Northwest Florida NaGISA

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Introduction to Water Quality Collection and analyzation

Why is it important to collect hydrologic data on a water body? The health of a water body, or its water quality, is determined by measurements of its chemical, biological, and physical conditions. The chemical parameters include pH, dissolved oxygen, nitrates, phosphates, and dissolved solids. A biological assessment is conducted by measuring the abundance and diversity of aquatic plants and animals. Physical characteristics that affect the quality of the water body is clarity, temperature, discharge (flow rate), and the condition of the stream banks.

> *"The Environmental Protection Agency (EPA) cites these five major reasons for monitoring a river: 1. to characterize waters and identify changes or trends in water quality over time; 2. to identify specific existing or emerging water quality problems; 3. to gather information to design specific pollution prevention or remediation programs; 4. to determine whether program goals—such as compliance with pollution regulations or implementation of effective pollution control actions—are being met; and 5. to respond to emergencies, such as spills and floods."*

Why do we follow certain steps when collecting data? Many local, state, national and international organizations agree that monitoring data is useful as long as the methodologies are standard for all collections. One of the most important standard is to collect numerous samples which is more effective than using data from a single sample. Why? Water conditions are always changing and do not fully represent the natural variations that scientists find in waterbodies. However, the most effective *method* to sampling a waterbody is to collect multiple times throughout the year, over several years. This allows for seasonal and annual variations to be displayed and understood. This method also provides insight into the impact of pollution, development, and other land uses over time. It is also important that several sites throughout the waterbody are sampled to learn the affects of land use and environmental variations along the waterbody. Finally, the sampling methods and procedures must be consistent over time and between monitors. Samples should be collected and analyzed using standardized techniques that are well documented and accepted. These measures ensure that data from one waterbody can be readily compared to data from other similar waterbodies and established water quality standards.

Objectives of NaGISA students:

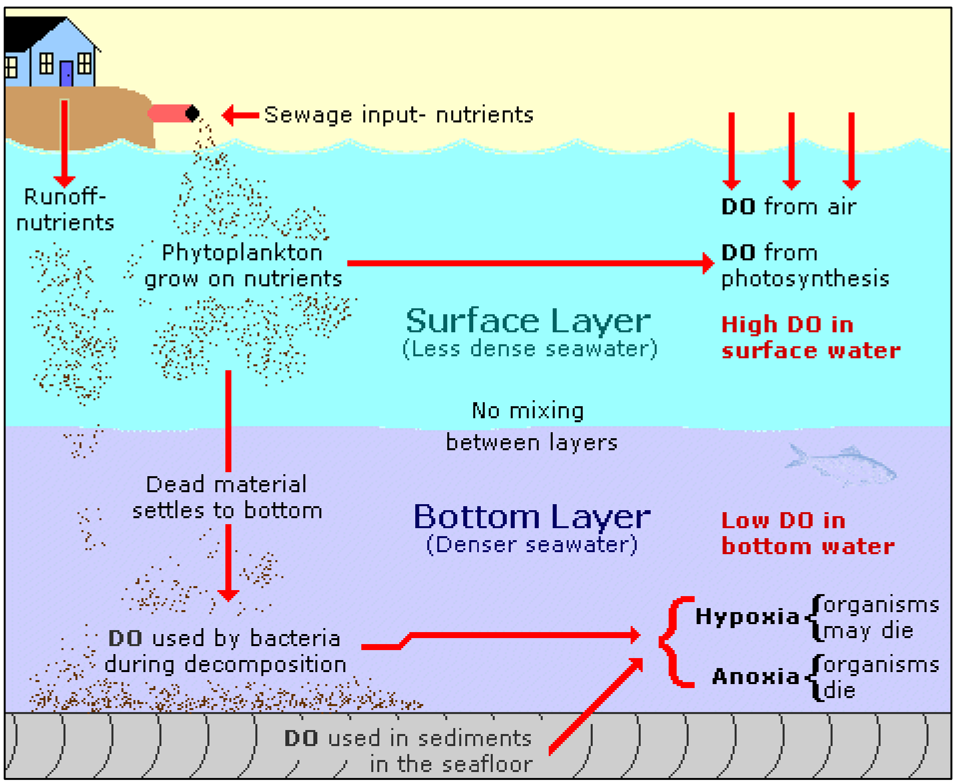
- Swift Creek water chemistry, nutrients, and chlorophyll *a* trends by investigating influences on parameters
- Compare and contrast data with historical data on Swift Creek
- Compare cumulative data to other similar streams
- Map the watershed of Swift Creek to understand land use impacts
- Water flow profile with Brandy Foley, Monitoring Coordinator

The Parameters.

