS units*

7. Explain that the students are going to use GPS units to find their latitude, longitude, and elevation in the schoolyard. They will compare it to the answers they derived from the topographic maps.

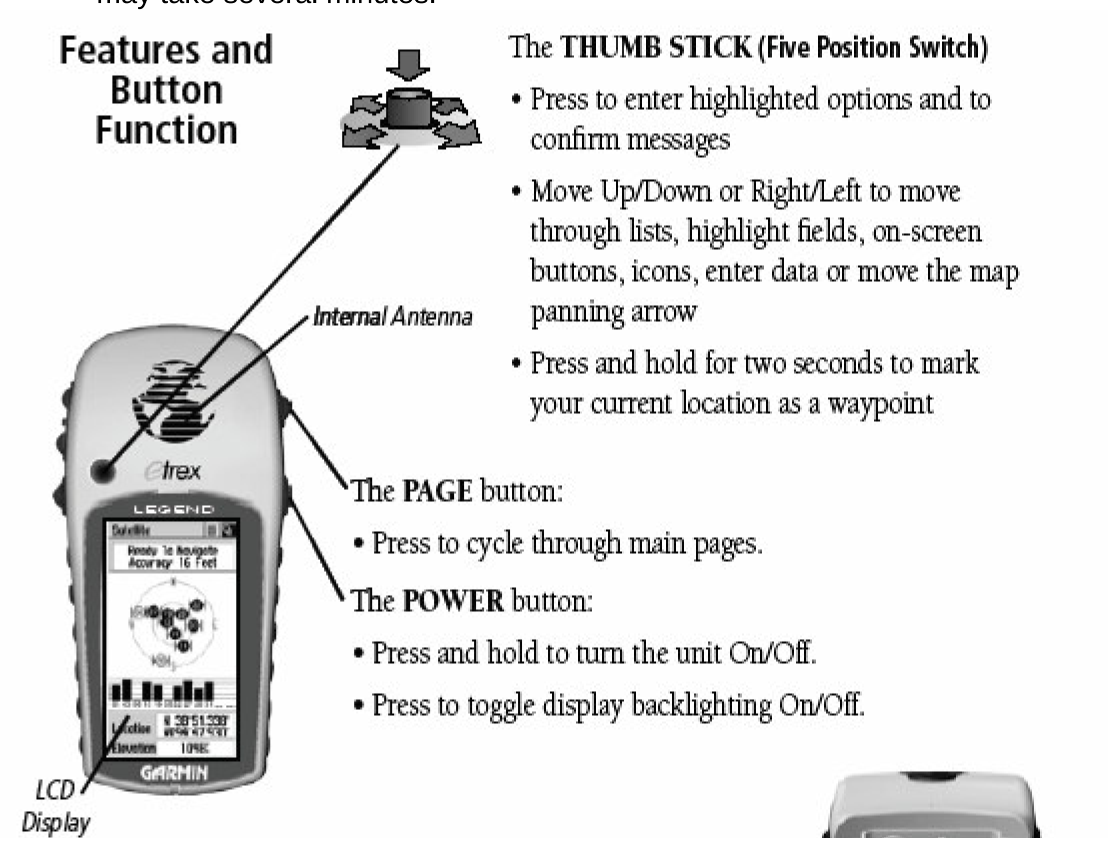
8. Before you take you students to the schoolyard, explain how the GPS units work.

9. The GPS unit needs at least three satellites to pinpoint precise location. You might ask them, "why?" or demonstrate using 3 circles of known radius, e.g.,



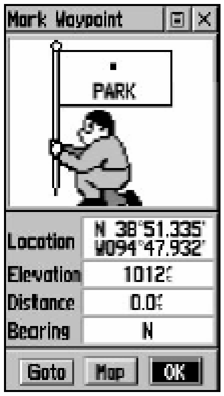
10. Go to an unobstructed outside location.

11. Have students turn on GPS receiver to acquire a 3-D Navigation status. This process may take several minutes.



12. Once the unit is ready to navigate, have students mark a waypoint, i.e., a physical reference point for aligning subsequent measurements.

13. Press and hold the thumb stick until the mark waypoint screen appears.



Mark Waypoint Page

14. Emphasize to your students that it is important for the GPS receiver to remain stationary when taking these readings. You might want to recommend that the receiver be placed directly on the ground.

15. The students should record the Latitude and Longitude and Elevation found on this screen.

16. Back in the classroom, have your students compare the latitude and longitude and elevation they found using the GPS to the one they found on the topographic maps.

17. Why are their differences? *Scale of map, accuracy of GPS unit, different locations on schoolyard*

Extensions:

1. Make a copy of your school's topographic maps found at www.school2bay.pbworks.com
   - Using the map and the GPS unit, have your students record elevations in the schoolyard and record them on the map
   - From their findings, have them estimate the contour interval of the map

2. Have students investigate the topographic features found in each of the geologic regions of Virginia found on the map on the following page.

3. For more great lessons using the GPS visit http://sciencespot.net/Pages/classgpslsn.html

Investigating Topographic Maps

Names: ____

Investigate the different topographic maps and complete the following table:

	1:50,000 scale map	**1:100,000 scale map**	**1:250,000 scale map**	
Latitude at school				
Longitude at school				
Elevation at School				
1 cm = ? Km				
Contour Interval				

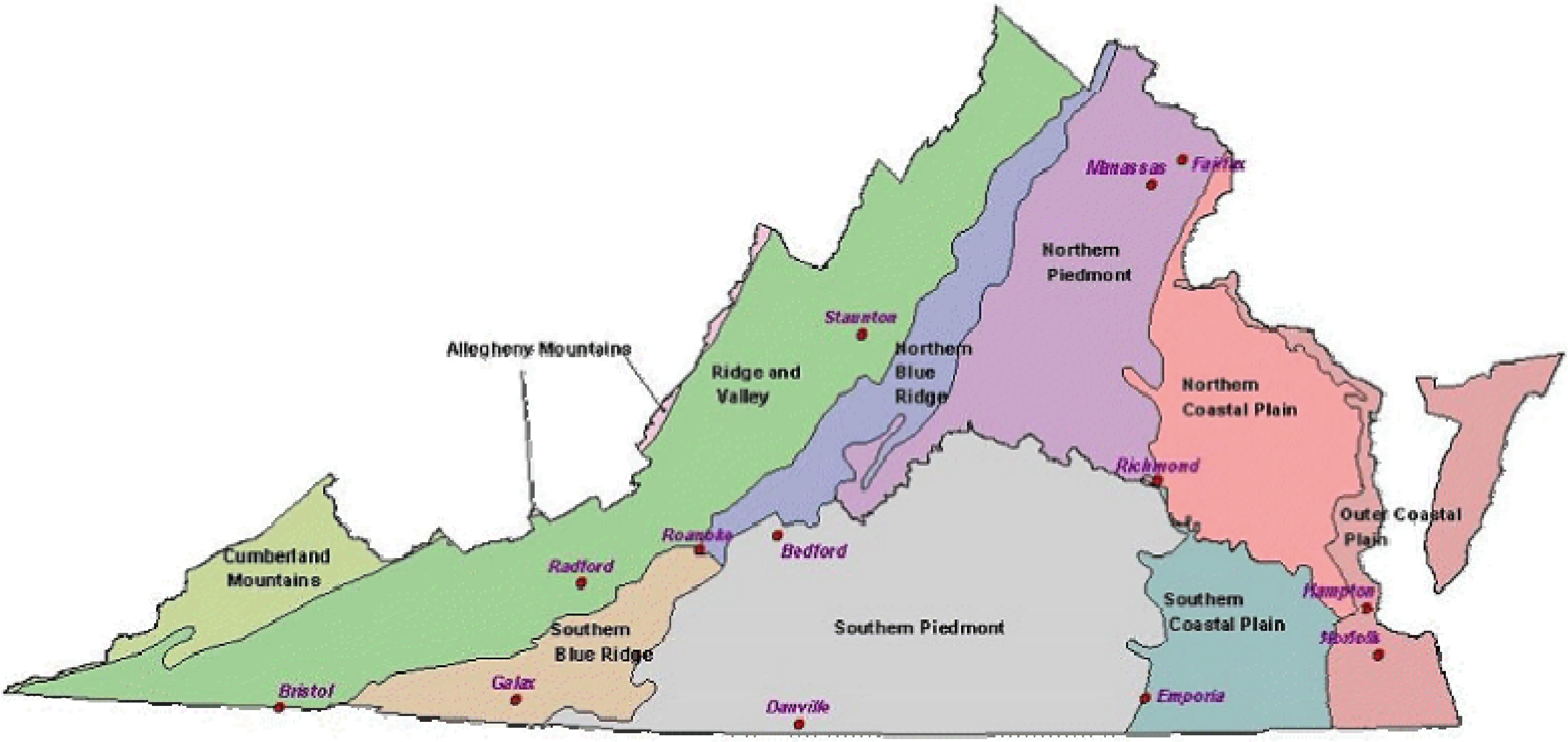
Elevation found using G.P.S. Unit: __________________________

Latitude found using G.P.S. Unit: ___________________________

Longitude found using G.P.S. Unit: ___________________________

Why are there differences in the information derived from the maps and from the G.P.S. unit?

____


Allegheny Mountains
Cumberland Mountains
Ridge and Valley
Northern Blue Ridge
Northern Piedmont
Northern Coastal Plain
Outer Coastal Plain
Southern Blue Ridge
Southern Piedmont
Southern Coastal Plain
Manassas
Fairfax
Staunton
Richmond
Roanoke
Bedford
Radford
Hampton
Norfolk
Bristol
Galax
Danville
Emporia

Watershed Overview

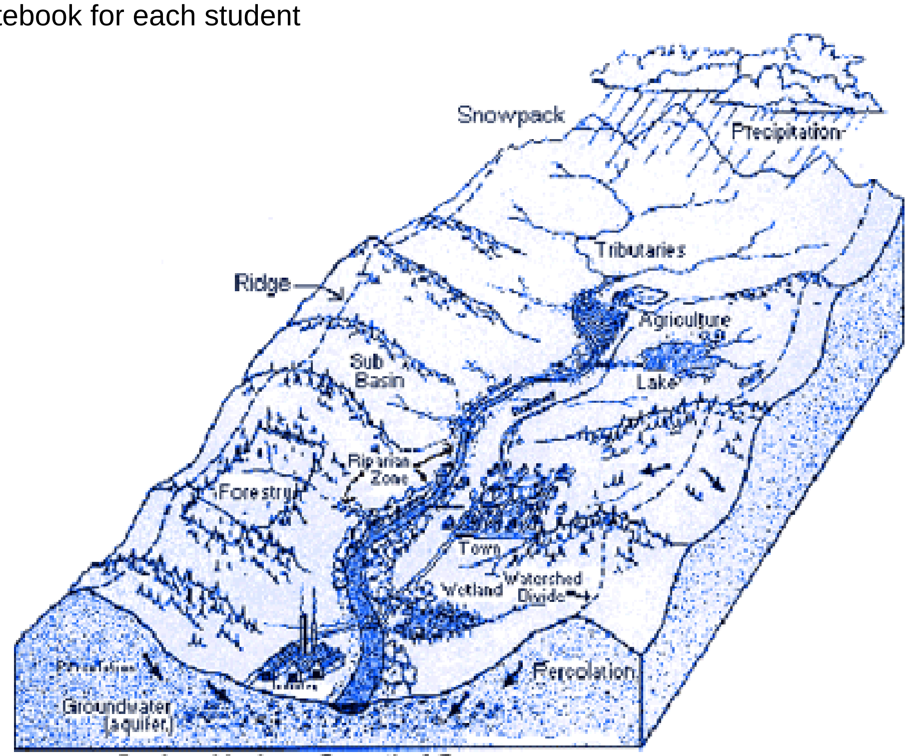
Connecting to the Chesapeake Bay

Overview:

Students will gain an understanding of the physical aspects of watersheds and how the boundaries are determined. Students will view their school and determine the route runoff travels by navigating through satellite images, topographic, and terrain maps on Google maps. Students will investigate how water can cause erosion as it travels.

