

Wetland Investigations: Hydrology

Material adapted from:

“Action for Wetlands” & “Water We Have Here” from Wow! The Wonders of Wetlands: An Educator’s Guide, Project Wet.

Introduction:

There are many ways to monitor the health of a wetland. The presence of a certain plant and animal species can be used as a barometer of wetland conditions. A look at the composition of wetland soils can also offer clues. However, the investigation of water itself offers a fundamental approach to the study of a wetland’s well being. When the results of wetland water-quality parameter tests are documented, the data can be compared to data from other wetlands or from the same wetland over time (e.g. through a school year). The results can be correlated with other factors such as weather, watershed dynamics, and human activity.

This activity will provide students with an opportunity to better understand how water samples differ, and how a number of factors combine to greatly influence wetland water quality. These factors can affect the ability of wetlands to perform valuable natural functions.

Objectives:

Students will be able to:

- Measure and monitor water conditions (pH, temperature, salinity, dissolved oxygen, turbidity, rate of flow, and excess nutrients) in a local wetland.
- Draw conclusions about a wetland based on water analysis measurements.
- Analyze near-real time data taken from monitoring stations in the Columbia River.
- Compare and contrast hydrological data collected by hand sampling verses data obtained from research stations.

Ocean Literacy Principles

These activities support:

- Essential Principle # 5 - The ocean supports a great diversity of life and ecosystems
- Essential Principle # 7 - The ocean is largely unexplored

Materials:

- Water sampling equipment (see below)
- Clipboards, pencils and paper

Handouts/Transparencies:

Student Handouts:

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- **Measuring pH**
- **Measuring Temperature**
- **Measuring Salinity**
- **Measuring Dissolved Oxygen**
- **Measuring Turbidity**
- **Measuring Rate of Flow**
- **Measuring Excess Nutrients**
- **Water Data Analysis Information**
- **Water Data Sheet**
- **LOBO River Data**
- **SATURN River Station 05**

Teacher Resources:

- **Wetlands Websites**
- **Instructions for Making Simple Wetland Sampling Equipment**

Set-Up

1. Make or collect Wetland Sampling Equipment, using the teacher resource “Making Simple Wetland Sampling Equipment”.
2. Find a wetland to study. You can use the map resources from “Wetlands Websites” to help locate wetlands in your area.
3. Brainstorm a list of local wetland sites with your students. Some potential sites could include:
 - The edges of ponds, streams or other permanent bodies of water
 - Tidal zones along coastlines
 - Temporary bodies of water that are wet for weeks at a time
 - Drainage ditches
 - Sites with obvious wetland vegetation (cattails, rushes, etc.)

Part A: Wetland Sampling

1. Take a trip to your desired wetland sampling location.
2. Have students brainstorm a list of things people can study about water. What could the information they collected tell them about water quality?
3. Introduce and discuss the water-quality parameters to be measured.
4. Divide the class into groups. Assign each group a parameter to be responsible for collecting and analyzing. Provide each group with clipboards, paper and pencils and the relevant handout to their assigned parameter. Have students review their sampling procedures and plan their data collection.
5. Allow each group to collect their measurements within your desired time frame. You may wish to have groups rotate between each parameter to collect multiple

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measurements of the same data. This will allow each student to attempt each sampling method as well as provide multiple data sets, which can then be averaged to improve data accuracy.

6. Back in class, provide each student with a student data sheet. Have each group interpret their data, discuss their results and report back their findings to the rest of the class, using the “Water Data Analysis Information Sheet” or researching the parameter if necessary. Students can record each data set on their data sheet during these presentations.
7. Discuss with the students:
 - What does each of these parameters tell us about the water quality of the wetland?
 - Do students think these conditions indicate a healthy wetland? How might this affect the wetland as a habitat for wildlife?
 - What influences the results they gained?
 - What can we as community members do to keep the water in our local neighborhood healthy?

NB: Salinity, dissolved oxygen and excess nutrients are all measurements that are optional for this activity, as they will depend on both the sampling location and availability of equipment. However, pH, temperature and turbidity must be measured in order to be able to draw conclusions about the sampling location.

Part B: Columbia River Data

For this part of the class, students will use their newly acquired knowledge of wetland data to analyze real-time data collected by static instrumentation in different parts of the Columbia river basin. This real-time data is provided by CMOP, the Centers for Coastal Margins Observation and Prediction, obtained from LOBO (Land/Ocean Biogeochemical Observatory) instrumentation. More information about LOBO is available at: <http://columbia.loboviz.com/about/>.

NB: It is important to familiarize both yourself and the students with the measurement used for each parameter:

- Temperature - °C (Degrees Celsius)
 - Salinity - PSU (Practical Salinity Units)
 - Turbidity - NTU (Nephelometric Turbidity Units)
 - Nitrates - μM (Micromolar, a concentration of one millionth of a mole per liter)
1. Introduce the idea of aquatic monitoring systems and their presence in the Pacific Northwest. Explain LOBO sensors and their ability to monitor water quality measurements such as temperature, salinity and turbidity.
 2. Divide students into pairs and have them visit the CMOP SATURN Observation Network at: http://www.stccmop.org/datamart/observation_network. Explain that the interactive map they are presented with illustrates different water monitoring stations in the Columbia River Basin that are part of an observation network operated by CMOP as well as additional organizations such as NANOOS

