Module 7 How We Monitor and Practical Reporting

Introduction

What can we gain from taking a community approach to water quality issues? How do we go about monitoring and why should we do it?

The kind and type of monitoring that we do depends upon the use we have in mind for the water resources in our community. Over the generations of usage our Pacific Northwest waters and watersheds have changed. Water monitoring can assist in protecting existing watersheds and can aid in the recovery of those already impacted by human and biological systems.

In this module participants will examine: *How we monitor, types of water quality monitoring, accessing the sampling station, sampling, photo points as a monitoring tool, and practical reporting.*

How We Monitor

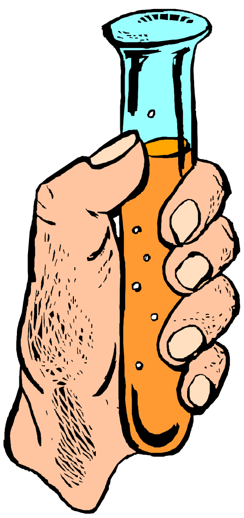
Many factors can affect the water quality in a river, lake, or pond. The conditions of these water resources can fluctuate periodically, so individuals or groups need to monitor at different times of the year to capture the best picture of the individual water body. Water that is safe for one use may not be for another purpose. In fact water quality experts refer to measurements in terms of specific use.

The categories used for making recommendations on water use are:

- Water supply for domestic and industrial use;
- Recreation for total body contact like swimming, water skiing, skin diving, and windsurfing;
- Partial body contact recreation like fishing and boating;
- Protection of aquatic organisms such as fish;
- Agricultural uses like livestock watering, irrigation, and spraying; and
- Commercial uses such as navigation, hydroelectric, and steam generated electric power.

In an attempt to devise a system to compare rivers in various parts of the country, the National Sanitation Foundation (NSF) created and designed a standard index, called the water quality index (WQI). The WQI is one of the most widely used standards of all existing water quality indices. It was developed in 1970, and can be used to measure water quality changes in a particular river or stream reach over time, compare different water quality from different reaches of the same river or stream system, and even compare different streams or rivers. The WQI and other water quality indexes can then be used to determine the relative health of a river or stream. Each index requires a specific protocol and needs to be selected based on agreed upon measurements by local, state, tribal, and/or federal authorities set up for your community.

For example, to determine the WQI, nine tests are performed. These include dissolved oxygen, fecal coliform, pH, biochemical oxygen demand (5 day), temperature, total phosphate, nitrates, turbidity, and total solids. After the tests are complete the results are compared to a weighted curve chart and a numerical value is assigned. Other indexes may use different tests and may include a combination of physical and biological components of the same stream.



Types of Water Quality Monitoring

The term “monitor” is defined as to watch or check. Although it is not an explicit part of the definition, the term monitoring suggests a series of observations over time. This repetition of measurements over time for the purpose of detecting change distinguishes monitoring from inventory and assessment. While both inventories and assessments can be based on a single measurement or observation, they also can incorporate a series of observations to obtain a better estimate of a particular parameter. For example, the number of species of fish in a particular reach might be counted as part of an inventory of fish species, and several counts might be made in order to obtain a more accurate estimate. Similarly, maximum daily water temperature might be measured several times over the course of a summer to assess whether summer temperatures might be an important limitation to the quality of fish habitat under the existing conditions. However, if water temperatures are measured over several years to determine the effect of upstream management activities or climatic variations, this is clearly monitoring. The overlap in the definitions of assessment, inventory, and monitoring means that in some cases the primary distinguishing feature of monitoring will be the intent to assess change rather than the number or type of measurements.

Often an assessment or inventory serves as the first step towards establishing a monitoring project. Knowledge of the spatial and temporal variability is essential to developing an efficient monitoring plan. Inventory and assessment techniques overlap with monitoring procedures.

A number of federal and state agencies have defined the different types of monitoring carried out by their particular organization. Unfortunately, these definitions are not consistent, and this has often resulted in semantic confusion. In most cases a clear statement of the purpose of the monitoring will be the best method of defining the type of monitoring, and it then is simply a matter of attaching a mutually agreeable label to that particular type of monitoring.

Most water quality monitoring projects will involve more than one type of monitoring. Distinct objectives attained through different types of monitoring do not necessarily require distinct and independent collection efforts. There is often considerable overlap in terms of data needs and recognition of this can result in cost savings.

General Characteristics of Monitoring Types				
Type of Monitoring	**Number and Type of Water Quality Parameters**	**Frequency of Measurements**	**Duration of Monitoring**	**Intensity of Data Analysis**
Trend	Usually water column	Low	Long	Low to moderate
Baseline	Variable	Low	Short to medium	Low to moderate
Implementation	None	Variable	Duration of project	Low
Effectiveness	Near activity	Medium to high	Usually short to medium	Medium
Project	Variable	Medium to high	> Project duration	Medium
Validation	Few	High	Usually medium to long	High
Compliance	Few	Variable	Dependent on project	Moderate to high

1. ***Trend monitoring.*** In view of the definition of monitoring, this term is redundant. Use of the adjective "trend" implies that measurements will be made at regular, well-spaced time intervals in order to determine the long-term trend in a particular parameter. Typically the observations are not taken specifically to evaluate management practices (effectiveness), management activities (project), water quality models (validation), or water quality standards (compliance), although trend data may be utilized for one or all of these other purposes.

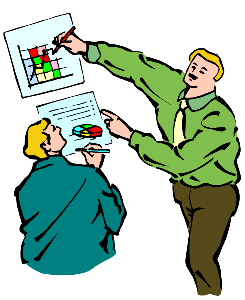
2. ***Baseline monitoring.*** Baseline monitoring is used to characterize existing water quality conditions, and to establish a database for planning or future comparisons. The intent of baseline monitoring is to capture much of the temporal variability of the constituent(s) of interest, but there is no explicit endpoint at which continued baseline monitoring becomes trend monitoring. Those who prefer the terms “inventory monitoring” and “assessment monitoring” often define them such that they are essentially synonymous with baseline monitoring to refer to long-term trend monitoring on major streams.