Materials:

- One 8.5" x 11" sheet of graph paper per student group
- One sheet of construction paper per student group
- Water-soluble, non-permanent felt markers, the best colors are dark colors, such as black, brown, purple, and green.
- One blue colored pencil per student
- Spray bottles with tap water in them
- Scotch tape
- Scissors
- Relief maps and topographic maps
- Computer with web browser, able to access to the Internet and Google Maps
- Notebook for each student



Produced by Lane Council of Governments

Image from: http://www.epa.gov/owow/watershed/whatis.html

Engage:

1. Have students work in pairs. Take a sheet of graph paper and crumple it up into a wad. The tighter the crumpling, the more complex the watershed modeling.

2. Uncrumple the paper and set it on the sheet of cardboard. Tape the edges of the paper onto the construction paper base, leaving about an inch of construction paper exposed around the perimeter. This will create a miniature landscape of mountains and valleys. Ask the students to identify the tallest mountain or the deepest canyon.

3. Have them inspect their landscape from above. Have them look at their landscape from the side as if they were on a nearby plain looking up at the mountains.

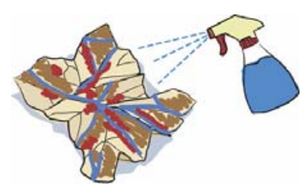
4. Use a dark-color water soluble marker, other than blue, and gently trace the tops of the “mountain” ridges and divides. Encourage the students to carefully follow ridges as far as they go.

5. Take the time to explain that ridges define the boundaries of watersheds. Careful observation will also show that big watersheds are made up of smaller watersheds.

6. Make predictions: Ask the students to use a blue colored pencil and carefully draw where they think the rivers and lakes would be in their valleys.

7. For rivers, it is easiest to start at the bottom of a valley and follow it uphill. If there are valleys where they can not go “down” any further, that may be a place to draw a lake.

8. Although watersheds are defined by the ridges, they are named by the rivers and streams. Have students write their names on the bottom of the construction paper before the next step.



9. Now have the students that test their predictions of the paths of the rivers. Take the spray bottle and simulate rain by misting the paper watershed while it is flat on a counter. Don’t spray directly on the paper, but have the droplets fall on the paper.

10. Have students observe as the water seeps downhill through the paper. You can make different effects by adjusting how wet you make the paper. If you spray the paper heavily, actual drops will run down the sides of the paper and pool into “lakes.”

11. Let the paper watersheds dry. The paper will become even more colorful as the dark inks slowly separate into a rainbow of colors.

12. Once the models are dry, have students determine whether they correctly predicted where the water would flow into rivers and lakes.

13. Finish by asking them again to define what a watershed is and with a new color or marker, have them outline one entire watershed on their model.

Extension:

1. Create a topographic map using the paper watersheds: Use graph paper to create an elevation and have each student render a topographic map that represents their three-dimensional watersheds.

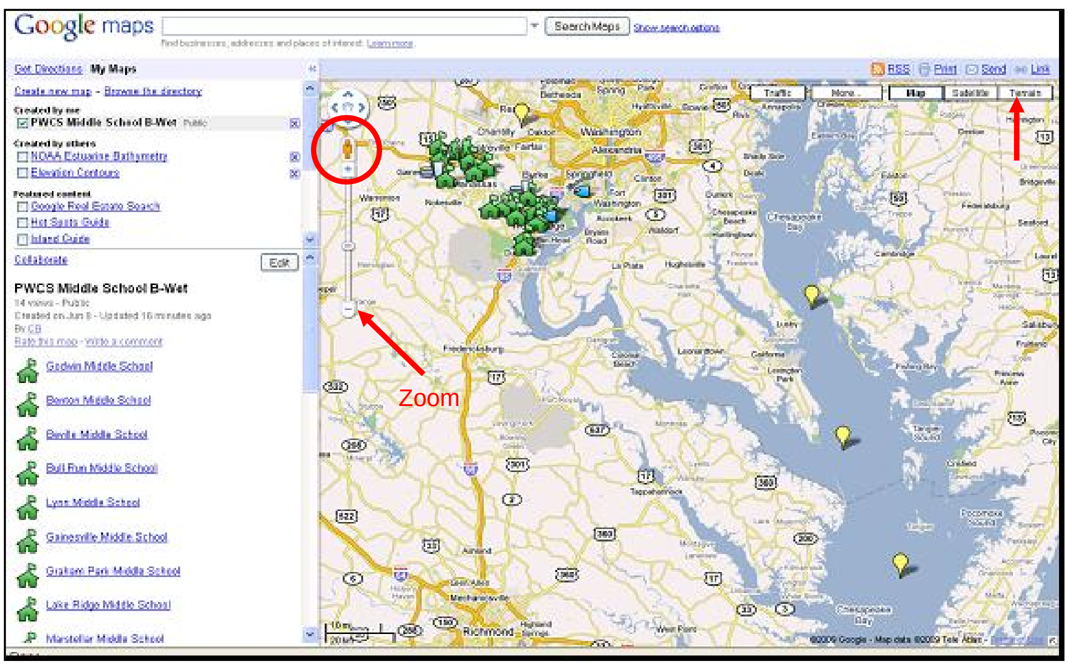
Have them decide on the scale of graph paper grid lines and then have them estimate:

- The lengths of the rivers
- The heights of the mountains
- The area of the valleys
- The volume of water that would enter the watershed if one inch of rain fell in one of those valleys.

2. Before the students spray their watershed, have them use water soluble markers draw symbols to represent houses, farms and industry on their paper. The students can also place a couple of drops of food coloring (e.g. red, green, and yellow) to represent fertilizer, manure, and chemicals. Then follow the steps #1-#13 listed above. Have students record their observations about where the food coloring ends up. How could they prevent some of this pollution?

Learning Experiences:

A. Explore:



1. Have the students think about when it rains. What happens to the water? *Absorbed into ground to replenish groundwater, or runs off* Do you know where the runoff goes? Let's see if we can find out those answers using Google maps.

2. On the Internet, go to our customized **Google Map** via this URL: http://tinyurl.com/pwcs-hs . After a few moments, a map of the Chesapeake Bay and PWCS high schools will appear. (It may take a minute or two to load). To the left of the map is a "legend," or key to understanding the symbols on the map.

3. Click on your school's name from the list in the legend. Clicking there will re-center the map on your school. If you do not see your school, scroll down to the bottom of the page and go to page 2.

4. Have students investigate map. From their school they should record the name of the closest body of water (where water would runoff first when it rains)

5. Have them follow the water and record where the water would travel to next.

6. Continue this process until they arrive at the Chesapeake Bay. Have them record the path in their science journal.

7. Have them zoom in to Southeastern Virginia and try to locate a stream that flows in to the North Carolina Sounds. If it ends up in a different body of water have them start again. They should record the path the water takes.

8. **Challenge activity:** Use the zoom out button to be able to see Western Virginia. Zoom in on Western Virginia. Have the students find a stream that they predict will drain into the Gulf of Mexico. Have them follow it and record the bodies of water it runs into. If it ends up in a different body of water have them start again. (For hints on streams reference the Virginia Watershed map in this lesson)

Extension Activity 1: How Far from Here to the Bay?

If you want to find out distances between places, or perimeter of buildings/structures or the distance a rain drop travels from your school to the Bay; in Edit mode, click on the Line Tool and drag it to your beginning point and click. Click again where you wish to stop measuring (i.e. a bend in a stream). Keep clicking and the distance traveled increases

Differentiation:

Have students visit the following web site to play the "What is a Watershed" Movie.
http://www.cacaponinstitute.org/Watershed/What_Watershed.html

B. Elaborate:

Stream Table Investigation: Adapted from Maine Geological Survey

http://www.maine.gov/doc/nrimc/mgs/education/lessons/act15.htm

Overview:
Students will investigate different factors that cause and prevent water-induced erosion.

Background:

Erosion is the wearing away of the soil by water, wind, and/or ice. This lab activity will consider only erosion caused by the runoff of liquid water. This type of erosion accounts for about 2/3 of all topsoil (surface) and subsoil (subsurface) loss.

About 25 percent of the land in the Chesapeake Bay watershed is dedicated to agriculture. While tilled soil is beneficial to crops, it becomes a pollutant if water from irrigation and precipitation washes it into local waterways. Farmers that use conservation practices such as nutrient management plans, cover crops, vegetative buffers, conservation tillage and animal manure and poultry litter controls help to improve the water quality of the Bay.

Materials:

- Stream table
- Sand or soil
- Various types of mulch such as hay, pine needles, shredded newsprint or wood ships will also be needed (materials will differ based on what your students decide to test)
- Blocks of wood (or books) of different sizes to elevate stream table
- Small pebbles
- Water

Learning Experience:

1. Divide your students into cooperative groups.

2. Show the students the stream table and explain that the model represents a stream traveling to a larger body of water like the Bay.

3. Each student group is going to come up with a stream design. The goal is to have the least amount of erosion on the stream banks.

4. Each design has to include some elevation so the water will flow and the sand or soil.

5. After the group has completed the design, they will present their idea to the class. The class will vote on two of the designs that will be constructed and tested in the stream table.

6. In each test, the same amount of "rain" should be allowed to fall on the soil so the results obtained will have some degree of consistency.

