# Limno Loan Program

## I Have the Equipment, Now What?

Sea Grant
Illinois - Indiana

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Funding for this manual was provided by the Great Lakes Restoration Initiative.

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IISG-13-78

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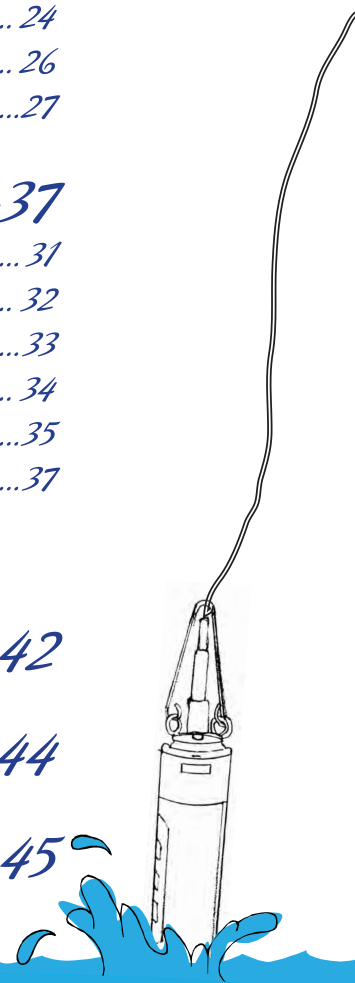
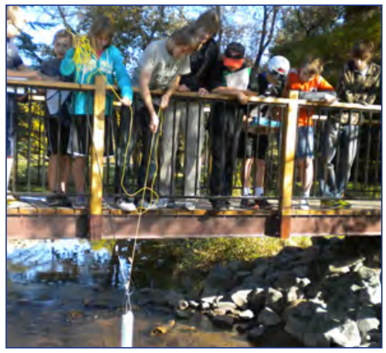


# Introduction

*Welcome to the Limno Loan program! This is a joint program between the U.S. Environmental Protection Agency Great Lakes National Program Office and Illinois-Indiana Sea Grant. The Limno Loan program provides your students the opportunity to collect and analyze real data with actual equipment used by scientists in the field. This program also has been developed to meet the Next Generation of Science Standards.*



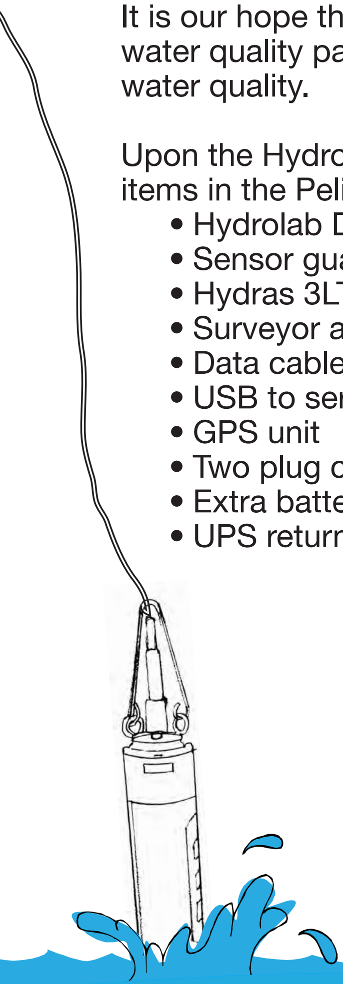
There are several characteristics of water that can be measured to assess water quality. Each Hydrolab DS5 DataSonde contains sensors that measure seven standard parameters.

- Chlorophyll *a*
- Conductivity
- Depth
- Dissolved oxygen
- pH
- Temperature
- Turbidity

It is our hope that by providing your students with an understanding of each of these water quality parameters, they also will develop an appreciation of the importance of water quality.

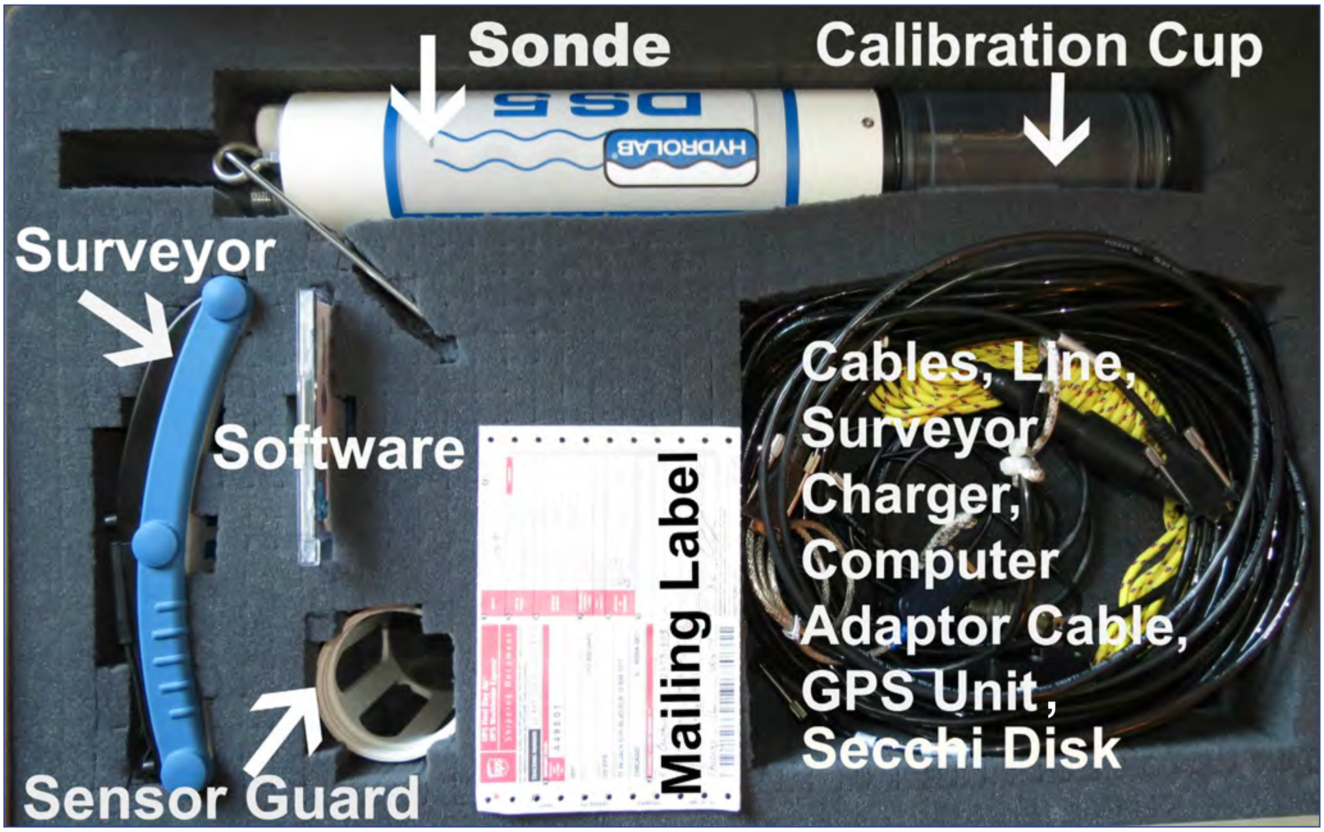
Upon the Hydrolab's arrival please make sure that you have received the following items in the Pelican case.

- Hydrolab DS5 DataSonde with storage cup attached
- Sensor guard
- Hydras 3LT software CD
- Surveyor and charger
- Data cables
- USB to serial cable
- GPS unit
- Two plug caps
- Extra batteries
- UPS return label



## Basic Set-up and Calibration

Your Hydrolab will arrive in a Pelican case and should look like the photo below. (When you open it, be sure to remove the mailing label and place it in a secure spot. It may get wet if left in the box.)




The Surveyor will need to be charged for at least three hours prior to use.

## Components of the Hydrolab


**Hydrolab DS5 Data Sonde**

**Calibration/ Storage Cup**

**Sensor Guard**


**Surveyor**

**2 Cables**
1) long cable for Hydrolab connection
2) short cable for Surveyor to laptop connection

**Surveyor Charging Cable**

**Deploying Line**

## Components of the Hydrolab, continued

**GPS Unit**

**USB-Serial Port Adapter**
(CD for driver with
Hydras Software)


**Hydras 3LT Software CD**

### Calibration: Dissolved Oxygen Sensor

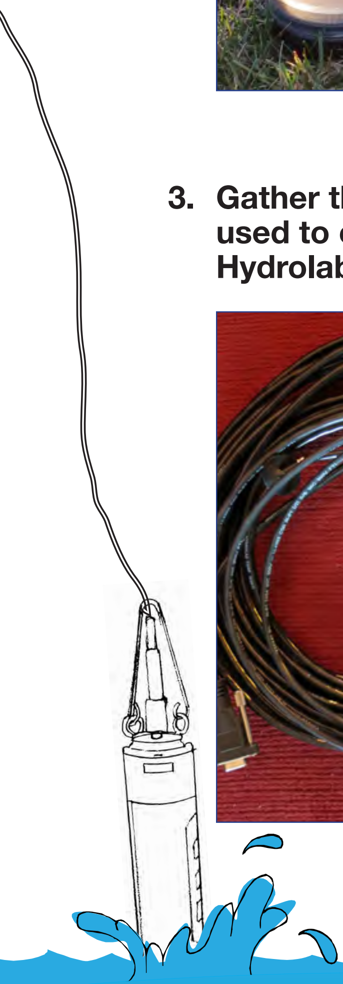
All of the probes have been calibrated, but the Dissolved Oxygen (DO%) Sensor must be recalibrated to match the barometric pressure of your location. Barometric pressure can change change daily due to weather, therefore DO% should be recalibrated each day. It is easy to do!

1. **Put a small amount of water in the calibration cup. (The water should not touch the sensors when the Hydrolab is screwed onto the cup.)**

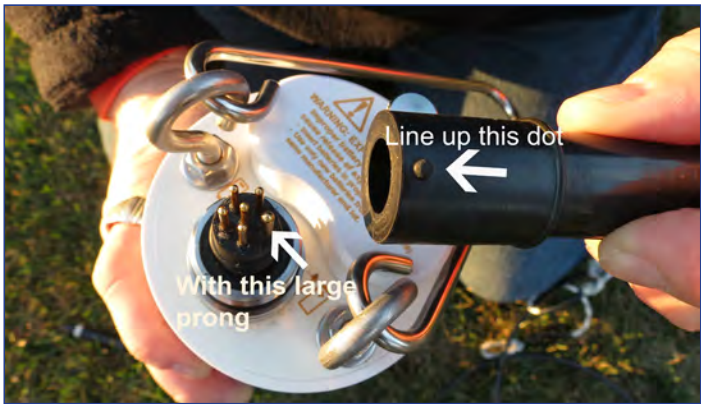
2. **Remove the sensor guard from the Hydrolab and screw on the calibration cup.**

3. **Gather the long cable used to connect the Hydrolab to the Surveyor.**

4. **Remove plugs from cable and Hydrolab (put them in a secure place—please don't lose them!)**



5. **Line up the raised dot on the cable with the large prong. Be careful with the pins!**



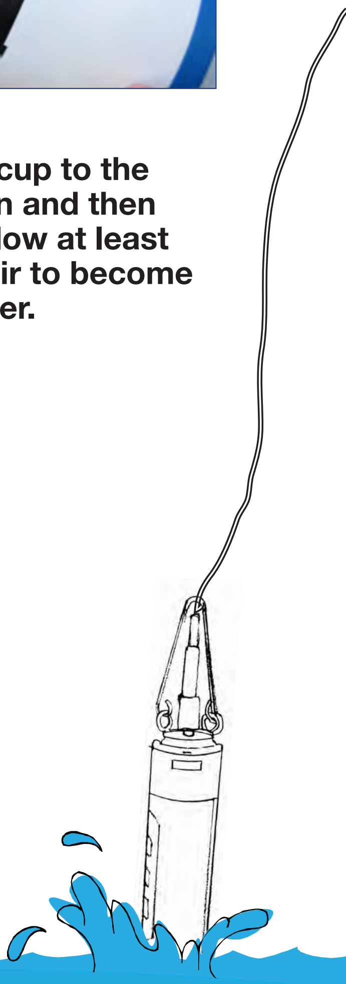

6. **Push the cable plug over the pins and then screw on the plug cover.**

7. **Attach serial port end to the Surveyor.**

8. **Dry off the probes with a tissue.**

9. **Dry the area where the cup will attach.**

10. **Attach calibration cup to the Hydrolab. Screw on and then back off ¼ turn. Allow at least 5 minutes for the air to become saturated with water.**

**11. Push the power button to start the Surveyor.**


**12. Find the barometric pressure on the Surveyor screen. It will say *BP*. (If it is not on the display, refer to *Setting up the Surveyor Display* on page 11.) You will need this number to calibrate the DO%.**


Press **SETUP/CAL**.

Press **CALIBRATION**.

Press **SONDE**.