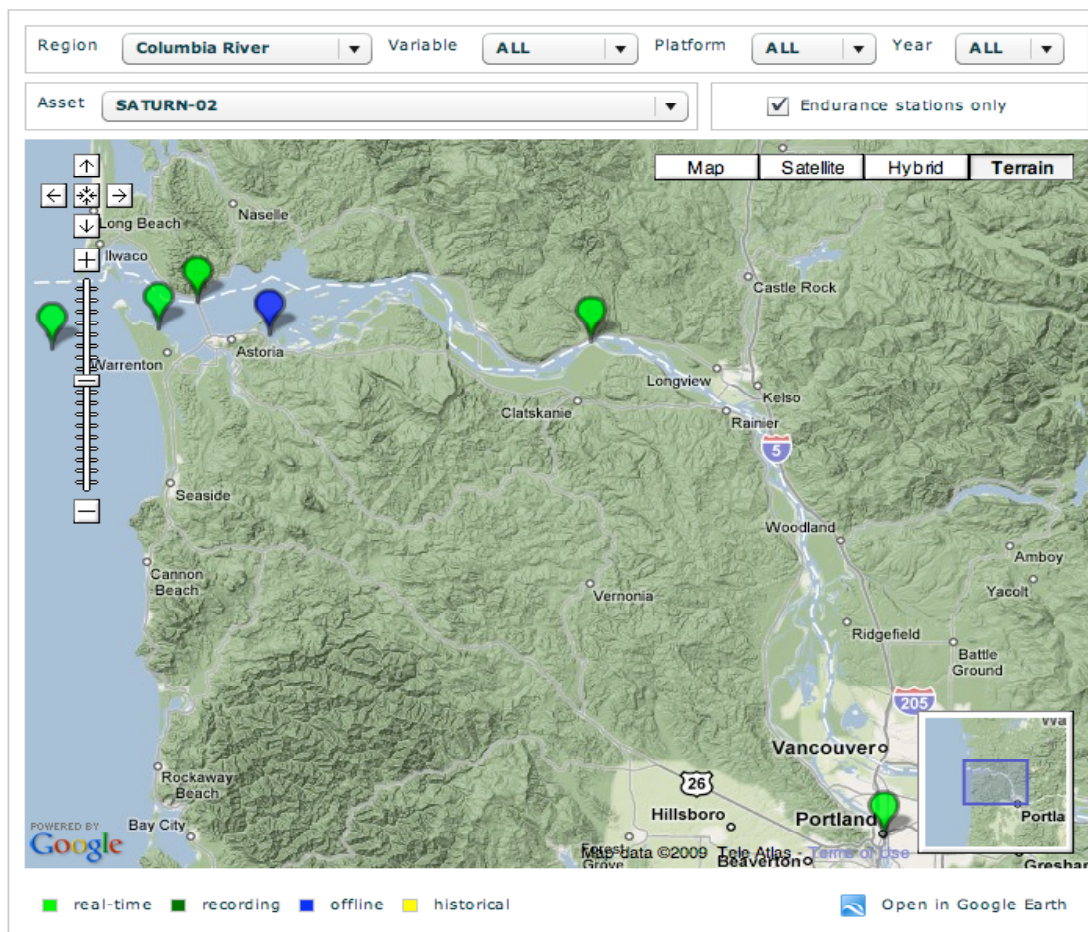
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(Northwest Association of Networked Ocean Observing Systems), Satlantic, WET Labs and USGS. Have students spend some time looking at the real-time data available at different stations.

3. Explain to the students they are going to look more closely at data from SATURN River Station 05, a LOBO instrument located in the Lower Columbia region. On the observation interactive map, have students click the check box for “Endurance stations only”. Have them locate SATURN River Station 05 and click on its marker to bring up current data for that station.

SATURN Observation Network: Endurance Stations

This is an interactive map with links to physical and biogeochemical data from endurance stations in the Columbia River estuary. Stations are part of CMOP's end-to-end collaboratory, SATURN, and contribute to NANOOS, a regional association of the U.S. Integrated Ocean Observing System.



4. The homepage for this station will provide a list of latest observations from that station. Have students click on the “Data” tab, followed by “Real-time (Raw)”. This will bring up a tool for students to explore graphs of different data from this station.
5. Students will now create plots for periods of data from June/July 2009. Have them select the following parameters:

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X Variable - Select "Date"

Y Variable - Check "Temperature", "Salinity", "Turbidity" and "Nitrate"

Data Range - Select "Custom", Start Date as 2009-6-25, End Date as 2009-7-08

Time Zone - Leave as "PST"

Group Data - Change to "1 day"

Depth - Leave as "2.5" and the "combine" check box as blank

Now click "plot data".

This will load a set of graphs illustrating the data selected for those dates. Have students either print or save the graphs for later.

HOME

DATA

STATUS

HELP

ARCHIVE (QC)

REAL TIME (RAW)

Data Disclaimer: raw data not subject to quality control, tide information is from Astoria.

X Variable

- ☒ Date
- ☐ Temperature [C]
- ☐ Salinity [psu]
- ☐ Turbidity [NTU]
- ☐ Fluorescence [ug/l]
- ☐ Nitrate [uM]
- ☐ CDOM [ppb]
- ☐ Chlorophyll [ug/L]
- ☐ Conductivity [mS/cm]
- ☐ Oxygen [ml/l]
- ☐ Oxygen saturation [ml/l]
- ☐ Fscat coef [1/(m x sr)]

Y Variable

- ☒ Temperature [C]
- ☒ Salinity [psu]
- ☒ Turbidity [NTU]
- ☐ Fluorescence [ug/l]
- ☒ Nitrate [uM]
- ☐ CDOM [dbar]
- ☐ Chlorophyll [ug/L]
- ☐ Conductivity [mS/cm]
- ☐ Oxygen [ml/l]
- ☐ Oxygen saturation [ml/l]
- ☐ Fscat coef [1/(m x sr)]

Data Range

- ☐ day of End date
- ☐ 3 days from End date
- ☐ week of End date
- ☐ month of End date
- ☒ custom

2009625

(Start)

200978

(End)

Time zone : PST

Group data: 1 day

Depth: 2.5 Combine: ☐

Plot data

Download

More

- Now have students create a similar plot for July/August 2009. Use the above parameters once again, only this time with the Data Range as Start Date 2009-7-25 and End Date as 2009-8-08. Once again have them plot the data and print/save the produced graphs.

NB: If computers are unavailable. These plots are available on the LOBO River Data handout.

- Finally, have students create a topography map of the location in which SATURN River Station 05 is located. This could be done by using Google Earth and the Latitude-Longitude value for the site: **46 11.070N, 123 11.246W**.

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NB: If computers are unavailable, use the SATURN River Station 05 Handout for ready-made maps.

8. Have students compare each set of data plots from SATURN River Station 05. Have them discuss the following questions:
 - Which parameters (temp, salinity, turbidity, nitrates) have shown significant change between months? Which have remained constant or have incurred little change?
 - What does the data indicate about the water quality of this region? Are there any tidal influences?
 - What do these plots indicate about the health of this region?
 - Are there any correlations between parameters, i.e. is one parameter change linked to another? Provide potential explanations.
 - What natural/human factors may have influenced these outcomes? (Using the map may help). Are any of these factors controllable?