3. ***Implementation monitoring.*** This type of monitoring assesses whether activities were carried out as planned. The most common use of implementation monitoring is to determine whether Best Management Practices (BMPs) were implemented as specified in an environmental assessment, environmental impact statement, other planning document, or contract. Typically this is carried out as an administrative review and does not involve any water quality measurements. Implementation monitoring is one of the few terms which has a relatively widespread and consistent definition. Many believe that implementation monitoring is the most cost-effective means to reduce nonpoint source pollution because it provides immediate feedback to the managers on whether the BMP process is being carried out as intended. On its own, however, implementation monitoring cannot directly link management activities to water quality, as no water quality measurements are being made.

4. ***Effectiveness monitoring.*** While implementation monitoring is used to assess whether a particular activity was carried out as planned, effectiveness monitoring is used to evaluate whether the specified activities had the desired effect. Confusion arises over whether effectiveness monitoring should be limited to evaluating individual BMPs, or whether it also can be used to evaluate the total effect of an entire set of practices. The problem with this broader definition is that the distinction between effectiveness monitoring and other terms, such as project or compliance monitoring, becomes blurred.

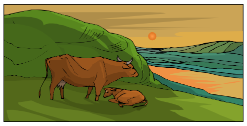
   Monitoring the effectiveness of individual BMPs such as the spacing of water bars on skid trails, is an important part of the overall process of controlling nonpoint source pollution. However, in most cases the monitoring of individual BMPs is quite different from monitoring to determine whether the cumulative effect of all the BMPs results in adequate water quality protection. Evaluating individual BMPs may require detailed and specialized measurements best made at the site of, or immediately adjacent to, the management practice. Thus effectiveness monitoring often occurs outside of the stream channel and riparian area, even though the objective of a particular practice is intended to protect the designated uses of a water body. In contrast, monitoring the overall effectiveness of BMPs usually is done in the stream channel, and it may be difficult to relate these measurements to the effectiveness of individual BMPs.

5. ***Project monitoring.*** This type of monitoring assesses the impact of a particular activity or project, such as a timber sale or construction of a ski run on water quality. Often this assessment is done by comparing data taken upstream and downstream of the particular project, although in some cases, such as a fish habitat improvement project, the comparison may be on a before and after basis. Because such comparisons may, in part, indicate the overall effectiveness of the BMPs and other mitigation measures associated with the project, some agencies consider project monitoring to be a subset of effectiveness monitoring. Again, the problem is that water quality is a function of more than the effectiveness of the BMPs associated with the project.



6. ***Validation monitoring.*** This refers to the quantitative evaluation of the proposed water quality model. The data set used for validation should be different from the data set used to construct and calibrate the model. This separation helps ensure that the validation data will provide an unbiased evaluation of the overall performance of the model. The intensity and type of sampling for validation monitoring should be consistent with the output of the model being validated.

7. ***Compliance monitoring.*** This is the monitoring used to determine whether specified water quality criteria are being met. The criteria can be numerical or descriptive. Usually the regulations associated with individual criterion specify the location, frequency, and method of measurement.



Monitoring Concepts for Rangeland Management

Short-term Monitoring

Short-term monitoring involves collecting and recording vegetation and other resource characteristic information within a year, mainly for day-to-day and annual management decisions. Short-term monitoring focuses on such questions as: Is the grazing occurring as planned? Are there outside influences on the vegetation? What changes should be made now or next year to better meet management objectives? Short-term monitoring also provides essential information for interpreting long-term monitoring studies.

Recommended short-term monitoring practices include:

- Vegetation evaluation — Systematic observations or sampling during the growing season for cover, yield, and/or species composition.
- Climate records — Precipitation, temperature, etc. (This may be accomplished by summarizing available USDC weather records.)
- Residue maps — Identification of areas where too much or too little grazing is occurring by mapping residual dry matter (RDM) at high, low, and moderate levels after livestock are removed from pastures or during late September or early October.
- Actual use records of livestock grazing — Livestock numbers, types and dates, animal condition score and/or weights (actual or estimated) in and out of pastures. The UC Cooperative Extension Pasture Inventory Program (http://danr.ucop.edu/uccelr/h15.htm) can help you handle this information systematically.

- Unplanned disturbances — Recording fires, wildlife use, insect and weed infestations, acts of vandalism, etc.

Long-term Monitoring

Long-term monitoring involves documenting measurements and observations for several years on study sites selected within the management area, grazing lease, pasture, or areas of specific concern. Conducting measurements and/or observations over several years provides a trend. Site locations and types of data to be collected are determined by the management plan's objectives. Records must be carefully maintained, protected, and made available for planning.

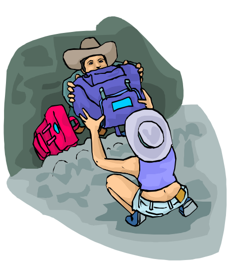
A long-term monitoring program should include:

- Trend transects — Systematic measurements (every 3 to 5 years) of the vegetation or other resource characteristics.

- Trend photo points — Permanently established points at which photos are taken annually of a general view and one or more close-ups of important resource characteristics.

- Aerial photos— Regularly scheduled photos of the same area to show major vegetation changes in brush, trees, and grasslands.

Accessing the Sampling Station



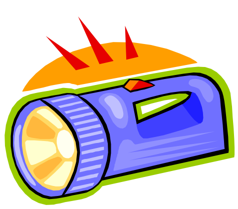
1. Entering Private Property

Although the state retains ownership of marine tidelands up to the mean high tide line in most places, accessing those areas — and accessing freshwater streams, creeks, lakes, and ponds in the uplands —may involve crossing private property. While access to government land (e.g. state, federal, county, city) typically is presumed, volunteer monitors must obtain express authorization from private and tribal property owners if the volunteer enters or crosses the property owner's land at any point during sampling activities.