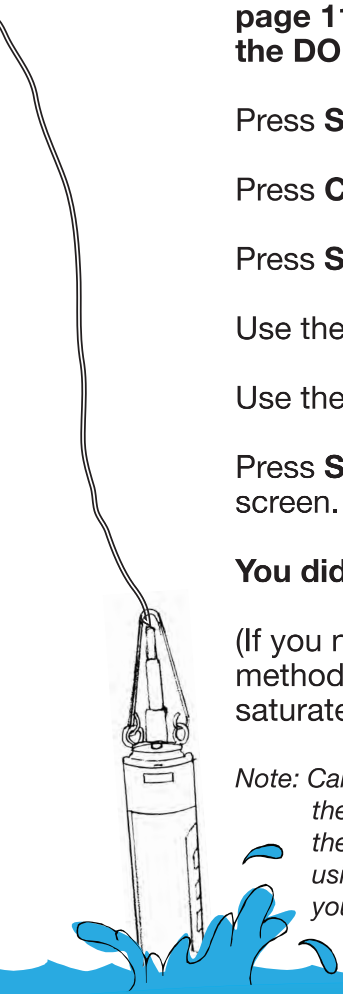
Use the arrow key to find DO% and press **SELECT**.

Use the Cursor Keys to put in the BP.

Press **SELECT** and **DONE** to return to the home screen.

**You did it!**

(If you need more information, review the calibration method in official Hydrolab manual for LDO%—water saturated air—on page 25, Section 4.2.6.1.)

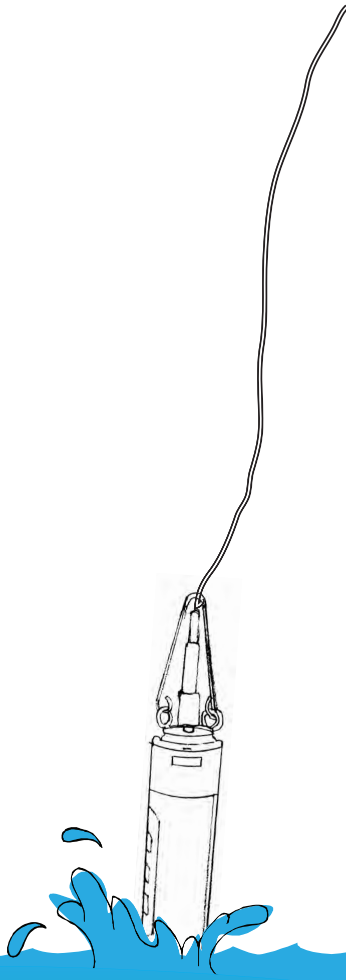


*Note: Calibration of the dissolved oxygen can also be done using the Hydras 3LT software. Once in the software program, choose the* Calibration *tab and then follow the instructions 1-10 above using your computer rather than the Surveyor. You can obtain your barometric pressure from a local weather station or airport.*

## Setting up the Surveyor for Collecting Data

1. **Remove plugs from cable and Hydrolab (put them in a secure place—please don't lose them.)**

2. **Line up the raised dot on the cable with the large prong. Be careful with the pins!**

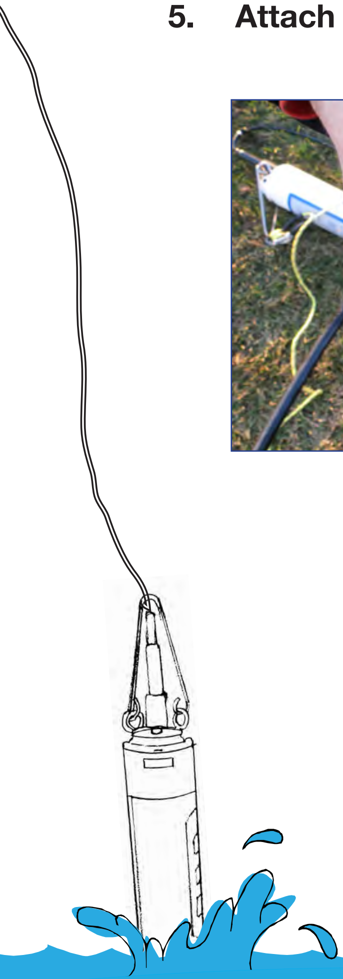



3. Push the cable plug over the pins and then screw on the plug cover. You will hear a beep sound when this makes contact.

4. Attach the deploying line to the Hydrolab using the screw link.

5. Attach serial port end to the Surveyor.

6. Push the power button to start the Surveyor

### Setting up the Surveyor Display


**Function Keys** - takes the action indicated on one of the four rectangles at the bottom of the screen.

**Cursor Keys** - moves the cursor up, down, right and left in screen. Hold down key to scroll.

**Backlight Key** - turns the backlight on and off for use in low light.

The Surveyor display should show all the parameters that the Hydrolab measures (see table on the next page). However, if you would like to alter what is displayed, follow the instructions below.

Press **SETUP/CAL** (using the function keys).

Press **SETUP.**

Highlight - Display: **TABULAR.**

Press **SELECT.**

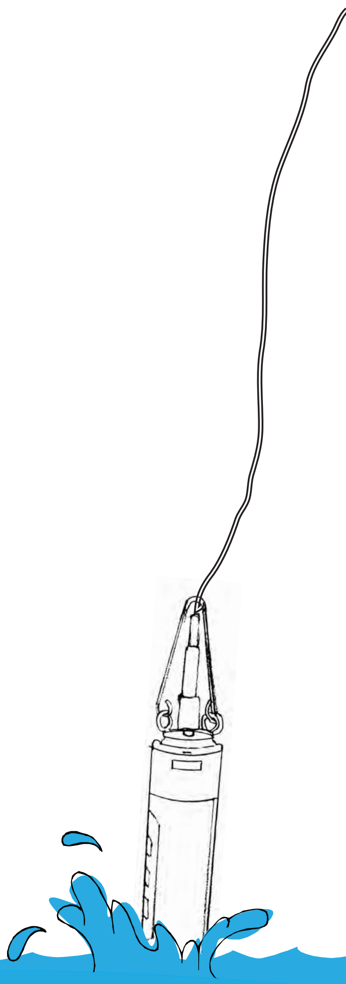
Use the arrow keys to highlight a parameter you wish to test.

Press **ADD.**

Continue to highlight and add or remove parameters.

Press **DONE** when finished.

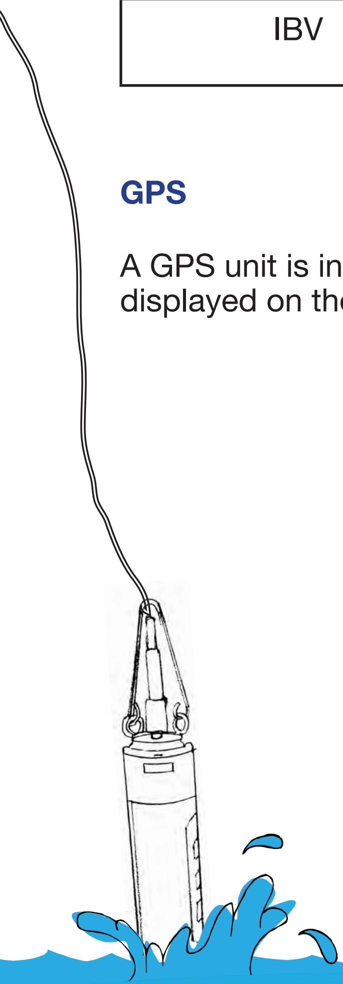
Press any key, then press **GO BACK** to get to the main screen.



| Parameter | Unit of Measure | Parameter |
|---|---|---|
| EBa | % Left | Internal Battery for the Hydrolab sonde |
| D/T | MDY/HMS | Date and Time (month, day, year, hour, minute, second) |
| Tem | °C | Temperature |
| pH | | pH |
| SpC | µS/cm | Specific Conductance |
| LDO | % Saturation | Dissolved Oxygen (Luminescent-type of sensor used) |
| LDO | mg/l | Dissolved Oxygen (Luminescent-type of sensor used) |
| Dep | meters | Depth |
| CHL | ug/l | Chlorophyll a |
| Tur | NTU | Turbidity |
| BP | mmHg | Barometric Pressure |
| Lat | decimal degrees | Latitude |
| Lon | decimal degrees | Longitude |
| IBV | Volts | Internal Battery for Surveyor (charge when under 6.5 V) |

### GPS

A GPS unit is included in the kit. It can be attached to the Surveyor and location will be displayed on the Surveyor screen when LAT/LONG are selected as parameters.



## Deploying the Hydrolab

- ✓ Make sure the sensor guard is on the Hydrolab.
- ✓ Hold the Hydrolab by the bale.
- ✓ If collecting data at multiple depths, zero out the depth parameter on the Surveyor or laptop under *Calibration* right before deployment. (This needs to been done daily since the sensor is influenced by barometric pressure.)
- ✓ Lower Hydrolab to the water source using the line—do not use the cable. (It's best not to stress the cable as it's meant for transferring data, not for raising and lowering the heavy equipment.)
- ✓ Be careful when raising and lowering the Hydrolab; make sure it doesn't swing and hit structures.
- ✓ The Hydrolab should be kept off the bottom of a lake or stream since loose sediment can affect readings.

## Software Installation

***Hydra3 LT Software***

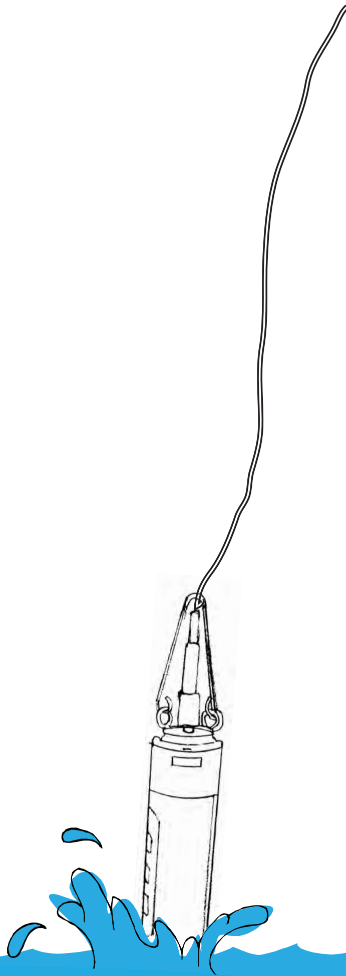
1. Insert CD-ROM.
2. Open *Folder to View Files*.
3. Choose language.
4. Double click *Set up*.
5. Go through the *Installshield Wizard*.
6. Icon for program will be in the start menu or with *All Programs*.

*Note: If for some reason the installed software displays in German, just press F3 to toggle to English.*

***USB Driver***

(If your computer doesn't have a serial 9-pin port, you'll need to use the USB adapter and associated driver software.)

1. Insert Driver CD.
2. Open folder.
3. Double click on *Prolific_DriverInstaller_v110*.
4. Go through the *InstallShield Wizard*.