Temperature. This important measurement can indicate healthy or poor water conditions. Many factors may affect the temperature of the water, but in streams and rivers soil erosion and thermal pollution have the largest impact. Soil erosion causes water to become murky and results in an increased absorption of the sun's rays. Thermal pollution is the addition of relatively warm water to a waterway from a power plant or urban runoff from warmed streets and pavement which can increase the temperature of the waterbody. Temperature has a direct influence on the amount of dissolved oxygen in a waterbody. Generally, warmer waters have lower dissolved oxygen levels than colder waters because the oxygen is easily released, whereas in colder water the water molecules move less and retain oxygen better. In addition, to the chemical changes that happen in warmer water, algae and bacteria thrive in warmer waterbodies and deplete the water of oxygen when dead phyto-plankton/algae decay. For our monitoring purposes, we measure temperature in degrees Fahrenheit.

Dissolved Oxygen. The dissolved oxygen (DO) is the amount of oxygen dissolved in the water. DO is one of the best indicators of water quality. Organisms and plants in the aquatic system can be greatly impacted by dissolved oxygen levels. Oxygen enters the water at the surface of the water where exchange between the atmosphere and the water take place. Waves and wind help as well as through phytoplankton photosynthesis byproduct. Photosynthesis can cause the water to have more dissolved oxygen than the saturation amount, called “supersaturation” (> 100%). Oxygen found in the deeper water comes from mixing with surface water. If water at the surface (high levels of oxygen) is not mixed with deeper water layers form and the water becomes stratified – in conditions like this the deeper water can become unhealthy.

Figure 1 - Dissolved Oxygen



(http://omp.gso.uri.edu/ompweb/doee/science/physical/choxy1.htm)

Above 5mg/L dissolved oxygen most marine plants and animals have enough oxygen to survive. When the DO is low, below 3mg/L, the water is called hypoxic. If all of the dissolved oxygen is used up, below 0.5 mg/L, the water is called anoxic. Prolonged exposure to low dissolved oxygen levels (<5 mg/L) may not directly kill an organisms, but will increase its susceptibility to other environmental stresses. However, exposure to <2 mg/L for one to four days may kill most of the biota in a system. If oxygen-requiring organisms perish, the remaining organisms will be air-breathing insects and anaerobic (do not require oxygen to live) bacteria.

The dissolved oxygen measurements that students will record for DO levels is milligrams per liter (mg/L) and percent of saturation- amount of oxygen that water can hold (%).

Specific Conductivity (SpC). Specific conductance is a measure of the ability of water to conduct an electrical current. SpC is an important water-quality measurement because it gives a good idea of the amount of dissolved material in the water. Conductivity in water is affected by the presence or inorganic dissolved solids. Pure water (distilled water) will have a very low specific conductance, and sea water will have a high specific conductance. SpC is affected by temperature: the warmer the water, the higher the conductivity. Conductivity in streams and rivers is affected primarily by the geology of the area. Streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Discharges to the streams (stormwater runoff, sewage leak) can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream. Students will measure the conductivity in millisiemens per centimeter (ms/cm).

pH. The pH measures how acidic or basic the water is. The pH measure the concentration of the hydrogen ions (H+) in the water. The landscape in a watershed can influence the pH of its waters. While not directly affected by the other water quality parameters, pH can be highly influenced by clarity and turbidity. Watersheds that contain bogs, marshes, or pine forests tend to support waters with a lower pH, while sphagnum moss and pine needles are slightly acidic. Decaying vegetation produces organic acids that leach into the ground or join runoff and flow into nearby waters, thus reducing pH. In general, most aquatic organisms can survive in waters between a pH of 5 to 9. Beyond this range, the diversity of species decreases, as pH fluctuations and the associated bioavailability changes will stress or even kill aquatic life. The pH measurement scale ranges from 0 to 14, a pH of 7 is neutral.