The first rule of monitoring on or around private property is NEVER TRESPASS. To avoid unintended trespass, please check the land ownership maps prior to occupying your monitoring station, and obtain written authorization from property owners as needed.

2. Safe and Sound Site Access

Weather, daylight, rugged terrain, wild and domestic animals, and other access issues can impact your sampling efforts. Although sampling stations should be selected in ways that promote accessibility, sometimes the only way to get to a particular waterbody is through or over rugged terrain. In such cases, the monitor should ensure that she/he is fully prepared — physically and otherwise — to get in and out of the site. Furthermore, because a primary purpose of the monitoring effort is to promote sound stewardship practices, volunteers should always avoid streambank trampling or accelerating waterside erosion. Here are a few other rules for ensuring a safe and sound sampling experience:



- If driving, park your vehicle off roads and out of the way of traffic. Always watch for traffic.

- Always plan for incoming tides at marine or estuarine sampling stations.

- Use common sense in approaching your site and approach your site carefully. Mud, exposed roots, steep slopes, and ice can pose dangerous access problems. Walking sticks, ice axes, toe cleats, and other equipment can help make access safer. Getting samples is important, but not at the risk of injury.

- Bring a flashlight to guide you during dark or overcast conditions.

- Take appropriate precautions around domestic and wild animals.

At the Monitoring Station

Prior to sampling, monitors should check their kits and reagents to ensure they have all the chemicals and equipment needed to monitor the full spectrum of parameters. When you arrive at the sampling station, try to find a place to set out your equipment and chemicals where they will not be sitting in strong, direct sunlight. On windy days, beware of small containers being blown into the water. And of course, follow all the safety and access rules outlined by your monitoring group.

Sampling

Key points to remember in sampling:

- Exercise care in sampling and consider depth of sample, velocity of current, and distance of sample from shore.

- Near shore sampling will not be as accurate as those collected in the middle of a water body and below the surface, so a bridge, a boat, or the end of a dock may be more accurate.

- Sampling devices can be constructed to assist with sample collection: metal rods, bamboo poles etc. These devices can be extended out from the shore if no bridges are near the reach or shore you are planning to study.

- Grab samples taken with collecting devices need to be replicated to improve accuracy.

- Take sample from a representative section of the creek (away from pools and steep riffles), at the same location every time. Stand downstream from your sample, so you don’t affect it. Rinse your container at least once with flowing stream water, and hold it with its opening at least 1" below the water surface. When testing for dissolved oxygen, make sure no air bubbles are present in the bottle. Stabilize the sample immediately so increases in temperature won’t release oxygen to the atmosphere and affect the results.

- It’s important to remember that the shorter the time between sampling and analysis, the more reliable the results. Many tests can be completed at the sampling site, collected samples need to be protected if further testing will need to be conducted by licensed laboratories. Specific sampling considerations will be covered under the appropriate water quality tests.

- It is important to sample at the same location and the same time over a period of years. This will enhance the validity of the data collected and help to note change in the selected water quality index.

- If contamination is suspected it is important to sample upstream or creek from the suspect source and below the source. If change is indicated contact an expert monitor or oversight agency to verify the finding.

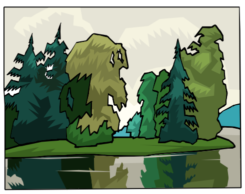


Photo Points as a Monitoring Tool

Establishing a photographic collection to monitor vegetation changes does not generate the kinds of intense data that are gathered using methods to determine cover, density, production, etc. However, they do surpass these data in their ability to portray changes on a large scale and to transfer this information to audiences of different backgrounds.

The strengths of repeated photographs in monitoring vegetation changes are: (1) a complete inventory of the landscape is encapsuled in the picture; (2) rates of vegetation change and events associated with that change are documented; and (3) the field portion of the process can be executed rapidly and easily.

The weaknesses of repeated photographs in monitoring vegetation are: (1) observable changes in species composition are limited to obvious species such as woody plant invasion, large herbaceous species replacing small species, etc.; (2) photographs can represent a biased selection of the conditions present in the entire area when photographed; and (3) alterations in the photographs to enhance the artistic aspect of the image can misrepresent conditions.

Establishment of a basic photo point requires a steel fence post, a two- to five-pound hammer, a set of metal letters and number stamps, a compass, and a camera.

The post can be cut in half for ease of handling. The photo point number, date, and observers' initials are stamped into the spade. The bottom of the post will be inverted so that the spade will be exposed when the post is driven into the ground. The top half of the post can then be used to locate the close-up photo center.

The long view photo should be a representative view of the area and have a distinctive landmark in the background (peak, rock outcrop, tree, etc.) to aid in repeating the photo in the future. The remaining top of the steel post will act as the center of focus for the close-up photo. If the vegetation is relatively complex, additional steel post tops may be needed as reference close-up photo centers. A compass bearing from the photo point to the center of focus must be recorded for both long view and close-up photos.

A 35-mm camera with color slide film or digital camera is the best combination for taking photos, but any camera with appropriate film, used carefully, will produce useful photos.

The process of developing a photograph collection includes: (1) the retrieval of old images and the relocation of photo points; (2) the establishment of new photo points; (3) a systematic method of recording information about each photo; and (4) methods for the storage and use of the collection.

One difficult obstacle to rephotographing photo points is the lack of accompanying records describing the location, time of year, and time of day the photographs was taken. Develop a field data form to systematically record this and other information concerning the photograph and the photo point.

For each photo point there should be a description of each photo point, including:

- Photo point number or name
- Name of photographer
- Date of photograph
- Date established
- Time of day
- Magnetic declination or compass direction
- Location: Specify, if possible, township, range, ¼ of ¼ section, altitude, and description of area, including notation of prominent landmarks so that the plot can be found easily by others.
- Comments and notations on vegetation and other conditions.

Have a place for keeping photos. This could be an envelope or prints attached to notebook sheets. Each photo must be identified on back of the print or on the edge of the slide. Successful storage can be measured by ease of retrieval.