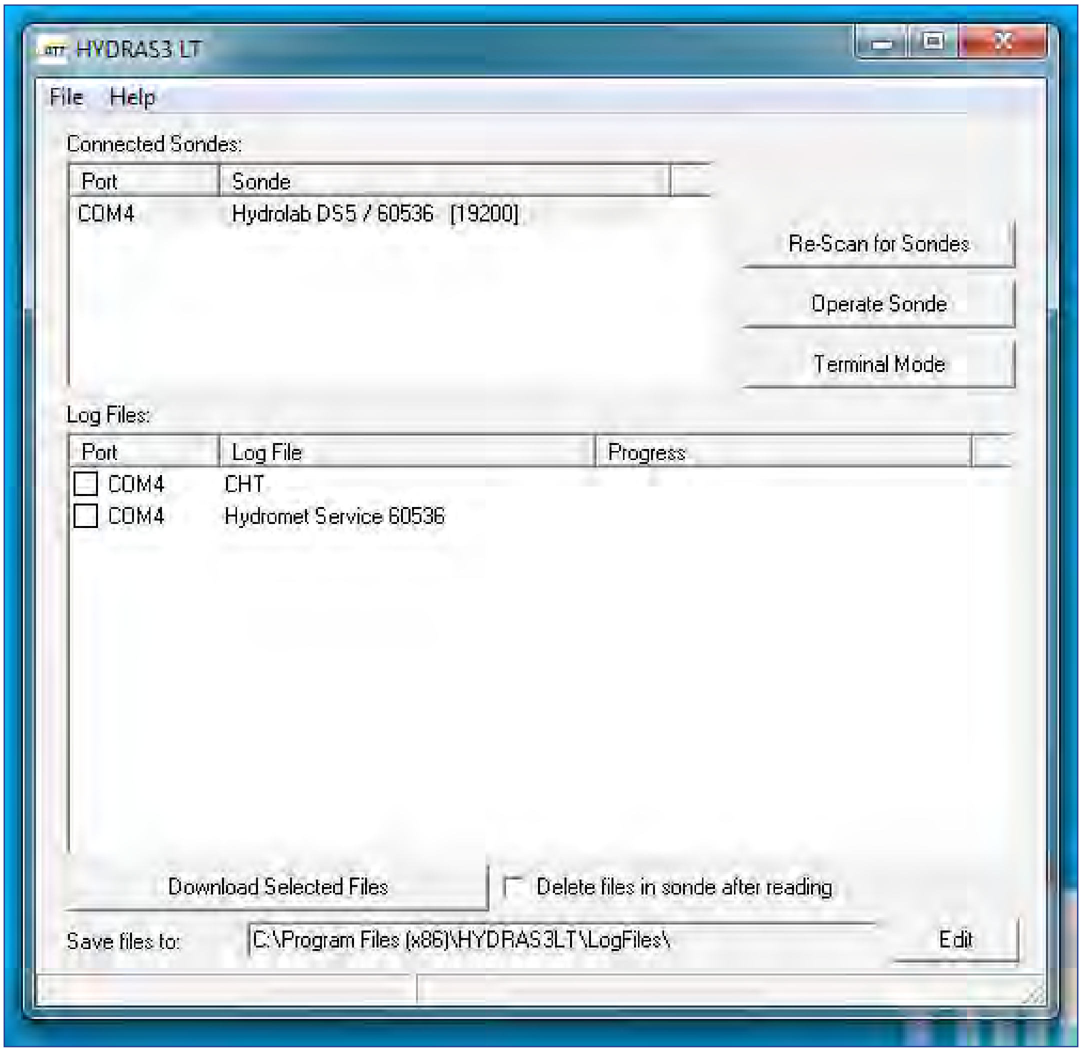


## Start Up for Online Monitoring

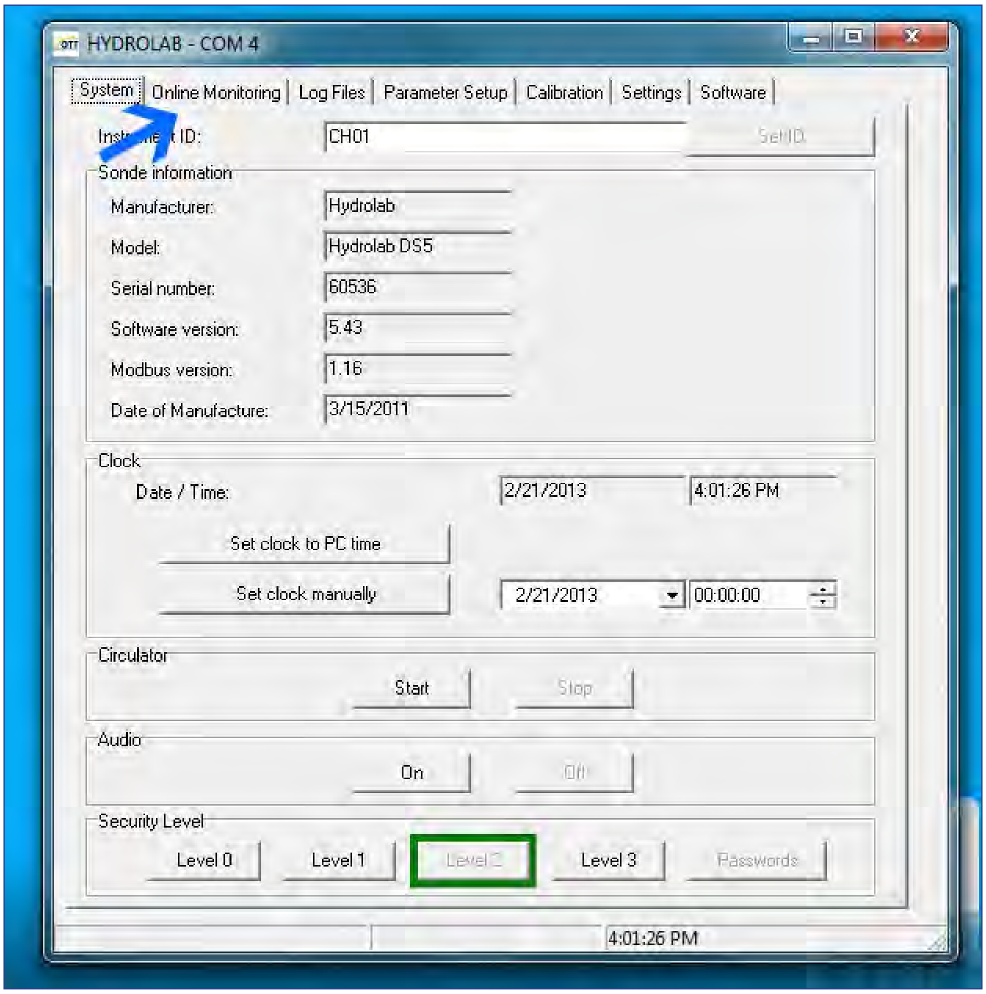
1. Connect the data cable from the Hydrolab to the computer. You likely will need the USB adapter to connect the cable to your computer.

2. Start the Hydras 3 LT software. The Hydrolab will be detected and displayed in the *Connected Sondes* box.

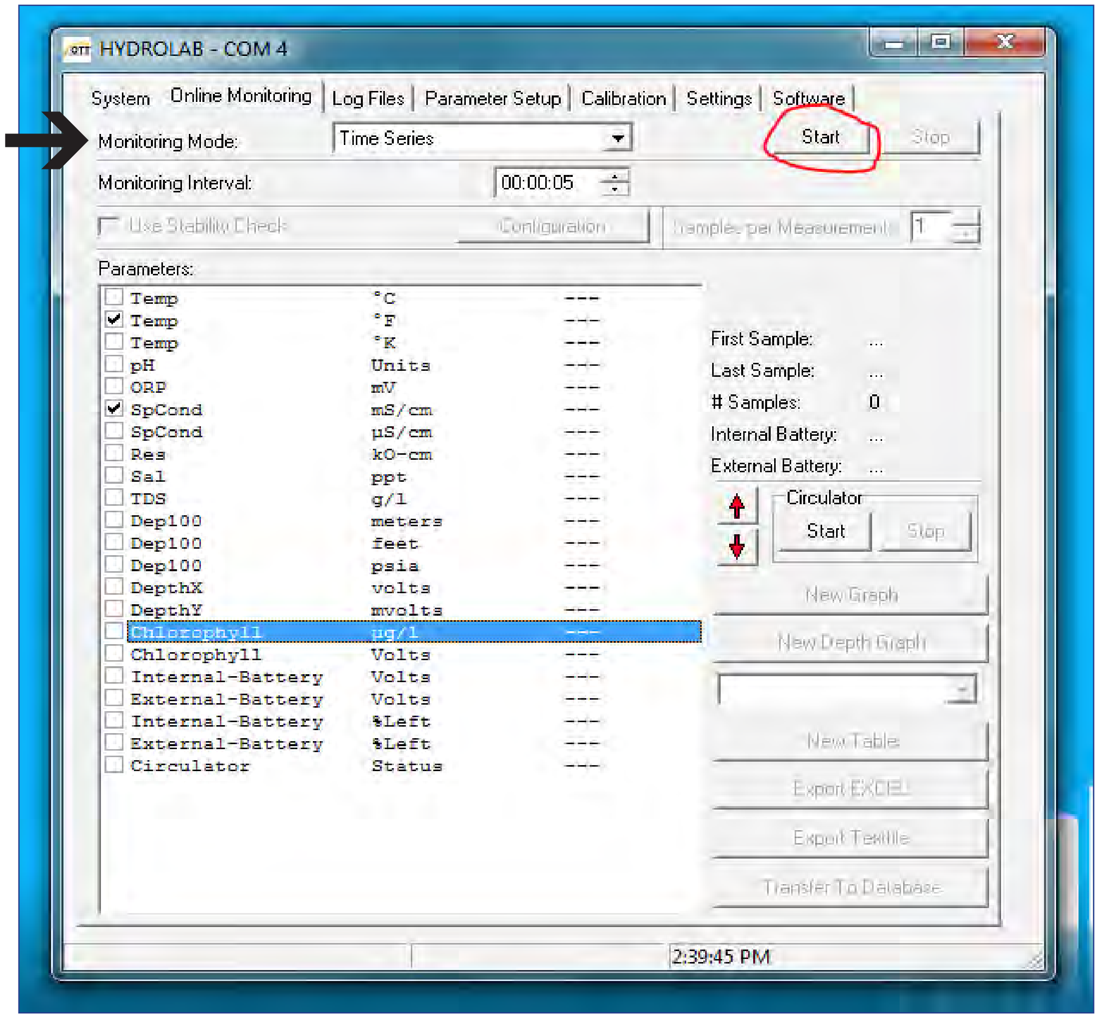
3. Highlight the Hydrolab and press *Operate Sonde*.



4. Choose *Online Monitoring* from the top tabs.

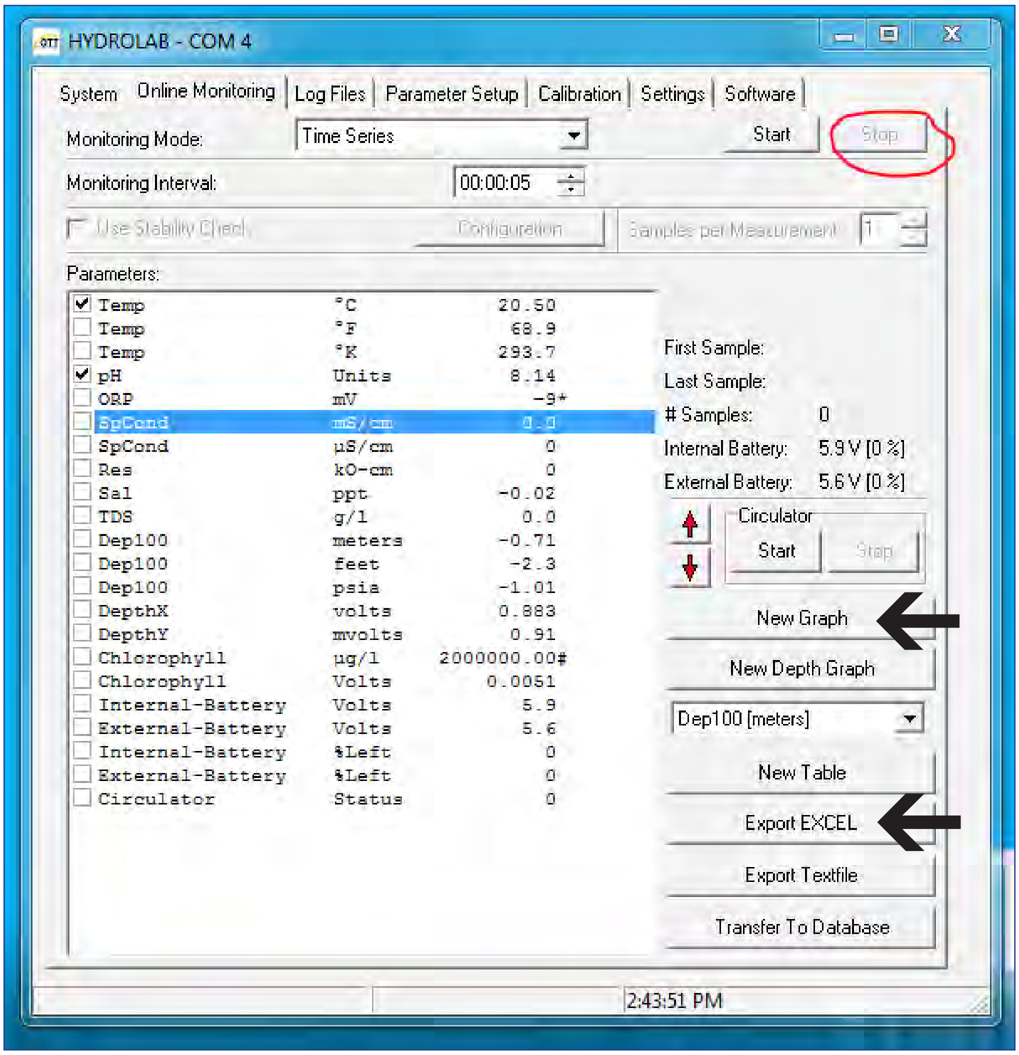


5. Choose parameters to monitor and your *Monitoring Mode*. You can monitor by time (and choose at what interval), by depth (at chosen interval in vertical profile) or by hand (manually). Once ready, click the *Start* button.




6. To end monitoring, click the *Stop* button.

7. Graphs can be created from this page and information can be exported to Excel.



# Preparing for Return Shipment

1. Please clean off the Hydrolab, rinse off the cable and line, and make sure all equipment is dry before packing up in the case.

2. Make sure the calibration cup is on the Hydrolab with ½ inch of deionized water (or tap water if you don't have DI water) to keep the probes from drying out. (Do not put water in the little cap that protects the pH probe.)

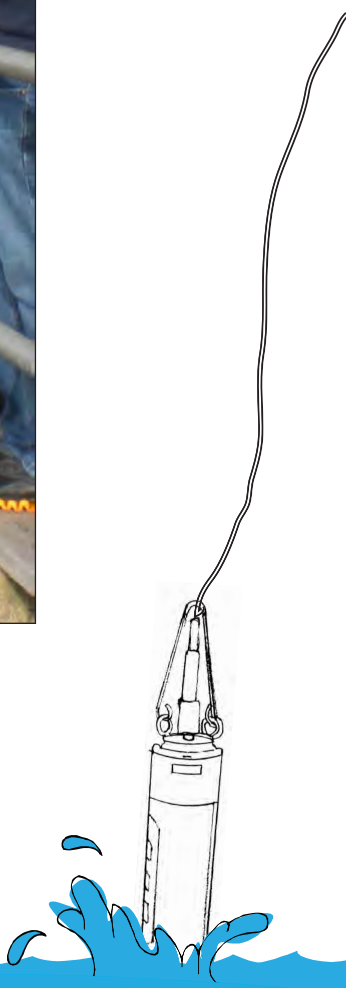
3. Sign the guest book! Encourage your students to comment!

3. Return using pre-paid UPS mailing label.

4. Notify EPA by phone or e-mail once it has been shipped (see Contacts).

5. After using the Hydrolab, we will ask you to complete a brief evaluation which will be sent to you via e-mail. The feedback gathered from the evaluation will be used to continue to improve the Limno Loan program.