Extensions:

1. If possible, carry the water sampling further by having the students monitor the water quality parameters for several days, or periodically over a number of weeks, graphing results and correlating the data with weather conditions and/or any noticeable polluting events (e.g. a rainstorm washes sediment from a nearby construction site).
2. Have students use calculus to calculate the rate of change for a chosen set of parameter changes in each of the plots. Calculations could include:
 - Overall rate of change across the date range
 - Rate of change across a specific day or number of days
 - Rate of change corresponding to a particular weather event on observed day(s) (i.e. using past weather records for those day(s))
3. Allow students to explore more LOBO data, but this time in Yaquina Bay, in Newport, OR. Use the interactive exhibit available at: http://www.nanoos.org/education/learning_tools/lobo/lobo_exhibit.php, which introduces students to graphing water monitoring data and parameters. This exhibit was developed by Sarah Mikulak, an Marine Resource Management alumni at Oregon State University, as part of a project involving LOBO, NANOOS, CMOP and Wetlabs Inc.

Making Simple Wetland Sampling Equipment

(Materials in **bold** are provided by SMILE)

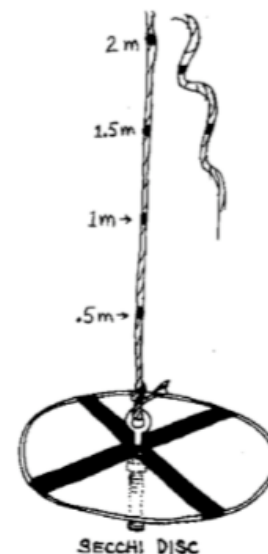
SECCHI DISC

Materials

- **White stovetop cover**/paint lid painted white
- **Black waterproof paint**
- Drill or ice pick
- **Eye bolt and nut**
- **Nylon string**
- Tape measure
- Permanent marker
- Glass jars (optional)

Directions

- Paint a large black X on top of the stovetop cover
- Punch or drill a small hole in the middle of the X and attach a string to the lid with the eye bolt and nut
- Mark of .5 meter (or 1 foot) increments on the string with the marker



How to Use

1. Gently lower the disc straight down in the water until you can no longer see the X
2. Inch the disc up until you can just barely see the X and hold the disc there
3. Reach down and grasp the string right at the surface of the water
4. Keep hold of the spot as you pull the disc out
5. Read the marking on the string to determine the depth to which light could penetrate

DEEP WATER SAMPLER

Materials:

- 1 clear plastic milk or beverage bottle (preferably with handle)
- **Nylon String** (long enough to reach desired depths)
- Rubber stopper (to fit bottle)
- Eyehook bolt/screw (large enough for rope to pass through)
- Drill with ¼ inch bit
- Electrical or duct tape
- Small rock
- Scissors
- Yardstick



Directions

- Drill hole in rubber stopper
- Screw in eyehook
- Tie rope onto eyehook, leaving a 15-20cm (6-8inch) tail
- Attach tail of rope to bottle handle or around bottleneck.
- Use yardstick to mark 30 cm (1 foot) increments on the rope, starting at the

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- mouth of the bottle. Mark increments with pieces of tape
- Cut a 60 cm (2 foot) piece of rope to tie around the rock.
 - Secure the rope, with rock attached, around the base of the bottle with tape

How to Use

1. Lower the bottle gently to the desired depth, making sure the stopper is in place
2. A sharp tug on the line will pop the stopper out and the bottle will fill up
3. Wait several minutes before gently pulling the bottle up
4. Empty the contents into a clean sample jar and store in an ice-filled cooler until you can perform the water quality tests



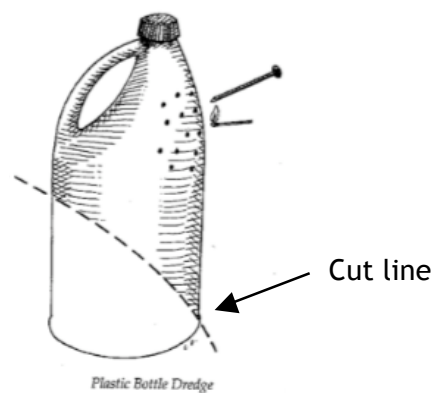
PLASTIC BOTTLE DREDGE

Materials

- Plastic bottle with handle and screw-on lid
- Scissors or sharp knife
- Large nail
- Oven mitt or protective glove
- Matches or lighter
- Sieve or jar

Directions

- Screw the lid on securely
- Cut bottle as shown
- Using a hot nail, poke holes in the plastic bottle (make sure to use a protective glove)



How to Use

1. Holding the handle of the bottle, scoop up bottom sediments
2. Empty contents of dredge into a sieve (or a wide mouth jar for storage)
3. To collect organisms, use a hose or bucket of water to wash away sediment.

DIP NET

Materials

- Wire kitchen strainer with handle
- Broom handle or other wooden pole about 3m (4ft) long
- Electrical or duct tape
- Scissors

Directions

- Mount strainer on broom handle

How to use

1. Move net from side to side in water with a sweeping motion, working your way deeper into the mud or gravel
2. Scoop up swimming invertebrates or fish
3. Periodically empty the contents into a sampling pan or use the forceps to remove smaller organisms



Wetlands Websites

This list is meant to get you started, to find your specific area you may need to do some research on your own.

Federal Agencies

- U.S. Army Corps of Engineers, www.usace.army.mil
- U.S. Environmental Protection Agency, www.epa.gov
- National Marine Fisheries Service, www.nmfx.noaa.gov
- U.S. Fish and Wildlife Services, www.fws.gov
- U.S. Natural Resources Conservation Service, www.nrcs.usda.gov

State Agencies

- Department of Natural Resources, www.oregon.gov/ODA/NRD/
- Department of the Environment, www.oregon.gov/DEQ
- Your local Conservation District

Wetland Organizations

- Ducks Unlimited, www.ducks.org
- Isaac Walton League of America, www.iwla.org
- Audubon Society, www.audubon.org
- Environmental Law Institute, www.eli.org
- Ramsar Convention, www.ramsar.org
- Society of Wetland Scientists, www.sws.org
- Association of State Wetland Managers, www.aswm.org
- Wetland International, www.wetlands.org

Other Resources

- Acorn Naturalists, www.acornnaturalists.com
- The Digital Frog Trip to the Wetlands, www.digitalfrog.com
- E-Field Trips, www.efieldtrips.org
- E-Nature, www.enature.com
- Enviroscope Wetlands Model, www.enviroscapes.com
- JASON Project, www.jasonproject.org

