April

Water quality monitoring

As you know from previous chapters, many factors affect the chemical, physical, and biological characteristics of a water body. Events that humans have no control over, such as weather, create some of these factors. Human activities are responsible for other factors. Last month's chapter discussed some of the impacts human activities have on aquatic ecosystems. This month, the ***Adopt-A-Salmon Family Teacher's Guide*** and ***The Salmon Times*** discuss how people determine the health of a water body and keep track of its improvement or degradation.

When we try to determine the health of a water body or its **water quality**, we evaluate water's chemical, physical, and biological

Why monitor water quality?

There are many reasons why people monitor water quality. Determining *why* you want to monitor is as important as determining what, when and where.

1. Monitoring helps *determine baseline conditions*. Baseline data provide reference points against which future measurements can be compared. Baseline information that is gathered year-round, for example, can help determine seasonal trends and variations.

2. Monitoring can help *identify problem spots or events* when significant and detrimental changes show up in the physical, chemical, or biological characteristics of a water body. In this case the monitoring program is usually designed to compare characteristics from up and downstream of a suspected site, from before and after an event, or between one water body and another very similar water body.

3. Monitoring can also help natural resource managers determine if certain management practices that have been put in place to *remedy a problem* are working. For example, monitoring might be used to show that sediment barriers at a construction site are effectively reducing sediment-filled runoff entering a stream.

4. Sometimes the purpose of monitoring is strictly educational. This type of monitoring project is designed to *teach people* about the characteristics of water, what factors affect those characteristics, and how to conduct water quality tests.

5. Water quality monitoring can be both an inspiration for and a result of environmental *stewardship*. Monitoring means watching and is a way of actively keeping track of the

characteristics. For example, a simple evaluation might consist of measuring the pH, temperature, and aquatic insect members of a water body. Certain fluctuations in water quality characteristics are normal and dependent on seasons, time of day, or the location of the testing site. Other fluctuations can be a result of human activities within a watershed that impact the chemistry, physical nature, or biological inhabitants of water.

The chemical, physical, and biological health of waters are so important that they are protected by the Federal Water Pollution Control Act. This legislation's purpose is the restoration and maintenance of the chemical, physical and biological integrity of the Nation's waters. A classification system was developed to help with the implementation of this law. Each water body is assigned to a class which is a reflection of the water body's intended use. These class uses are sometimes simplified to *Drinkable, Swimmable, and Fishable.* The class determines the water quality standard according to measurements of criteria such as dissolved oxygen, fecal coliform and color and odor. For example, a water body that serves as a source of drinking water would belong to a class that has much stricter water quality standards than one that is used for irrigation of inedible crops. The water quality standards for drinking water are the same for all states and are administered by the Environmental Protection Agency (EPA). State standards must be equal to or more restrictive than federal standards. Acceptable standards and water quality testing procedures are usually determined by state agencies involved in public health or environmental protection.

Water quality monitoring happens when water quality surveys are performed on a regular basis for a specific purpose on a particular water body. Water quality monitoring involves recording data about these various characteristics and usually involves analyzing and interpreting these data. Monitoring helps ensure that a water body is suitable for its determined use. It can also be used in protective ways to prevent degradation or to upgrade the class.

What kind of information do water quality monitors look for? There are many aspects of a water body that can be measured or observed and provide helpful information. Some of the measurements and observations are easy to make, others are much more complicated. In the discussion that follows, we will highlight measurements and observations that have fairly simple procedures and can be conducted either at the sampling site or in most post elementary school laboratories. This is *not* a comprehensive list of possible parameters. It is merely a sampling. See the references at the end of the chapter to learn procedures for conducting these tests.

I. OBSERVATIONS

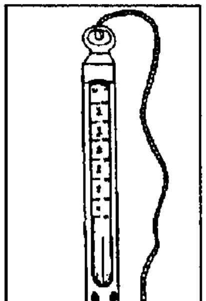
One of the simplest ways to learn more about a water body is to use the senses. Observing color, flow, streambank condition, wildlife evidence, types of vegetation, debris, and signs of human activity provide information. What odors do you smell? - mustiness, gasoline, organics, chemicals, dead fish, or rotten eggs? Can you hear flowing water, drain discharge, fish jumping, waterfowl, or boats? Using the senses is not only a good way to gather information, but can also help monitors decide what and where they would like to monitor.

II. WATERSHED SURVEYS

When monitors conduct their observations in a systematic and formal way, they are doing watershed surveys. A watershed survey usually involves combining existing information about sources of pollution with observations of potential sources of pollution such as sewage treatment plants, landfills, and residential areas. Usually monitors will use a map to help guide the survey. See March activity - What's Around our Water.

III. TEMPERATURE

Obviously, water temperature is a characteristic that can vary widely and is influenced by a number of variables including geographic location, shading, water source, thermal discharges, water body size and depth. Temperature has a great influence in determining what organisms can survive in a water body. Temperature directly affects the amount of oxygen that can be dissolved in water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases. Atlantic salmon and the prey they depend upon survive best in cool, oxygen-rich waters.


thermometer

Humans activities influence water temperature. The March chapter of the ***Teacher's Guide*** discussed the effects of thermal pollution and streamside clearing, both of which can create changes in water temperature. Soil erosion raises water temperature by increasing the amount of suspended solids in the water. Suspended solids make water cloudy. Cloudy water absorbs more radiation (and warmth) from the sun than clear water does.