# Parameters Measured



## Chlorophyll *a*

***What is it?***
Chlorophyll *a* is the green pigment in plants that helps plants change light into food (i.e., for photosynthesis).

Chlorophyll *a* is measured as the number of micrograms per one liter (µg Chl *a*/L) of water.

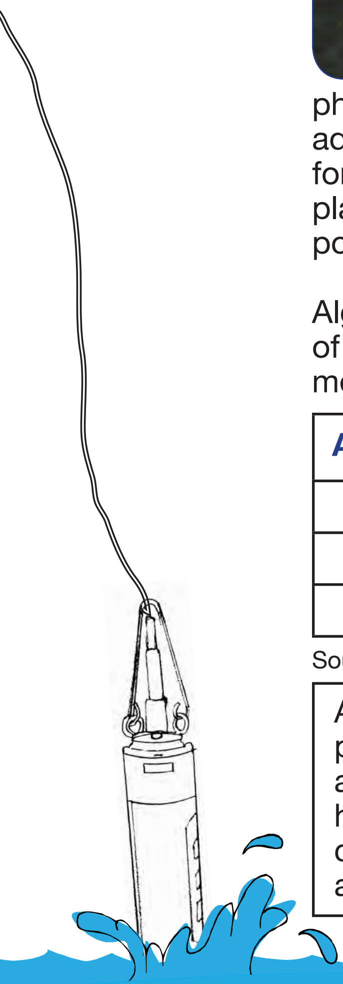
***Why do we measure it?***
Measuring the concentration of chlorophyll *a* in water provides an estimate of algal biomass (i.e., amount of phytoplankton), which is an indicator of the health of a body of water. Too much or too little overall algal growth, or too much of a certain type of algae (such as cyanobacteria, often called blue green algae), can cause problems in an aquatic ecosystem. If there are insufficient levels of chlorophyll *a* in a body of water there might not be enough food available to sustain its food web. On the other hand, too much chlorophyll *a* could signal a rapid growth of algae and indicate an algal bloom. One reason an algal bloom presents a problem for aquatic ecosystems is because when algae die they can sink to the bottom and decompose, using up the oxygen which organisms need to live.

***What affects it?***
The amount of chlorophyll *a* found in a body of water depends on the water's temperature, nutrient content, sunlight and wind. Humans increase the amount of nutrients, such as nitrogen and phosphorus, when they allow sewage and fertilizer to pollute a body of water. The additional load of these nutrients facilitates the growth of algae beyond what is healthy for aquatic organisms. Fish can die due to low levels of oxygen and the number of plants can decrease due to a lack of sunlight. And some blue green algae can produce poisonous toxins that are harmful to living things.

Algae need sunlight in order to photosynthesize, thus they will grow in the sunlit portion of a lake. Therefore, the amount of chlorophyll *a* will vary depending on what depth the measurement is recorded.

| Aquatic System Trophic Status | Mean Chlorophyll *a* Concentration (µg/L) |
| --- | --- |
| Oligotrophic | 0.3 - 3 |
| Mesotrophic | 2-15 |
| Eutrophic | > 10 |

Source: Wetzel, 2001



An oligotrophic water body typically has low productivity and low nutrient input. Under mesotrophic conditions, a water body has moderate nutrient input and productivity. When a water body reaches eutrophic conditions, there is high nutrient input and productivity. Often there is an excess of algae which can lead to reduced water clarity, low dissolved oxygen, and possibly harmful algal blooms.

## Conductivity

***What is it?***
Conductivity is the water's ability to conduct an electrical current. The sensor works by running an electrical current through the water between two metal electrodes. In distilled water the current does not have a medium in which to flow easily, but when ions (from dissolved salts) are present in water the electrical current can easily pass through. When the electricity uses these substances to pass through the water, the water is said to conduct electricity.

Electrical conductivity (EC) is measured in microsiemens per centimeter (µS/cm). Since conductivity increases as the temperature of water increases, EC values are automatically corrected to a standard value of 25°C and the values are then referred to as *specific* electrical conductivity or specific conductance.

*Note: Total Dissolved Solids in ppm can be obtained by multiplying EC (µS/cm) by 0.67. (This measurement is different from total solids because it does not include suspended material.)*

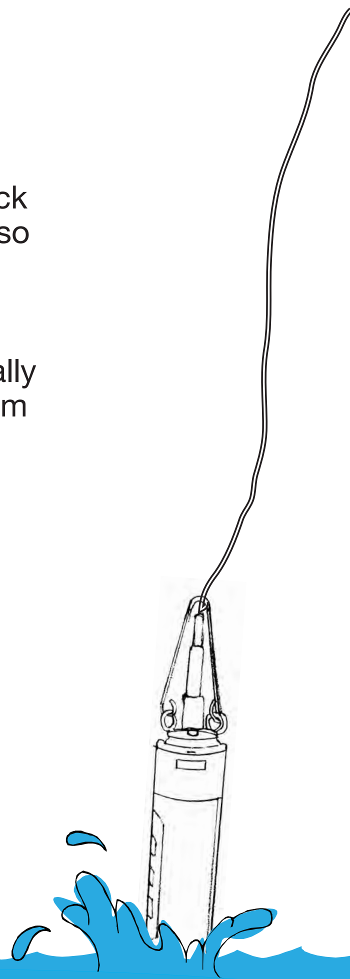
***Why do we measure it?***
Conductivity is used to help assess the health of a waterway. Aquatic organisms need a fairly constant concentration of major dissolved ions in the water. If concentrations are too high or too low, it could impact the growth, reproduction, etc. of certain organisms. Also, in normal conditions conductivity is fairly constant, therefore any large changes from a waterway's baseline level can potentially indicate discharge or runoff of some kind of pollution.

***What affects it?***
The geology of a lake or river strongly influences its conductivity. The composition of minerals in the lake or river bed and their tendency to ionize (i.e., readily erode or breakdown) can impact the conductivity. For example, waterways with granite bedrock will have a lower conductivity than those that flow through limestone. Temperature also affects conductivity; warmer water conducts electricity better than cooler water.

Humans can impact conductivity too. Wastewater from sewage treatment plants and septic systems can increase conductivity, as well as urban runoff from roads (especially road salt). In addition, agricultural runoff can increase conductivity. Water draining from the fields can have high levels of dissolved salts.

| Type of Waterway | Conductivity Measured |
|---|---|
| Distilled water | 0.5 to 3 µS/cm |
| U.S. rivers | 50 to 1500 µS/cm |
| U.S. streams supporting good mixed fisheries | 150 and 500 µS/cm |
| Industrial waters | Up to 10,000 µS/cm |

Source: US EPA



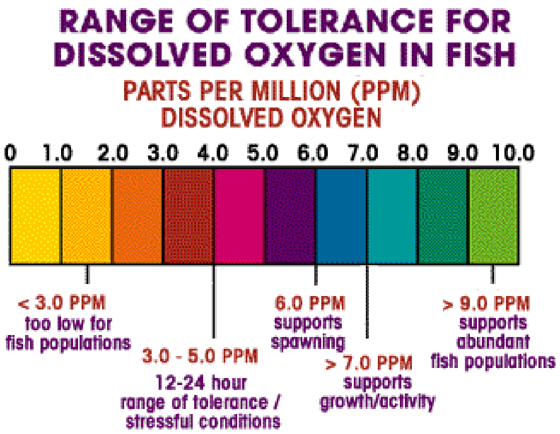
## Dissolved Oxygen

***What is it?***
Oxygen is a natural element needed by all forms of life, including aquatic life. Most aquatic animals use oxygen dissolved in water. Oxygen primarily enters water via diffusion from surrounding air and from photosynthesis by aquatic plants.

Dissolved oxygen is measured in units of milligrams/liter (mg/L) or as a percent of saturation (%).

***Why do we measure it?***
Oxygen is necessary for all living things and for many of the chemical processes that take place in water. The amount of dissolved oxygen needed by an aquatic organism depends on a variety of factors including the species, water temperature, and the species' metabolic rate and overall health. Organisms typically have an optimum range in which they do best.

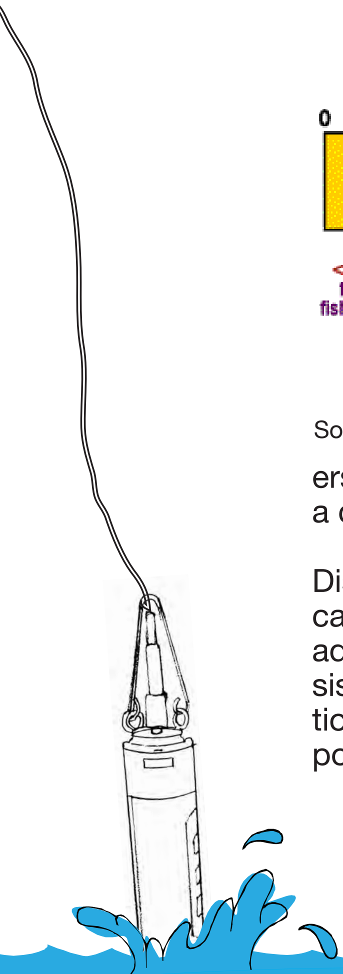
***What affects it?***
The temperature and salinity of water influence how much oxygen it can hold. Warm water holds less dissolved oxygen than cold water because the molecules are moving faster than in cold water and thereby allow oxygen to escape from the water. Freshwater can hold more dissolved oxygen than saltwater because saltwater has less space for oxygen molecules due to the sodium and chloride ions it contains. Therefore the warmer and saltier the water, the less dissolved oxygen it will contain.




Source: PBS

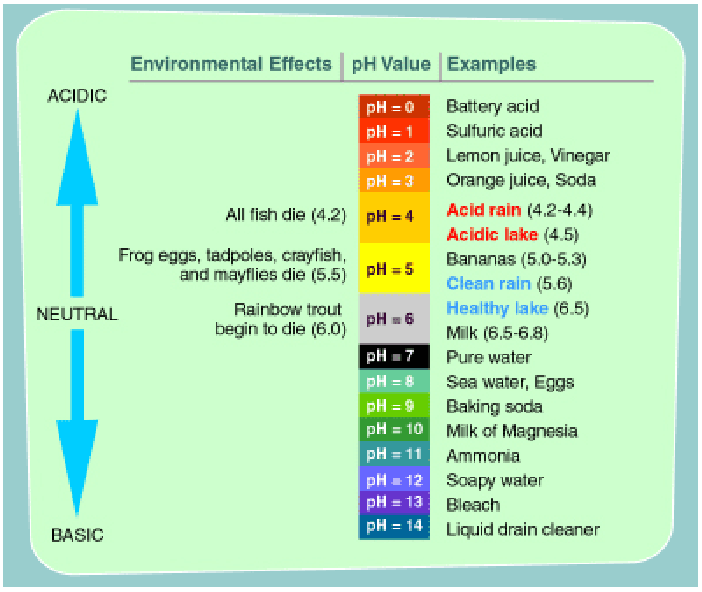
Also, as mentioned previously, oxygen is added to water at the surface where gases in the atmosphere come into contact with it. Therefore, the movement of water from wind and waves can help oxygenate water. In addition, deeper water gets oxygen from the upper layers when mixing occurs. This mixing is aided when the density of water changes due to a change in water temperature. (See *Temperature* section for more information.)

Dissolved oxygen can also be influenced by humans. For instance, additional nutrients can enter a waterbody in runoff from lawns or farm fields, and cause a large increase in aquatic plant growth. While initially this may raise oxygen levels through photosynthesis, excess algal growth will consume oxygen on cloudy days and at night via respiration. Also, as all the plants die off, oxygen will be consumed by bacteria in the decomposition process.



# pH

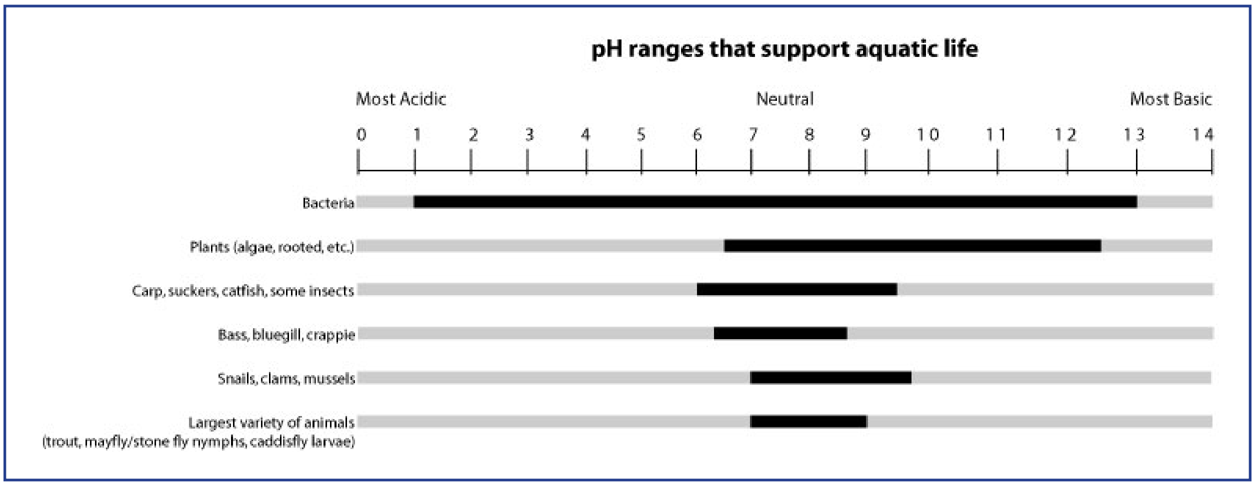
***What is it?***
The pH measurement shows how acidic or basic a water body is. The amount of hydrogen ion activity in water determines the level of pH on a scale from 0-14. The lower the pH value, the more acidic the water is. The pH range for natural bodies of water in the United States is around 6.5-8.5.