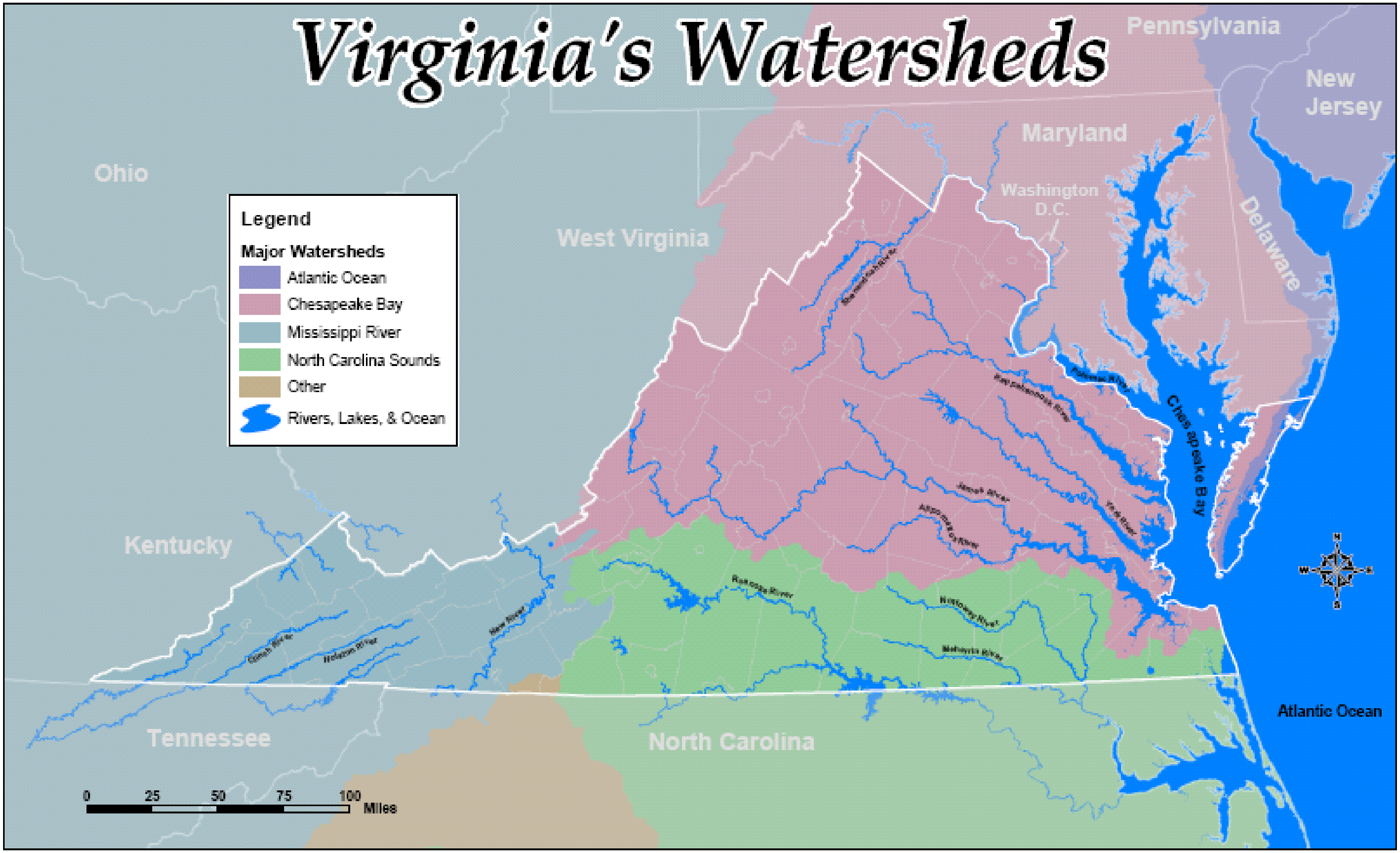
Closure:

After the stream tables have been constructed and tested, discuss the results:
What worked? What didn't? What would you change?

Extensions:

1. Watch the animation: Sedimentation Blues
http://www.cacaponinstitute.org/Benthics/stream%20sediment%20-%20v.html
Afterwards ask them what happens when too much sediment enters a stream.

2. Use the stream table to test effects of slope, dams, contour plowing, and different soil types on erosion.



Science Standards of Learning Connections

This map was designed to support the following standards.

4.8 The student will investigate and understand important Virginia natural resources. Key concepts include
a) watershed and water resources;
b) animals and plants;
c) minerals, rocks, ores, and energy sources; and
d) forests, soil, and land.

6.7 The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include
a) the health of ecosystems and the abiotic factors of a watershed;
b) the location and structure of Virginia's regional watershed systems;
c) divides, tributaries, river systems, and river and stream processes;
d) wetlands;
e) estuaries;
f) major conservation, health, and safety issues associated with watersheds; and
g) water monitoring and analysis using field equipment including hand-held technology.

Virginia Naturally

Funded by the Virginia Department of Game and Inland Fisheries, the Virginia Department of Environmental Quality and the Virginia Department of Education

Virginia Department of Education

DEQ
Virginia Department of Environmental Quality

State of the Bay

Issues Affecting the Chesapeake Bay

Overview of the Chesapeake Bay TMDL
Exploring Our Watershed

Overview:
Students will learn about the Chesapeake Bay Watershed and some of the issues this estuary faces.

Teacher Background:

Visit www.livebinders.com/edit?id=1925 and click on the Chesapeake Bay link for lots of great information on the Chesapeake Bay.

Materials:

- LCD projector or smart board to display power point
- “Chesapeake Bay TMDL” power point from CD or http://school2bay.pbworks.com/High-School
- Composition Notebook for each student

Setting the Stage:

The Chesapeake Bay is in trouble due to many years of pollution. This pollution includes nutrients (potent fertilizers), toxic chemicals, sediments (which cloud the water), and other substances. Water pollution can be traced to two general areas of origin: point sources and non-point sources. Every state is required by the EPA to keep a list of impaired waters. Those are waters which don’t meet goals such as being fishable, swimmable or drinkable. If these waters are too polluted and don’t meet their water quality goals by the date set, federal (EPA) law (under the Clean Water Act) requires the state or local jurisdiction to develop and implement a “TMDL.” A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. For the Chesapeake Bay, this is a very difficult goal to reach because the watershed is so large and involves so many different states, counties and cities, all of which have different policies for managing water quality.

Acquisition of Learning:

1. Ask someone to tell the class the name of the large watershed we live in. (*Chesapeake Bay)* Ask them what the biggest problem in the Bay is today. Encourage them to explain why they believe it is the biggest problem.

2. Explain that the Chesapeake Bay is a very important estuary. (*where fresh and salt water mix)* but it has some big issues. After the slide show students will be ask to come to resolution in their group on how to ‘fairly’ resolve one pollution issue in the Bay

3. As you present power point, have the students write down responses on the Student Worksheet: Phosphorus typically travels into water attached to soil particles. Nitrogen is water soluble and flows with stormwater into streams and beyond. Record any other information that they feel will help them make a decision for Northern Virginia on how to resolve a pollution issue.

4. After the presentation is complete, have the students work in cooperative groups and compare their notes. Each group will choose an issue to solve of these three: Reducing

the amount of phosphorus or nitrogen or sediment in the Bay. Groups can choose to set a policy for just Northern Virginia that can be defendable between other VA counties and cities.

5. Have each group come up with a solution to how the Bay TMDL should be implemented. What is the most reasonable way to make counties and cities or states to control the specific pollutant selected. (*sediment, nitrogen and phosphorus*)? Remember to include a solution for farming and urban runoff which includes all lawn areas, golf courses, parks, and school athletic fields. Remind them…the more stormwater they can keep on sites, in yards and out of storm sewers, streams, ponds and rivers, the cleaner the Bay will be.
6. Ask the group to explain how they will implement their solution. The rest of class should question them and try to find the loop holes and ask each team how they will control for them.

7. The brainstorming students are doing is exactly what the scientists and county, regional and federal policy makers are currently discussing. They look at data from different models and extrapolate the data for different jurisdictions. There is a great deal of arguing about the models and the implications on businesses and citizens.

Closure:

Have students summarize the class findings in their science notebook.

Data from the Field

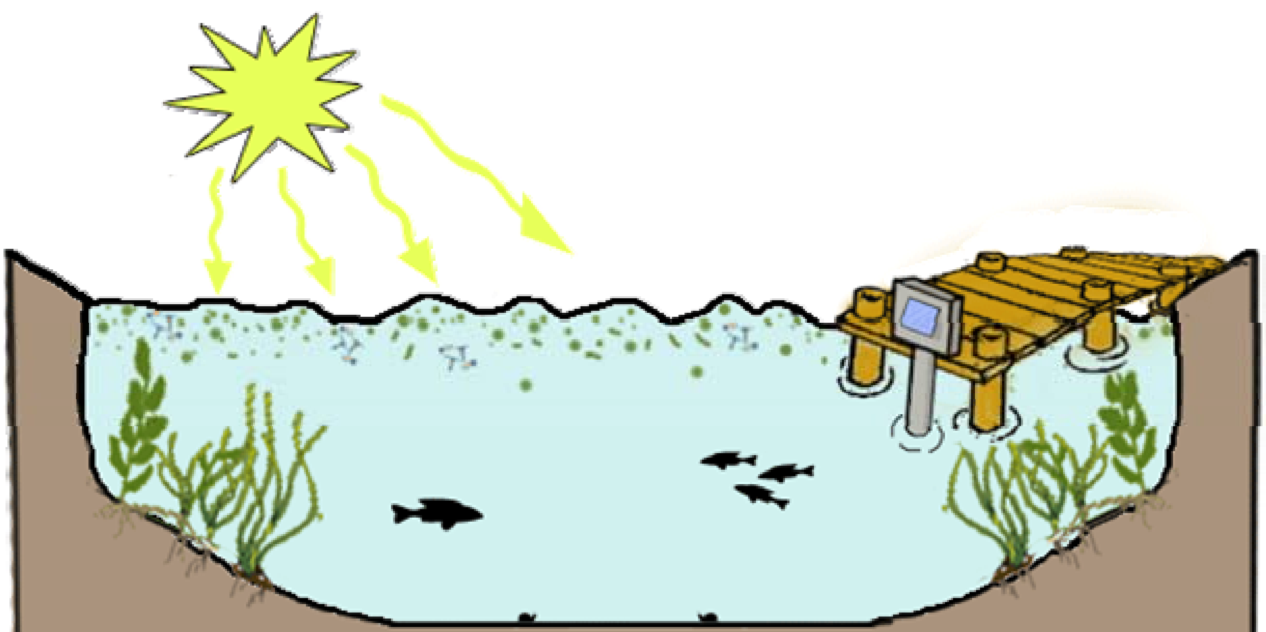
Dissolved Oxygen in Aquatic Systems: Photosynthesis and Respiration