Measuring pH

Background

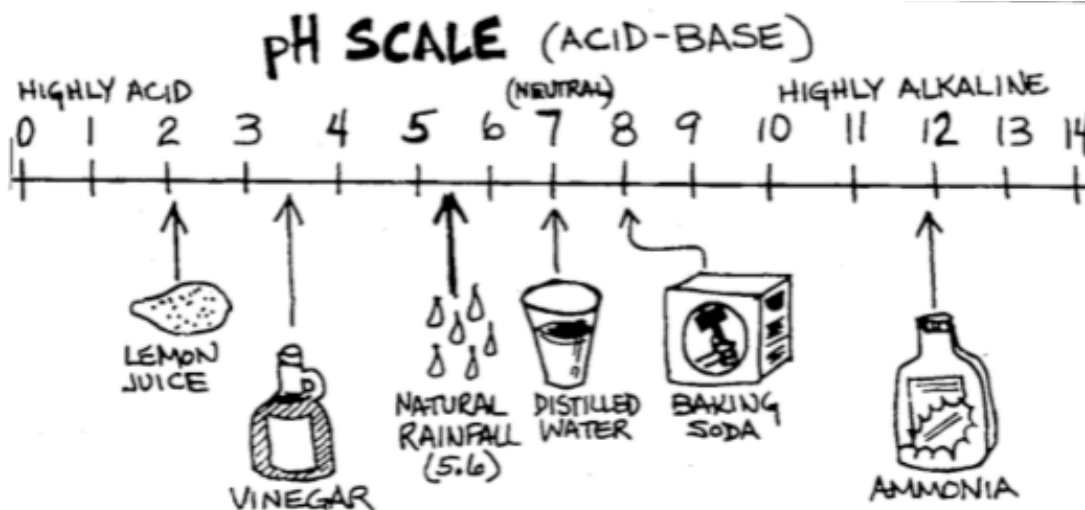
What substances do you think are acidic or basic (alkaline)? The measure of hydrogen ions (H^+) in a solution is called the pH. A solution is more acidic when it contains more hydrogen ions. pH is measured on a scale of 0-14, where 0 is extremely acidic, 7 is neutral, and 14 is extremely basic.

Several factors contribute to the natural pH level of water and soils. For example, vegetation type and density, the underlying strata of the rocks and soil, and the quality of waters flowing through the area will affect ground water and soil acidity. The pH range of natural systems under normal circumstances is typically between 6.0 and 8.0. This is most the favorable range for life and, although some organisms can tolerate harsher conditions (e.g. plants and animals of highly acidic peat bogs). The pH level of the water in wetlands is important to plant and animal life. Sudden, dramatic changes in pH could endanger the lives of young animals, in particular.

Human activity can change the level of acidity in watery environments. For example, automobiles and coal-burning utilities and factories contribute to acid rain. Sulfur dioxide (SO_2) and nitrogen oxide (NO_2) are emitted from tailpipes and smokestacks. When these compounds combine with water in the atmosphere, they form sulfuric and nitric acids (H_2SO_4 and HNO_3), which fall to earth as acid rain, snow, hail and fog. This precipitation mixes with surface water in wetland areas. The acidity of the water in wetlands can also be changed by pollutants transported in runoff. On the other hand, the lime in agricultural and household products has an opposite, buffering or neutralizing effect. When limestone or nitrates (e.g. in ammonia) combine with water that has a pH of less than 8.0, it reduces acidity.

In general, naturally occurring organic acids from plants (sphagnum moss, several tree species, etc.) are weaker and less harmful to life than inorganic acids such as sulfuric acid. In fact, organic acids from plants can actually have a buffering effect on inorganic acids that have entered the system.

Note: Seawater has a natural buffering capacity because of the many salts it contains.



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Materials

- pH paper or pH testing kit
- Small jars or cups
- Distilled water
- Broom handle or stick
- Wire or string

Procedure

1. Rinse a glass jar with distilled water and leave it outside to collect rainwater. Measure the rainwater's pH. Is the rain in your area acidic or more neutral?
2. At a wetland site, collect small water samples from several different places (near shore, out several feet, etc.) and measure the pH. To sample beyond reach, tie string or wire around a jar and tie the jar to a broom handle or stick for dipping.

Questions to Consider

- How does the pH of the rainwater compare with the pH of the wetland water?
- Do you think the rain has any effect on the wetland water? How can you tell? Test the pH of the wetland water right after it rains to see if it has changed.
- Are there other factors affecting the pH of the water? Was the pH taken near the land different from the other measurements? Why?
- How could you help reduce your contribution to acid rain?

Measuring Temperature

Background

What is the importance of temperature in habitat? Most creatures that live in water are cold-blooded, so their body temperatures, metabolism and growth rates are determined (and limited) by the surrounding water temperature. Most can tolerate only a certain range of temperatures.

Dissolved oxygen (DO), necessary for the survival of aquatic life, is also dependant upon temperature. Cold water can hold more DO than warm water. All else being equal, warm water will support less life than cold.

The waterways around some power plants are affected by increased temperatures because water used to cool the plants' reactors picks up heat from the reactors before it is released into waterways. This is called thermal pollution. Some aquatic life cannot tolerate such an increase in temperature.

Water requires more heat than either air or land for each degree of increased temperature. Bodies of water therefore change temperatures more slowly and have more stable temperatures than land or air. Lakes and oceans water adjacent land in winter and cool it in the summer.

Materials

- Lab or aquarium thermometers
- Meter stick or weighted string with length increments marked

Procedure

1. At the wetland, take and record the temperature (T) of the water in several places and at several depths (using the meter stick or weighted string to measure the depth first). Do not hold the bulb end of the thermometer in your hand before taking the water temperature, as this will affect accuracy. To get a more accurate reading, keep the thermometer in place in the water for a minute or more. Compare temperatures taken in direct sunlight and in the shade, at the surface and at depth, in moving and still water.
2. While you record the water temperature, leave a thermometer out to take the air temperature. Attempt to record ground temperature by placing the thermometer in to the nearby soil.

Questions to Consider

- How do these air/ground temperatures compare to the water temperature?
- Graph the water temperature in different locations at the wetland with depth. Are there any patterns? If so, why are these patterns occurring?
- What other factors may be affecting water temperature in your wetland site? Why?
- Research past air temperatures for that wetland (i.e. weather records). Do you think this recent weather has had an effect on the water temperature?

Measuring Salinity

Background

Salinity (the concentration of dissolved salts in the water) is an important factor in a habitat. Aquatic animals are adapted to living in certain salinity ranges. Sunfish, for example, are common in ponds and freshwater streams, but cannot survive in salt water. Animals that live in salty environments tend to be more tolerant of wider salinity ranges. Some species of fish migrate from salt water to freshwater to spawn (e.g. some salmon).