To determine the location for photo points for water quality monitoring consider the following:

- Locations that capture the perceived problem and/or landscape.
- Locations that are easily relocatable with easy access.
- In areas where you have knowledge of what your are photographing:
    - To show cause and effect
    - To show change over time
    - To show impact of a major event (fire, flood, etc.)

Practical Reporting

Monitoring Data Sheets

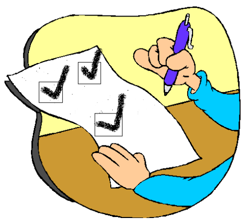
All data should be recorded on the standardized data sheets provided by the Monitoring Coordinator. Please keep an ample supply of these sheets on hand and use a fresh one for each sampling event at each site.

Data should be entered using a fine-point "Sharpie" or other indelible marker. If the data sheet is wet and the Sharpie won't write, use a #2 pencil and go over it with a Sharpie when the sheet dries. If you make a mistake, draw one line through the characters in question, enter the new characters to the immediate right of the lined-out entries, and initial the change immediately after the new characters.

It may not always be easy under field conditions, but try to write as legibly as possible, especially when entering numbers. All numeric data should be entered in the appropriate spaces, using the decimal places provided on the form. When entering temperatures, please remember to specify if they are negative. All letters and words should be printed. Record all of your observations and test results as you go along; don't rely on memory!

The first data you record on your data sheet should be the printed names of the monitors, the name and number of the station, the date, and the time. When entering the time be sure to circle either AM or PM. Next, record the latitude, longitude, and elevation of your site and indicate whether you used a GPS or a topographical map to determine this information. (If you are returning to your regular monitoring site you may copy this information from previous data sheets).

Finally, do not forget to have all monitors sign the data sheet when testing is complete!



Field Procedure Checklist

Below is the recommended order in which to conduct your tests. This order tends to maximize your efficiency, and should keep your sampling activities to under one hour.

- Put on safety gear (rubber gloves and eye protection).
- Collect the water sample according to the procedure described later in this section.
- Place air thermometer in shaded area near sample bucket to allow it to stabilize.
- Hang water thermometer inside sample bucket.
- Perform steps of the dissolved oxygen testing procedure as described later in this section.
- Fill out page one of the data sheet: monitor names, site name, site number, date, time, site location, air temperature, wind and weather conditions, water surface condition, tidal stage, observations, sketches or photos.
- Compare and record the apparent color of the sample water.
- Measure and record clarity of the sample water.
- Read the water temperature and record it on the data sheet.

- Measure and record the pH of the sample water.
- Complete steps of the dissolved oxygen test procedures and record the results.
- Measure and record phosphate and nitrate (freshwater only) content of water in sample bucket.
- Check for completeness and legibility and have all team members sign the data sheet!

There are many types and forms of monitoring data sheets. For this short-course we have provided one example used in the *Streamwalk* program in Idaho. We will be using this in the field portion of this short-course. A modified PondWatch data form is also provided for your consideration.

If you find new terms on the data sheets that you are unfamiliar with, these are explained in Parts Three and Four of this guide. Please ask questions about data sheet terms if you need further clarification after completing these sections in the guide.

Streamwalk Data Sheets

Date: ______________ Stream Section #: ______________

Stream Name: ______________ Team Members: ______________

Stream Location: ______________ ______________
(township/range)

County: ______________ ______________

State: ______________ ______________

Stream Transect Measurements (in feet)

	Transect #1	Transect #2
Stream width		
Stream depth - ¼ mark		
Stream depth - ½ mark		
Stream depth - ¾ mark		
Substrate class* - ¼ mark		
Substrate class* - ½ mark		
Substrate class* - ¾ mark		
Riparian zone width		

Weather:

____

____

____

____

____

____

*Substrate Classes

Sand .... <.25″
Gravel .... .25″-3″
Cobble .... 3″-12″
Boulder .... > 12″
Bedrock .... solid rock

Stream Conditions

Stream Characteristics

% pools ______

% riffles ______

% runs ______

% pocket water ______

total 100%

Canopy Cover

❑ 0-25% ❑ 25-50%

❑ 50-75% ❑ 75-100%

Artificial Streambank Materials

❑ 0-25% ❑ 25-50%

❑ 50-75% ❑ 75-100%

Type(s) ________________________

____

____

____

____

Riparian Vegetation Streambank Coverage

% of bank covered by riparian vegetation ___

% of bank not covered ___

total 100%

Streambank Stability

% of bank stable (not slumping, sloughing, or eroding) _____

% of bank unstable (slumping, sloughing, or eroding) _____

total 100%

Large Organic Debris (>4")

❑ None ❑ Occasional ❑ Common

Streamside Vegetation Type

% woody plants _______

% grasses _______

% broad-leafed plants _______

total 100%

Stream Conditions

Woody plants

Type(s) ____________________________

____

____

____

____

Other Species

Type(s) ____________________________

____

____

____

____

Grasses

Type(s) ____________________________

____

____

____

____

Broad-leaf Plants

Type(s) ____________________________

____

____

____

____

Drawing or picture of the site below:

Stream Conditions (check all that apply)

(check "0" if absent, "1" if present, "2" if present and clearly impacting the stream)

0	1	2	Stream Conditions
❑	❑	❑	Mud / silt / sand entering stream?
❑	❑	❑	Damming / dredging / filling or channelizing?
❑	❑	❑	Algae / scum floating / covering rocks?
❑	❑	❑	Surface foam or oil?

Describe: ____

____

____

0	1	2	
❑	❑	❑	Livestock on or with unrestricted access to stream?
❑	❑	❑	Discharge pipe(s) present?