Student Exercise Using Continuous Monitoring Data

By R. Christian Jones

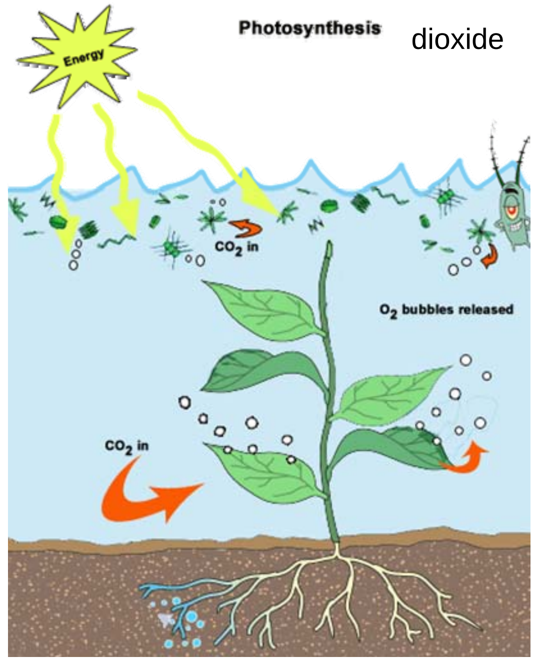
Overview
Students investigate the processes of **photosynthesis** and cellular **respiration** and their role in determining dissolved oxygen concentrations in aquatic systems. They will access and download light data from a weather station and dissolved oxygen data from a water quality monitoring site. Students will choose a one week period with at least one very sunny day and one cloudier day based on light data from the weather station. They will download this week of light data. Then they will download dissolved oxygen data from the continuous water quality monitor for that week. They examine changes in dissolved oxygen during the day (when photosynthesis is active) and night (when only respiration is active) to test the hypothesis that: if oxygen is produced by photosynthesis and consumed by respiration, then dissolved oxygen will be highest during the day when PAR is high and lowest during the night when PAR is low. And the amount of photosynthesis (as indicated by DO change) will be greater on a sunny day than on a cloudy day. Students will determine maximum, minimum and net change in dissolved oxygen on a daily basis and create graphs from this data.

Materials Needed
Computer with internet access.
Belmont parameter sheets
Weather data and dissolved oxygen data at: http://perec.gmu.edu
Setting the Stage:
To better understand water quality in and around the Chesapeake Bay, scientists frequently look at data collected from probes attached to buoys or docks that sample water every fifteen minutes. Weather data is also collected continuously. By examining continuous monitoring data scientists and anyone with a computer can to see how weather and water quality parameters, change throughout the day and night as well as monthly and yearly.



A solar powered monitoring probe attached to a dock or buoy, continually collects data which can be viewed on your computer screen. Data collected includes depth, dissolved oxygen, temperature, pH, conductivity, chlorophyll, and turbidity.

Basics:



Photosynthesis is the basic process by which carbon dioxide is converted into biomass by plants and algae (phytoplankton).
In the process dissolved oxygen is produced. The basic equation for photosynthesis is:

$$CO_2 + H_2 0 + light \rightarrow (CH_2 O) + \ O_2$$

OR *carbon dioxide* + *water* + *light* YIELDS *carbohydrate* + *oxygen*

The process of photosynthesis provides a way for plants and algae to store the sun's energy in the form of chemical bonds of carbohydrate. From the carbohydrate base, other essential **biochemicals** such as proteins, fats, and nucleic acids can be produced and then use by the plant for growth, maintenance and reproduction.

In aquatic systems, when oxygen is released by plants and algae, it increases the concentration of dissolved oxygen in the water. The three requirements of photosynthesis are carbon dioxide, water and light. Since carbon dioxide and water are rarely limited in aquatic systems, the amount of oxygen produced is typically a function of light availability.

The process of **cellular respiration** provides a way for all organisms (plants, animals, fungi and microbes) to access the energy stored in carbohydrates. This energy is used to power the growth and cellular processes of all living things. The basic equation for respiration is:

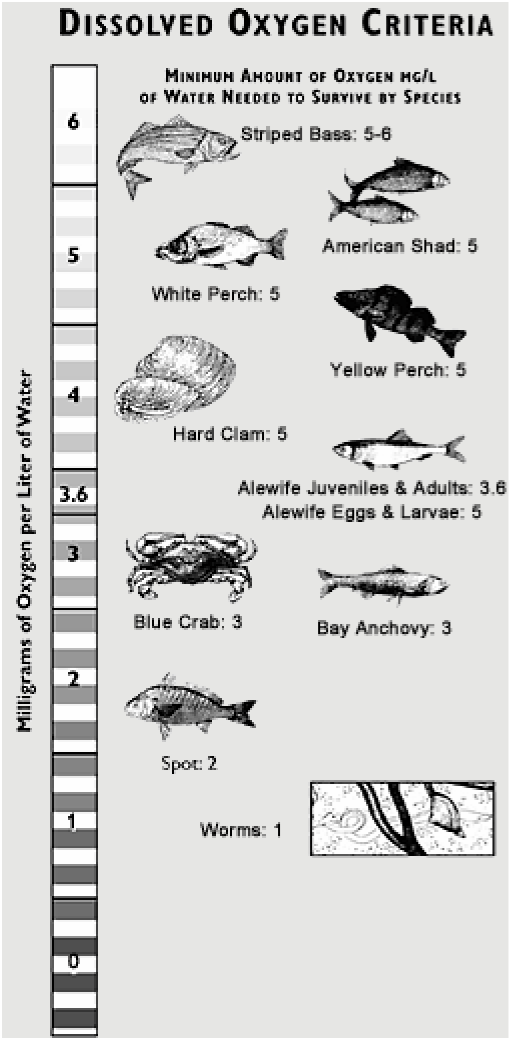
$$CH_2 O + O_2 \ \rightarrow CO_2 + \ H_2 O + energy$$

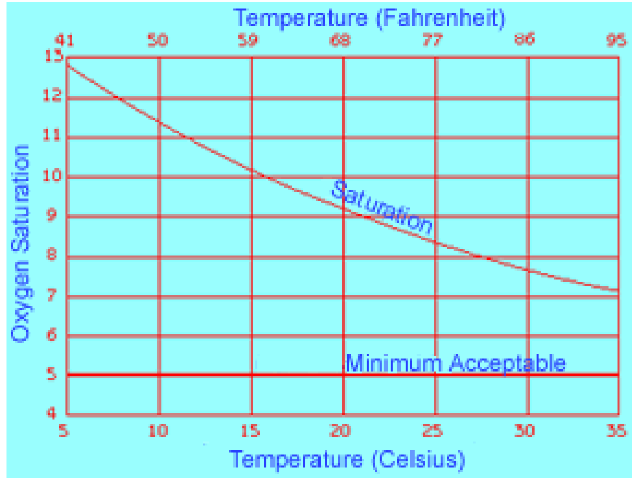
OR carbohydrate + dissolved oxygen YIELDS carbon dioxide + water + energy (ATP)

For every atom of carbon in carbohydrate that is respired, one molecule of molecular oxygen is consumed. In aquatic systems, the oxygen is removed from the water and decreases the concentration of dissolved oxygen in the water. Respiration occurs at a more or less constant rate both day and night in aquatic systems.

Molecular oxygen is very abundant in air composing about 20% of its volume and mass. However, molecular oxygen is much less abundant in water. Water can be saturated by bubbling it with air for an extended period. When this is done, we achieve 100% saturation with respect to air. This saturation value is a function of temperature, but is roughly 10 mg/L.

The amount of dissolved oxygen that the water can hold depends on the temperature and salinity of the water. Cold water can hold more dissolved oxygen than warm water and fresh water can hold more dissolved oxygen than salt water. Thus, the warmer and saltier the water, the less dissolved oxygen it can hold. The maximum amount of dissolved oxygen that the water can hold is called the saturation value. Dissolved oxygen measurements are given as a percent of saturation (%) or in units of milligrams per liter (mg/l).



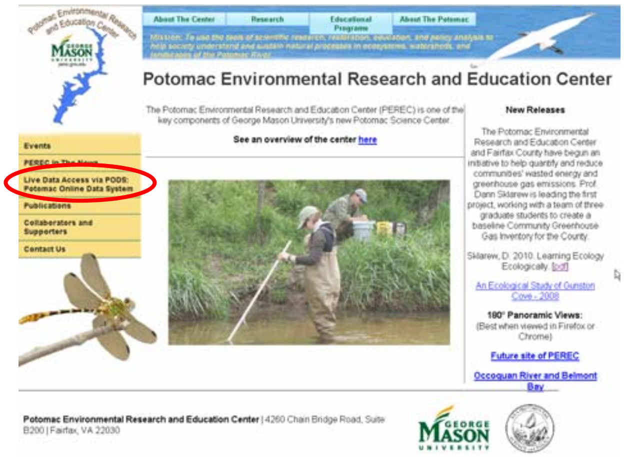


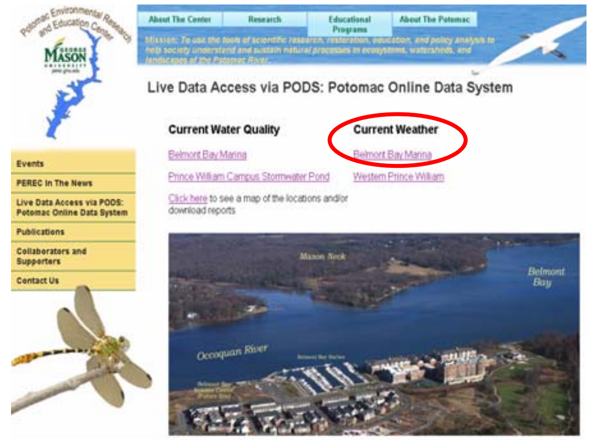
Above 5 mg/l dissolved O_2, most aquatic organism can survive. Anoxia occurs when almost all the dissolved oxygen is used up, below 0.5 mg/l. Very few organisms can survive anoxic conditions which during warm summer months on the Chesapeake Bay.