Figure 2 - pH Scale

	Name	Example	pH Scale
14	strong base	lye	14
13		bleach	13
12		ammonia	12
11	Base	milk of magnesia	11
10		borax	10
9		baking soda sea water	9
8	weak base	blood	8
7	Neutral	distilled water	7
6	weak acid	milk corn	6
5		boric acid	5
4		orange juice	4
3	Acid	vinegar	3
2		lemon juice	2
1			1
0	strong acid	battery acid	0

(http://omp.gso.uri.edu/ompweb/doee/science/physical/chph1.htm)

Salinity. Salinity is the measurement of all the salts dissolved in water. The average ocean salinity is 35 ppt and the average water salinity is 0.5 ppt or less.This means that in every kilogram (1000 grams) of ocean water, 35 grams are salt. Water in estuaries, like the Choctawhatchee Bay, is a mix of fresh water and ocean water. That means that, depending on the tide the salinity levels range but are typically less than 35 ppt. The salt in the ocean is mostly made up of the elements sodium (Na) and chlorine (Cl).

It is measured in unit of PSU (Practical Salinity Unit) which is based on the properties of sea water conducitivity. For all practical purposes, salinity is PSS or PSU has the same numerical value as salinity in parts per thousand (ppt).

Turbidity (NTU). Turbidity is one method to measure the water clarity how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, sand), algae, plankton, microbes, and other substances. Turbidity can affect the color of the water. High turbidity increases water temperatures because suspended particles absorb more heat. This warming reduces the concentration of dissolved oxygen. Suspended materials can clog fish gills, reducing their growth rates. Sources of turbidity include soil erosion, water discharge, urban runoff, eroding stream banks, excessive algal growth. Turbidity can be an indicator of the effects of runoff from construction, agricultural practices, logging activity, discharges, and other sources. Turbidity often increases sharply during a rainfall and/or stormwater runoff. Turbidity is measured in nephelometric turbidity units or NTUs from 0 to 1000.

Nutrients. Nutrients in streams serve the same basic function as nutrients in a garden – they are essential for growth. The overabundance of certain nutrients in water can cause a number of adverse health and ecological effects. Nitrogen and Phosphorus are essential nutrients needed for plant growth. They are naturally abundant in the environment, but they are also introduced through agriculture and lawn fertilizers and sewage. Excess of these nutrients can cause overstimulation of growth of aquatic plants and algae. Excessive growth in these organisms can clog water intakes, use up dissolved oxygen as they decompose, and block light to deeper waters. Florida LAKEWATCH analyzes the smaller water bottles for Total Nitrogen and Total Phosphorus levels.

Chlorophyll *a*. Chlorophyll is the green pigment in all plants. Chlorophyll *a* is the most common type of chlorophyll. Plants use chlorophyll to capture sunlight for photosynthesis. Chlorophyll *a* is measured to estimate the abundance of phytoplankton in the water. More chlorophyll *a* indicates that there are more phytoplankton present. Most chlorophyll *a* is found near the surface of the water because there is less light at depth. Chlorophyll *a* concentrations are often highest just below the surface, not at the surface. Chlorophyll *a* concentrations change with the factors that affect phytoplankton growth. Some of those factors are: amount of sunlight, nutrient concentrations (nitrates and phosphate), amount of mixing (stratification), water temperature, and water quality. Individual samples of chlorophyll *a* are measured by filtering a known amount of sample water through a glass fiber filter. The filter paper itself is used for the analysis. The filter is ground up in an acetone solution and either a fluorometer or spectrophotometer is used to read the light transmission at a given wavelength, which in turn is used to calculate the concentration of chlorophyll *a*.