Describe material being discharged: __________________________

____

____

Adjacent Land Uses (check all that apply)

(check "0" if absent, "1" if present, "2" if present and clearly impacting the stream)

0	1	2	Land Development	0	1	2	Roads, etc.
❑	❑	❑	Single family housing	❑	❑	❑	Paved roads
❑	❑	❑	Multi-family housing	❑	❑	❑	Unpaved roads
❑	❑	❑	Commercial development	❑	❑	❑	Bridges
❑	❑	❑	Industry development	❑	❑	❑	Parking lots

0	1	2	Other Land Uses	0	1	2	Construction Underway on:
❑	❑	❑	Livestock grazing land	❑	❑	❑	Single family housing
❑	❑	❑	Feedlots / animal corrals	❑	❑	❑	Multi-family housing
❑	❑	❑	Cropland	❑	❑	❑	Commercial development
❑	❑	❑	Mining or gravel pit	❑	❑	❑	Industry development
❑	❑	❑	Recreation	❑	❑	❑	Roads / bridges

Class Water Quality Data Summary

Name:______________________________

Date: ______________________________

Test	Stream	Stream	Stream
Temperature°			
Dissolved Oxygen (mg/l)			
pH			
BOD (mg/l)			
Fecal Coliform (mg/l)			
Phosphates (mg/l)			
Nitrates (mg/l)			
Turbidity (mg/l)			
Total Solids (mg/l)			
Alkalinity (mg/l)			
Conductivity (umhos)			

Comments:

Water Quality Index

(Modified from Mitchell and Stapp, 1991 and Beckwith, 1991)

Stream

Station No.

Test	Units Data Recorded In	Class Data- Average Results	Q Value Refer to Table	Weighting Factor	Total Q Value x Weight Factor =Total
1. Dissolved Oxygen	% Sat. See Table for Q Value	mg/l		0.17	
2. Fecal Coliform	Colonies/ 100 ml			0.16	
3. pH	Units			0.11	
4. BOD	mg/l			0.11	
5. Temperature	Change in degrees C			0.11	
6. Total Phosphate	mg/l			0.10	
7. Nitrates	mg/l			0.10	
8. Turbidity	NTU/ Secchi Feet			0.08	
9. Total Solid	mg/l			0.07	
Add Column to Determine Water Quality Index					

Alkalinity mg/l ________________

Conductivity micromhos ________________

Water Quality Index	
100-90	Excellent
89-70	Good
69-50	Medium
49-25	Bad
24-0	Very Bad

Comments:

Organic Pollution Index (OPI) Worksheet

Taxa or Name	Column A (Organic Pollution Tolerance Value)	Column B # of invertebrates	Column C (column A x column B)
Mayfly	2		
Stonefly	2		
Caddisfly	2		
Midge	8		
Black fly	6		
Mosquito	8		
Crane fly	4		
Leech	10		
Crayfish	7		
Water mite	8		
Dragonfly	10		
Water strider	5		
Clam/Mussel	8		
Snail	7		
Aquatic beetle	10		
Flat worm	4		
Hellgramite	1		
Alderfly	2		
Ostracod	8		
Amphipod	4		
Water boatman	10		
Roundworm	5		
Giant water bug	10		
Column C Total		X	
Column B Total			X

OPI=

Organic Pollution Index (OPI) = $\frac{\text{Column C Total}}{\text{Column B Total}}$

Sediment Pollution Index (SPI) Worksheet

Taxa or Name	Column A (Sediment Pollution Tolerance Value)	Column B # of invertebrates	Column C (column A x column B)
Mayfly	4		
Stonefly	2		
Caddisfly	4		
Midge	10		
Black fly	10		
Mosquito	10		
Crane fly	5		
Leech	10		
Crayfish	10		
Water mite	10		
Dragonfly	7		
Water strider	7		
Clam/Mussel	10		
Snail	10		
Aquatic beetle	7		
Flat worm	10		
Hellgramite	7		
Alderfly	7		
Ostracod	10		
Amphipod	10		
Water boatman	10		
Roundworm	10		
Giant water bug	7		
Column C Total		X	
Column B Total			X

$$\text{Sediment Pollution Index (SPI)} = \frac{\text{Column C Total}}{\text{Column B Total}}$$

SPI=

Clean Water Index (CWI)/Stream Condition Index (SCI) Worksheet

Taxa or Name	Column A # of invertebrates	Column B # of invertebrates
Mayfly		X
Stonefly		X
Caddisfly		X
Column A Total		X
Midge	X	
Black fly	X	
Mosquito	X	
Crane fly	X	
Leech	X	
Crayfish	X	
Water mite	X	
Dragonfly	X	
Water strider	X	
Clam/Mussel	X	
Snail	X	
Aquatic beetle	X	
Flat worm	X	
Hellgramite	X	
Alderfly	X	
Ostracod	X	
Amphipod	X	
Water boatman	X	
Roundworm	X	
Giant water bug	X	
Column B Total	X	

Calculate an overall Stream Condition Index (SCI) using the following equation:

$$SCI = \frac{OPI \times SPI \times CWI}{3}$$

SCI =

$$\text{Clean Water Index (CWI)} = \left[\frac{\text{Column A Total}}{\text{Column A Total} + \text{Column B Total}}\right] \times 10$$

CWI=

Streamwalk Summary Sheet

Date: ____________________

Stream Name: ____________________

Stream Location: ____________________

County: ____________________

State: ____________________

Organic Pollution Index (OPI) __________________

Sediment Pollution Index (SPI) _________________

Clean Water Index (CWI) ______________________

Stream Condition Index (SCI) __________________

PondWatch Data Submittal

Town/City: ______________________________________

State: ________ Zip Code: __________

Enter Data Collection Time: ______________________________________

Month: ________ Day: ________ Year: ________

Name of Pond: ______________________________________

Pond's Geographic Location:

Latitude: ________ Degrees; ________ Minutes; ________ (N or S)
Longitude: ________ Degrees; ________ Minutes; ________ (E or W)

Elevation: ________ (in approximate feet above sea level)

Note: If you are not sure of your latitude, longitude, or elevation you can look it up at: www.mit.edu:8001/geo and then come back here to fill it in!!!