Salinity is measure as a ratio of salts to water, and is expressed in parts per thousand (ppt), which means the number of units of salts per thousand units of water. There are three main categories of salinity: freshwater (0-0.5 ppt), brackish water (partly salty, or 0.5-30 ppt), and salt water (greater than 30 ppt).

An estuary is a body of water than contains a number of salinity zones. Estuaries are partially enclosed by land and fed by freshwater rivers, opening out into the ocean. With this wide range of habitats, estuaries support an abundance of life.

Salinity is affected by weather, especially at the surface of the water. During dry seasons, water evaporates, making salty water saltier (as the concentration of salt increases). When it rains, salty water is diluted by the added freshwater.

Salinity, like, temperature, affects the amount of dissolved oxygen (DO) in the water. At high salinities, molecules of salts take up more space between water molecules, so there is less space for oxygen.

Materials

- Hydrometer (available from aquarium supply stores)

Procedure

1. Use the hydrometer to test the water in the wetland. Test several locations to determine the wetland's salinity range.
2. Test the salinity of an additional rainwater sample

Questions to Consider

- What is the salinity range in the wetland area? Is the range large or small? Why?
- Average the salinities obtained, is this salinity relatively high or low? Explain this outcome relative to the location of you wetland site.
- Do you think this region is influenced by tidal waters? Why?

Measuring Dissolved Oxygen

Background

Dissolved oxygen (DO) is vital to the health of aquatic habitats. Plants and animals need oxygen to survive and metabolize. A low amount of oxygen in the water is a sign that the habitat is stressed.

Oxygen from the air is mixed into the water with the help of rain, wind, waves and currents. Fast-moving water contains more DO than still water because it has had more contact with the air. Underwater plants and algae also contribute to the oxygen during photosynthesis.

DO is affected by weather, temperature, and salinity. Cold, fresh water holds more oxygen than warm or salty water. Because trout need a high level of oxygen to survive, they live in fast-moving, cold streams and rivers. Water must contain around 5 parts per million (ppm) DO to sustain life. Anoxic conditions (less than 2 ppm) result from dry, hot weather, when water warms and evaporation increases. If these conditions are severe, large “fish kills” (floating dead fish) may result due to lack of oxygen.

It is important to monitor DO. Since it can be used as an indicator of water quality. Anoxia can also result from the runoff of fertilizer and organic wastes (including pet droppings) from streets, lawns and farms. When excess nutrients, including nitrogen and phosphorus, enter an aquatic system, a rapid growth of algae is promoted (algal bloom). Algae produces oxygen by day by photosynthesis, but also quickly consumes oxygen at night during plant respiration. When the alga bloom dies, bacteria use a significant amount of oxygen to decompose the algae. The result is a lack of available oxygen for other plants and animals that need it.

Note: DO levels change throughout the day. DO levels raise as plants photosynthesize during the day, but decrease in the evening as the plants start to respire. The reverse takes place with regard to carbon dioxide in the water.

Materials

- Dissolved oxygen test kit.
- Safety goggles and facilities for washing hands
- Clear jars

Procedure

1. At the wetland, measure the level of DO in the water. If you monitor DO over several days, be sure to take readings at the same time each day.
2. Take DO measurements at different locations in the wetland, e.g. light verses shade, near shore verses further from shore.

Questions to Consider

- How well do you think your wetland site can support aquatic life? Are there areas more oxygenated than others? What other indicators are present that could support these ideas?

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- Do your measurements compare or contrast with location across the site, i.e. are they similar everywhere or significantly different in certain places?
- What factors could be influencing the DO levels at your specific site?
- What human activities in this area could alter DO? Are there any signs near the wetland itself? What could be done to change these activities and/or increase DO?

Measuring Turbidity

Background

What do plants need for growth? One factor is light. Because underwater plants also need light, water clarity is an important influence in wetland habitats. Fewer plants means less food for many animals, and less production of oxygen from plants to help keep the water environment healthy. Young and otherwise venerable creatures find protection in the beds of underwater plants. These plants also feed and protect many of the foods we eat, including fish, crabs, ducks and geese.

When water is cloudy, it is said to be turbid. Turbidity is caused when sediment and other materials are stirred up in the water. When loose soil from construction sites, bare lawns and eroding shorelines washes into a wetland, sediments levels rise. Excess nutrients in runoff promote the growth of algae, which can also cloud the water. Rain, wind, tides, animals, and various human activities can all stir up these suspended solids and increase turbidity.

Turbidity blocks the sunlight that is so vital to aquatic life. Fish, oysters, and other gilled creatures suffocate when their gills are clogged by sediment. Suspended particles absorb heat from sunlight as well, warming the water and decreasing DO.

A secchi disc is used to measure depth of light penetration or turbidity. The deeper the disc is visible, the clearer and less turbid the water. Secchi discs are used in water that is fairly deep and slow or still.

Materials

- White stovetop cover or paint can lid painted white
- Black waterproof paint
- Drill or ice pick
- Eye bolt and nut
- Heavy nylon string
- Tape measure
- Permanent marker
- Glass jars

Procedure

1. Paint the stovetop cover/lid white, then paint a large black X on top.
2. Punch or drill a hole in the middle of the X and attach the string to the lid with the eyebolt and nut.
3. Mark off 0.5-meter (or 1-foot) increments on the string with the marker.
4. At the wetland, gently lower the disc straight down into the water until you can no longer see the X. Then, inch the disc back up until you can just barely see the X and hold it there. Reach down and grasp the string right at the surface of the water, and hold the string there while you pull the disc back out. Read the marking on the string to determine the depth to which light could penetrate. Compare readings from several places in the wetland.

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5. If the water is fast moving, making the use of the secchi disc difficult, collect running water in clear jars at different places. Let the jars sit until the solids settle out, and compare solids collected at different locations by weight or volume.

Questions to Consider

- Were some places more turbid than others? Were you able to see what caused the turbidity?
- Are there any places where runoff and sediment are washing into the water from the land? Are fish stirring up the water?
- If you were standing in the water, did that affect your turbidity measurements accuracy?
- Were there any other indicators that this site is usually of that turbidity level? What were those indicators?

Measuring Rate of Flow

Background

What happens to a nearby stream or other body of water when it rains, or has not rained in a long time? You may have noticed a change in the rate of flow.