Secchi Depth. Secchi depth and vanishing measurements are taken to track water level and clarity changes. Water clarity (same as turbidity) and water depth is measured by using a secchi disk.

Flow. A river flows at various rates throughout a watershed and throughout the seasons. Flow, or the speed at which water moves past a given point in one second, is typically measured in cubic feet per second or cfs. Both the width of a stream and the depth of its channel play a role in determining flow. Flow tends to be higher in the springtime when storms add volume to rivers. Depending on your geographic location, flows tend to be lower in the winter when much of the precipitation decreases or is frozen as snow.

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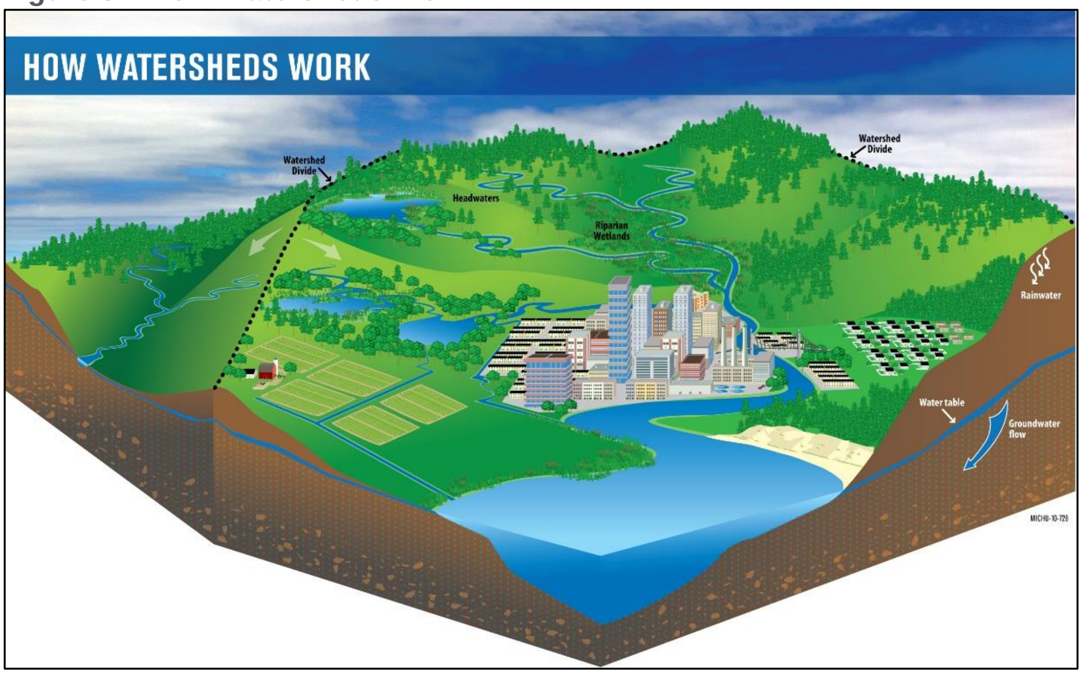
Watershed. A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place.

How to delineate a watershed: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_014819.pdf

Figure 3 – How Watersheds Work



Wetlands. A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. The primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation of aquatic plants adapted to the unique hydric soil. Wetlands play a number of roles in the environment, principally water purification, flood control, carbon sink and shoreline stability. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to a wide range of plant and animal life.

Land Use. There are two major sources of water quality impacts. The one that has received most attention for many years is point source pollution, which comes from wastewater treatment facilities and industrial plants. The other major category is nonpoint source pollution, which is also known as poison runoff. Point sources usually have a discharge permit. Your state water quality agency can help you to understand the impacts of point sources on your local streams. Nonpoint sources do not have permits usually. These pollutants come from diffuse sources, including lawns and gardens, industrial activity, parking lots, septic tanks, agriculture, and pet droppings. Some of the pollutants or problems that come from nonpoint sources include: pathogens (bacteria and viruses, excess nutrients (nitrogen and phosphorus), toxic contaminants (pesticides, lead, PCBs), eroded sediment, debris