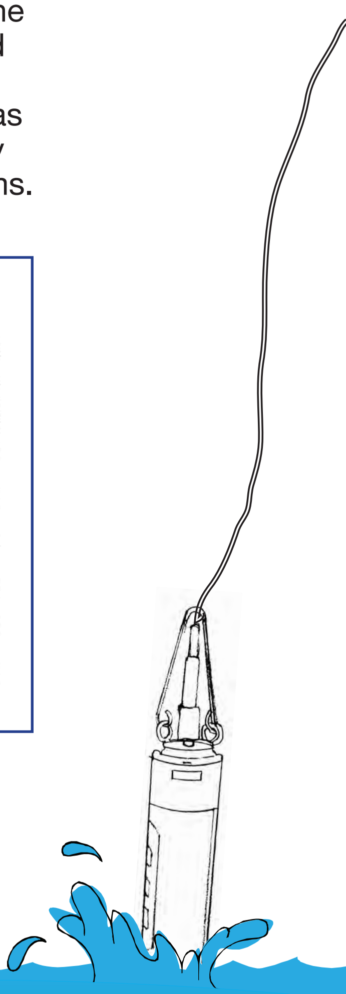
Source: US EPA

***Why do we measure it?***
The pH is an important water quality parameter. Aquatic animals and plants are adapted to a certain pH range, but most prefer between 6.5-8.0. An increase or decrease in pH outside the normal range of a water body can be detrimental to organisms depending on their sensitivity.

***What affects it?***
A variety of natural and human factors can influence the pH level of a body of water. For example, water can be made more acidic by acid rain or the vegetation found near the water. The acidity of a lake or pond also depends upon its age. Older bodies of water typically have more organic material, which leads to lower pH levels as the organic material decays. Regardless of which end of the spectrum a pH level may gravitate toward, extremes in the pH level can be damaging to most aquatic organisms.



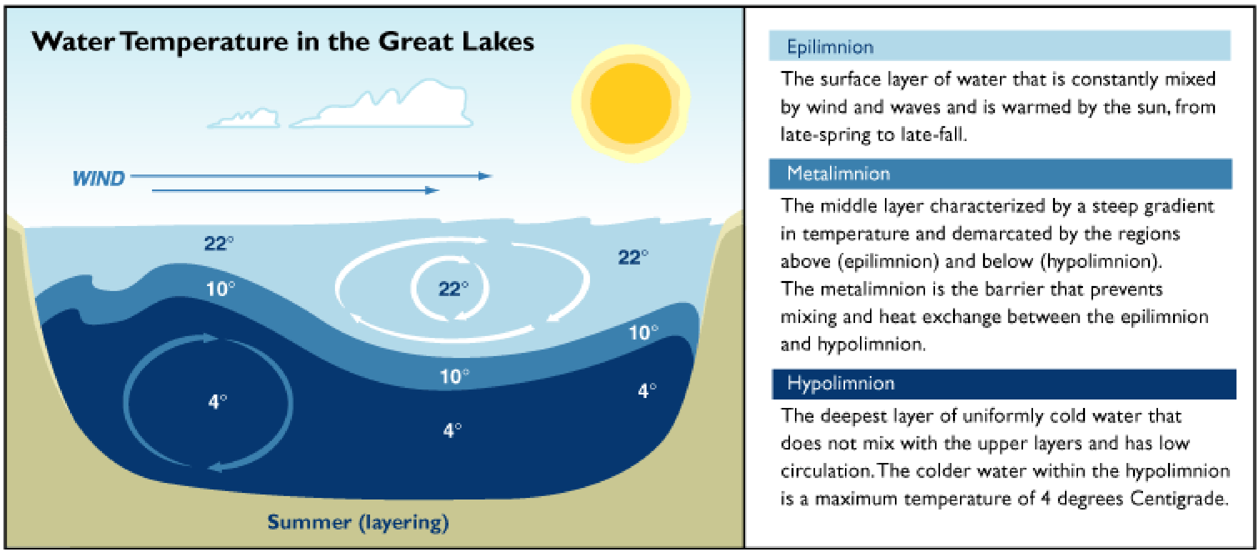
Source: Michigan Sea Grant



## Temperature

***What is it?***
Temperature can be measured either as degrees Celsius (°C) or Fahrenheit (°F). Temperature can vary depending on the time of year and the size and depth of a body of water.

A unique phenomenon for lakes is the stratification of the water into layers due to changes in temperature at different depths. These layers occur because as water temperature changes so does its density. The stratification of a lake typically includes three general layers: the upper, warmer epilimnion, the middle metalimnion (which includes the thermocline), and the lower, colder hypolimnion. In regions that have fluctuating water temperatures (i.e., change of seasons), the layers of water will turn over (known as mixing) due to the change in temperature, and thus density.

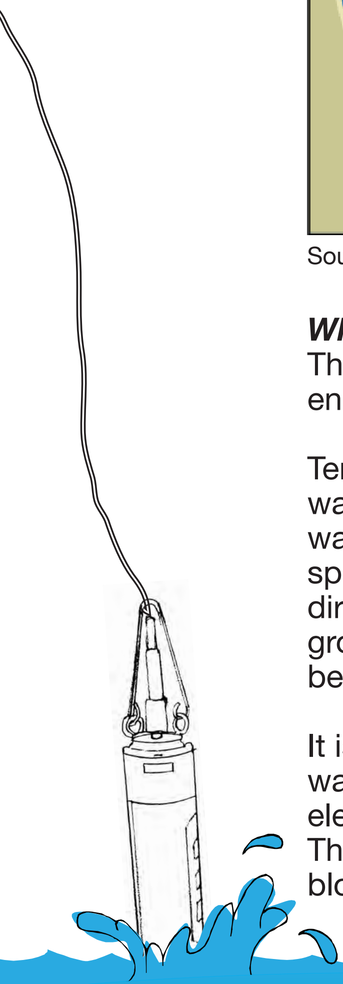


Source: Michigan Sea Grant

***Why do we measure it?***
The temperature of water has a large impact on overall water quality as it directly influences many of the other parameters. Temperature also is very important to aquatic life.

Temperature influences the amount of dissolved oxygen water can hold (e.g., colder water holds more). Conductivity also increases as the temperature rises. In addition, warmer water makes some substances more toxic for aquatic animals because the speed of chemical reactions usually increases at higher temperatures. Temperature directly influences aquatic life by impacting the rate of metabolism, photosynthesis, growth, decay, etc. Every aquatic animal has an optimum temperature range that is best for its health.

It is also important to be aware of the negative impact climate change could have on water quality. For example, a potential increase in severe rain events could lead to elevated concentrations of pollutants and nutrients entering a waterway from runoff. The increase of nutrients, such as nitrogen and phosphorus, could lead to more algal blooms, which in turn could result in a decrease of dissolved oxygen.



***What affects it?***
Temperature naturally varies at different depths and by season. Also, riparian vegetation produces shade, which can cool water. Conversely, when the vegetation is removed, more sunlight can penetrate and warm up the water. In addition, erosion can raise water temperature by increasing suspended particles, which absorb the sun's heat.

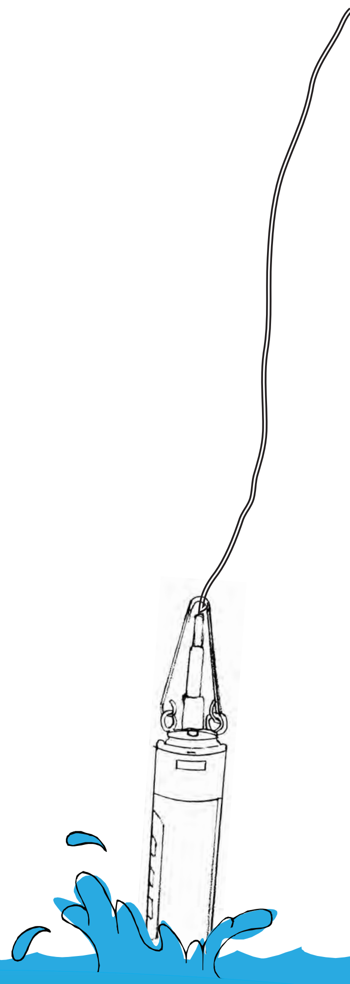
Water temperature can be impacted directly by humans, by means of thermal pollution and urban runoff. It is common to find thermal pollution near power plants, which use water to cool machinery and then discharge the warmed water back into the waterway. Urban runoff can also increase the temperature of streams, rivers, and lakes when rain water is heated up on pavement and sidewalks and then runs into the water body.

**Fish Species Activity Temperature Range**

| Species | Lower Limits | Most Active | Upper Limits |
|---|---|---|---|
| Carp | 74°F (24°C) | 84°F (29°C) | 88°F (31°C) |
| Largemouth Bass | 50°F (10°C) | 70°F (21°C) | 84°F (29°C) |
| Bluegill | 58°F (14°C) | 69°F (20°C) | 75°F (24°C) |
| Walleye | 50°F (10°C) | 67°F (19°C) | 76°F (24°C) |
| Smallmouth Bass | 60°F (16°C) | 67°F (19°C) | 73°F (23°C) |
| Northern Pike | 56°F (13°C) | 63°F (17°C) | 74°F (23°C) |
| Coho Salmon | 44°F (7°C) | 54°F (12°C) | 60°F (15°C) |
| Lake Trout | 42°F (4°C) | 54°F (12°C) | 62°F (17°C) |

This table shows fish species and their preferred temperature range in which they are most active.

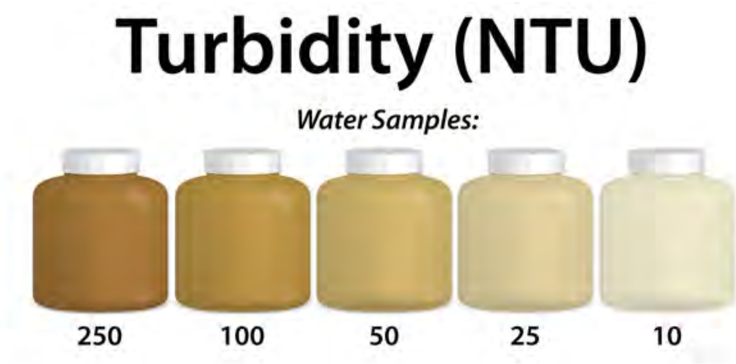
Source: Outdoor Life



## Turbidity

***What is it?***
Turbidity often is used as a proxy for water clarity. Technically what turbidity measures is the intensity of light scattered by particles in the water sample at 90° incident to a light source. Particles such as clay, silt, sand, algae, plankton, microorganisms, and other matter suspended in the water scatter the passage of light through water. To the naked eye, turbidity appears as cloudy or muddy water. However, it differs from color in that water can have a dark color but low turbidity (e.g., tannin-rich waters that flow through peaty areas).

Turbidity is reported in units called Nephelometric Turbidity Units or NTUs. The Hydrolab sensor's range is 0-3,000, but likely your measurements will be on the lower end.



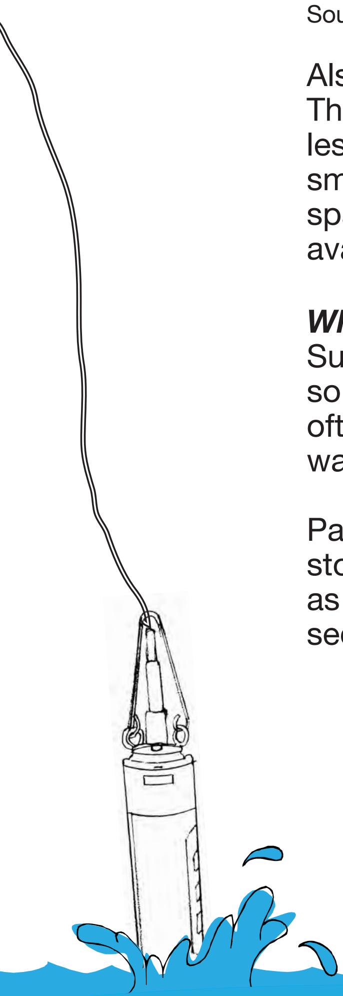
Source: Learn NC

***Why do we measure it?***
Turbidity is important to measure because at certain levels (typically higher) it can impact a waterbody. For instance, high turbidity reduces the amount of light passing through water from the surface. Reduced light, in turn, can reduce the rate of photosynthesis and therefore lower dissolved oxygen levels.

Also, suspended particles absorb heat, so high turbidity can raise the water temperature. This, in turn, can reduce the concentration of dissolved oxygen, since warm water holds less dissolved oxygen than cold water. Suspended materials can clog fish gills too, or smother fish eggs when they settle to the bottom. These particles also can settle into the spaces between the rocks on the bottom and decrease the amount and type of habitat available for aquatic invertebrates.