Rate of flow is a measure of how fast the water in a wetland is moving. Most flowing bodies of water have varying flow rates. Reasons for this variation include precipitation, spring thaws of snow and ice, and changes in the land use in the watershed. During a dry season or drought, the flow may be greatly slowed by the lack of rainfall. Some bodies of water may become smaller or narrower than usual. Small streams may stop flowing altogether (intermittent streams). Some bodies of water do not flow much at all and are nearly still.

Moving water typically carries many materials, including dissolved gases and salts (e.g. oxygen and sodium chloride), soil, mineral sediments, organic materials, nutrients, litter, etc. As water travels through an area, it may deposit materials, pick them up, or both. This action provides important metabolic building blocks for aquatic plants and animals. In bodies of water with little or now flow (e.g. a pond), wind and animals' activities help mix these materials.

As rain and runoff wash into a body of water, the rate of flow increased. Rushing floodwaters can be dangerous to people and property and can cause damage to the water itself, as soil and other pollutants are washed from the land. This input of sediment muddies the water, choking plants and animals. As the shoreline is carved away, valuable land and habitat are lost. Moreover, animals that are adapted to slow-moving water may not survive if the flow rate is greatly increased, particularly over a long period.

The combination of moving water and human development can seriously impact local watersheds. In areas with a great deal of pavement, water cannot penetrate the ground, increasing runoff, which increases flow rate. On the other hand, parking lots, driveways and sidewalks covered with gravel or woodchips allow some rainwater to soak into the ground. Runoff can also be slowed by a human-made, plant-filled buffer zone along a shoreline or water edge. A wetland performs this action naturally, providing a place where sediments and pollution can settle out before runoff reaches the waterway.

Materials

- 2 stakes or sticks
- String
- Measuring tape
- 2 oranges of similar size and weight
- Stopwatch or watch with second hand
- Dipnet (optional)

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Procedure

1. At the wetland, measure at least a 4.5-meter distance along the bank, where the water is visible. Measure 30 meters if possible. Mark the length by setting the stakes in the ground at each end and connecting them with string.
2. Have a timekeeper stand at the upstream stake. Toss an orange into the water upstream of this stake. Begin timing as the orange floats by this stake. Move to the other stake before the orange gets there and stop the watch just as the orange reaches passes the second stake. Recover the orange with the dipnet if you can do so safely and repeat the test for accuracy.
3. Repeat the test at different faster flowing locations in your wetland site.
4. Now calculate the rate of flow.

Rate (r) x Time (t) = Distance (d), so $r = d / t$

Units should be expressed as meters per second (m/s).

Questions to Consider

- On average, is your wetland area a fast-moving or slow water environment? What adaptations may some organisms have in this area to account for this?
- What natural or human factors may influence this rate of flow in this area? Are these factors controllable?
- How accurate were these flow measurements? Have there been any recent events that may have affected your results (e.g. snowmelt, heavy rainfall)?

Measuring Excess Nutrients

Background

Phosphorus (P) is an essential nutrient for plant growth and animal metabolism. Plant growth depends on the amount of P available. In many bodies of water, P is present in very low concentrations, so it is a growth-limiting factor.

Nitrogen (N) is another essential nutrient. Plants and animals use N to build proteins. Plants absorb N through their roots and use it to make plant proteins, which are then converted into animal proteins when animals eat the plants. N is usually more available for use than P, because it is found in water in different forms: molecular nitrogen (N_2); ammonia (NH_3), a product of animal wastes and the decay of animal matter; and nitrate (NO_3^-), which are formed when specialized bacteria combine ammonia with oxygen.

Although N and P are necessary nutrients, too much of them in the water cause pollution. Algae use up P very quickly and excess P encourages a vast growth of algae (algal bloom). Algal blooms use up a great deal of dissolved oxygen (DO), causing anoxic conditions. Too much N (ammonia and nitrates) causes similar problems. This excessive nutrient enrichment of water can cause eutrophication (aging of a lake or wetland).

Nutrients enter the water during natural events or human activity. Organic P and N are present in living plant and animal tissues, and become organic matter when those organisms die. The natural weathering of rocks and soil transports minerals and nutrients. Precipitation and snowmelt increase runoff that carries nutrients and other pollutants to waterways. Ground water flow and streams/rivers carry nutrients from place to place. This natural transport of materials helps supply plants and animals with need nutrients.

However, a variety of human activities can send excess nutrients into an ecosystem. Human and other animal wastes enter waterways through wastewater treatment plants and agricultural run off. Disturbance of the land and its vegetation adds excess nutrients that are normally help in the soil. Erosion is speeded by these activities, so that soil and its accompanying nutrients end up in the water. And nutrients stored in wetlands are drained for development.

Wetlands filter and trap excess nutrients and other pollutants before they can enter waterways. Wetland plants use up many of the excess nutrients that run off the land. Wetlands work to keep things in balance in the water.

Materials

- Nitrogen and phosphorus level test kits

Procedure

1. At the wetland, look for signs of eutrophication. Are there a lot of algae in the water and on the surface? What color is the water? If it is very green or brown it probably has a high nutrient content.

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2. Test for nutrient levels using instructions on the test kit. Remember - some level of N and P should already be there, it is the excess that can be harmful. Test various locations in the wetland area to compare different zones.
3. Test water flowing in and out of the wetland where lots of plants grow.

Questions to Consider

- Is the nutrient level consistent across the wetland? Why might this be?
- Is there a difference between nutrient levels in the slow-flowing areas versus the fast flowing? Suggest reasons.
- Are there any human activities nearby that could potentially increase the nutrient level in the water? How? What could be done to reduce these impacts?
- What natural sources of nutrients in this area exist?
- What evidence in this area could show that levels of N and P differ during growing seasons and in the winter? Why would this happen?

Water Data Analysis Information

Use this chart as a guide for interpreting water quality field data, however remember that each wetland is different and may not hold completely true in each case.