Pond Data: If you are using the Pondwater Tour program simply give your "low-medium-high" values for the ammonia, dissolved oxygen, and nitrate fields. If you are using other water monitoring equipment please give specific numerical values.

pH Level: ____________

Ammonia: ____________

Dissolved Oxygen: ____________

Nitrate: ____________

Water Temperature: ____________

Approximate Pond Size: ____________ (acres)

Approximate Pond Depth: ____________ (feet)

Check all the species of fish found in your pond:

White Perch	☐	Salmon	☐	Rainbow Trout	☐
Yellow Perch	☐	Catfish	☐	Brook Trout	☐
Bass	☐	Brown Trout	☐	Blue Gill/Sunfish	☐
Sucker	☐	Cutthroat Trout	☐	Carp	☐
Minnow	☐	Northern Pike	☐	Sculpin	☐
Walleye	☐	Whitefish	☐		

Macroinvertebrates can indicate the quality of your water supply. Below you will find three charts that list macroinvertebrates for various types of water quality. Check off those that you find in your pond from each category below:

Found in Good Quality Water:

☐ Stonefly	☐ Riffle Beetle Adult	☐ Gilled Snail
☐ Planarian	☐ Mayfly	☐ Water Penny
☐ Caddisfly	☐ Dobsonfly	

Found in Good or Fair Quality Water:

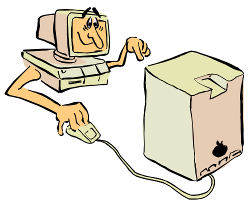
☐ Crayfish	☐ Alderfly	☐ Crane Fly
☐ Riffle Beetle Larva	☐ Damselfly	☐ Sowbug
☐ Dragonfly	☐ Watersnipe Fly	☐ Scud
☐ Whirligig	☐ Fishfly	☐ Clam or Mussel

Found in Any Quality Water:

- ☐ Aquatic Worm
- ☐ Lunged Snail
- ☐ Black Fly
- ☐ Leech
- ☐ Midge Fly

Check each type of land use surrounding the pond:

- ☐ Residential
- ☐ Single-Family
- ☐ Multi-Family
- ☐ Agricultural
- ☐ Grazing
- ☐ Crops
- ☐ Commercial
- ☐ Industrial
- ☐ Forested



Links to Monitoring and Data Collection

- The **Students Investigating Today's Environment (SITE)** project involves middle school, junior high school, and high school students in the gathering, recording, and analysis of environmental water quality data at various sites. The study provides several significant benefits and opportunities for enhancing educational activities, particularly in the life sciences and in the application of cooperative research in scientific studies. The purpose of the project is to enhance the learning experience of students by rekindling the spirit of discovery and providing an opportunity to experience first hand the excitement of real world science.

  The SITE project uses the Water Quality Index (WQI) established by the National Sanitation Foundation to standardize water quality testing. To aid teachers in implementing a water quality testing program, student and teacher manuals have been developed that provide lesson plans and directions in the use of the WQI. Several high schools are currently involved in gathering and sharing water quality data and there are openings for more schools and community groups to participate.

  The requirements are simply computer and communication capabilities adequate to access the Internet. The SITE system will support a PC running MS-DOS, Apple MAC, or any machine that will emulate a vt100 terminal, or a workstation. A SITE User Manual is available describing use of the SITE system.
  Web site: http://www.WQI.org/

- **Watch Over Washington** (WOW) has two goals: to help citizens of all ages work together within their watersheds to provide a local source of information on

environmental conditions and to support volunteer monitors in learning how to collect reliable, consistent environmental information. WOW currently knows that over 11,000 people in Washington State voluntarily monitor various aspects of their environment. They want to do more; they want to do it better. This organization and Web site provides resources to accomplish these tasks.
Web site: http://www.wa.gov/ecology/wq/wow/index.html

- **The Washington Lake Book** offers a starting point for people who are concerned about their lake's future. The nine chapters are a great primer for monitoring efforts.
Web site: http://www.ecy.wa.gov/programs/wq/plants/lakes/book_contents.html

- **The PondWatch Project.** Ponds are an important natural resource of your community. A pond is also a good indicator of the present condition of your immediate environment. Every pond supports a variety of life forms that can easily be identified and studied. Ponds not only provide us with a wealth of resources, they also afford tremendous recreational value to community members. It is very important that we realize the value of this resource and take steps to protect it from any adverse use or effects. Site offers monitoring data recording opportunity.
Web site: http://www.edutel.org/pondwatch/about_pondwatch.html

- **Educating Young People About Water.** Great curricula and over 100 curricula reviewed for improving water quality.
Web site: http://www.uwex.edu/erc/ywc/sumlist.htm

Discussion Points

- When you consider all the types of water monitoring, which ones seem the most appropriate to your watershed?
- If you were able to construct a data collection form for a local stream, pond, or lake what would you include that you did not find in the sample forms?
- Role play a monitoring event with your group. On 3 x 5 cards ask each participant to come up with three potential events that might occur on a monitoring outing then equally divide the cards in groups. See what happens in the role play that unfolds and debrief the group after each session.
- Why are photo points important and where might you find historical photo points for your community?
- How would you go about selecting a water monitoring protocol or index for your community or watershed? Why?

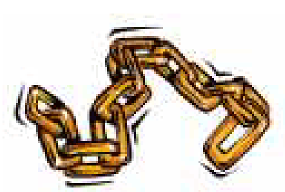
Major Points to Remember

- In an attempt to devise a system to compare rivers in various parts of the country, the National Sanitation Foundation (NSF) created and designed a standard index, called the water quality index (WQI). Indexes are used to compare lake, pond, and stream water quality.
- There are seven general types of water quality monitoring: trend, baseline, implementation, effectiveness, project, validation, and compliance.
- When accessing sampling stations get permission to enter and be safe and sound in your access process.