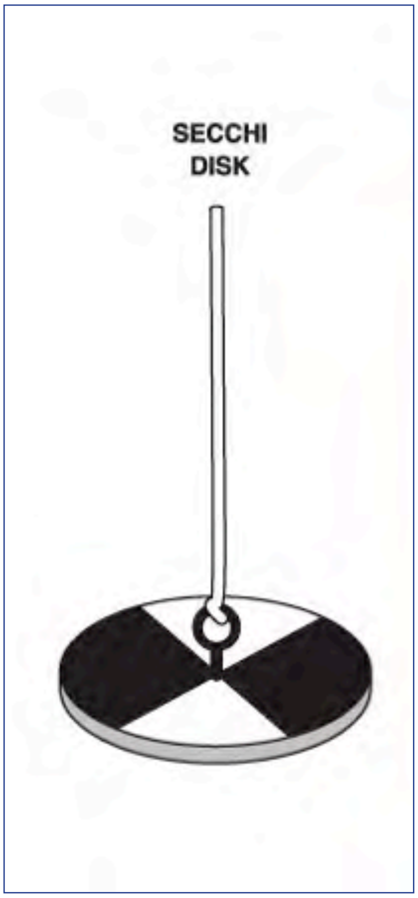
***What affects it?***
Suspended materials can enter the water by natural or human-caused means such as by soil erosion of a river bank or urban/agricultural runoff from surrounding land. Turbidity often increases sharply during and after a rainfall since the energy of falling and flowing water is the primary way that sediment gets dislodged and carried into rivers.

Particulates also could be introduced into a waterway directly from a pipe, such as for storm or wastewater discharge. In addition, biological activity can increase turbidity such as from excessive algal growth or from bottom feeders such as carp stirring up bottom sediments.



## Secchi Disk

***What is it?***
This is a separate instrument from the Hydrolab in the Pelican case. A secchi disk contains alternating black and white quadrants and is attached to a line. This line is used to lower the disk into a body of water with the purpose of measuring the clarity of the water. The depth at which the disk can no longer be seen is called the secchi depth and is the measurement recorded.

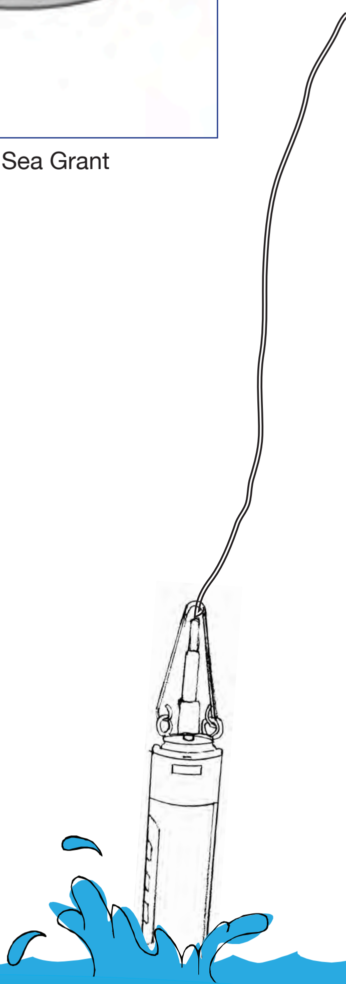


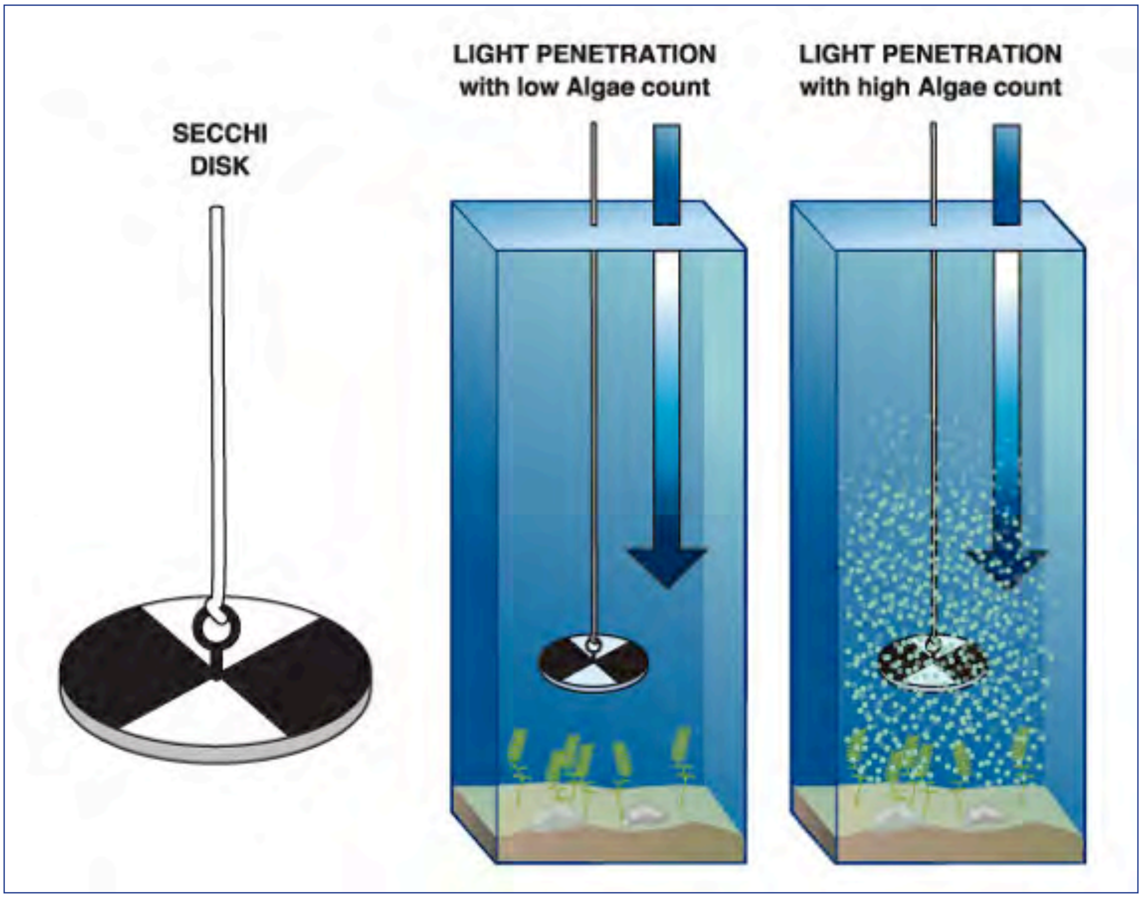
Source: Michigan Sea Grant

***Why do we measure it?***
Secchi depth is important to measure because the clarity of water impacts the amount of light penetration and in turn can affect photosynthesis and the distribution of organisms. While people often focus on the negative aspect of losing clarity, completely clear water is usually not desirable either because that means the water is devoid of needed food like plankton.

Secchi disk readings are useful in comparing bodies of water or looking for changes to a specific body of water over time. Changes in clarity of water can be an indicator of a human threat to an ecosystem.

***What affects it?***
Clarity will decrease as color, abundance of algae or suspended sediments increase. The color of water is sometimes caused by staining, due to decay of plant material. Excess algae growth can occur where there is additional input of nutrients like phosphorus and nitrogen from agriculture and/or sewage treatment or septic system waste. An increase in suspended sediments can be the result of urban, agricultural or storm runoff.





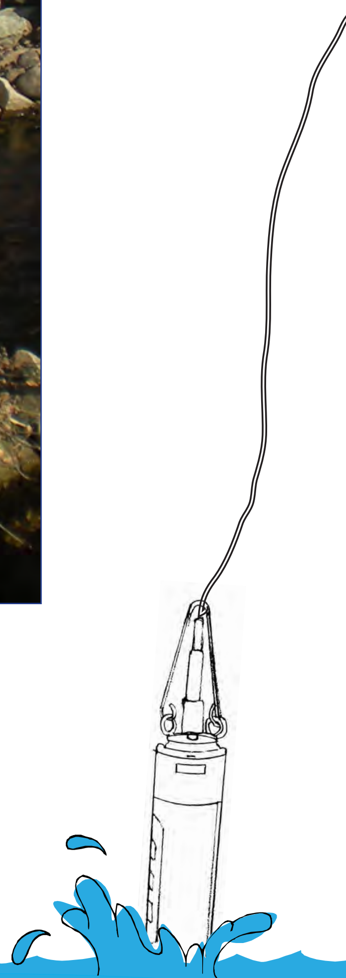

Source: Michigan Sea Grant

***Procedure for use in the field:***
The secchi disk can be lowered from a boat, pier, or bridge. It is best deployed in a shaded area in calm water between 10 am and 4 pm. Also, the observer should not wear sunglasses.

1. Lower the secchi disk into the water, keeping it parallel.
2. Slowly lower the disk until you can't see it any more. At that point, raise it back up until you can see it again and then slowly lower it back down until right when it disappears again.*
3. At that point, notice where the water's surface intersects the marked line.
4. Raise the disk and count the markings on the line from that intersection point down to the disk.
5. The resulting measurement is the depth at which it disappeared.

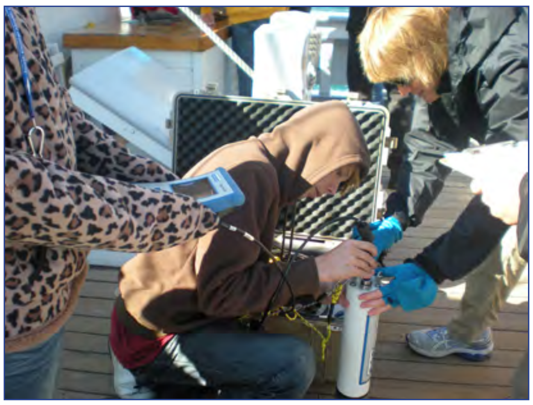
*This procedure is used by USEPA, GLNPO.

# Lesson Materials

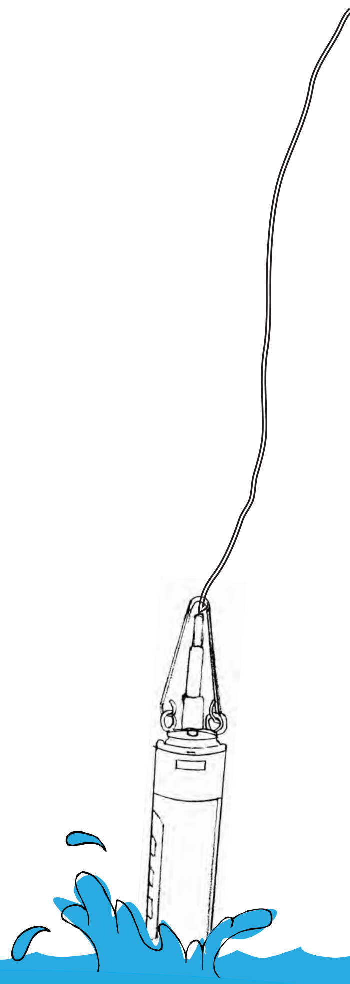
## Lesson Materials

- ✓ **Student Jobs with Hydrolab During Outing** - This sheet may be used to assign jobs to students when taking the Hydrolab into the field.
- ✓ **Hydrolab Data Sheet** - Each student or group of students can use this data sheet to record Hydrolab data in the field. Parameters can be added or changed as needed.
- ✓ **Hydrolab Data** - This is an Excel lesson for back in the classroom. Students used three sets of data and create spread sheets and graphs using the information they have gathered from the Hydrolab.
- ✓ **Graphic Organizer: Water Quality Parameters** - Students can record information about the parameters on this graphic organizer.
- ✓ **Hydrolab Crossword Puzzle** - This is a fun review for students using the Hydrolab in their class.
- ✓ **Water Quality Quiz** - As a wrap up or an addition to a unit test, this quiz is available to test student knowledge.



## Student Jobs with Hydrolab During Outing

| *Job* | *Creek* | *Dam* |
|---|---|---|
| Waders #1 | | |
| Waders #2 | | |
| Surveyor Holder | | |
| Surveyor Reader | | |
| Official Data Collector | | |
| Cable Deployment | | |
| Line Deployment | | |
| Attach Master | | |
| Attach Assistant | | |
| Photos #1 | | |
| Photos #2 | | |
| Bag Carrier | | |
| Safety | | |
| Time Keeper | | |



## Hydrolab Data Sheet

| Location | Water Source | Vegetation | Land Use | pH | Dissolved Oxygen | Chlorophyll a | Temp |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## Hydrolab Data

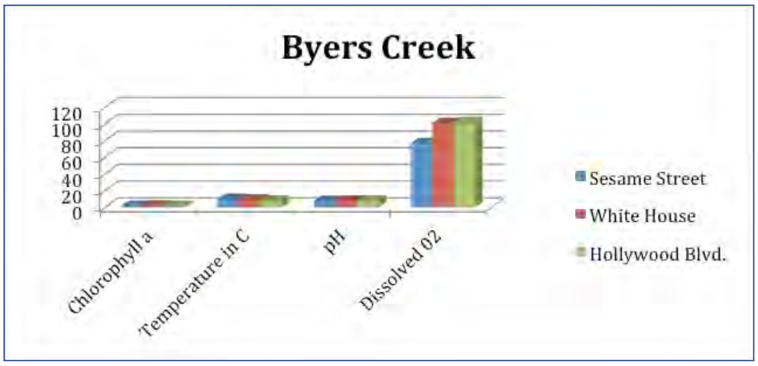
You will be entering data for three different areas: Flume Creek, Lake Michigan #1, and Lake Michigan #2. Make three different data tables and three different graphs.