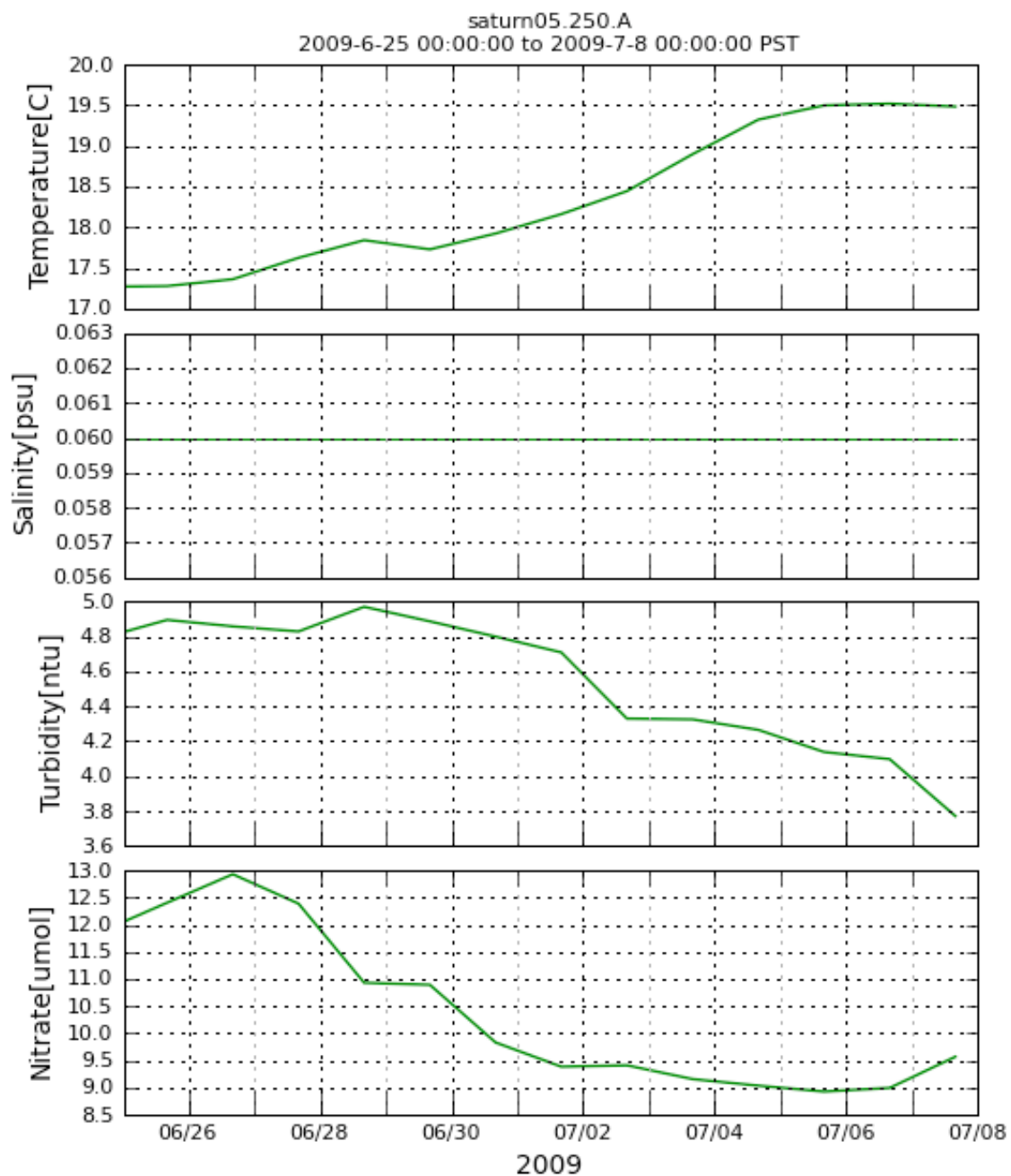
Water Test	What It Measures	Natural Reading	Danger Reading	Source	Potential Remedies
SALINITY	Amount of dissolved salts	Varies - higher in summer and fall, lower in spring	–	<i>Fresh:</i> rain and streams <i>Salt:</i> Ocean water (and evaporation)	–
DISSOLVED OXYGEN	Amount of oxygen in the water	7-14 ppm	3-5 = stress 1-2 = poor 0 = anoxic	Wind, waves, running water	Control nutrient content/algae growth, increase wind/water movement
pH	Acid/base of the water	Generally 6.5-8.5 (However bogs are naturally acidic, can be as low as 4.2)	Below 6.5; above 8.5	Acid rain, industrial pollution, chemical spills, excess nutrients	Pollution controls
PHOSPHATES AND NITRATES	Amount of these nutrients in the water	P - 0.00-0.65 ppm; N - 0.0-0.08 ppm	Any reading higher than normal	Sewage, industry, detergents, fertilizer, animal wastes	Removal by water treatment, restrictive use, less pavement to reduce runoff/leaching
TEMPERATURE	Average amount of heat in the water	Varies	Generally above 27°C (81°F) (>24°C for trout streams)	Waste heat, solar heat	Cooling towers in power plants, etc. (decreased T also increases DO)
TURBIDITY	Clarity of the water	80-120 cm (0-8 NTU)	Increased turbidity	Sediment, excessive algae growth, boat traffic, storms, etc	Sediment/erosion controls, reduced nutrient leaching to reduce algae growth, boat speed limits

Wetland Investigations: Student Data Sheet

		Day 1: Date _____	Day 2: Date _____	Day 3: Date _____
W A T E R	Temperature (T) (in degrees C or F)			
	Salinity (S) (in ppt; or fresh, salty or brackish)			
	pH			
	Is the water tidal or nontidal?			
	Dissolved Oxygen (DO)			
	Turbidity			
	Rate of Flow (Give units)			
	Nitrogen (N)			
	Phosphorus (P)			