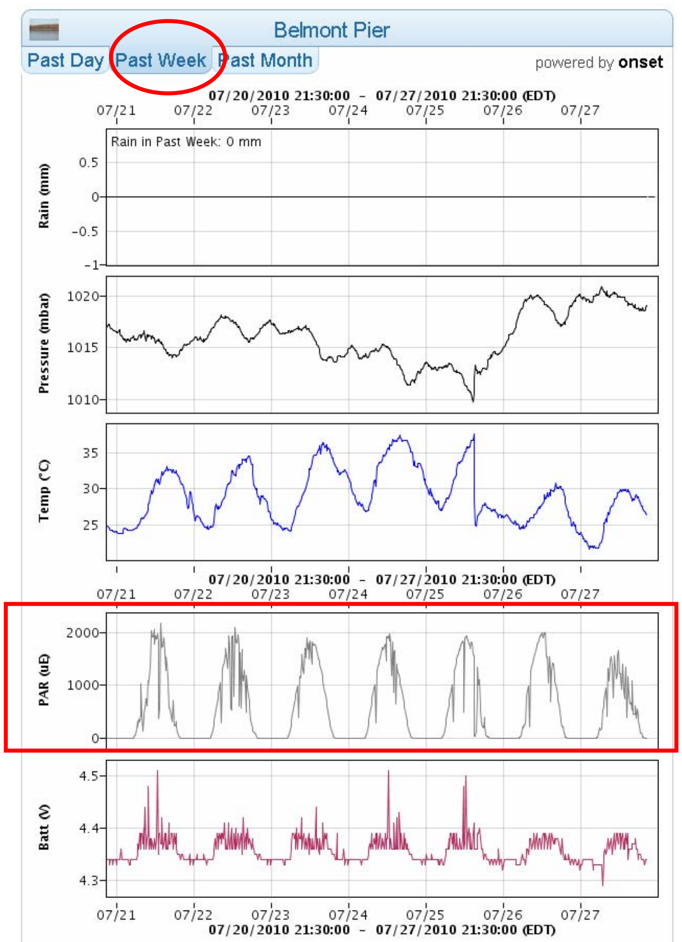
While other factors may be important in some cases, the dissolved oxygen in an aquatic system is often directly related to the processes of photosynthesis and respiration. In this lab we will test the hypothesis that dissolved oxygen in an aquatic ecosystem is controlled by the processes of photosynthesis and respiration.

Engage:

1. Access a computer which has internet access and EXCEL.
2. Log onto the PEREC website http://perec.gmu.edu/ and click on the left panel: **Live Data Access via PODS Potomac Online Data System**
3. Click on **Current Weather Belmont Bay Marina**







4. Click on the tab for **Past Week** and examine the graph of PAR. PAR is the amount of Photosynthetically Active Radiation, or light energy that can be used by aquatic plants and algae. Write down the dates you are examining data from _____ to _______.

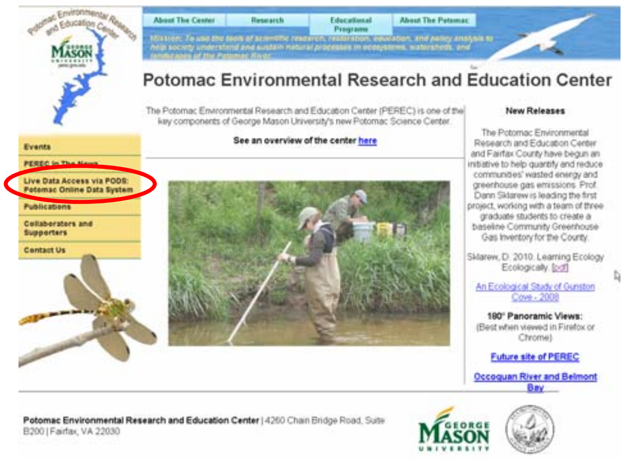
5. What do you notice about the graph? At about what time does PAR peak? Are all days in that week similar in terms of peak value?

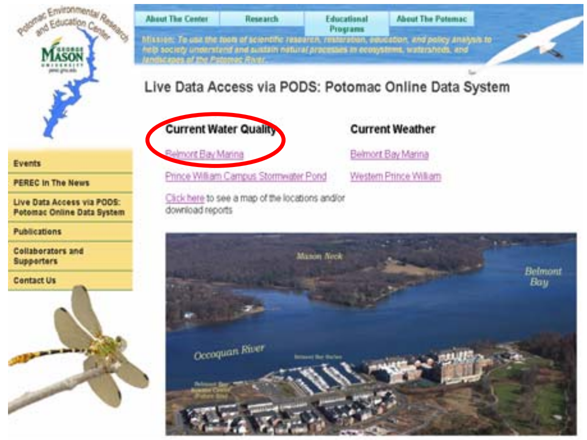
6. For each date, determine the approximate maximum PAR value from the graph and record in Table 1.

7. Students will compare this PAR data to a graph of Dissolved Oxygen data collected during the same week period.

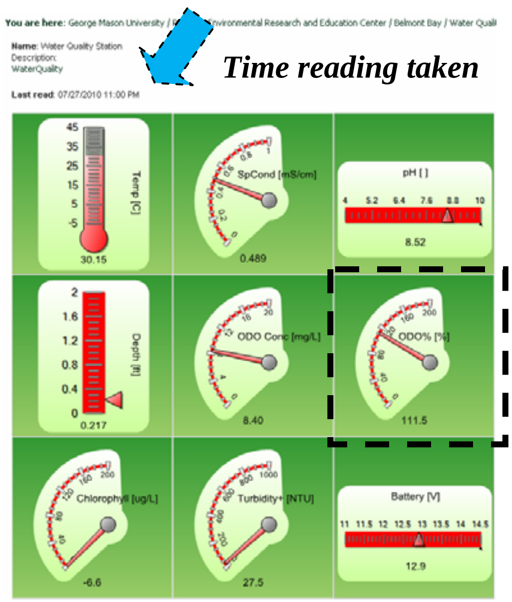
8. Log onto the PEREC website http://perec.gmu.edu/ and click on the left panel: **Live Data Access via PODS Potomac Online Data System**

9. Click on **Current Water Quality Belmont Bay Marina**. This link will take you directly to data collected every 15 minutes from the data probe attached to the Belmont Marina dock.





10. Examine the **ODO mg/l gauge**. What is the amount of dissolved oxygen in the water? _________mg/l. Is this amount high enough to support life in Belmont Bay? ______________



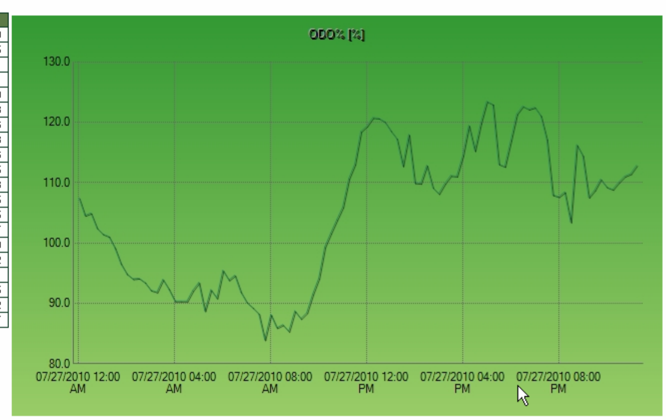
11. Examine **ODO % dissolved oxygen**. What is the current percent saturation of Dissolved Oxygen? _______________. What time of day was the most current reading taken? ___________.

12. Click on the **ODO % gauge**. A table containing Local Time and Value and a graph will show up. This graph is for the last day.

Parameter: ODO% [%]
Start Date: 7/27/2010 End Date: 7/28/2010 Submit

Local Time	Value
07/27/2010 11:15 PM	112.9
07/27/2010 11:00 PM	111.5
07/27/2010 10:45 PM	111.1
07/27/2010 10:30 PM	110.1
07/27/2010 10:15 PM	108.9
07/27/2010 10:00 PM	109.3
07/27/2010 09:45 PM	110.6
07/27/2010 09:30 PM	108.8
07/27/2010 09:15 PM	107.6
07/27/2010 09:00 PM	114.5
07/27/2010 08:45 PM	116.3
07/27/2010 08:30 PM	103.5
07/27/2010 08:15 PM	108.5
07/27/2010 08:00 PM	107.7
07/27/2010 07:45 PM	108.0
07/27/2010 07:30 PM	117.2
07/27/2010 07:15 PM	121.1
07/27/2010 07:00 PM	122.5
07/27/2010 06:45 PM	122.2
07/27/2010 06:30 PM	122.7

Previous Next



15. Graph the DO data for the two days on a common time axis (24 hr).
16. Compute the difference between maximum and minimum DO for each day.
17. Test the hypothesis by examining:
18. –Graphs

A. During what time of the day is the percent saturation of Dissolved Oxygen the highest? When is it the lowest?

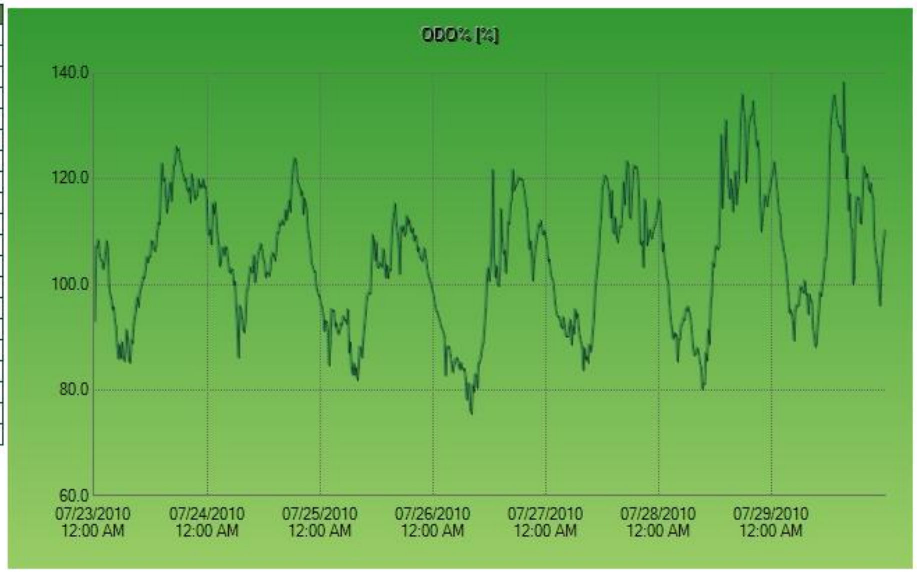
B. Using the dates you wrote down in step 4 above, type them into the boxes marked **Start Date** and **End Date** and click **Submit.**

15. You will get a new graph (on the right side of the screen) showing the full week's data. For each day you get an approximate minimum and maximum dissolved oxygen value. To get accurate maximum and minimum values as well as the time of occurrence of these, you can scroll through the data table on the left side of the screen using the "Previous" and "Next" buttons at the bottom of the table. For each day record Max ODO% value and time and Min ODO% value and time.