Set up an Excel file with these categories and enter your data. Then highlight your work and select *all borders*.

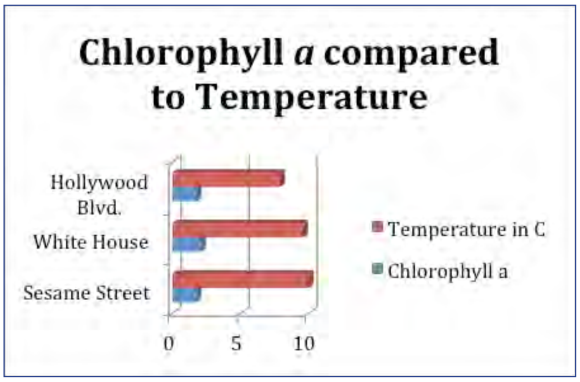
| Location | pH | Dissolved 02 | Chlorophyll *a* | Temperature in C |
|---|---|---|---|---|
| Sesame Street | 7.8 | 77 | 1.78 | 10 |
| White House | 8.1 | 101 | 2.09 | 9.6 |
| Hollywood Blvd. | 8 | 102 | 1.78 | 7.9 |

### *Making Your Graphs*

1. Highlight your work.
2. Go to the Insert tab at the top of the screen and choose a bar or column graph.
3. Under the *Insert* tab choose the *Layout* tab, *Chart Title*, *Above Chart* and make an appropriate title.

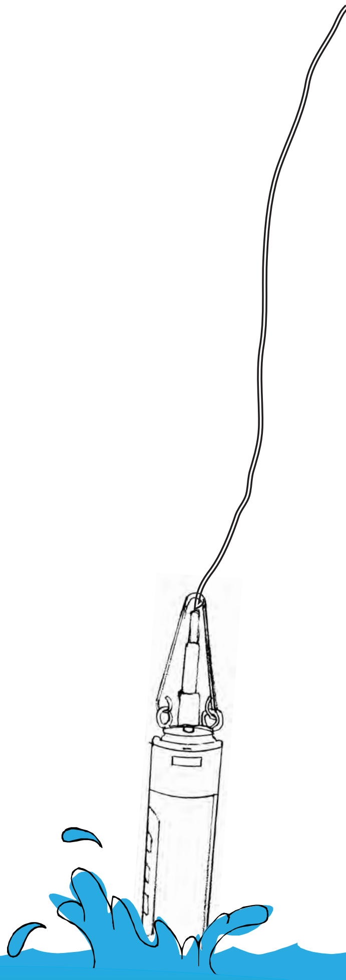



4. Make another graph with just part of the data.

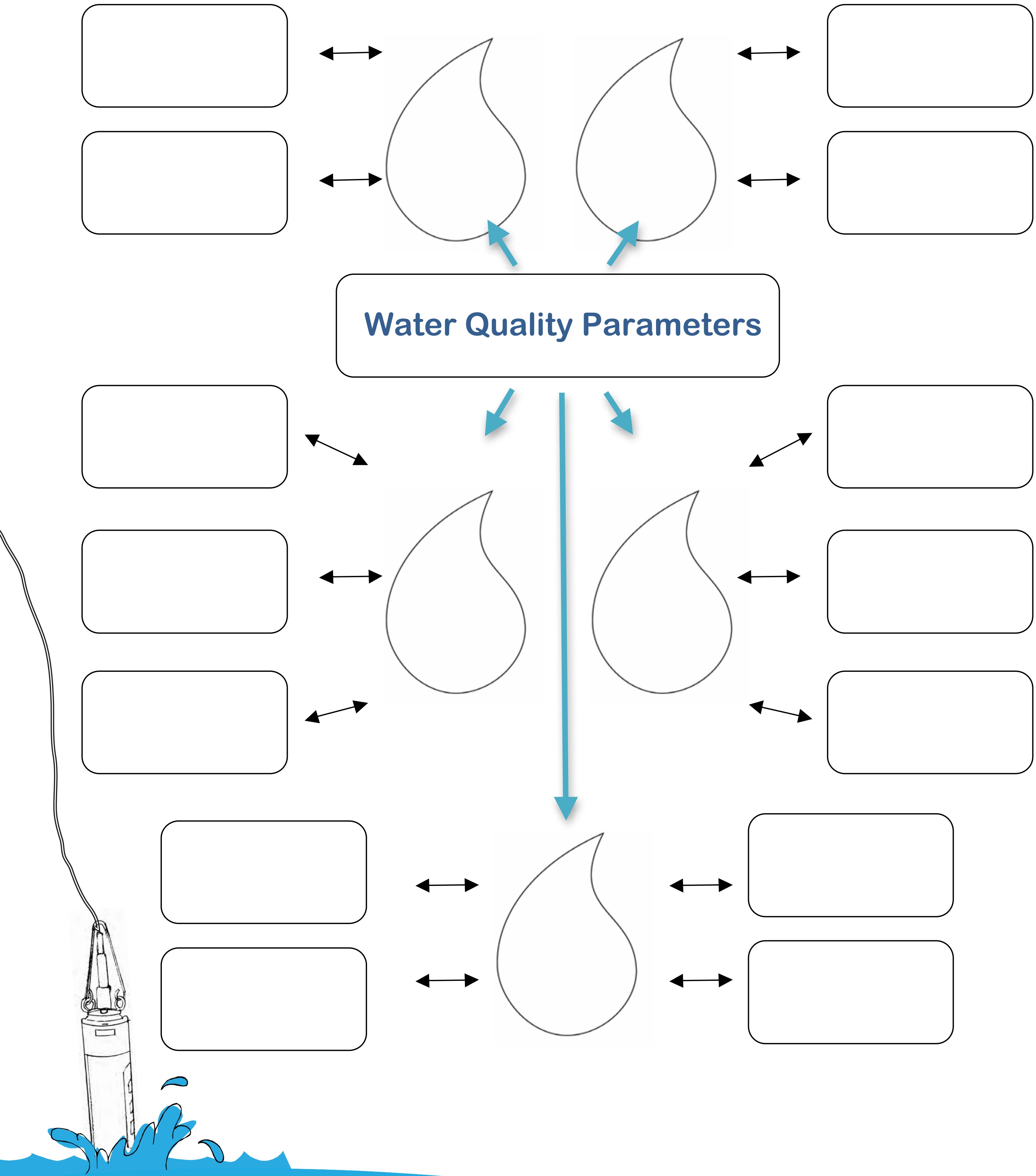



5. Do this for all three sets of data.

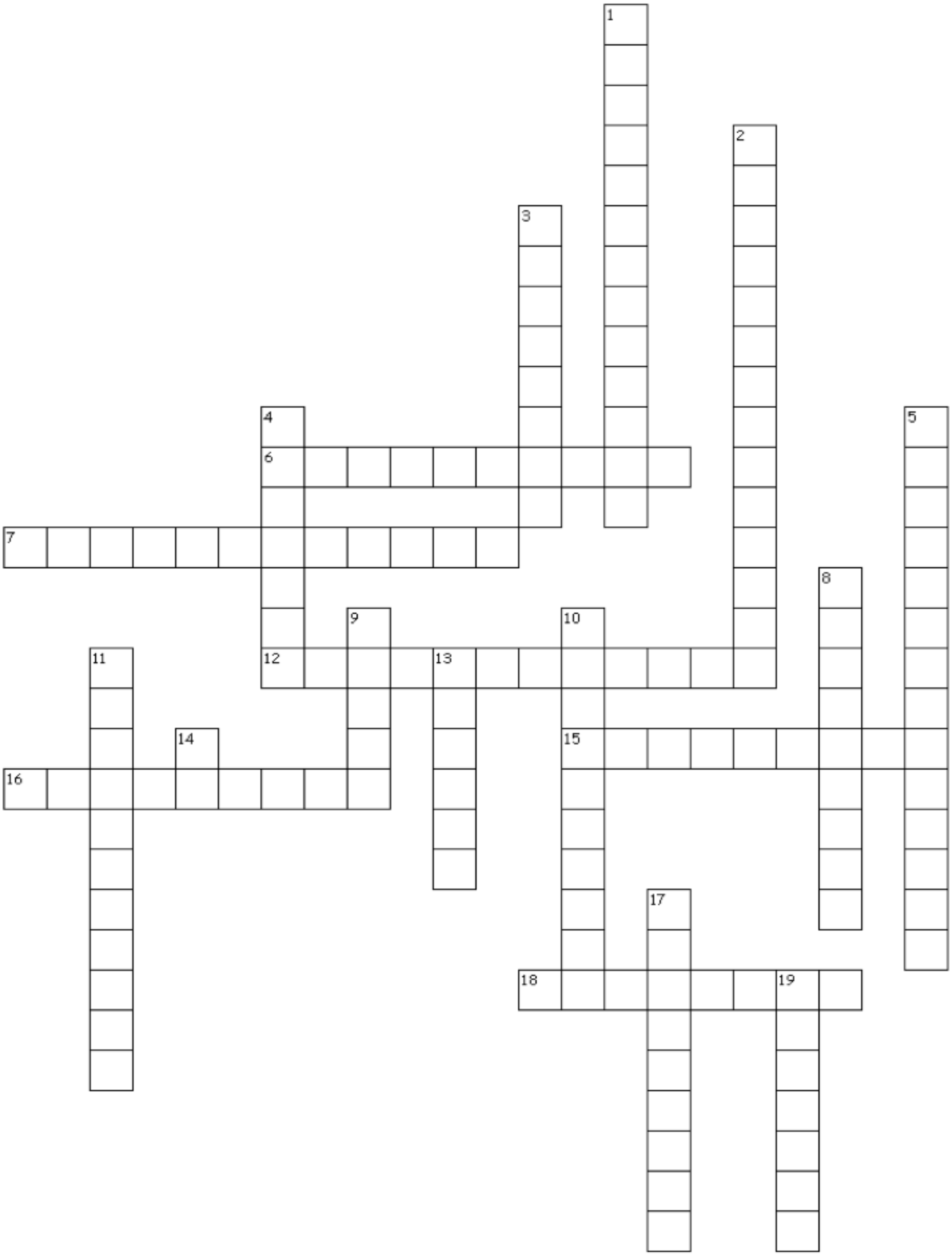
6. Print your data sheets.

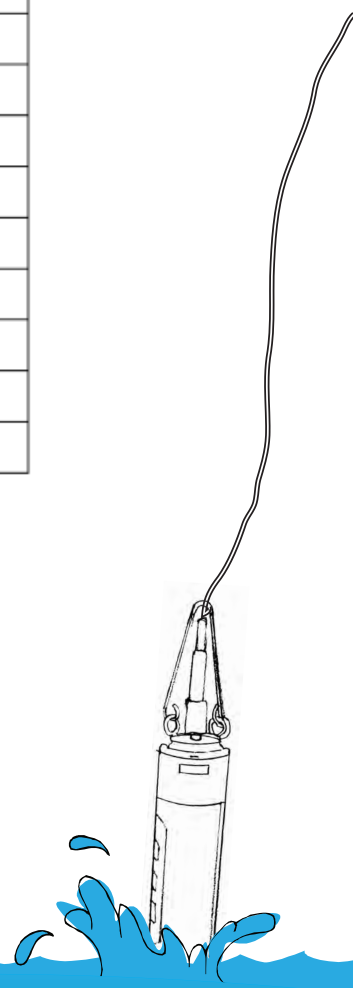


## Graphic Organizer



# Hydrolab Crossword



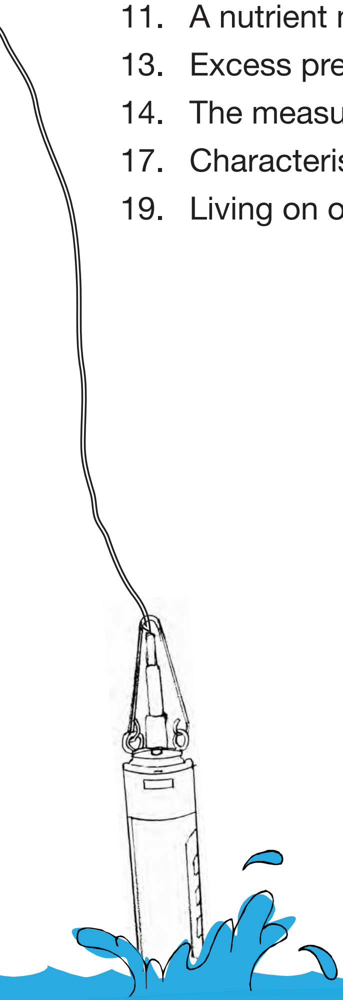



## Across

6. Top or upper layer of water in a lake
7. Ability to pass electric current
12. Contains green pigments found in algae
15. Organism living without oxygen
16. Rate of water passing by a point
18. Instrument used to monitor water quality

## Down

1. Tiny plant-like organisms
2. Process of plants making food
3. Particles in water that settle to the bottom
4. Organisms living at the bottom of lakes
5. The separation of lake water into distinct layers
8. The process of standardizing/correcting sensors
9. Photosynthetic organism
10. The buffering capacity of water
11. A nutrient needed for plant growth
13. Excess precipitation that doesn't infiltrate into ground or evaporate
14. The measure of hydrogen ions in solution
17. Characteristic being measured
19. Living on or in water



## Water Quality Quiz

Name: ______________________________

1. What is the name of the instrument that we'll be testing water with? _____________

2. What is the range of the pH scale? _______________

3. What is an example of an acid? _______________

4. What is an example of a base? ________________

5. What are some things that influence the amount of dissolved oxygen in a body of water?

6. What is chlorophyll *a* and why is it an important water quality parameter to measure? __________

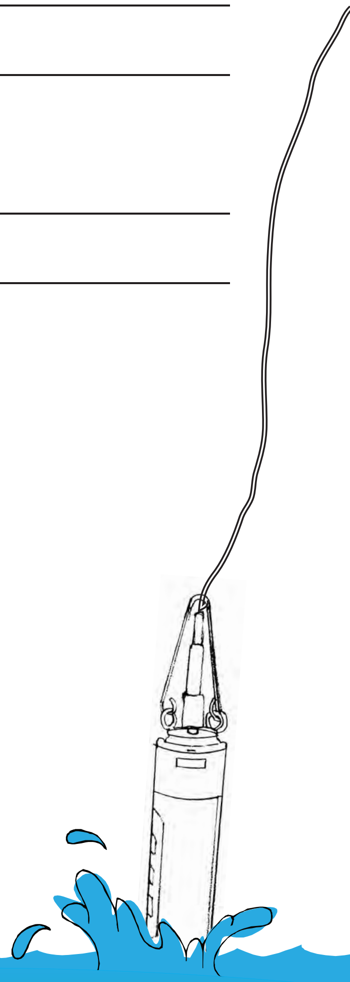
_______________________________________________________________________________

_______________________________________________________________________________

7. What is turbidity?

_______________________________________________________________________________

_______________________________________________________________________________



# Next Generation Science Standards

The specific standards addressed when using the Hydrolab will vary depending on instruction. For a complete list of NGSS standards please see: www.nextgenscience.org/.