- Follow approved sampling procedures and protocols for the tests that you are conducting. Sample at the same location and during the same periods over time.
- Photo points can add to the quality of the data collected by monitoring groups. Consider this opportunity when selecting monitoring sites.
- Monitoring data sheets and field procedure check lists provide the foundation for a water quality monitoring program. Fill them out completely and be sure to properly submit them to your monitoring group.

Journal and Evaluation

In your journal write down one or two paragraphs or draw a picture or two that would help you to visualize a good and bad monitoring event. What is the best outcome that you could hope for? What is the worst thing that could happen?



Links and References

Beckwith, R. (1991) Students investigating today's environment (SITE), INEL/EG&G Idaho Centennial High School Meridian, ID. 64 pp.

Mitchell, M. and W. Stapp (1991) Field Manual for Water Quality Monitoring, Thomson-Shore Inc. Dexter, MI.

Mitchell, M. and W. Stapp (2000) Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools, 12th Edition, Kendall/Hunt Publishing Company, Dubuque, IA.

Monitoring California's Annual Rangeland Vegetation. UC/DANR Leaflet 21486, Dec. 1990. http://danr.ucop.edu/uccelr/h15.htm

Monitoring Water Quality. U.S. Environmental Protection Agency, Office of Water (4503F), Washington, DC 20460. EPA 841-B-98-002; July 1998 (http://www.epa.gov/owow/monitoring/volunteer/).

Photo Points as a Monitoring Tool, Rangeland Watershed Program, Oregon State University Extension Service, Fact Sheet No. 17, Corvallis, OR.

Stapp, W. and M. Mitchell (1997) Field Manual for Global Low-Cost Water Quality Monitoring, 2nd Edition, Kendall/Hunt Publishing Company, Dubuque, IA.

Types of Monitoring, Rangeland Watershed Program, Oregon State University Extension Service, Fact Sheet No. 18, Corvallis, OR.

Short-course Presenters

General goals for group monitoring

Individuals, communities, volunteers or agencies that begin a volunteer water monitoring program face an array of planning decisions.

As a first step, organizers of volunteer programs should establish their general goals. Are they interested in providing credible information on water quality conditions to state and local agencies? Or are they primarily interested in educating the public about water quality issues? Do they wish to build a constituency of involved citizens?

All three goals can be achieved by a well-organized and maintained program, but it is important to determine which of these goals is paramount. This guide is directed primarily to those volunteer programs that seek to improve the basic awareness and understanding of lake, pond, or stream conditions. Other programs can build upon this knowledge by implementing monitoring efforts.

Early in the planning stage, organizers should identify how data collected by the lake, pond, or stream volunteer programs might be used and who will use it. Data can be used to establish baseline conditions, determine trends in water quality, or identify current and emerging problems.

Prospective users of volunteer-collected data include the data collector, and his or her community. Other interested groups might include local soil and water conservation districts, irrigation districts, municipal water districts, schools, parks, and recreation staffs; local government planning and zoning agencies. Concerns and collected data may also be shared with state water quality analysts, planners, fisheries biologists, agricultural agencies, university researchers; and federal agencies such as the U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. EPA, and U.S. Department of Agriculture.

A planning committee made up of representatives from the identified data users should be convened early in the development of a program. Initially, the planning committee must make several important decisions in the development of a volunteer monitoring program. Basically, the committee must decide:

- Why a monitoring program should be conducted (purpose);
- What the major goals of the program will be;
- What existing or potential lake, pond, or stream conditions will be the focus of monitoring;
- What sampling parameters should be used to characterize the selected lake, pond, or stream condition;
- What procedures volunteers should use to sample each parameter;
- How volunteers will be trained;
- Who will train them;
- When and for how long the program will be carried out; and
- How the results of monitoring will be presented.

Once a monitoring program is established, the planning committee should meet periodically to evaluate it, update objectives, and fine-tune activities. This review should ensure that the volunteer monitoring efforts continue to provide useful information to those who need lake, pond, or stream data.

Planning the training of volunteers

Once the program description is agreed to, the planning committee can start designing the actual training sessions. The committee must decide if the training is to occur in a group setting or on a one-on-one basis.

Group training saves money and time, especially when there are many volunteers who must be trained simultaneously. This approach has its drawbacks because every lake, pond, or stream has unique characteristics. Thus, there may be circumstances or problems that can be addressed only on an individual basis.

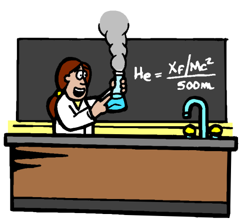
For example, training a volunteer to locate a sampling site is best done on the lake, pond, or stream. One-on-one training is more time consuming and expensive but allows program managers to instruct and demonstrate procedures under actual conditions experienced by the volunteer. For those programs operating under strict quality assurance/quality control guidelines, individual one-on-one training is essential.

In practice, it is often best to structure the training program so that there are group sessions as well as individual follow-up sessions for each water resource. Given this scenario, the group presentation can be used to introduce program personnel and educate the volunteers about the following topics:

- Purpose, goals, and objectives;
- Basic lake, pond or stream ecology, preservation, and management;
- How the collected data will be used and by whom;
- The role of volunteers;
- Lake, pond or stream condition being monitored;
- Parameters to monitor the condition;
- Procedures to measure the parameters;
- Distribution and preparation of the sampling equipment; and
- How the results are reported to the data users and to the volunteers.

Follow-up sessions will reinforce what was taught in the short-course and allow program officials to adapt any special variations of training protocol. Topics such as how to find a sampling site and how to prepare samples for shipment can be discussed and practiced at the actual locations.

In most instances, the job description document will serve as the foundation of the training session. Thus, the training session can be broken down into a series of mini-lessons designed to teach the skills needed to perform each of the tasks in the job description. An example of how to plan a mini-lesson is presented on the following pages.



Sample Mini-lesson: Secchi Disk
The content and activities of the mini-lesson need to be planned so that the task is covered thoroughly within the time allotted. The lessons should include volunteer participation wherever possible. Active participation usually stimulates questions and enhances the learning experience.