Parameter: ODO% [%]
Start Date: 7/23/2010 End Date: 7/30/2010 **Submit**

Local Time	Value
07/29/2010 11:45 PM	110.5
07/29/2010 11:30 PM	108.3
07/29/2010 11:15 PM	105.9
07/29/2010 11:00 PM	102.7
07/29/2010 10:45 PM	96.2
07/29/2010 10:30 PM	99.6
07/29/2010 10:15 PM	103.4
07/29/2010 10:00 PM	104.5
07/29/2010 09:45 PM	106.7
07/29/2010 09:30 PM	109.1
07/29/2010 09:15 PM	116.6
07/29/2010 09:00 PM	117.4
07/29/2010 08:45 PM	119.4
07/29/2010 08:30 PM	117.7
07/29/2010 08:15 PM	118.3
07/29/2010 08:00 PM	121.2
07/29/2010 07:45 PM	120.5
07/29/2010 07:30 PM	121.6
07/29/2010 07:15 PM	122.6
07/29/2010 07:00 PM	117.3

Previous Next

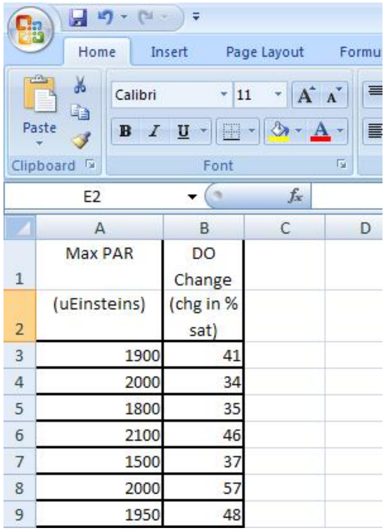


16. Calculate the DO Change for each day by subtracting the Min DO from the Max DO on each day.

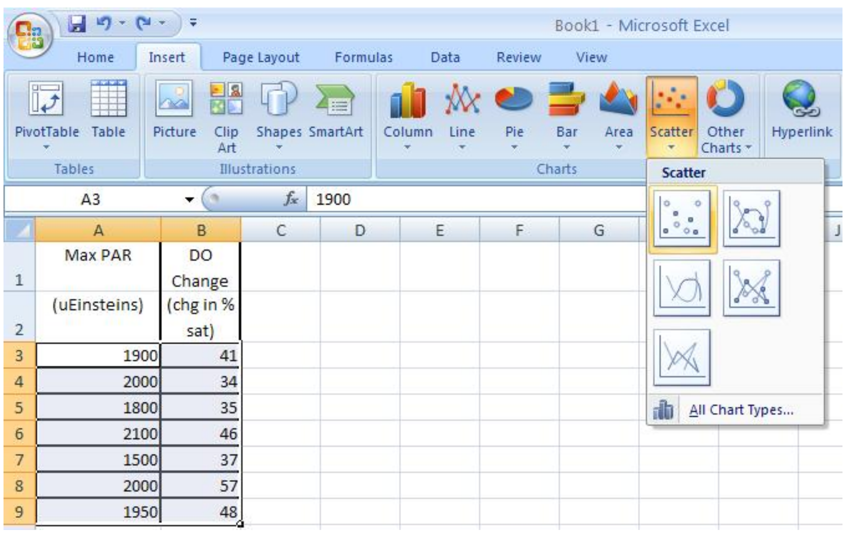
17. Hypothesis 1 states that DO will undergo a diel (24 hour) cycle based on photosynthesis occurring during the day leading to maximum DO in the late afternoon and respiration dominating at night leading to a minimum DO in the early morning hours. Is this what you found?

18. Hypothesis 2 states that the amount of DO change will be proportional to the maximum PAR value on a given day. We will test this by constructing a scatterplot with PAR on the x-axis and DO change on the y-axis. If there is a relationship, a trend should be apparent with points tending to increase from left to right on the graph.

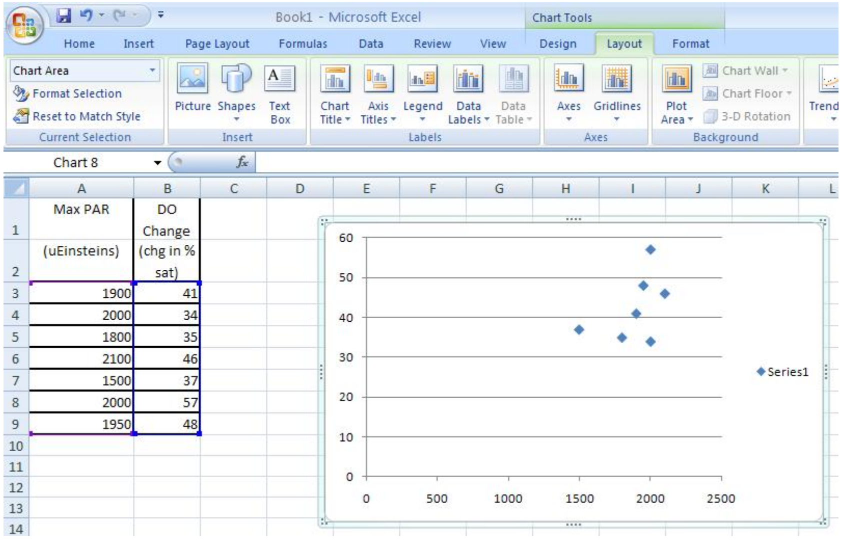
19. Open a blank sheet in Excel. Then copy and paste the Max PAR and DO Change columns from Table 1 into Excel.



20. Highlight the data in both columns. Click the Insert tab at the top of the page. Click Scatter and then the highlighted scatter plot shown in the screenshot below.



21. A scatter plot showing the data will appear on the screen. Max PAR should be on the x-axis and DO Change on the y-axis. However, these will not be labeled so you will have to label these axes and also give the plot an appropriate title. This can be done by clicking the Layout tab under Chart Tools and choosing Chart Title and Axis Titles.



Report

1. Table 1 showing Solar radiation (PAR) and DO Minimum, Maximum, Difference table for each day 2.
2. Graph showing relationship between Maximum PAR and %ODO Difference
3. Answer questions:
    - -Does the data support your hypothesis?
    - -Critique of test of hypothesis
    - -Possible alternative explanations for the data
    - -Other ways to test the hypothesis
    - -What might happen if we had a lot of cloudy days in a row?

Extension

Retest for another set of paired dates at different time of year
Retest for another set of paired dates at different site (VECOS, Eyes on the Bay, CBIBS)
Set up an in lab (more controlled?) test using Labware and aquariums with defined species
Elodea & Photosynthesis Lab

Dissolved Oxygen criteria image: http://www.chesapeakebay.net/do.htm

Vocabulary

Biomass: the amount of living matter in a given habitat, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat. Aerial productivity of algae biomass is reported as grams per square meter, tons per acre, tonnes per hectare. Volumetric productivity of algae biomass is commonly reported as grams per liter.

Cellular respiration is carried out by every cell in both plants and animals and is essential for daily living. It is the process by which food is broken down by the body's cells to produce energy, in the form of ATP molecules. In plants and algae, some of this ATP energy is used during photosynthesis to produce sugar. These sugars are in turn broken down during cellular respiration, continuing the cycle that is essential for growth. Dissolved oxygen is used to make ATP energy.

Name:______________________________

Table 1.

Date	Max PAR (uEinsteins)	Min DO (% saturation)	Time of Min DO	Max DO (% saturation)	Time of Max DO	DO Change (chg in % sat)

Human Impacts and Stewardship – Making a Difference

Investigating Human Impact

Design Your Own Walter Filter

Overview

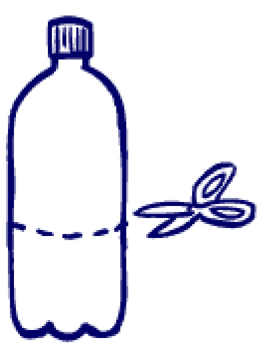
In the engagement activity (adapted from *WOW: The Wonders of Wetlands*[1]), students discover that fresh water is a renewable natural resource but that it is locally available in limited amounts at any given moment. So conservation of this resource is important. Students will problem solve to create their own water filter and collect data to test their results.

Background

- 71% of the planet Earth is covered with water.
- Only 3% of the water is fresh; only 0.6% is non-frozen.
- Only 0.00003% is not polluted, or trapped in soil or groundwater too far underground.
- On a global scale only a small percentage of water is available for use.
- Geography, climate, and weather effect water distribution.
- Land and water use for agriculture, industry, and homes affect the quantity and quality of available fresh water. This in turn affects our watersheds and wetlands.

Materials

- Water
- 1000 mL beaker
- 100 mL graduated cylinder
- Petri dish
- Salt
- Globe
- Large sheet of white paper
- Bucket
- 2 L pop clear pop bottle per group cut as shown



- Sand
- Gravel
- Activated carbon (charcoal)
- Cotton balls
- Cheese cloth

[1] To obtain, please see http://www.wetland.org/education_wow.htm or any national book retailer.

- Paper towels
- Sponges
- Soil
- Lemon juice
- Motor oil
- Fertilizer
- Pieces of paper
- Chocolate sprinkles
- Spices
- Labquests with pH probe, turbidity probe or water quality test kits
- Nitrogen test kit

Engage:

1. Show the class 1000 mL of water. This represents all of the water on earth. Question: Where is most of the water on earth located? *(About 97% of all water is in the ocean.)* Use the globe to demonstrate.

2. Pour 30 mL of water into the 100mL cylinder. Add salt to the 1000 mL beaker to show that this is unsuitable for human consumption. Question: Where is most of the fresh water on the planet? *(About 80 % of freshwater is frozen in ice caps or glaciers.)*

3. Pour 6 ml of water into a dish. This is the only non-frozen fresh water.

4. Remove a single drop of water from the dish using an eye dropper. This water, about 1.5 mL is surface water- the rest is groundwater.

5. Drop that drop of water into bucket- represents 0.00003% of total!

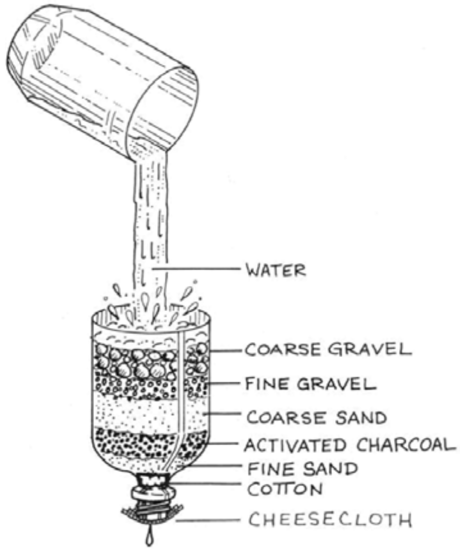
6. Ask students what are the consequences of having such a small amount of water available for human consumption? *Conservation, don't pollute, use wisely*

Learning Experiences:
A. Explore

1. Show students gallon container of clean water. Hand out the student data sheets.
2. As a class, collect the following data about the tap water: odor, turbidity, appearance, pH, nitrogen. You can either use the water quality test kits or demonstrate how to use the Vernier probeware (see appendix for instructions)
3. After you have collected the results from the tap water ask the students what are some ways that the small amount of fresh water we have on earth can become polluted? (Guide students for answers) As they answer- add pollutants to the fresh water as follows:
   a. Oil spills- add motor oil
   b. Sediment- add soil
   c. Nutrients- add fertilizer
   d. Trash- add paper pieces
   e. Acid rain- add lemon juice
   f. Industrial waste- add spices
   g. Agricultural waste- add chocolate sprinkles

4. Mix the water in the container and pour it into a clear beaker. Does this look like water you would like to drink?

5. Tell students that their challenge is to work in a team to create a water filter that will remove as many of the pollutants as possible.
6. Go over the materials that they can use to create their filter.
7. They will make their filter in the top half of the soda bottle and filter the water into the lower half. See example filter below:



Note: The diagram to the left is just an example of one type of filter. Encourage the students to be creative to design their own filter with the materials they predict will work best.

8. Before they filter their water they should collect data using the water quality test kits or Vernier probeware.
9. Have them record their data on their data sheet.
10. When they have completed their tests, have each group share their results with the class and discuss what type of filter worked the best and why.

Water Filter Challenge

Date:________ Names of Team Members:________________________________

Record Your Water Quality Data on the Table Below:

Properties	Clean Water	Gray Water	After First Filtering	After Second Filtering
Appearance				
Odor				
Turbidity				
pH				
Nitrogen				

Draw and Label a diagram of your filter in the space below:

Conclusion:

1. Did your filter help to clean the water? ______ How do you know?

____

2. What would you change if you could create a different filter?

____

B. Elaborate:

1. To further investigate human impact on our watershed, have the students visit: http://www.cacaponinstitute.org/high.htm
2. Have the students click on the "Decision Matrix" listed under activities.
3. Students should read the background about how each decision will impact the watershed and then complete the activity.
4. In teams, have them share the results of their decisions

Student Inquiry

Student Stewardship Project

We Can Make A Difference!

Overview
Students will work together to design a project that will improve their school yard environment or somehow benefit the Chesapeake Bay.

Materials
- Will depend on the project

Engage:
Have the students reflect on what they have studied during this watershed unit. Even though they might be located far from the Bay, do their actions still affect it? Will changes at the local level affect the Chesapeake?

Learning Experiences:
A. Explore
1. Take the students to investigate the school yard for evidence of human impact. Have them record their observations.
2. Based on their observations of their schoolyard and the activities they participated in, have student groups brainstorm to create projects that they could do as a class or as a school to help improve the quality of their schoolyard, community, and ultimately the Bay.
3. Make sure that it is a project that could be done by students (e.g. conducting a schoolyard clean up, not building better sewage treatment plants ☺)
4. Student groups should develop an outline for their project. It should include a materials list, amount of time, budget, and how it will improve the environment.
5. Have each group present their project to the class. Have the students discuss the pros and cons of each proposal.
6. Have the students vote on the projects to decide which one they would like to undertake.
7. Encourage students to write letters to get the community and local government officials involved. Contact info for the PWC Board of County Supervisors located here: http://www.pwcgov.org/default.aspx?topic=040050000940000442
8. Invite reporters, school board representatives, local government, PTSO members, and the community to participate in the project or to encourage the students in their stewardship of the environment.
9. Have students act as reporters and photographers to document the stewardship projects.

Encourage students to come up with their own ideas based on their observations and data collection.

For additional ideas for Schoolyard Stewardship Projects visit: www.livebinders.com/edit?id=1925

Or see:

Lessons from the Bay at http://www.pen.k12.va.us/VDOE/LFB/lessonplans/index.html

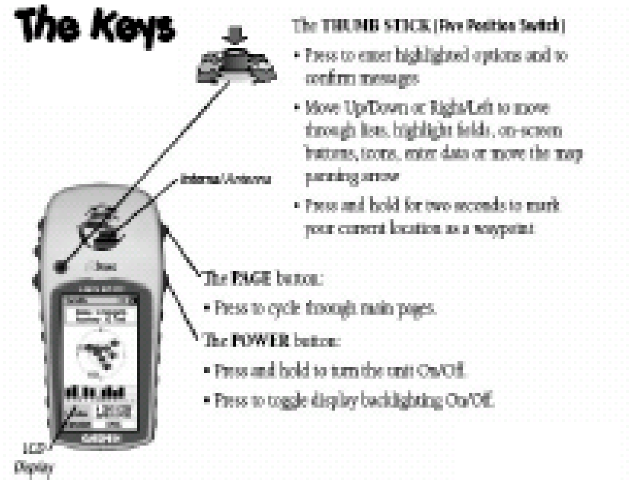
Bridging the Watershed at http://www.btwaction.org

Bay Backback at http://www.baybackpack.com

Appendix

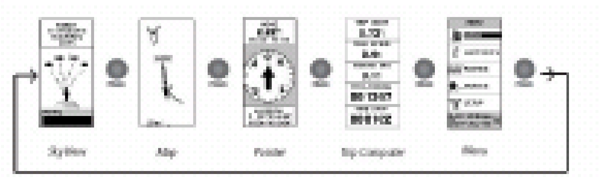
Garmin eTrex Legend Basics

The Keys

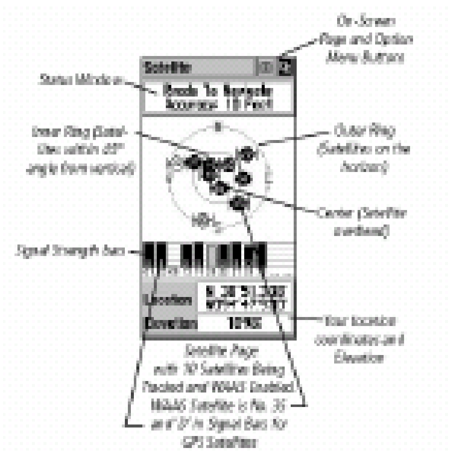


Display Screens

Use the PAGE button on the top right of the receiver to switch between the different screens.

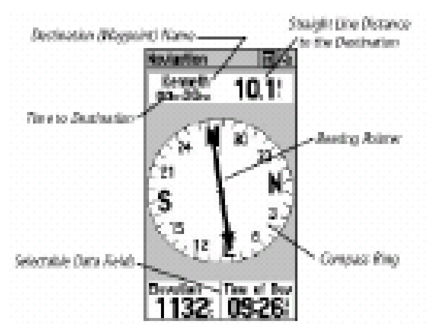


Satellite Page



The dark bars show the satellites you are "locked" on. You need at least 3 bars to use the receiver.

Pointer Page Basics

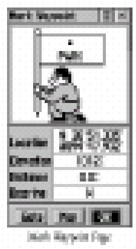


Go in the direction the arrow is pointing to move towards your waypoint or landmark.

NOTE: You must be moving in order for the GPS unit to determine where you are and which way you are moving.

Marking a Waypoint (Location)

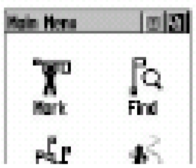
1 – Press and hold the THUMB STICK until the MARK WAYPOINT screen appears with the guy holding a flag.



2 – Your waypoint is automatically assigned a three-digit number. To change the name of the waypoint, use the THUMB STICK button to highlight its name. Use the THUMB STICK to select the new name for the waypoint.

3 – When you are done, use the THUMB STICK to highlight the OK button and press the THUMB STICK button once.

Finding a Waypoint (Location)



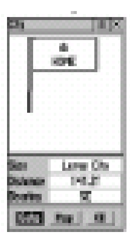
1 - Use the PAGE button to find the main menu. Use the THUMB STICK to go to the FIND option and press the same button to select this option.

> You can also press the bottom left button on the receiver to go directly to the Find screen.

3 - Select WAYPOINTS by pressing the THUMB STICK button.

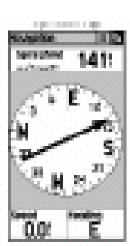
4 - Choose NEAREST on the next menu.

5 - Select the waypoint you want using the THUMB STICK button.



6 - Use the THUMB STICK button to select GOTO at the bottom of the screen.

> Remember ...
> You must be moving in order for the receiver to keep track of your location!



7 - Use the navigation screen to help you locate your destination. You need to move in the direction of the large arrow. When you get close to your destination, an "Arriving at Destination" message will be displayed.

Getting Started with Vernier Probeware

Using the Vernier LabQuest and sensors

<u>FOR PRACTICE getting started:</u>

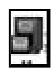
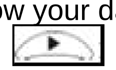
TO COLLECT DATA

1. Ensure stylus is securely connected
2. To power on **LabQuest**, press the silver button at the top left 
3. Connect the temperature sensor to one of the 4 available ports at the top (CH1, CH2, CH3, CH4) – (*these will be the ports we use for the other sensors – Turbidity, Dissolved Oxygen, pH, & Conductivity*)
4. *Notice the temperature display on the screen*
5. Press the Collect button  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
6. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
7. Press the Collect button  again to stop data collection.

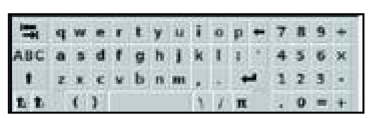
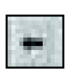
<u>TO ANALYZE THE DATA YOU COLLECTED</u>

1. After data collection (above), use the stylus to tap a point on your graph
2. *Notice (1) the lines to the x and y axes; (2) the circle around the point you chose, and (3) the readings at the right of your graph – these are the x and y readings for the point you chose*
3. You can make adjustments to the cursor location by using the left and right cursor keys on the keypad below the screen. *Notice how the circle and lines move and the numbers at the right side change – these are the new points you are moving to.*

<u>TO COLLECT ADDITIONAL DATA</u>

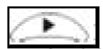
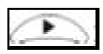
1. To start a second data collection run, tap the file  cabinet in the upper right corner. *You should now see* Run 2 *displayed with a blank graph*.
2. Press the Collect button  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
3. Press the Collect button  again to stop data collection.

<u>SAVING YOUR DATA</u>

1. To save your data, tap **File** with the stylus
2. In the drop down menu, tap **Save**
3. *The screen will change to a file list and allow you to type your filename (you will see* untitled *in the* Name *bar)*
4. Using the stylus, tap in the Name bar
5. A keyboard will appear → → → 
6. Using the back arrow,  delete untitled and type the name of your file ("*Rob's Temp Data*")

TO TURN OFF LABQUEST, HOLD DOWN POWER  **UTTON FOR 3 SECONDS**

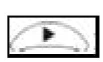
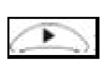
Using the Vernier LabQuest with the Temperature Sensor

1. To power on **LabQuest**, press the silver button at the top left
2. Connect the temperature sensor to one of the 4 available ports at the top (CH1, CH2, CH3, CH4)
3. *Notice the temperature display on the screen*
4. Put stainless steel portion of temperature sensor into water you want to measure
    a. ***DO NOT completely submerge the temperature sensor, the plastic part is NOT waterproof***
5. Press the Collect button  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
6. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
7. Press the Collect button  again to stop data collection.

8. Refer to SAVING, VIEWING, & UPLOADING YOUR DATA to save, review, & upload your data.

9. **When you are finished with the temperature sensor:**
    a. Carefully unplug it from the **LabQuest** port and return it to its plastic storage bag.