IV. VELOCITY

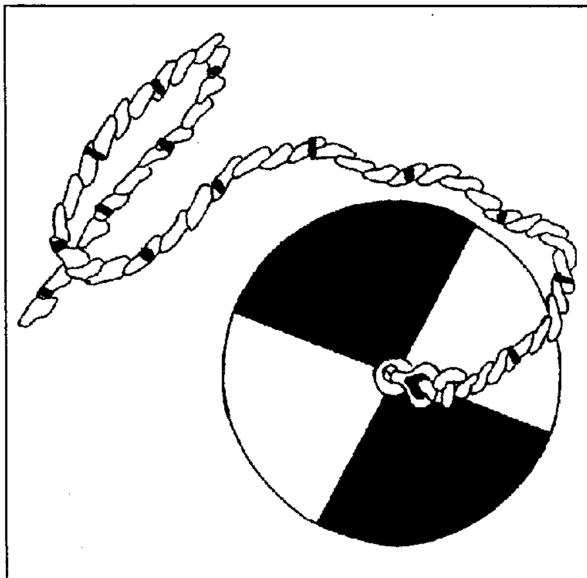
The flow rate of moving water is influenced by topography, rainfall, structures, and aquatic vegetation. Typically, fast moving water is well oxygenated. Slow flow allows pollutants to collect and oxygen to be depleted. Inconsistent flows can disrupt invertebrate and fish nesting areas.

V. WATER TRANSPARENCY

When substances such as silt, microorganisms, plant fibers, sawdust, wood ashes, chemicals, coal dust, and plankton are suspended in water, they make it cloudy. **Transparency** is a measure of how cloudy water is. Plankton and soil erosion are the most common sources of low transparency.

The decreased transparency of **turbid** waters can have both positive and negative consequences for aquatic life. It depends on the source and degree of suspended particles. For example, plankton, a valuable food source for fish, causes decreased transparency. It may be easier for some fish to hide themselves from predators in turbid waters. Very low transparency, on the other hand, can be detrimental to aquatic life in a number of ways.

1. Turbid conditions prevent sunlight from penetrating into the water column and reaching aquatic plants. Aquatic plants need sunlight for photosynthesis. Photosynthesis provides oxygen for aquatic life. A reduction in photosynthesis results in lower oxygen concentration levels and high carbon dioxide levels.
2. Turbid waters carrying large amounts of suspended particles may flow through the gills of fish, mussels, and aquatic insects, clogging them and killing or burying the animals.



secchi disk for measuring water transparency

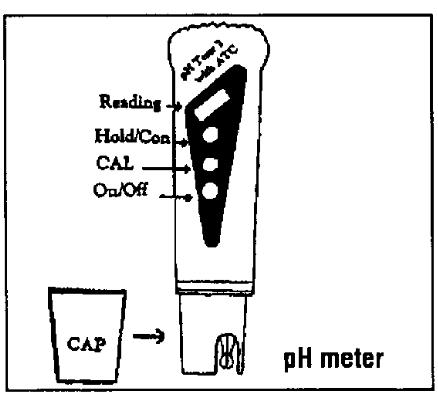
Limiting pH Values Minimum	Maximum	Effects of Some Scientific Studies
3.8	10.0	Fish eggs could be hatched, but deformed young were often produced.
4.0	10.1	Limits for the most resistant fish species.
4.1	9.5	Range tolerated by trout.
4.3	—	Carp died in five days.
4.5	9.0	Trout eggs and larvae develop normally.
4.6	9.5	Limits for perch.
5.0	—	Limits for stickleback fish.
5.0	9.0	Tolerable range for most fish.
—	8.7	Upper limit for good fishing waters.
5.4	11.4	Fish avoided waters beyond these limits.
6.0	7.2	Optimum (best) range for fish eggs.
1.0	—	Mosquito larvae were destroyed at this pH value.
3.3	4.7	Mosquito larva lived within this range.
7.5	8.4	Best range for the growth of algae.

3. Some suspended particles may carry harmful microorganisms.
4. Turbid waters make it difficult for fish that depend on seeing their food to find it.

VI. pH

Water contains both **hydrogen (H+)** and **hydroxyl (OH-)** ions. The **pH** reading of a solution is an expression of the concentration of hydrogen (H+) ions. It is used to describe the acidity of a solution. The pH scale ranges from 1 (very **acidic**) to 14 (very **basic** or **alkaline**). Pure deionized water is considered neutral. It has an equal concentration of hydrogen and hydroxyl ions and has a pH of 7. If a sample has a pH less than 7, it is considered acidic. If it has a pH greater than 7, it is considered basic or alkaline. pH is logarithmic, so that a single unit change in pH reflects a 10 fold change in hydrogen ion concentration or acidity. The pH of a water body is affected by its age, geology, and the chemicals discharged into it by communities and industries. Most lakes become more acidic as they age due to the accumulation and decomposition of organic materials. During decay, carbon dioxide forms and combines with water to form carbonic acid which lowers the water's pH.

Human activities affect the pH of water bodies. Acid precipitation is the result of nitrogen oxide gases (NO_X) and sulfur dioxide (SO_2) combining with water in the atmosphere to produce nitric and sulfuric acids. These gases are produced and released into the atmosphere during the burning of fossil fuels such as gas, oil, and coal. Driving a car, heating a home, producing coal-fired electricity and manufacturing products involve burning fossil fuels and contribute to the production of acid rain. Acid precipitation falls into water bodies and makes some of them acidic. Runoff from acidic soils also contributes to acid waters. Water bodies that have limestone geology are less susceptible because the alkaline carbonates of limestone help neutralize the effects of acid precipitation.



Most aquatic organisms survive best within a limited pH range. Even small changes in pH are harmful to pH sensitive species. Most fish can tolerate pH values of about 5.0 to 9.0. pH values outside that range can create problems for reproduction and survival. Amphibians are particularly susceptible to acid waters. Acid waters in conjunction with some metals such as aluminum, lead, and copper create an even more toxic environment than either of the substances alone.

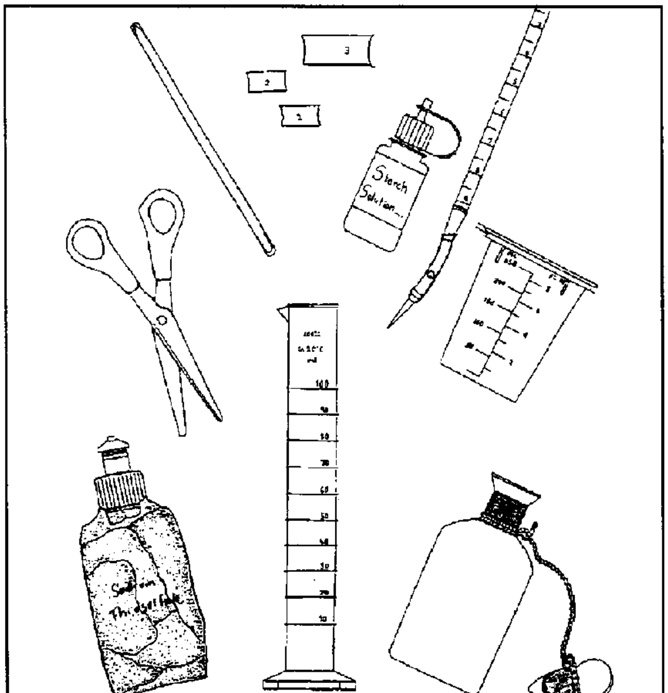
Acid precipitation can also corrode structures by slowly eating away at the exposed stone, metal, and paints. Unpolluted rain has a pH of around 5.6 (slightly acid). The average rain and snowfall in most states east of the Mississippi River measures between 4 and

5 on the pH scale. Some individual storms go as low as 3.0! Although there are ways to reduce the amount of harmful gases entering the atmosphere, there are no easy solutions to the problem of acid precipitation. The pH of salt water is not as easily affected by acid precipitation as fresh water pH is. The salts in salt water act as buffers to acid falling into it. Many shellfish and algae are more sensitive than fish to large changes in pH, so they need the sea's relatively stable pH environment to survive.

VII. ALKALINITY

Alkalinity refers to the ability of a solution to resist changes in pH. Alkalinity **buffers** waters against dramatic changes in pH. Adding a weak acid or base to a buffered solution will not cause changes to the pH very easily, however, adding acid or base to an unbuffered solution can cause dramatic changes in pH. The main sources of natural alkalinity are rocks which contain carbonate, bicarbonate and hydroxide compounds. Borates, silicates, and phosphates also may contribute to alkalinity. Waters flowing through limestone typically have good buffering capacity. Waters flowing through granite areas, like most of New England, typically have low alkalinity and poor buffering capacity.

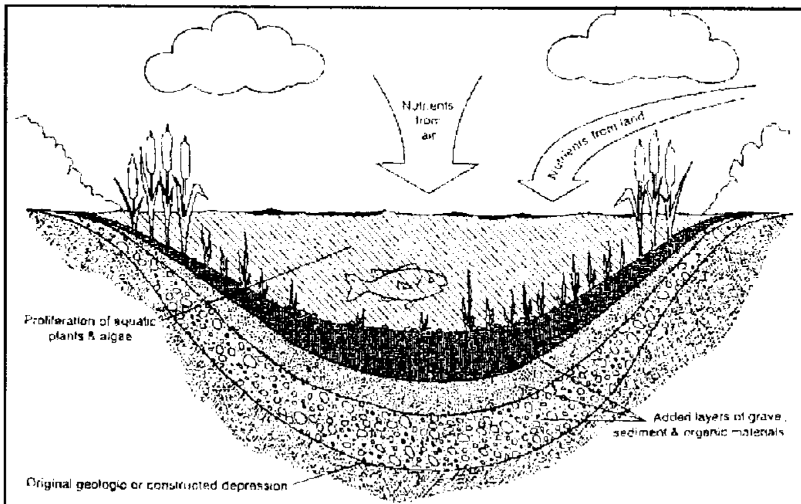
Alkalinity helps fish and aquatic life because it protects against pH changes and makes water less vulnerable to acid rain. When alkalinity falls below 2 mg. per liter the pH of waters can change easily. During the spring, alkalinity is especially important for protecting aquatic organisms in their early stages from large amounts of acidic snowmelt and runoff.


equipment for measuring dissolved oxygen

VIII. DISSOLVED OXYGEN

Aquatic organisms cannot survive without oxygen. Only oxygen-rich waters can support a broad variety of aquatic organisms. Remember, a wide variety of organisms (biodiversity) helps preserve stability in an ecological system. Waters with low amounts of dissolved oxygen can support only limited amounts and types of aquatic organism. The best trout and salmon streams are cool and well oxygenated. Catfish and carp dominated aquatic systems are typical of waters with low levels of oxygen.

Dissolved oxygen comes from a variety of sources. The action of waves and water tumbling over rocks helps mix oxygen in the atmosphere with moving water. Plants also release oxygen into the water as a byproduct of photosynthesis during daylight hours. Plants and animals use oxygen during respiration and produce carbon dioxide. Both oxygen and carbon dioxide are more soluble in water at low temperatures than at high ones. Large amounts of carbon dioxide are a sign of accumulating organic material and low dissolved oxygen. Human activities have great potential to influence dissolved oxygen levels because they are so closely linked to temperature and nutrient levels. Increased nutrients (like phosphorus and nitrogen) stimulate algal growth. Eventually the algae die and accumulate. Animal waste, sewage, food and paper industry discharges, agricultural and urban runoff in addition to the dead algae create a large amount of organic material. Bacteria, fungi and other decomposers use oxygen to break down these large amounts of organic material and the **biochemical oxygen demand** within the system increases.



eutrofication

Biochemical oxygen demand refers to the amount of oxygen required by microorganisms to oxidize organic materials. A high demand lowers the availability of dissolved oxygen in the water.

When oxygen is consumed by aerobic bacterias, there is less available for other aquatic organisms. Only organisms, such as carp, midge flies, and leeches that are tolerant of low dissolved oxygen levels will survive. This reduces the diversity within the system creating a system that is less complex and therefore, ecologically less stable.

Cool trout and salmon waters generally contain oxygen concentrations above 5 mg. per liter (ppm). Waters with at least a 90 percent dissolved oxygen saturation value are considered healthy unless they are supersaturated due to cultural eutrophication. Waters with less than 90 percent saturation may have large amounts of oxygen demanding materials.

IX. TOTAL PHOSPHORUS

Phosphorus is sometimes called a **limiting factor** for aquatic plant life because the amount of phosphorus has great influence over plant growth. Phosphorus exists in aquatic ecosystems in several forms. Phosphorus is part of plant and animal tissue. Phosphorus also exists dissolved in water. It can also attach to tiny particles of silt and sediment. Plants take up as much free phosphorus from soil and water as they need. Animals get it from eating plants.

Nitrogen in the form of nitrate also contributes to plankton overgrowth in aquatic systems. It washes in from fertilizers on nearby farms and lawns, manure piles, leaking septic tanks, and car exhaust. Nitrogen in the form of nitrites in drinking water can cause serious problems for infants who ingest it. Nitrites react with human blood and impair the blood cell's ability to transport oxygen. These nutrients are difficult to test for.

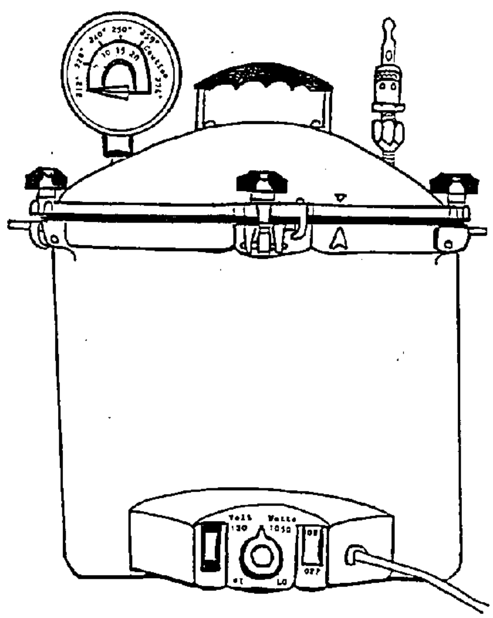
Phosphorus shortages are rare because phosphorus can enter water bodies in many different ways. Because phosphorus is part of plant and animal tissue, phosphorus is released into the water when aquatic plants and animals die and decompose. Phosphorus from animal and human waste also enters water bodies with agricultural and residential runoff. Inadequately treated sewage from wastewater treatment plants and septic tanks contains phosphorus. Because it is part of many soils, phosphorus washes with rain and snow into water bodies when the soil surface is disturbed during vegetation removal from farming or construction. Many fertilizers used on agricultural lands and on lawns contain phosphorus. Any phosphorus that is not taken up by plants can wash into water bodies from surface runoff. Remember that wetlands serve to hold nutrients. When wetlands are destroyed and organic-rich soils are disturbed, nutrients that have accumulated over years are released. Industries release phosphorus from cleaning compounds and other wastes. Phosphorus also comes from phosphate-rich rocks.

In some systems, phosphorus can become a problem because it causes an overgrowth of plant material that creates disruption to the system overall. Algae in aquatic ecosystems require very little phosphorus to live. **Algal blooms** are typical of waters with excess nutrients. Algal blooms cause water to become green and thick with algae. Algal blooms are often a sign of **cultural eutrophication.** Non-cultural eutrophication is the natural aging process of water bodies. Over hundreds of thousands of years, open water bodies gradually collect sediment, algae, protozoans and rooted aquatic vegetation. Eventually the algae flourish, bacteria levels increase, oxygen levels drop, fish die and the basin begins to fill with plants. Eventually the pond becomes more like a swamp. After more time the swamp becomes forest. Cultural eutrophication occurs when biodegradable wastes (excess nutrients) speed up the aging process by accelerating algal blooms, increasing bacteria levels and depleting oxygen.

A limited diversity of organisms can survive the low oxygen levels of eutrophic ponds and lakes. Only the most tolerant organisms - carp, midge larvae, sewage worms, Tubifex, and others can live and reproduce.

X. INDICATOR BACTERIA

Water contains **microbes**, tiny organisms such as bacteria, algae and protozoa that are too small to see without a microscope. **Pathogenic** microbes, such as bacteria, viruses and parasites in drinking water can cause diseases in humans. In order for waters to be safe for drinking and swimming, they must be checked for the presence of harmful microbes. These pathogens are difficult to detect in water because there aren't many of them and they can't survive very long outside of a human or animal body. Water quality monitors looking for harmful microbes check for **total coliform** or **fecal coliform bacteria**. Total coliform bacteria naturally coexist with pathogens inside the intestines of both warm and cold blooded animals. These bacteria are beneficial in the intestines of humans and other animals and aid in digestion. Total coliform includes all coliform bacteria that come from the gut of vertebrates as well as from some soil dwelling bacteria. Fecal coliform bacteria are only present in the intestines of warm blooded animals. **E-coli** is a type of fecal coliform that is commonly monitored by state health labs. Fecal coliform bacteria can create intestinal problems, however they are not, themselves, considered pathogenic. Their presence indicates that excrement from humans or other warm blooded animals has contaminated a water source. Unprocessed toilet wastes, farm animal wastes and pet waste that make it into a water supply or swimming area can contaminate that water body. Untreated overflow from wastewater treatment plants or sewer systems can discharge contaminated wastewater into a lake, river, or estuary. Faulty septic tanks also allow harmful bacteria to pass untreated into another water body. Diseases such as hepatitis, dysentery, typhoid fever, and ear infections can be contracted in waters with high fecal coliform counts.

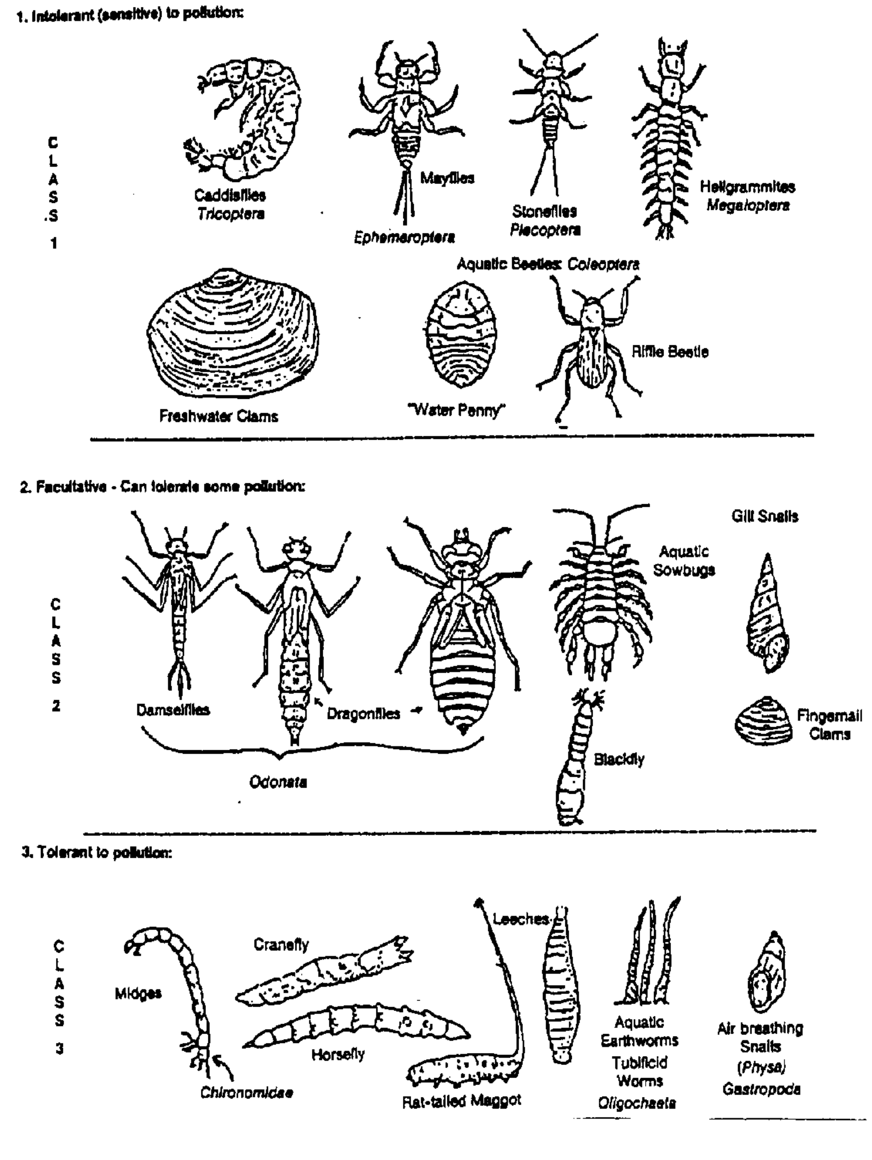


equipment for monitoring fecal coliform bacteria

XI. BIOINDICATORS - MACROINVERTEBRATES and FISH

Bioindicators are organisms whose presence, absence, or condition provides information about environmental quality. Every organism has particular environmental requirements for it to be healthy and reproduce successfully. The presence or absence of healthy populations of organisms within their habitats is a sign of particular environmental characteristics. The advantage of using bioindicators over chemical and physical tests when evaluating water quality is that the presence of living organisms inherently provides information about water quality over time. Chemical and physical tests give information that is accurate at that moment. The presence of a mixed population of healthy aquatic insects, mussels, or fish

Macroinvertebrates According to Beck's Biotic Index Classes (Ref. A-2).



usually indicates that the water quality has been good for some time. The absence of bioindicators at a site that appears good according to chemical and physical sampling might prompt further investigation for toxics or periodic insults to water quality. Imagine that a pulse of toxics entered a particular stream or river. While the chemical evidence may have been taken downstream, the lack or poor condition of bioindicators might provide a clue that something had happened.

In streams and rivers, water quality monitors often look for benthic macroinvertebrates to get an idea of water quality. Benthic macroinvertebrates include aquatic insects, worms, shellfish, crustaceans, and other animals without backbones that are large enough to see without a microscope and live at the bottom of a water body. Many species of mayfly nymphs, caddisfly larva, water pennies, and stonefly larva, for example, can survive only in swift, cool, well oxygenated water. Their presence at a sampling site is generally a sign of good water quality. Black fly larva, midges, leeches, and aquatic worms on the other hand, are quite tolerant of pollution. They can be found in waters of both good and poor quality. If they are the *only* types of macroinvertebrates found at a site, chances are the site is silty and has low dissolved oxygen. Such conditions might represent a polluted first order stream or a downstream site near the mouth of a river.

Aside from using the presence or absence of certain indicator species to determine water quality, the number of different species or **EPT richness** can provide even more information. The three most pollution intolerant families of aquatic insects are the Ephemeroptera, Plecoptera, Trichoptera - EPT. The higher the percentage of pollution intolerant species in relation to the percentage of tolerant species at a site, the better the water quality.

Ephemeroptera = mayflies
Plecoptera = stoneflies
Trichoptera = caddisflies

The health of resident fish species will be indicative of overall water quality. Condition is determined by comparing the length of the fish to its

dwarf wedge mussel

weight. The heavier the fish for its length, the better the condition. Fisheries biologists also look at scales under a microscope to learn about the age and growth history of a fish.

Freshwater mussels, like aquatic insects serve as bioindicators. Each specie of mussel has different environmental requirements. Some species like *Elliptio complanata*, the Eastern elliptio mussel, are more pollution tolerant than species like the endangered *Alasmidonta heterodon* or dwarf wedge mussel. Freshwater mussels are filter feeders, who depend on their gills to retrieve oxygen from the water and an incurrent siphon to retrieve food from water flowing by them. Because they move so slowly, mussels must be able to obtain their food and oxygen from one spot. If their habitat becomes inundated with pollution such as toxics or silt, some of them will most likely perish.

Perhaps the most interesting aspect of freshwater mussel natural history is reproduction. Larval mussels, called **glochidia** attach to the gills or scales of fish nearby. The glochidia develop attached to the fish and eventually drop to the bottom. Scientists think that the mussel glochidia will only survive attached, in some cases, to particular species of host fish. If obstacles such as dams, poor water quality, or overfishing interfere with the survival of fish, they are also most likely interfering with the survival of mussels! Because freshwater mussels can live for decades, their presence or absence can provide even more information about the history of water quality at a site. Their longevity may be how they continue to survive with such a risky reproductive strategy.

Next month's chapter suggests ways people can prevent damage to and even improve water habitats.

Word Power

*acidic
*algae
*alkaline
*baseline data
*bioindicators
*diversity
*coliform bacteria
*downstream bypass
*fecal coliform bacteria
*filter-feed
*fish ladder
*fish lift
*intolerant
*invertebrates
*macroinvertebrates
*monitoring
*nitrogen
*pH
*phosphorus
*respiration
*surveyed
*turbid(ity)
*water quality
algal bloom
alkalinity
base
biochemical oxygen demand
buffers
cultural eutrophication
EPT richness
eutrophication
glochidia
hydrogen (H+)
hydroxyl (OH-)
limiting factor
microbes

Water Quality Monitoring

This ***Guide*** will not provide detailed descriptions of water quality sampling protocols because many sources of this information already exist. In addition, the tests you choose to conduct will depend on whether you are sampling lakes, streams, estuaries, or ocean waters. Which tests to choose also depends on your reason for monitoring. In New Hampshire, contact your county Cooperative Extension office to borrow a lake or stream study kit. For information about references, water quality monitoring programs in your area or to inquire about borrowing or making sampling equipment contact UNH Cooperative Extension, Water Resources, Pettee Hall (603) 862-1029. Be prepared to discuss when, where, and why you wish to monitor as well as who will be conducting the tests in order to focus on the best sources of information.

If you do wish to study or monitor the water quality characteristics of a water body, keep the following guidelines in mind. These are taken from *Stream Study and Water Quality Assessment Curriculum.*

Preparing students:

1. Prepare students for field work by presenting appropriate background information.
2. Demonstrate or practice the use of the equipment, including the test kits, before going into the field.
3. Make sure everyone has a role in the process and that there is sufficient adult (or older peer) supervision for the activities.
4. Explain the goals, methods, and ground rules for the field session before heading out.
5. Instruct students to wash on return from field sessions, especially before eating.

Choose sites that...

1. are easily and safely accessible for the number of people involved and will not be damaged by repeated visits.
2. are typical of the waterbody being studied.
3. may show differences in water quality above and below land uses that might impair water quality.

Timing and frequency of sampling:

1. The more frequent the study and sampling, the more accurate the interpretations about water quality will be - weekly sampling is considered very frequent, monthly not very frequent.
2. For water quality assessment, periods immediately following heavy rain or snow melt will show the greatest effect of non-point pollutants resulting from land use factors (e.g. urban runoff, dry fallout of pollutants).
3. Alternate between storm/snowmelt runoff periods and "base flow" periods (i.e. when stream is fed only by groundwater, not surface runoff) to evaluate the impact of stormwater runoff.

Conducting tests:

Note: Chemical test kits are not appropriate for use by younger children- under grade 6. Use by grades 6 and up should always occur with adult supervision. Wear safety goggles when conducting tests. Chemical testing is best done back in the classroom to minimize the chance of damage to equipment. Collect water in a suitable container and minimize heating or disturbance.

The following guidelines are based on the equipment that is available through UNH Cooperative Extension's stream and lake monitoring kits. Most of the following tests can be accomplished with the kits, however, not all.

I. and **II. Observations and Watershed surveys** - These two tests require skills in observation, reflection, critical thinking, recording, map reading and social interaction. See March activity - *What is Around our Water?*

III. Temperature

1. Swirl the thermometer in water until it reaches equilibrium.
2. Measure temperature at different times through the sampling session to check on daily range.

IV. Velocity

1. Measure and mark a 100, 50, or 25 foot distance along a straight section of your stream. Throw a stick, orange, apple or other object that barely floats into the water far enough above the upstream marker for it to reach the speed of the water before it reaches the first marker. Measure the number of seconds it takes to float downstream between the markers. Record below. Now divide the 100, 50 or 25 foot distance by the total seconds it took the stick to float between the stakes. Repeat this procedure 3 times and find the average.

Number of feet/number of seconds = ________ feet per second.

V. Water transparency

1. Determine at which depth a secchi disk is no longer distinguishable by submerging the disk until you cannot see white. Note the depth of the water at that point by looking at the depth marks on the rope.

VI. pH

1. Using a pH meter, fill a container with 1 1/2 inches of water to be tested (the container can be marked ahead of time - if immersed deeper, water can enter the unit and ruin it!). Place the meter in water for abut five minutes, then turn on the switch, swirl gently in the water, and when the reading stabilizes, take the reading. Turn the switch and replace the protective cap.

VII. Alkalinity

1. Follow the directions in the kit. Use an average of the gray and pink end points as your alkalinity reading.

VIII. Dissolved oxygen

1. Collect water sample by carefully filling 60 ml. BOD bottle.
2. Follow directions in kit. Note: If using the Hach kit from a UNH Cooperative Extension stream study kit, be sure to do the final titration (addition of soldium thiosulfate) in the small glass bottle which has had 5 ml. of the 60 ml. prepared sample added to it. The 5 ml. test tube is unmarked as such. It is the small plastic one kept next to the large jar which contains oxygen reagent #3. Optional: To enhance the endpoint color change, add a few drops of a starch solution to the jar after the solution starts to turn straw colored from the titrant. This blue color will disappear after one or two more drops of titrant are added.

IX. Total phosphorus

Phosphorus levels are an important influence on water quality because phosphorus is a limiting factor for plant growth. Phosporus levels, however, are difficult to detect with the inexpensive colorimetry tests currently available.

X. Indicator bacteria

The tests for indicator bacteria will vary depending on what type of bacteria you are sampling. Generally speaking, monitors will test specifically for e-coli in fresh water used for drinking and swimming and salt water used for swimming. In estuarine waters, monitors will usually test for any fecal coliform bacteria. The tests results come from the number of colonies found in a sample after membrane filtration and incubation.

XI. Macroinvertebrates

See *Go Buggy* activity from the December chapter for instructions on collecting and viewing macroinvertebrates. Record the different types found and approximate the numbers of each type.

Recording data:

1. Record field notes and observations in pencil.
2. Remember to record the units used (e.g. fahrenheit, celsius, mg./L, etc.)
3. Consider attaching a map to your data sheet showing sampling locations and points of interest along the shore.

Interpreting results:

1. Use this Simple Water Quality Index for Streams for a listing of relatively high and low values for the items measured and information in the chapter on the importance of the different water quality parameters.

OBSERVERS ____

WATER BODY________________________________DATE______________

SAMPLING SITE____

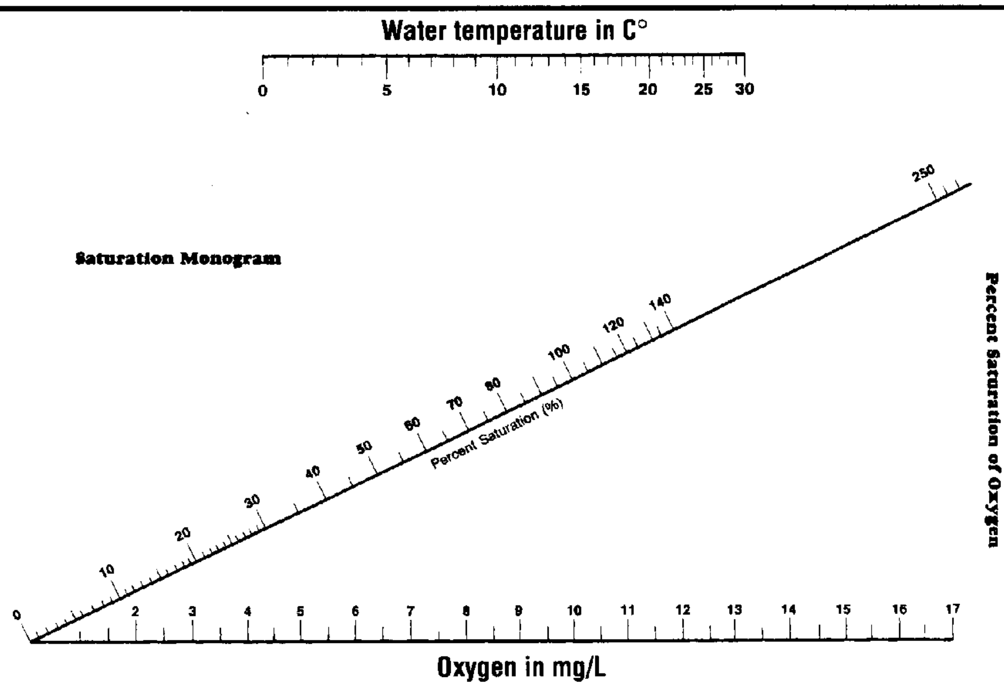
Circle the rating for each indicator below:

Water Quality Indicators	Excellent	Good	Poor
TEMPERATURE	<55F (13C)	55-75F (13-24C)	>75F (24C)
DISSOLVED OXYGEN (Use chart below to determine % saturation)	75 - 100%	50 - 75%	<50%
pH	6.0 - 7.5%	5.5 - 6.0	<5.5
ALKALINITY	>9 mg./L	4 - 9 mg./L	<4 mg./L
AQUATIC ANIMALS	>8 types	4 - 8 types	<4 types

Add the number of Excellent, Good and Poor ratings. ________Excellent _______ Good _______ Poor

Estimated overall Water Quality____

Percent Oxygen Saturation Chart: Find the amount of oxygen in your sample along the base line. Find the temperature of the water when you took your sample along the top line. Connect these two points with a straightedge and read the % saturation where the straightedge meets the % saturation line.



Partial list of sources of monitoring equipment and supplies:

Fisher Scientific
711 Forbes Ave.
Pittsburgh, PA 15219-4785
(800) 766-7000

HACH Company
P.O. Box 389
Loveland, CO 80539
(800) 525-5940

Hydrolab Corporation
P.O. Box 50116
Austin, TX 78763
(800) 949-3766

La Motte Chemical Products
P.O. Box 329
Chestertown, MD 21620
(800) 344-3100

Millipore Corporation
397 Williams Street
Marlborough, MA 01752
(800) 225-1380

VWR Scientific
P.O. Box 2643
Irving, TX 75061
(800) 527-1576

Wildlife Supply Company
301 Cass Street
Saginaw, MI 48602
(517) 799-8100

YSI Incorporated
1725 Brannum Lane
Yellow Springs, OH 45387
(800) 765-4974 ext. 346

UNH Cooperative Extension County Offices

(Loan centers for Stream Study for Lake Study kits, study guides, manuals, AV, and equipment.)

Belknap County
Laconia, NH
(603) 524-1737

Carroll County
Conway, NH
(603) 447-5922

Cheshire County
Keene, NH
(603) 352-4550

Coos County
Lancaster, NH
(603) 788- 4961

Grafton County
No. Haverhill, NH
(603) 787-6944

Hillsborough County
Milford, NH
(603) 673-2510

Merrimack County
Boscawen, NH
(603) 796-2151

Rockingham County
Brentwood, NH
(603) 679-5616

Strafford County
Dover, NH
(603) 749-4445

Sullivan County
Newport, NH
(603) 863-9200

Pine Island 4-H Environmental Education Center
Manchester, NH
(603) 627-5637

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Jacobson, Cliff. *Water, Water Everywhere.* Loveland, CO: Hach Company, 1991.

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United States Department of Agriculture. *Water Quality Indicators Guide: Surface Waters.* Washington: USDA, 1989.

To obtain information on doing water quality monitoring and buying or making water quality sampling equipment, contact:

UNH Cooperative Extension - Water Resources
Pettee Hall
University of New Hampshire
Durham, NH 03824
(603) 862 - 1029

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Page 2.
Debris and odor problems
Bob Nilson, Durham, NH.

Pages 3, 4, 5, and 7.
Water quality monitoring equipment
Illustrations given by a University of New Hampshire Sea Grant volunteer.

Page 4 and 13.
pH chart, saturation monogram
Water, Water Everywhere. Loveland, CO: Hach Company, 1991.

Pages 6 and 8.
Eutrophication diagram and aquatic invertebrate tolerance chart
United States Department of Agriculture. *Water Quality Indicators Guide: Surface Waters.* Washington: USDA, 1989.

Page 9.
Dwarf wedge mussel
US Fish and Wildlife Service - *New England Endangered Species Fact Sheet : The Dwarf Wedge Mussel*