Training Topic: Measuring Algae

Mini-lesson: Taking a Secchi disk measurement

Objective: To train volunteers how to use a Secchi disk and record the reading on the data sheet.

Time Allotted: 30 minutes

Equipment: Secchi disks (to be distributed to volunteers), rope lines (to be attached by the volunteers), clothes pins, data sheet, pencils

Topic A: Introduce the Secchi disk

Distribute the equipment to the volunteers.

Explain that the basic purpose of the Secchi disk is to measure water transparency.

Discuss the historical significance of the Secchi disk measurement.

Explain standard characteristics of the disk.

Topic B: Note factors influencing water transparency readings

Have the volunteers name factors that may influence Secchi disk readings (eyesight/glare or water reflection/cloud cover/algae in the water/sediment/waves).

Discuss the factors that influence readings.

Topic C: Purpose of the Secchi disk measurement

Discuss how the Secchi disk data collected by the volunteers will be used and by whom.

Discuss the importance of data quality.

Topic D: How to take a Secchi disk measurement

Demonstrate how a reading is taken.

Discuss the range of Secchi disk depths likely to be encountered in the field.

Topic E: Attaching, marking, and flagging the line

Demonstrate how the line is tied to the Secchi disk.

Demonstrate how a Secchi disk line is measured and marked (in inches).

Demonstrate how to attach and label duct tape flags to the line at six-inch intervals.

Instruct the class to attach, measure, mark, and flag their Secchi disk lines.

Topic F: Learning the motions

Demonstrate the task of making Secchi disk measurements (including placing the clothes pins on the line at the point the Secchi disk disappears and reappears).

Instruct the class to practice attaching the clothes pins to the line and making a reading.

Topic G: Filling out the data sheet

Demonstrate how to record the Secchi disk measurement on the data sheet.

Topic H: Quality control

Discuss standard operating procedures (including the importance of taking the measurement on the shady and calm side of the boat, not wearing sunglasses, and so forth).

Topic I: Secchi disk measurement procedure

The Secchi disk is used to measure the depth that a person can see into the water (transparency). A Secchi disk reading is a personal measurement; it involves only two pieces of equipment; the disk and the person's eyesight.

Because it is so individualistic, the Secchi disk measurement may have low comparability between lakes and even between volunteers on the same lake. The key for consistent results is to train volunteers to follow standard sampling procedures for every measurement. It is preferable to have the same individual take the reading at a site throughout the entire sampling season.

The line attached to the Secchi disk must be marked according to the units and increments designated by the planning committee. Many programs use meters as the measurement unit and require volunteers to measure to the nearest one-tenth meter.

The line markings must be made using waterproof ink. Meter intervals on the line can be tagged with a piece of duct tape with the interval indicated on the tag.

Procedure:

- Check to make sure that the Secchi disk is securely attached to the measured line.
- Lean over the side of the boat and lower the Secchi disk into the water, keeping your back toward the sun to block glare.

- Continue to lower the disk until it just disappears from view. Lower the disk another one third of a meter and then slowly raise the disk until it just reappears. Continue to move the disk up and down until the exact vanishing / reappearing point is found.

- Attach a clothespin to the line at the point where the line enters the water. This is the point the measurement will be read.

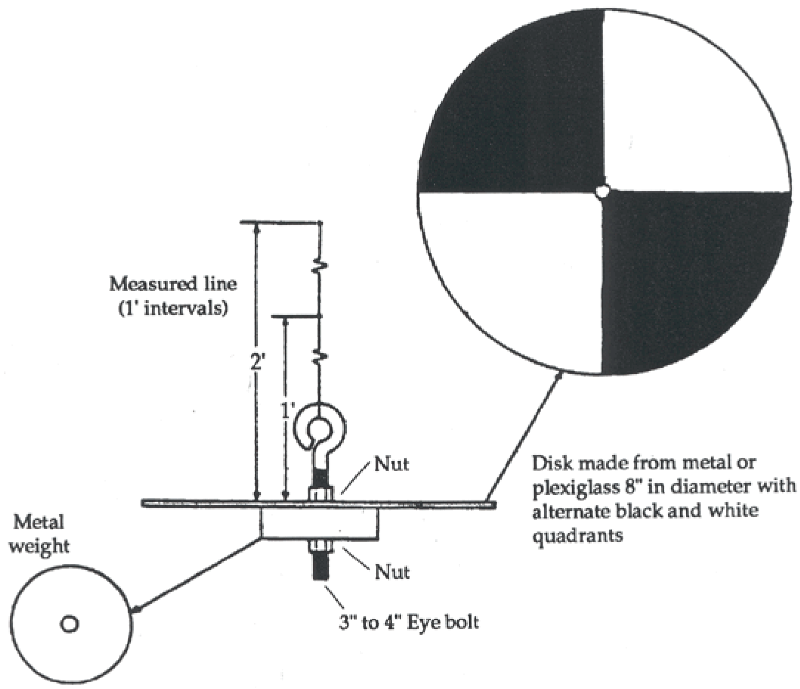
- Slowly pull the disk out of the water and record the measurement based on the location of the clothespin on the line.

This procedure can be repeated as a quality control check; an average of the two readings should be recorded on the sampling form.

Topic I: Closing the lesson

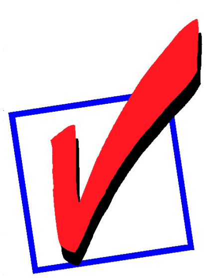
Review the Secchi disk measurement procedure and ask for questions.

MAKING A SECCHI DISK



From: Volunteer Lake Monitoring. USEPA Office of Water. EPA 440-4-91-002. http://www.epa.gov/OWOW/monitoring/volunteer/lake/index.html

Tips for Short-course Presenters



- **How We Monitor/Practical Reporting:** There are many different water quality indices and data collection forms that monitoring groups can use. Before the short-course contact local monitoring agencies and/or monitoring groups to obtain copies of their forms for display. Interview them as to what indices they are using and the protocols they have selected.