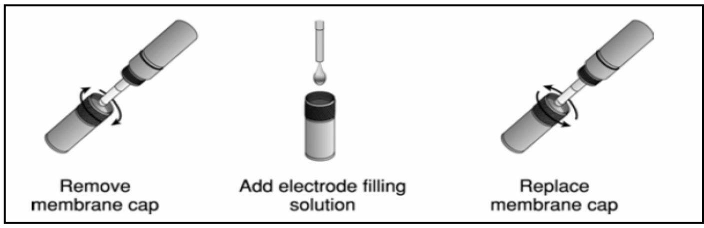
Using the Vernier LabQuest with the pH Sensor

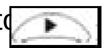
1. **Before you turn on LabQuest,** remove the storage bottle from the pH sensor by unscrewing the lid, removing the bottle, and sliding the lid off of the blue sensor.
2. With distilled water, thoroughly rinse the lower (blue) section of the sensor, especially the bulb.
    a. ***DO NOT completely submerge the pH sensor, the handle is NOT waterproof***
3. To power on **LabQuest**, press the silver button at the top left
4. Connect the pH sensor to one of the 4 available ports at the top (CH1, CH2, CH3, CH4)
    a. *Notice the pH display on the screen*
5. Put the blue portion of the pH sensor into the solution you want to measure
    a. ***DO NOT completely submerge the sensor, the handle is NOT waterproof***
6. Press the Collect button  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
7. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
8. Press the Collect button  again to stop data collection.
9.
10. Refer to SAVING, VIEWING, & UPLOADING YOUR DATA to save, review, & upload your data.
11. When you are finished with the pH sensor:
    - Carefully unplug it from the **LabQuest** port
    - Rinse the blue sensor with distilled water.
    - Slide the bottle lid onto the sensor (blue portion). Put the sensor into the storage bottle just until the bottom is submerged in the storage solution.

- ▪ ***DO NOT store the sensor in distilled water. It should ONLY be stored in the storage bottle with a special solution***
- Screw the lid onto the storage bottle.
- Return the sensor and storage bottle to the equipment box.

<u>Using the Vernier LabQuest with the Dissolved Oxygen (DO) Sensor</u>

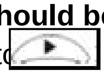
1. **Before you turn on LabQuest,** remove the blue protective cap from the tip of the probe and discard - **DO NOT replace protective cap after 1st use**
2. Unscrew the membrane cap from the tip of the sensor.



3. Using a pipet, fill the membrane cap with **1 mL** of *DO Electrode Filling Solution*.
4. Carefully thread the membrane cap back onto the sensor.
5. Place the sensor into a container filled with about 100 mL of distilled water.
   a. ***DO NOT completely submerge the DO sensor, the handle is NOT waterproof***
6. **You must warm-up the Dissolved Oxygen for 10 minutes before using it**
7. Leaving the sensor in the water, power on **LabQuest**, (press the silver button at the top left)
8. Connect the Dissolved Oxygen sensor to one of the 4 available ports at the top (CH1, CH2,…)
   a. *Notice the DO display on the screen (mg/L)*
   b. ***DO NOT use the dissolved oxygen sensor at the same time (in the same solution) as any other sensor (*it is best to use the dissolved oxygen sensor by itself)**
9. Leave the sensor in the water and connected to **LabQuest** interface with the data collection program running for **10 minutes**. The sensor **must stay connected at all times** to keep it warmed up. *If disconnected for a few minutes, it will be necessary to warm up the probe again.*
10. After 10 minutes, you are now ready to collect data.
11. Place the sensor into the water being tested (submerge 4–6 cm, less than the length of your index finger). ***DO NOT completely submerge the DO sensor, the handle is NOT waterproof***
12. Gently stir the sensor in the water sample. **To get accurate readings, there must always be water flowing past the probe tip when you are taking measurements.**
    a. **<u>IF the sensor is left still in calm water, the DO readings will be inaccurate</u>** (and appear to be dropping)
13. Press the Collect butt  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
14. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
15. Press the Collect butt  again to stop data collection.
16. **Refer to <u>SAVING, VIEWING, & UPLOADING YOUR DATA</u> to save, review, & upload your data.**

17. **WHEN YOU ARE FINISHED WITH THE DO SENSOR:**
18. Carefully unplug it from the **LABQUEST** port
19. Rinse the sensor with distilled water.
20. Slide the bottle lid onto the sensor. Put the sensor into the storage bottle ½ filled with distilled water. Ensure the sensor tip (membrane) is submerged in the distilled water.
21. Screw the lid onto the storage bottle.
22. Return the sensor and storage bottle to the equipment box.

<u>Using the Vernier LABQUEST WITH THE TURBIDITY SENSOR</u>

1. To power on **LABQUEST**, press the silver button at the top left
2. Ask your teacher if the sensor is already calibrated. If it's not, **<u>STOP</u>** - ask for help to calibrate it – go to **<u>CALIBRATING TURBIDITY SENSOR</u>** before continuing (it should be calibrated before use) *(see back of this page)*
3. Connect the Turbidity sensor to one of the 4 available ports at the top (CH1, CH2,…)
    a. *Notice the Turbidity display on the screen (NTU)*
4. Put the water sample into the empty bottle (cuvette) – fill it to the top of the line (the **meniscus should be at the top of the line for every measurement**)
5. Screw the lid on the bottle
6. Turn it upside down four (4) times to mix anything that settled to the bottom (**DO NOT SHAKE** – shaking will produce air bubbles that will affect turbidity reading)
7. Wipe the outside with a lint-free cloth or tissue
8. Holding by the lid, insert into the Turbidity Sensor - **align the mark on the bottle (black triangle) with the mark on the sensor (white triangle) - ****these marks must be aligned whenever a reading is taken**
9. Monitor the turbidity value on **LABQUEST - because particles will settle, turbidity readings should be taken soon after bottle is placed in the sensor**
10. Press the Collect butto  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
11. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
12. Press the Collect butto  again to stop data collection.
13. **Refer to <u>SAVING, VIEWING, & UPLOADING YOUR DATA</u> to save, review, & upload your data.**
14. **WHEN YOU ARE FINISHED WITH THE TURBIDITY SENSOR:**
    a. Carefully unplug it from the **LABQUEST** port
    b. Rinse the sample bottle (cuvette) with distilled water.
    c. Screw the lid back on, and return the sensor and bottle to the equipment box.

<u>CALIBRATING TURBIDITY SENSOR</u>

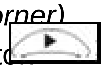
To CALIBRATE sensor before using (should be calibrated before 1st use)

1. Connect the Turbidity sensor to one of the 4 available ports at the top (CH1, CH2,…)
2. *Notice the Turbidity display on the screen (NTU)*
3. Get the bottle (cuvette) containing the Turbidity Standard (*STABLCAL FORMAZIN STANDARD)*

4. Turn it upside down four (4) times to mix anything that settled to the bottom (**<u>DO NOT SHAKE</u>** – shaking will produce air bubbles that will affect turbidity reading)
5. Enter Calibration routine of **LabQuest** – with sensor connected, tap *Sensors*, then *Calibrate*, and choose *Turbidity*
6. Holding the standard bottle (cuvette) by the lid, insert into turbidity sensor - **align the mark on the bottle (black triangle) with the mark on the sensor (white triangle) - ****these marks <u>must be</u> aligned *whenever* a reading is taken**
7. Close the lid
8. On the **LabQuest**, enter *100* in the *NTU* block in the top left
9. Remove the bottle from the Turbidity Sensor

10. **<u>For the 2^{nd} Calibration point</u>**, fill the empty bottle (cuvette) with distilled water
11. The meniscus should be at the top of the line for every measurement
12. Screw the lid on the bottle
13. Wipe the outside with a lint-free cloth or tissue
14. Holding by the lid, insert into the Turbidity Sensor
15. On the **LabQuest**, enter *0* (zero) in the *NTU* block in the top left
16. You are now ready to collect turbidity data

<u>Using the Vernier LabQuest with the Conductivity Sensor</u>

1. To power on **LabQuest**, press the silver button at the top left
2. Connect the conductivity sensor to one of the 4 available ports at the top (CH1, CH2,…)
   a. *Notice the conductivity (µS/cm) display on the screen*
3. Using distilled water, rinse the end of the sensor
4. Insert the sensor into the sample to be tested – be sure the opening is completely submerged
   a. ***DO NOT completely submerge the conductivity sensor, the handle is NOT waterproof***
5. Be sure the *Range* switch is set to _____
6. Gently stir the sensor in the water sample
7. Wait for the reading on **LabQuest** to stabilize – this should take less than 10 seconds
8. Press the Collect button  just below the screen. Data collection will begin, and a graph will show your data being plotted in real time.
   a. *Notice that the screen changed to a graph and is collecting data over time (lower right corner)*
9. Press the Collect button  again to stop data collection.
10. **Refer to <u>SAVING, VIEWING, & UPLOADING YOUR DATA</u> to save, review, & upload your data.**
11. **When you are finished with the Conductivity sensor:**
    - Carefully unplug it from the **LabQuest** port
    - Rinse the conductivity sensor with distilled water
    - Blot it dry using a paper towel or lab wipe and return it to its storage box.

SAVING, VIEWING, & UPLOADING YOUR DATA

Saving your data

1. To save your data, tap **File** with the stylus
2. In the drop down menu, tap **Save**
3. Tap the stylus in the **Name** bar where you see untitled
4. Using the stylus with the keyboard use the ***back arrow*** to delete untitled and type the name of your file, then tap **Save**.
5. IF you are adding data to an existing file, tap that filename and then tap **Overwrite** – this will add your new data set to the file.

Viewing your data

1. You can view all data in one file on one graph.
2. Using the stylus, tap **Run 1** (or Run __) in the upper right corner.
3. You will get a drop down menu with a list of your data runs (Run 1, Run 2, Run 3,….) and **All Runs**.
4. Using the stylus, **Either** tap the data run you want to view **or** tap **All Runs** to view all data on one graph

Uploading your data to a computer

1. On **LabQuest** open the file you want to transfer
   a. Power on **LabQuest**, press the silver button at the top left
   b. With the stylus, tap (select) *File* and tap (select) *Open*
   c. Tap (select) the file you want to open, then tap (select) *Open*
2. On your computer, open **Logger Lite**
3. Connect the **LabQuest** USB cable to your computer, then to **LabQuest**
4. You should see a pop-up window that indicates: *Remote Data Available – Remote data have been detected. Would you like to retrieve the data now?*
5. Select *Yes*
6. Select *Retrieve remote data into the current file* select *Ok*
7. On your computer, Save your file (select *File*, then *Save As*, then name your file and select *Save*)
8. You can now manipulate your data on your computer

Our Watershed in Jeopardy

Please visit http://school2bay.pbworks.com/High-School for access to associated powerpoint presentation.