The following NGSS standards are easily addressed when using the Hydrolab with your students:

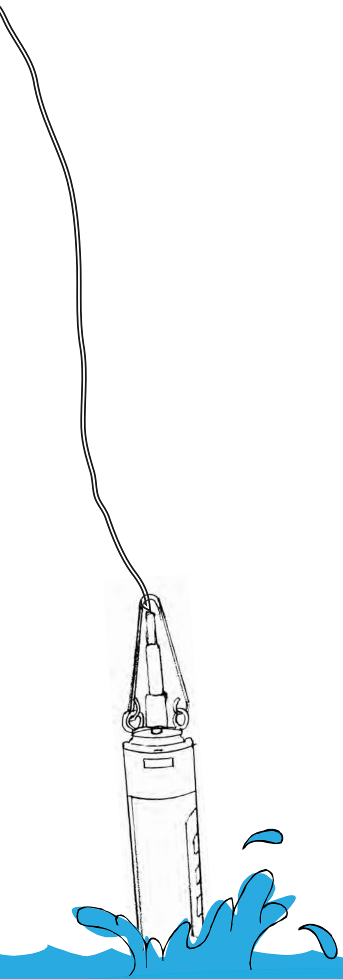
## MIDDLE SCHOOL

- MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

- MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds; and, creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

- MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

- MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]



- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

- MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

- MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

- MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

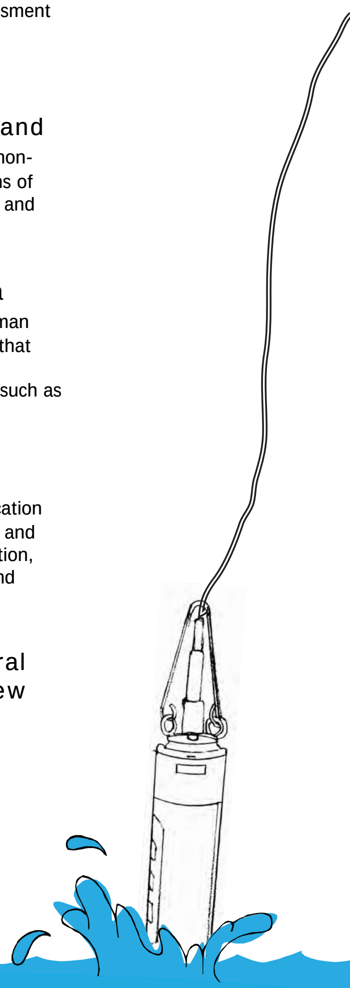
- MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



# HIGH SCHOOL

- HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.* [Clarification Statement: Emphasis is on the application of Le Chatlier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]

- HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

- HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

- HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

- HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

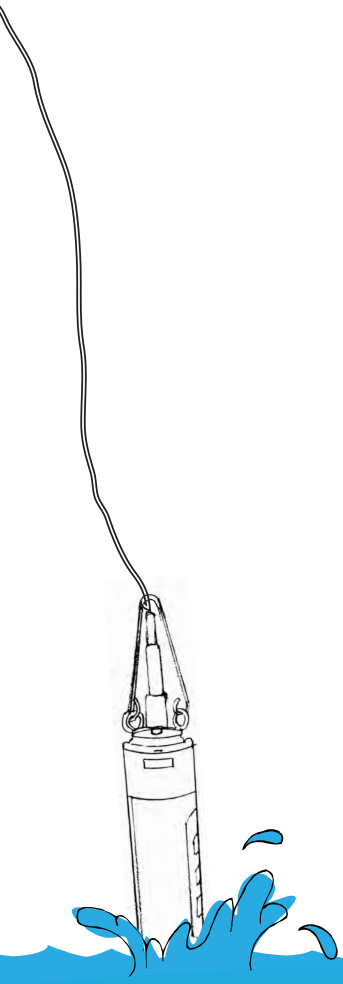
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and, extreme changes, such as volcanic eruption or sea level rise.]

- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

- HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

- HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

- HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]



- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

- HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

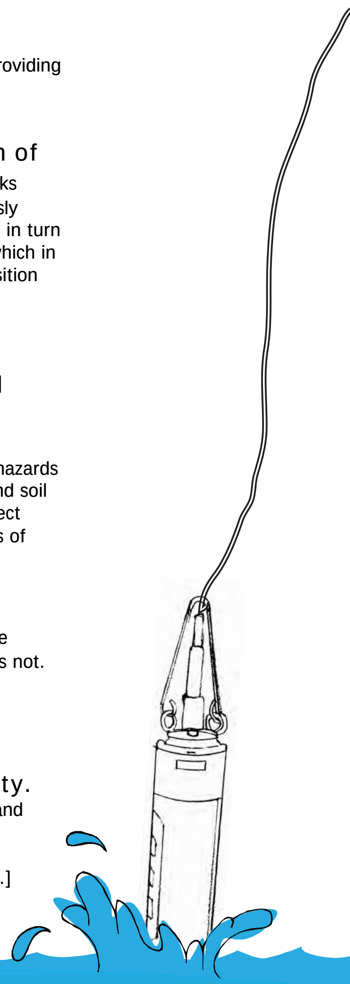
- HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

- HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]



- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activ on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quanti and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such a reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by m large changes to the atmosphere or ocean).]

- HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associ future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outp are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volume atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its asso impacts.]

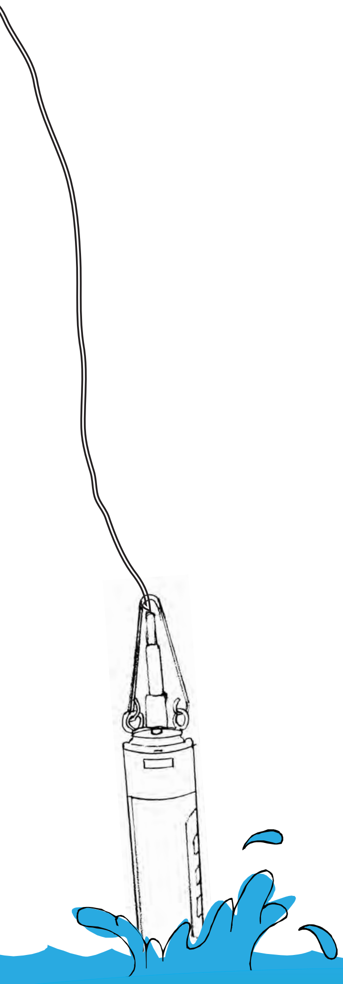
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteri and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a comp real-world problem with numerous criteria and constraints on interactions within and betw systems relevant to the problem.



# *Glossary*

**ALGAE:** photosynthetic unicellular or multicellular organisms

**ALKALINITY:** the buffering capacity of water, or the capacity of bases to neutralize

**ANAEROBIC:** organism living without oxygen

**AQUATIC:** relating to water; living on or in water

**BENTHIC ORGANISMS:** animals that live at the bottom of lakes

**BIOACCUMULATION:** the accumulation of chemicals taken up by organisms exposed to contaminated materials

**CALIBRATION:** to standardize or correct sensors after determining, by measurement or comparison with a standard, the correct value

**CHLOROPHYLL *a*:** a green pigment found in the chloroplasts of all algae and plants

**CONDUCTIVITY:** a measure of the ability of a substance to pass an electric current. This parameter indicates the amount of dissolved substances (salts) present in water.

**DISCHARGE:** the rate of liquid passing by one point at one time

**DISSOLVED OXYGEN:** number of oxygen molecules ($O_2$) dissolved in water

**DRAINAGE BASIN:** the total area that contributes water to a stream, including runoff and tributaries

**EFFLUENT:** the outflow from something, either a stream from a lake or waste from a sewage treatment facility

**EPILIMNION:** the upper layer of water in a lake

**EUTROPHICATION:** the process in which a body of water becomes more nutrient rich usually from nitrogen and phosphorus

**HEADWATER OR SOURCE:** the upper part of a stream close to or forming its source

**HYPOLIMNION:** the bottom layer of water in a lake

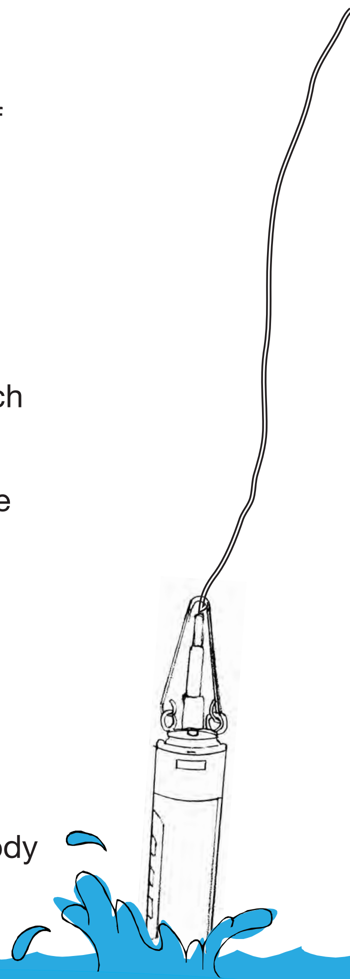
**HYPOXIA:** a deficiency in oxygen (less than 2.0 mg/l dissolved oxygen)

**HYPOXIC:** deficient in oxygen

**INVERTEBRATE:** animal having no backbone

**LOAD:** the total amount of material (typically related to pollutants) entering a waterbody (measured usually as weight per unit of time or area)

**NITRATE:** a plant nutrient ($NO_3$-)



**NUTRIENT:** an element or compound needed for plant or animal growth

**ORGANIC MATTER:** compounds that are or were once part of a living organism or produced by a living organism (contains carbon)

**PARAMETER:** characteristic being measured or described

**pH:** the measure of concentration of hydrogen ions in solution. This concentration determines the acidity of the solution.

**PHOSPHORUS:** a nutrient needed for plant growth (Note the crossword puzzle uses the adjective—phosphorous.)

**PHOTOSYNTHESIS:** a process where plants use the sun's energy to combine carbon dioxide and water into carbohydrates and oxygen is released

**PHYTOPLANKTON:** microscopic plant-like organisms that serve as the base of the aquatic food web and have an essential role in removing carbon dioxide from the air

**RIPARIAN:** relating to the banks of a natural course of water

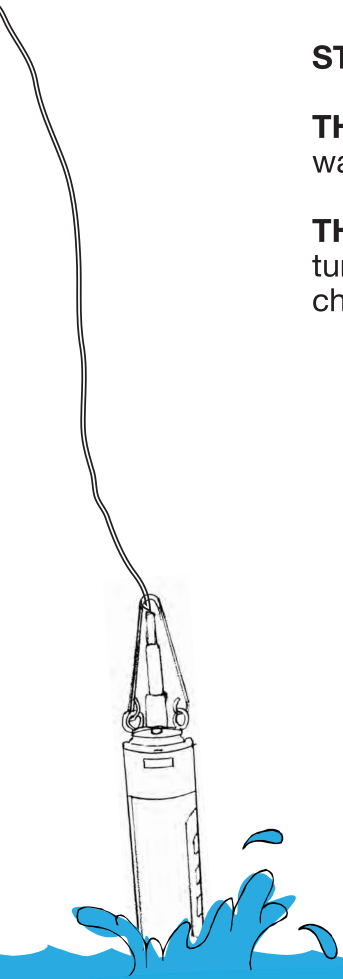
**RUNOFF:** precipitation (excess rain or snowmelt) that has drained through or over an area to streams

**SEDIMENT:** particles transported, suspended or settled in water

**STRATIFICATION:** arranged in layers

**THERMAL POLLUTION:** loss of water quality by any process that changes the natural water temperature

**THERMAL STRATIFICATION:** Stratification (or layering) occurs when the temperature changes at different depths in the water. The layers form because the density also changes with temperature.



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