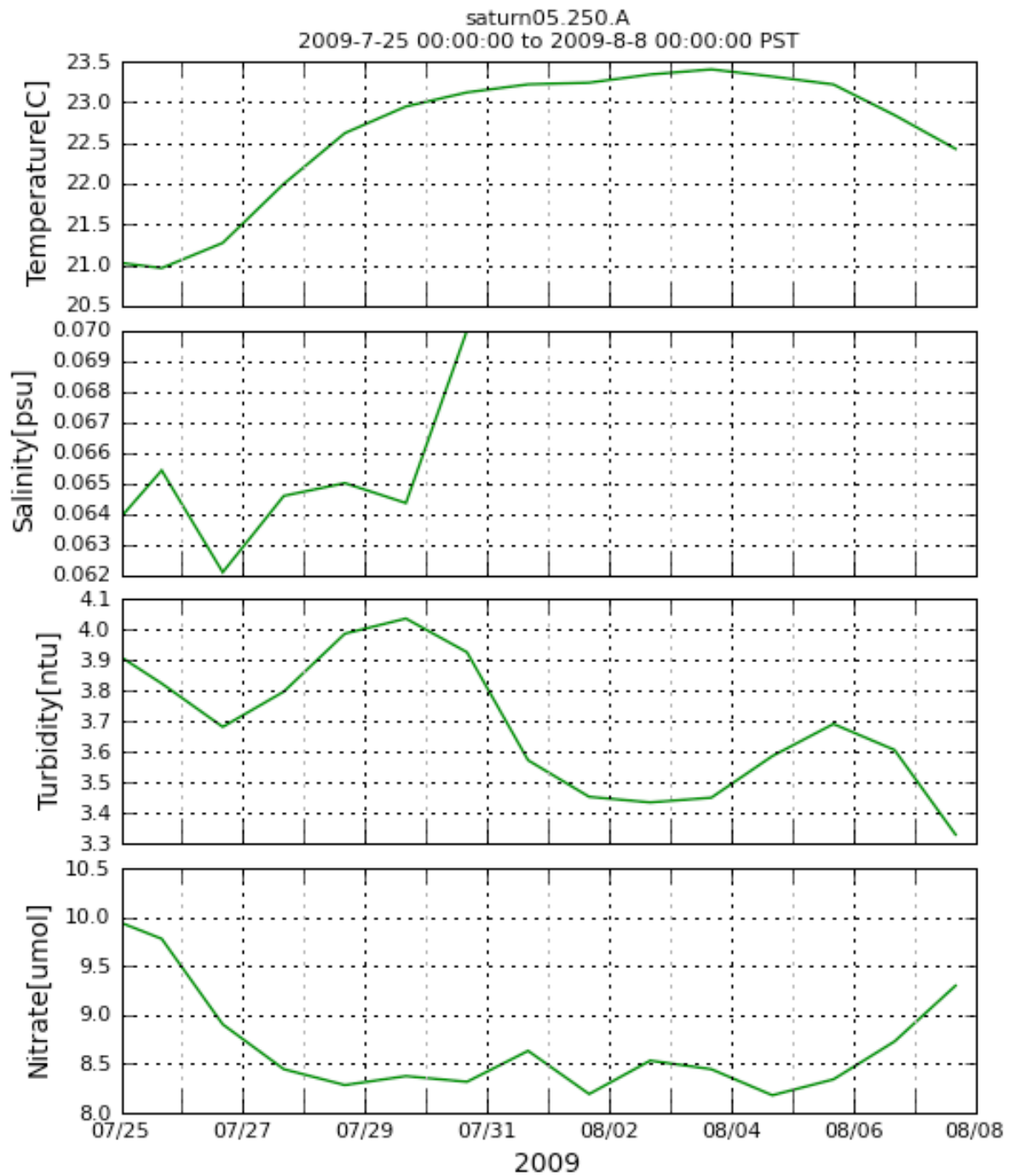
LOBO River Data

SATURN River Station 05: Jun/July 2009



LOBO River Data

SATURN River Station 05: July/August 2009



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Wetland Investigations: Hydrology

SATURN River Station 05

Columbia River Location:

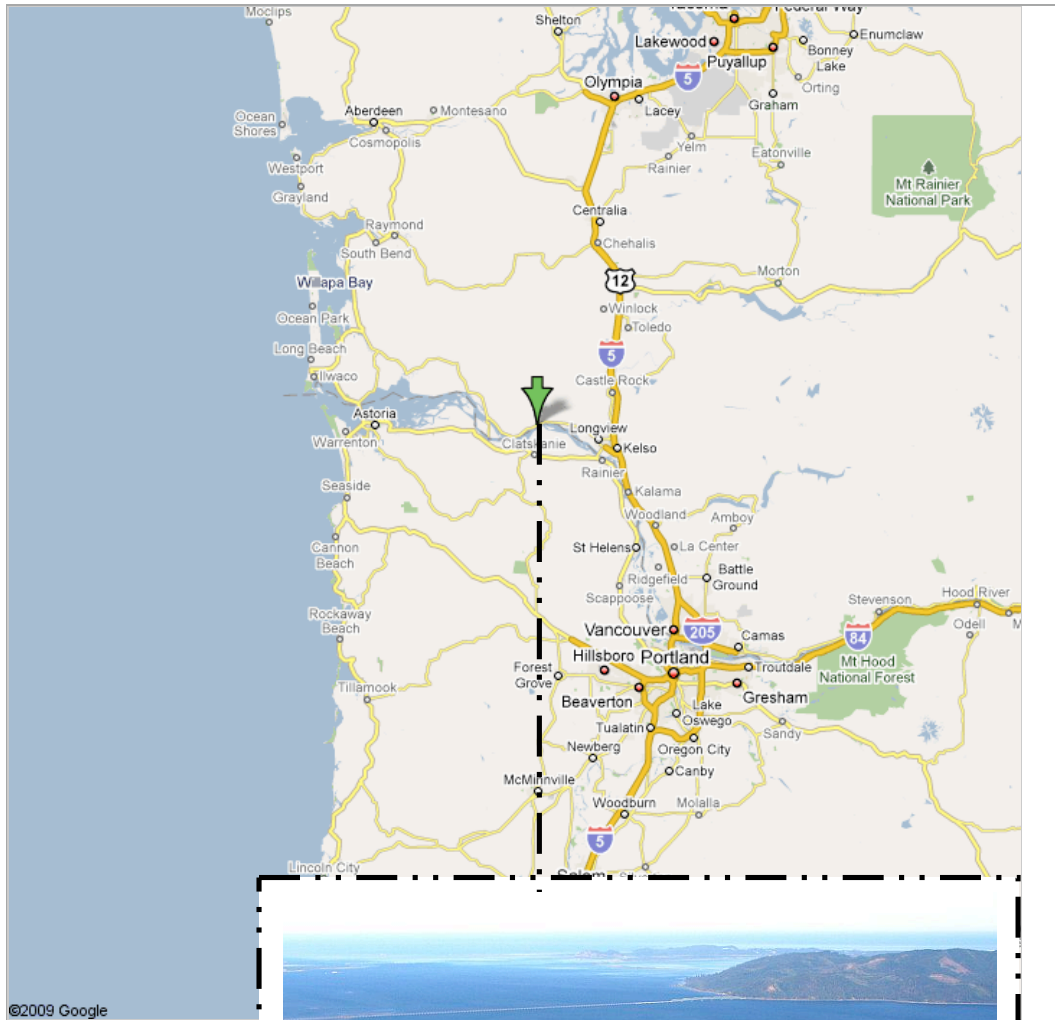
46 11.070N, 123 11.246W - Google Maps

8/9/09 4:30 PM



Address **Columbia River
Washington**

Notes Location of SATURN River Station
05



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SATURN River Station 05

Satellite Images:



SATURN River Station 05

Terrain:

