STREAMWALK II
Learning How to Monitor our Streams

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INTRODUCTION

This manual grew out of the "Streamwalk" program initiated by EPA Region 10 and the Idaho Water Resources Research Institute at the University of Idaho who offered support and assistance for this project.

"Streamwalk" was developed as a screening tool to identify potential problem areas and provide a standardized data collection method so regional and trend comparisons can be made. It also encourages citizen commitment to protecting streams and educates people about the relationship between streams and watersheds.

"Streamwalk II" is an experimental monitoring program dealing with some of the same objectives as "Streamwalk" except that it is more rigorous and demanding of the participants.

My approach to monitoring is to observe the macroinvertebrate community together with selected physical and chemical conditions in an impacted stream and compare these results with those from a reference or relatively unimpacted site using standard methods that can be repeated over time.

The program requires a commitment of from three to seven days in learning about the procedures performed together with going out in the field, collecting data, and later analyzing it.

The three modules studied consist of Habitat Assessment, Chemical Analysis, and Biomonitoring.

In the biomonitoring program most time is spent on the macroinvertebrate community in the stream and how these organisms provide indices of the relative health of the waterway. A semiquantitative approach in collecting these organisms from a number of habitats is utilized.

In learning how to monitor a stream, the participant develops skills in observation, data collection, and analysis and becomes more knowledgeable about ecological principles.

Also when citizens monitor a stream, useful data becomes available to the community and may be utilized by agency personnel especially if quality control is built into the program.

PLANNING THE STUDY

It is important to include a reconnaissance of the monitoring project to better plan how to study the stream. Problem situations encountered might be avoided by incorporating such a pilot study resulting in less time being lost.

Select a control or reference station that represents the best habitat and water quality conditions attainable for the region or watershed. It should be above the area of discharge or in a nearby drainage just outside the site impacted. When possible choose more than one station or stream to serve as a reference if time and resources are available.

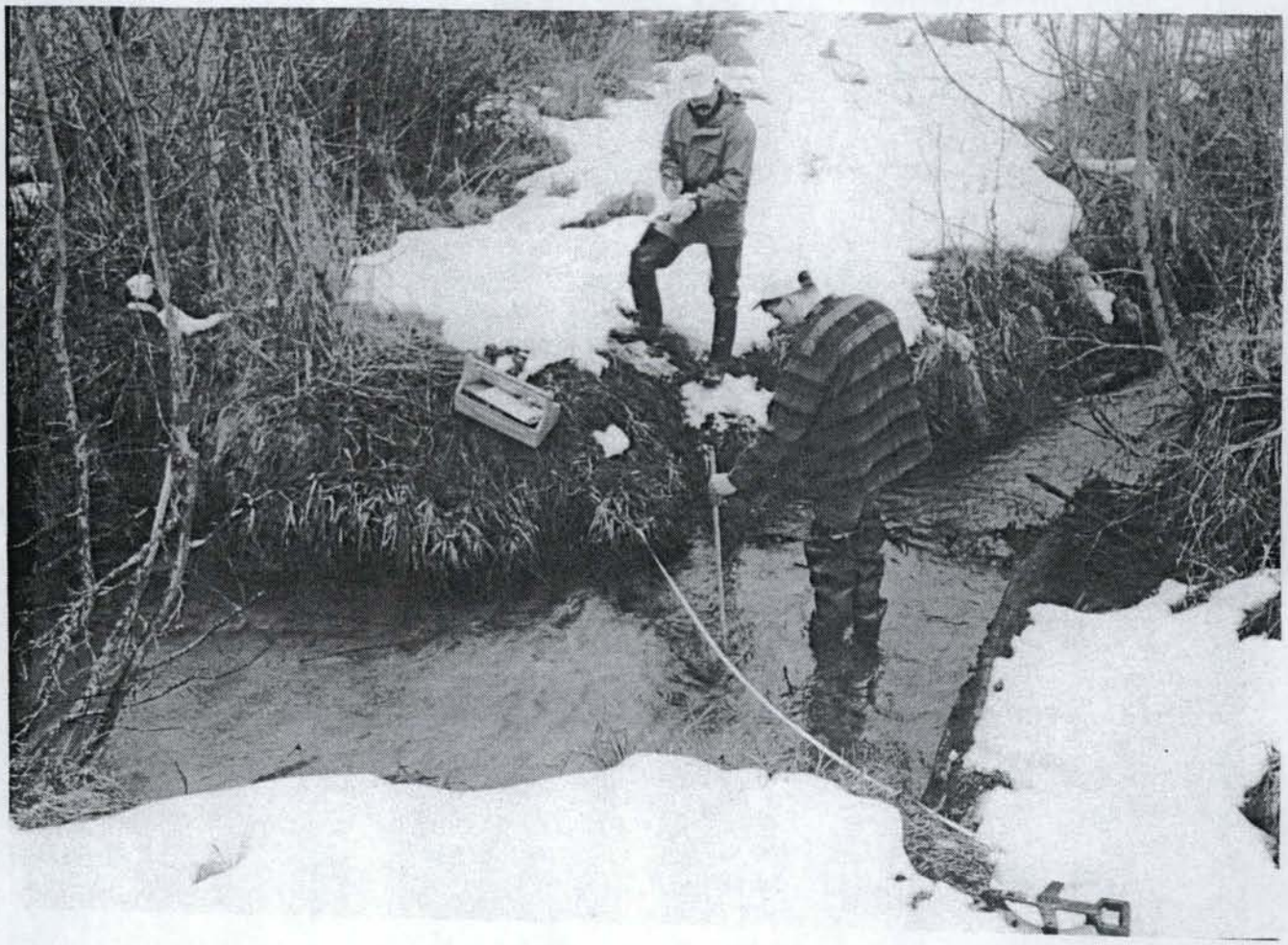
All test or sampling stations should be somewhat equally spaced in the stream. Physical, chemical, and biotic samples need all be collected in close proximity of each other. If possible collect samples from different stations the same time of day. Sites need to be accessible not requiring much time reaching them.

The initial step in planning any experiment or study is choosing an answerable question. All science advances by rejecting hypotheses (Ambrose and Ambrose, 1981). There is no such thing as proof. Because logical experimentation is based on rejection of hypotheses, experiments begin with a null hypothesis. As an example. Ho: There is no difference between the physical habitat comprising stream A and stream B.

You complete a Habitat Assessment of the two streams and find that the test stream scored only 50 percent as high as the reference or control stream. In this case you would reject the hypothesis.

Additional information concerning the scientific method as it applies to planning the study will be discussed.

HABITAT ASSESSMENT



HABITAT ASSESSMENT

The objectives of this module are to 1) measure selected physical factors of the environment to include depth, width, velocity, and substrate, 2) make observations of ten parameters comprising a habitat assessment and compare it with other stream sites studied.

This Habitat Assessment methodology is developed from the Rapid Bioassessment Protocols for Use in Streams and Rivers (Plafkin 1989) and information provided by state agency people (DEQ) and university personnel from Idaho. The various parameters are weighted to emphasize biological criteria. After surveying the reach to be studied, ratings are totaled and compared to a reference. This enables the investigator to come up with a final score. A ratio between the reach studied and the score for the reference site makes it possible to calculate a percent comparability score for each parameter at each reach studied.

Reference streams often come up short as to habitat quality but still should represent the best habitat conditions attainable for a region.

Usually primary parameters (Bottom Substrate, Embeddedness, Velocity/Depth) are evaluated first when sampling a riffle-pool sequence. These parameters are classed as Substrate and Instream Cover. They rank from 0-20 points.

Secondary parameters (Channel Morphology) consist of Wetted Channel Shape, Pool/Riffle Ratio and Channel Alteration and rank from 0-15 points.

Tertiary parameters (Riparian and Bank Structure) consist of Lower Bank Stability, Bank Vegetative Protection, Canopy Cover and Width of Riparian Zone. These rank from 0-10 points.

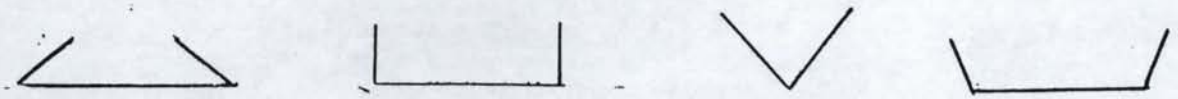
Secondary and tertiary parameters are often evaluated after scoring the primary parameters. They usually cover a larger area in an upstream direction.

The EPA manual emphasizes that a holistic strategy be kept in mind in making an assessment of the habitat so it is necessary to sacrifice some detail in order to have time to cover this methodology.

HABITAT ASSESSMENT FOR SMALL STREAMS*

STATION _____
DATE _____
OBSERVER _____

HABITAT PARAMETER	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Bottom Substrate	16-20 Greater than 50% rubble, gravel, submerged logs, other stable habitat	11-15 30-50% rubble, gravel, logs, other stable habitat	6-10 10-30% of the same	0-5 Less than 10% of the same
2. Embeddedness	16-20 Gravel, cobble and boulders surrounded by 0-25% fine sediment	11-15 Gravel, cobble boulders surrounded by 25-50% fine sediment	6-10 Substrate surrounded by 50-75% fine sediment	0-5 Substrate surrounded by over 75% fine sediment
3. Velocity/Depth	16-20 Slow (<0.3m/s), deep (>0.5m); slow shallow (<0.5m); fast (>0.3m/s) deep; fast-shallow. All habitats present.	11-15 Only 3 of the 4 habitat categories present (missing riffles or runs receive lower score than missing pools)	6-10 Only 2 of the 4 habitat categories present (missing riffles or runs receive lower score than missing pools)	0-5 Dominated by one velocity/depth category (usually pool)
4. Wetted Channel Shape	12-15	6-11	4-7	0-3



5.	Pool/Riffle, Run Bend Ratio. Difference between riffles divided by stream widths	12-15 5-7	6-11 7-15	4-7 15-25	0-3 > 25
6.	Channel Alteration	12-15 No channelization	6-11 25-50% channelization	4-7 50-75% channelization	0-3 >75% channelization
7.	Lower Bank Stability	9-10 Lower bank stable. No evidence of erosion or bank failure	6-8 Moderately stable Infrequent small areas of erosion mostly healed over	3-5 Moderately unstable Moderate frequency and size of erosional areas	0-2 Unstable. Many eroded areas. "Raw" sites frequent
8.	Bank Vegetative Protection	9-10 Over 90% of streambank surfaces covered by vegetation	6-8 70-89% streambank surfaces covered by vegetation	3-5 50-69% covered by vegetation	0-2 Less than 50% covered by vegetation
9.	Canopy Cover	9-10 Covered by moderate canopy	6-8 Covered by sparse canopy	3-5 Completely covered by dense canopy, water surface completely shaded	0-2 Full sunlight reaching water surface
10.	Width of Riparian Zone (consider both sides)	9-10 Width of zone at least 4 times width of stream	6-8 Width of zone at least 2 times width of stream	3-5 Width of zone at least as wide as stream	0-2 Little or no stream side cover.

*Modified from Rapid Bioassessment Protocols for Use in Streams and Rivers (EPA) and DEQ assessment of protocol (Oct, 1989)

Bottom Substrate- The term defines the habitat available for the support of biota in an aquatic environment. Optimum conditions exist if a diverse number of types exist. Rock and gravel provide more stable substrate than sand and soft sediments. Large size materials comprising the channel bottom are more permanent and are less apt to be moved by the water current.

In addition to mineral substrate, submergent and emergent aquatic plants, tree roots, logs, and undercut banks are important structural components of the stream. Such conditions often provide excellent habitat for macroinvertebrates and fish.

Natural dams created by logs and woody debris in the streams provide two additional habitat types which are lentic or standing water and coarse particulate organic material (CPOM) discussed later in the manual.

According to Forest Service personnel in Oregon, more optimum conditions exist in a stream if at least 20 pieces of large woody debris exist for every thousand feet of stream channel. In the past it was the policy of the Forest Service to remove this material from a stream channel.

Methods

Observe substrate conditions along the reach assigned. A plastic ruler is provided for measuring substrate size.

Bedrock- solid slab of rock
Boulders- greater than 10 inches in diameter
Cobbles or rubble- 2-10 inches
Gravel- 0.25 to 2 inches
Sand- up to 0.25 inches
Silt/mud/clay- fine particles

Record percent composition bottom substrate from an estimate of observations and measurements along the reach studied. Each person is to work independently. Results will be compared and an average substrate composition determined.

In addition note percentage of reach covered by aquatic plants, woody debris, and undercut banks if any or all of these habitat types exist.

Additional notes

Embeddedness- It is a measure of the amount of sediment deposited around boulders, cobble, or gravel. Large concentrations of fines surrounding or covering the rock substrate makes the stream habitat less suitable for spawning and egg incubation by fish and macroinvertebrates.

Sediment deposits are most apt to be present in pools and stream sections where gradient is reduced. Such invertebrate groups as fly larvae, aquatic earthworms, freshwater clams, and leeches are commonly found in such habitats. Forms with fine appendages and gills to include mayflies, stoneflies, and caddisworms are not common where embeddedness is high.

Additional notes

Velocity/Depth- In running waters that have a stream flow greater than 0.15 cubic meters per second (cms), velocity in conjunction with depth has a significant effect on the benthic life in the stream. The quality of the habitat can therefore be evaluated by measuring both depth and velocity.

Four different habitats are recognized:

1. slow, shallow-velocity less than 0.3 m/s, average depth is less than 0.5 m.
2. slow, deep-velocity less than 0.3 m/s, average depth more than 0.5 m.
3. fast, shallow-velocity more than 0.3 m/s, average depth less than 0.5 m.
4. fast, deep-velocity more than 0.3 m/s, average depth more than 0.5 m.

Water quantity or stream flow maintains a stable substrate where the velocity is less than 0.3 m/s.

Methods

Measure the width of the stream along the narrowest and widest length of the reach using a tape measure. Average these readings.

Use a meter stick and measure depths at 1/4, 1/2, and 3/4 of the stream width at the narrowest and widest length of the reach. Divide the total of three water measurements by four to take into consideration the depths of zero at where the water and stream banks meet. Average the readings of the narrow and wide sites.

Volume of flow- Select a straight stretch of stream riffle or run and pace off about 100 feet. Obtain a float such as a brightly colored orange, tennis ball, or leaf if the channel is shallow. Record time required for float to cover measured distance. Repeat three times and take average.

$$V = \frac{WDLa}{T}$$

where

v = volume in cubic feet per second (cfs) or cubic meters per second (cms).
W = average width of stream stretch in feet or meters. Measure at both ends of stretch.
D = average depth of stream stretch in feet or meters. Measure at both ends of stretch.
L = length of stream stretch in feet or meters.
T = average time for float to cover stream stretch.
a = constant as to bottom type
use 0.8 for rocky bottom, use 0.9 for smooth bottom.

Velocity of flow is simply the time in seconds it takes float to cover prescribed distance (feet or meters per second).

The float method might not be applicable if the channel shows a substantial meander. Instead employ a digital current meter which you place about midway in the water column facing upstream. Note the reading on the side of the meter and record. Leave instrument in water two minutes and record a second time.

If the stream is wide and moderately deep take readings at 1/4, 1/2, and 3/4 distance across the stream. If the stream is narrow and/or shallow take only one reading in the deepest fastest section.

If time allows take readings at both narrowest and widest length of reach.

Note difference between readings and divide by 120. Next observe where the data point intersects on the curve and read velocity in cm/sec.

Additional notes

Measuring stream velocity by the float method

Measuring depth and width of stream

Wetted Channel Shape is an extremely important morphological feature as relates to stability. A trapezoid shape bank represents the most stable situation. These streambank undercuts provide habitat for fish and are a good indicator of how successful or unsuccessful streambanks are protected by uses such as road building or livestock grazing.

The next most stable channel shape is a 90 degree slope followed by a "V" shape slope. The most unstable shape is an inverse trapezoid bank.

Additional notes

Pool/Riffle, Run/Bend Ratio- This amounts to the difference in distance between riffles or runs divided by stream width.

A riffle is a swiftly flowing stretch of water over partially or submerged obstructions resulting in agitation of the surface. Riffles are shallow rapids where standing waves are absent.

A pool is that part of a stream where water velocity is reduced and water is deeper than adjacent areas. Pools are used by fish for resting and cover and by macroinvertebrates adapted to burrowing in bottom sediments.

A run or glide is a section of a stream with moderately low velocity that flows gently and smoothly with little or no turbulence at the surface. A level or slightly sloped downstream longitudinal profile characterizes a run with no hydraulic control (a place where flow is constricted or top of an obstruction where flow of stream must rise before passing over).

Often times the difference between a pool and run is a value judgement. Pools are often located near the bend of a water course.

Bends or riffles are assumed to offer more diverse habitat than a stream run or stream with uniform depth. Bends often exist in streams of low gradient that lack riffle areas. They offer suitable habitat due to the cutting action of water at the bend.

Methods

Measure the width of the stream along the narrowest and widest length of the reach using a tape measure. Average these readings.

Pace off the distance between a number of riffles or bends and take an average of these distances.

Divide the average distance between riffles or bends by the average stream width.

Additional notes

Channel Alteration occurs when the channel is straightened causing a decrease in the sinuosity of the stream.

Sinuosity is the ratio of the length of channel to down valley distance or ratio between two points on a channel to the straight distance between these points. The term meander is used where channels have sinuosities of 1.5 or more.

Channelization results in increased stream velocity and subsequent scouring of the stream bed. This often occurs in streams on agricultural lands or in towns or cities with the construction of concrete embankments.

Alteration of channels may also cause deposition of materials on the inside of bends, below channel constrictions or where the gradient of the stream flattens out.

Methods

Attempt to view the reach studied from a high point and estimate whether or not no channelization occurs, 25-50% channelization, 50-75% channelization, or greater than 75% exists.

Also walk the reach to estimate the degree of channelization and record your observations.

Additional notes

Lower Bank Stability- This area exists from the normal high water line to the edge of the water during low flow in the summer. The water level naturally fluctuates during the year. The upper bank covers the break in the general slope of the surrounding land to the normal high water line. Terrestrial shrubs and trees usually cover this zone. The channel bottom is the submerged zone of the channel cross section which is totally aquatic.

The stability of the bank is ranked by noting existing or potential detachment of soil from the bank and its movement into the channel bottom.

The upper bank might show signs of bad erosion whereas the lower bank may be in good shape or the opposite condition might occur.

Methods

Initially become acquainted with examples of poor, marginal, sub-optimal and optimal lower bank stability.

Next rank the condition of the lower bank under study.

Additional notes

Bank Vegetative Protection- Root systems of higher plants are responsible for holding bank soil in place. In addition to vegetation, boulder, cobble, or gravel may be important in providing protection.

Banks which are covered by plant growth are assumed to be stable features of the stream ecosystem. If the slope of the bank is well vegetated, undercutting is not a problem in fact it provides important cover for aquatic organisms.

Since vegetation and bank structure indirectly affect the instream habitat features, they receive less weight or value in the ranking system than primary or secondary parameters.

Methods

Walk the stream reach and determine whether the banks on both sides are covered by less than 50%, 50-69%, 70-89%, over 90% vegetation or rock material.

Additional notes

Canopy Cover is important in terms of shading the stream thus helping modify the water temperature. The vegetative growth also contributes detritus or coarse particulate organic matter to the stream. This serves as a source of energy for shredders such as some stoneflies.

If the stream is completely covered by a dense canopy of trees then algal forms in the water are almost entirely absent because of the lack of light necessary for photosynthesis.

Additional notes

Width of Riparian Zone- The riparian is an area between a stream and adjacent upland characterized by distinctive higher plants and soil types. Riparian dominated by shrubs and trees contributes coarse particulate material to the benthic invertebrates inhabiting the stream. It also provides cover for fish and shades the stream.

In regards to fish density, shrubs are the optimal streamside cover followed by trees and then grass or forbes.

Methods

Observe whether the width of riparian is at least four times the width of stream, two times the width, about as wide as the stream, or little or no stream side cover.

Additional notes

Physical Characteristics

Drainage_____

Date_____

Parameter	Station 1_____	Station 2_____	Station 3_____
Av. width (meters) (feet)			
Av. depth (meters) (feet)			
Velocity (m/s) (f/s)			
Volume (cms) (cfs)			
Substrate (%) bedrock boulders rubble gravel sand silt			
Organic Substrate comments			

Parameter	Score Station	Station	Station
PRIMARY Bottom Substrate/cover			
Embeddedness			
Velocity/Depth			
SECONDARY Channel Shape			
Pool/Riffle Ratio			
Chanel Alteration			
TERTIARY Bank Stability			
Vegetative Protection			
Canopy Cover			
Width Riparian			
TOTAL SCORE			
PERCENT COMPARABILITY (with Reference Stream)			

Name of drainage_____

Investigators_____

Date_____

EQUIPMENT NEEDED

Hip boots or tennis shoes (depending on time of year)
meter stick
tape
current meter or float
field book
forms
pencils
clipboard
watch with second hand
camera (optional)
mm ruler

WATER CHEMISTRY

WATER CHEMISTRY

The objective of this module is to collect, analyze, and compare chemical information from different sites.

Many of the methods used here were taken from **Students on the Snake** project conducted at Centennial High School in Meridian, Idaho (Beckwith, 1991) who obtained much of his information from Mitchell and Stapp (1991).

Nine different tests of water chemistry are made at each station sampled. Some readings are conducted in the field, others in the lab.

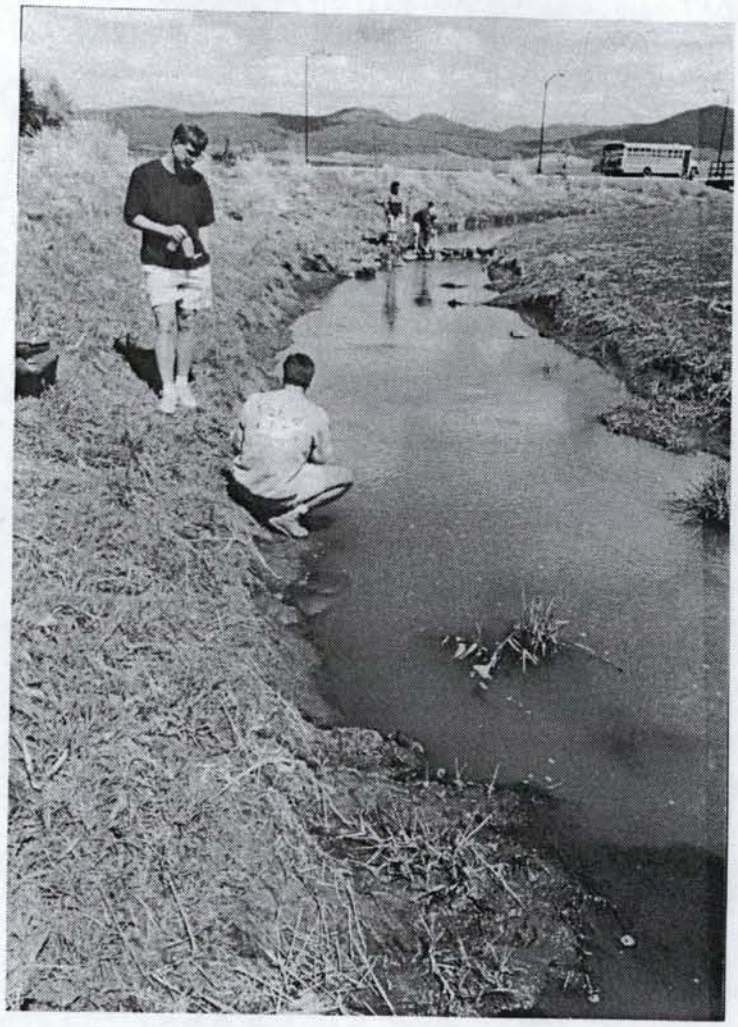
Results are recorded in a field book and later transferred to a Class Data Water Summary chart. Next "Q" values are determined and listed on a Water Quality Index (WQI) table. Weighting factors are applied to each test result and a total score is compared to predetermined Water Quality Index values rated Excellent, Good, Medium, Bad, and Very Bad.

Alkalinity and conductivity are measured in the field but not used in the Water Quality Index.

There is space on the WQI table to make remarks concerning stream conditions along the reach studied. These might include such things as garbage/junk in stream, pipes actively discharging material, foam or oil, algae scum on surface, etc.

In order to save time and simplify the module, some of the tests are run by a professional water testing lab. Such an approach also guarantees more accurate results.

Information concerning methods relating to chemical analysis are somewhat brief in this module mainly because of time restraints and background experience of the participants.



Collecting water samples for nitrates, phosphates, total solids, turbidity, fecal coliforms, biochemical oxygen demands, and pH to run in the lab.

Analysis in the field of dissolved oxygen, pH, alkalinity, and conductivity.

Dissolved oxygen in a well aerated stream is usually not limiting unless the water contains large amounts of organic material. Less oxygen is in pools where decomposition is commonly occurring at a faster rate than in riffles. Oxygen saturated water contains less than one percent by volume in contrast to the atmosphere which contains about 23 percent.

Winkler Method

Moisten the interior surface of a 250-300 ml ground glass bottle by rinsing which may help avoid getting air bubbles in the sample.

Tilt the bottle to a horizontal position allowing water to run in slowly. Let water flow over lip of bottle to further rid the sample of air bubbles.

Add 1 ml of manganous sulfate beneath the surface.

Add 3 ml of alkaline potassium iodide beneath surface. Do not be concerned if sample runs over.

Replace stopper and shake vigorously for about 15 seconds. Allow precipitate to settle. Observe this taking place in bottom half of bottle.

Holding tip of pipette against neck of bottle, add 2 ml of concentrated sulfuric acid or contents of sulfamic acid packet above the water level.

Pour 200 ml of treated sample into volumetric flask and transfer to Erlenmeyer flask.

Titrate sample with 0.025 N sodium thiosulfate or phenylarsene oxide (PAO).

After sample becomes pale yellow in color, add 1-2 ml of starch solution. Titrate until blue color disappears.

Dissolved oxygen in mg/l is equal to number of mg/l titrant.

Calculating Percent Saturation

The percent saturation of dissolved oxygen at a certain temperature is determined by pairing dissolved oxygen value in mg/l with temperature of water in centigrade on a percent saturation chart. Use a straight edge connecting the two points and read saturation value.

Record results on Class Data Water Summary.

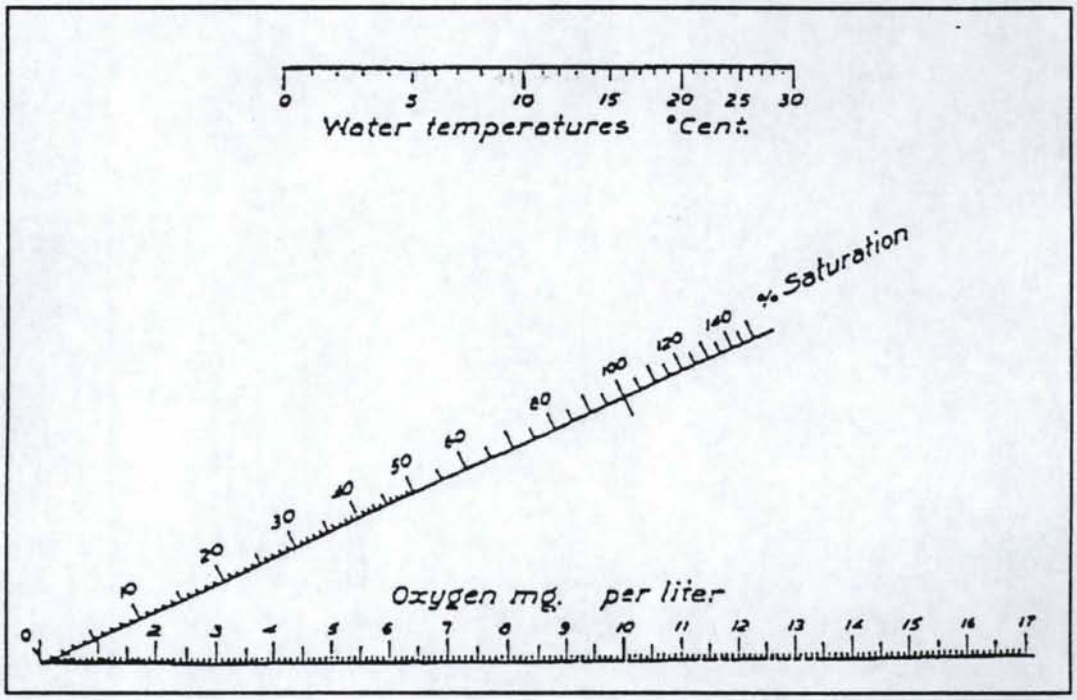
To calculate "Q" value, refer to figure of Dissolved Oxygen and locate percent saturation on horizontal axis. Follow that point up to where it intersects the line. The point of intersect is "Q" value.

Record value on WQI Summary Table.

Additional notes

Percent saturation

Draw a line between water temperature °C and oxygen mg/l. At point of intersection is % saturation.



Beckwith (1991)

Fecal coliform is a type of bacteria associated with mammal and human waste. When animals defecate, some of these bacteria pass out of their bodies and into the stream. In all probability, pathogens are probably also present along with the coliform type. The chance of pathogens being in the water sample increases significantly when the coliform count is over 200 colonies/100 ml water. Drinking water should not exceed 1 coliform/100 ml and treated sewage effluent is expected to be less than 200/100 ml.

Methods

Collect the sample in a 300 ml bottle that has been sterilized. Avoid touching the inside of the cap.

Face the bottle into the current below the surface. Wear gloves if there is a chance of pathogens being present in the water.

Place the sample on ice and keep cool as possible. Analyze the water within 24 hours.

In order to obtain more accurate results and save on time, it is recommended that a state or commercial water testing lab analyze the water for fecal coliforms.

Record results on Class Data Water Summary,

To calculate "Q" value, refer to Fecal Coliform figure and locate fecal coliform count on horizontal axis. Follow that point up to where it intersects the line. The point of intersect indicates "Q" value.

Record value on WQI Summary Table.

Additional notes

pH is a way to measure the acidic or basic nature of water in a stream. Water has a slight tendency to fall apart or dissociate into hydrogen and hydroxide ions. An acid is a substance that gives off hydrogen ions when dissolved in water whereas a base is any substance that accepts hydrogen ions when dissociated in water. The more hydrogen ions the more acid the water, the more hydroxide ions, the more basic. The pH scale runs from 0-14. Acid rain has a pH of about 4 as compared to the Great Salt Lake which has a pH of 10. Distilled water has a neutral pH of 7.

Methods

Collect a water sample below the surface.

Measure the pH using a color comparison method such as the Hach Kit. pH paper may also be used but is not as satisfactory.

Take an additional sample. Put on ice and return to lab. Analyze sample using a pH meter and compare with color disc technique.

Record information on Class Data Sheet and WQI Table after determining Q value.

Additional notes

Biochemical Oxygen Demand is high when the dissolved oxygen is low and low when dissolved oxygen is high. If considerable amounts of organic matter exist in a stream then the decomposition of this material by microorganisms requires ample oxygen for the process to take place. The demand for oxygen thus increases.

Methods

Fill a light bottle and dark bottle with water being careful not to aerate the sample.

Measure the dissolved oxygen in the light bottle-refer to information regarding Winkler method.

Place the dark bottle in an incubator or a darkened room for five days at 20 degrees C.

At the end of this period, analyze for dissolved oxygen.

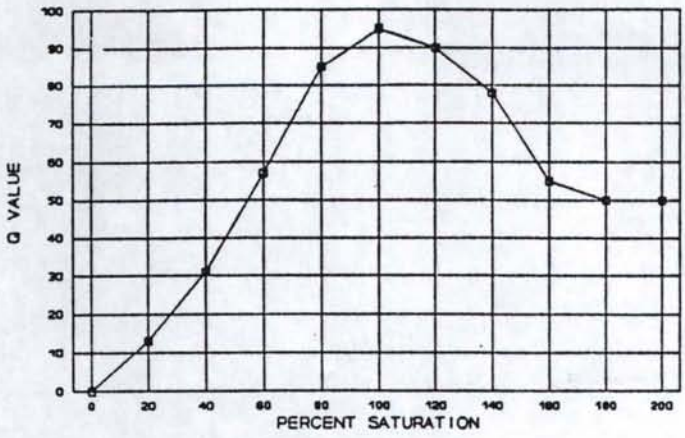
Subtract the dark bottle reading from the light bottle reading. This gives the BOD in mg/l.

Transfer this information to the Class Data Water Summary.

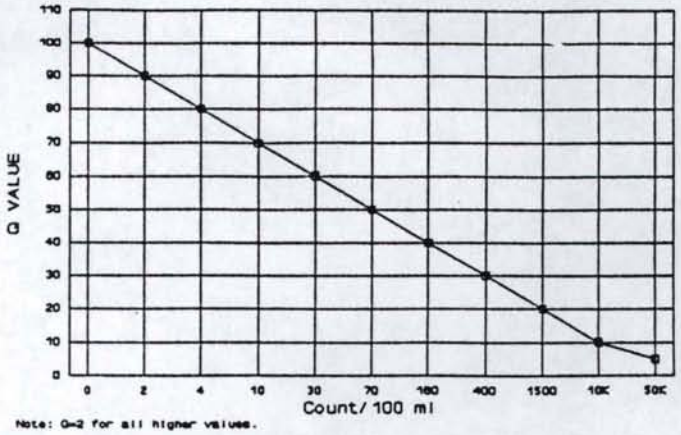
Next calculate a "Q" value and record on WQI Summary Table.

Additional notes

DISSOLVED OXYGEN



FECAL COLIFORM



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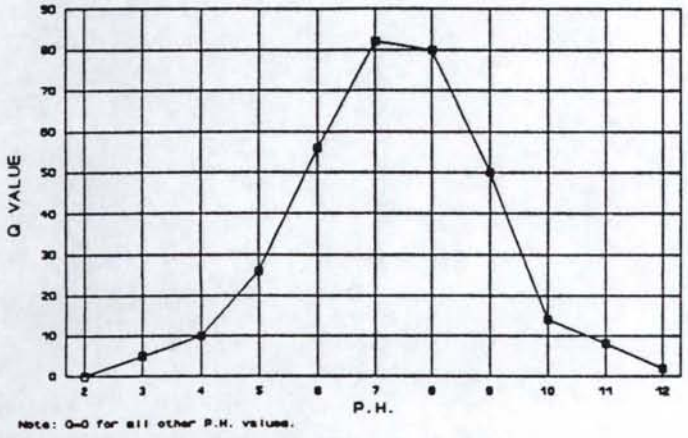
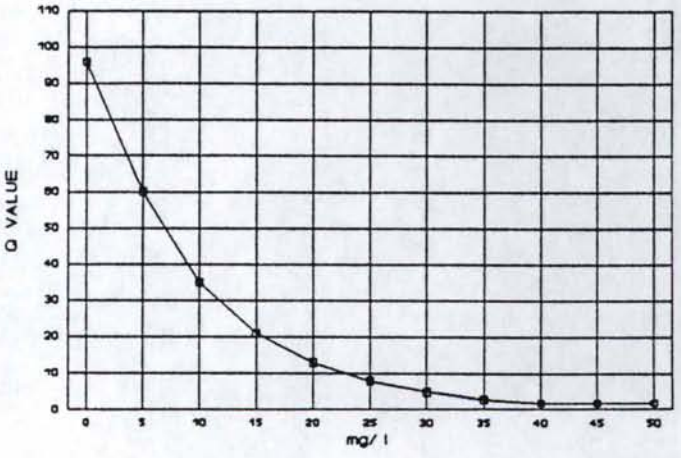


BIOCHEMICAL OXYGEN DEMAND



Beckwith (1991)

Phosphates are nutrients necessary for the growth of plants. If too many phosphates get into a stream from sources such as manure, septic tanks, or lawn fertilizer undesirable changes in the water occur. The phosphates taken up by the plants may cause undesirable mats of algae or unruly growth of water weeds in the stream channel. These plant materials eventually die and in the process of decomposition decrease the dissolved oxygen and increase the biochemical oxygen demand.

Methods

Collect sample below the water surface in a 100 ml container.

Place sample on ice and return to lab.

In order to obtain more accurate results and save time, it is recommended that a state or commercial water testing lab analyze the sample for phosphates.

Record results on Class Data Water Summary. Calculate "Q" value and transfer information to WQI Summary Table.

Additional notes

Nitrates like phosphates are necessary for plant growth. Elemental nitrogen in the atmosphere is fixed by bacteria and blue green algae to ammonia which is changed to nitrates by another team of microorganisms. Additional nitrates find their way into a stream through sources such as fertilizers, manure from cattle, and leaky septic tanks. Eutrophication or enrichment of the water occurs causing excessive plant growth in the stream.

Methods

Collect sample below the water surface in the same 100 ml container used to collect phosphates.

Place sample on ice and return to lab.

In order to obtain more accurate results and save time, it is recommended that a state or commercial water testing lab analyze the sample for nitrates.

Record results on Class Data Water Summary. Calculate "Q" value and transfer information to WQI Summary Table.

Additional notes

Turbidity is caused by suspended solids in the water such as clay, silt, or organic wastes. These materials trap more heat resulting in less oxygen because of the warmer water. Biological agents such as algae and plankton can also cause the water to be turbid as when enrichment takes place by excessive nitrates and phosphates.

Methods

Collect 100 ml water below the water surface. This can be part of the same sample collected for pH to be analyzed later.

Measure turbidity using a turbidimeter or send sample to state or commercial water testing lab for analysis.

Record results on Class Data Water Summary. Calculate "Q" value and transfer information to WQI Summary Table.

Additional notes

Total Solids consist of both suspended and dissolved materials in the water column. Suspended solids retained by a fine mesh filter include clay and silt particles from erosion, other point and non-point sources of pollution such as sewage and pesticides,and live organisms. Dissolved solids consist of inorganic materials such as nitrates, phosphates, calcium, and bicarbonate ions which pass through a fine filter. They provide nutrients for algae and higher plants at the base of the food chain and some are important buffering agents in the water.

Methods

Collect at least a 100 ml sample from the stream.

Weigh a small clean beaker on a sensitive balance to the nearest 0.0001 gram and remove it with tongs so that you do not change weight of beaker by touching it.

Pour the 100 ml water sample into the beaker and place in a drying oven at 103 degrees C overnight to evaporate the water.

Allow the beaker to cool and reweigh it.

Calculate the weight of residue by subtracting weight of beaker before sample introduced from weight of beaker and residue..

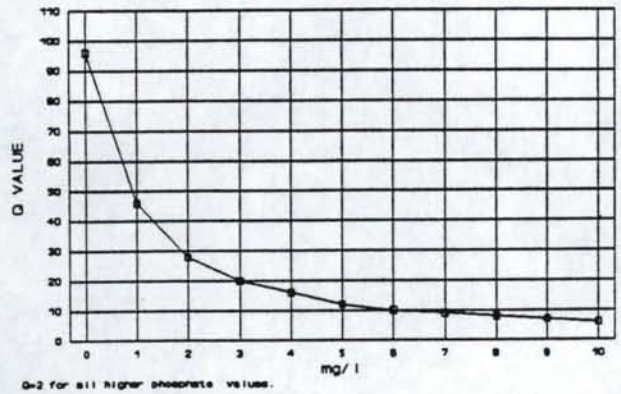
The following formula is used to determine total solids:

$$\frac{\text{Increase in weight in grams}}{\text{Volume in milliliters (ml)}} \times \frac{1000 \text{ mg}}{1 \text{ gm}} \times \frac{1000 \text{ ml}}{1 \text{ liter}} = \text{mg/l}$$

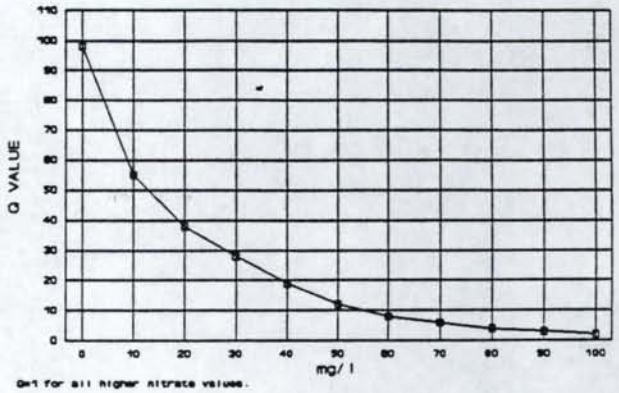
Record results in mg/l on Class Data Water Summary. Calculate "Q" value and transfer information to WQI Summary Table.

Additional notes

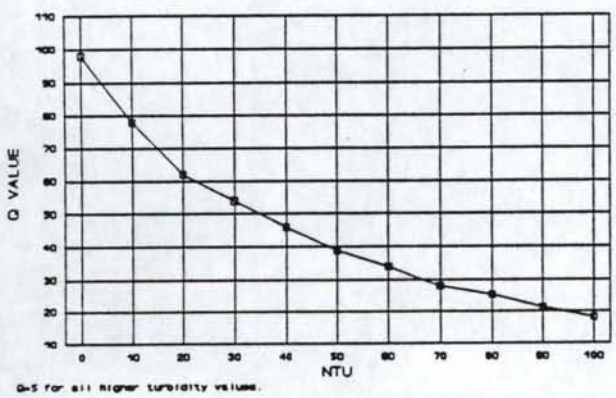
TOTAL PHOSPHATE



NITRATE - NO3



TURBIDITY



TOTAL SOLIDS

Beckwith (1991)

Temperature is one of the most important environmental characteristics in a stream. It varies from site to site. A temperature taken in a stream located in a wide open valley would be expected to differ from one situated in a narrow canyon. Riparian vegetation which shades a stream has a significant cooling effect on the water temperature.

Methods

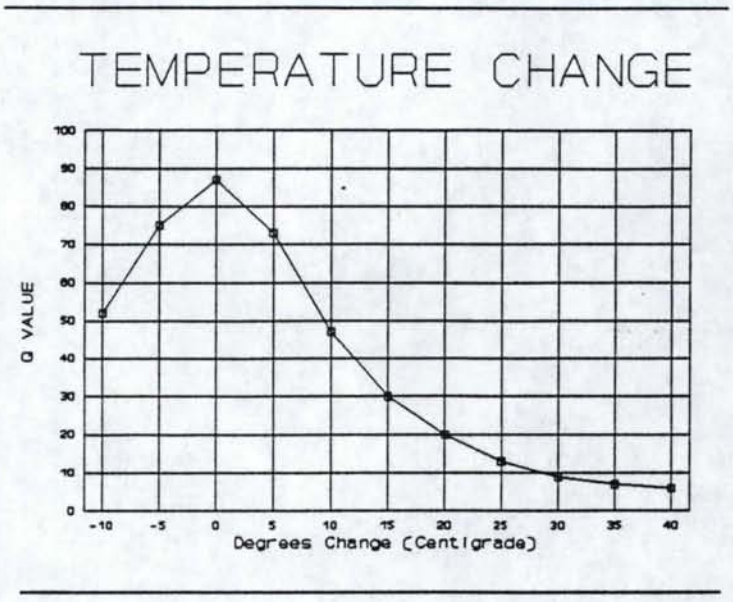
Use a thermometer and record temperature about four inches below the surface of the water if possible.

Read thermometer while submersed in water.

Subtract temperature taken at test site from upstream temperature if you are comparing stations on the same stream.

Use the temperature change information to determine "Q" value. Transfer data to Class Data Water Summary and WQI Table.

Additional notes



Beckwith (1991)

Alkalinity is expressed as calcium carbonate in mg/l even though alkalinity represents hydroxides and bicarbonates as well as carbonates. Alkalinity readings are low in soft water regions such as mountainous areas and high where hard water exists.

Methods

Collect 100 ml water.

Pour off into graduate and transfer to a white porcelain casserole placed over a white card.

Add four drops of phenolphthalein indicator to water. If solution becomes colored, carbonate or hydroxide is present.

Add 0.02 N sulfuric acid from a pipette until color disappears. Phenolphthalein alkalinity (mg/1) calcium carbonate is equal to number of ml sulfuric acid multiplied by 10.

Add two drops of methyl orange indicator to sample after titration for phenolphthalein alkalinity or if solution remains colorless after adding phenolphthalein indicator.

Introduce 0.02 N sulfuric acid to yellow-colored solution until it turns a faint pink (salmon pink) or until solution no longer appears yellow.

Methyl orange alkalinity (mg/1) of calcium carbonate is equal to number of ml 0.02 N sulfuric acid used multiplied by 10.

Total alkalinity is addition of methyl orange and phenolphthalein alkalinity values.

Record this information on Class Data Water Summary and WQI Summary Table. It is not used in the Water Quality Index.

Additional notes

Conductivity is a measure of the ability of water to conduct an electrical current. This ability is dependent upon the amount of dissolved charged particles (ions) present in the water. Ions such as sodium, calcium, and bicarbonate are dissolved into water from weathering of rock material in a drainage area. Conductivity values for freshwater are generally within the range of 100-1000 micromhos (reciprocal of resistance).

Methods

Use a conductivity meter and place probe in water.

Adjust temperature knob on the meter to the temperature of the water.

Turn the other knob until needle lines up with a red line on the scale.

Next turn this same knob to the appropriate scale and read needle in micromhos.

Turn meter off when finished.

This data should be included on Class Data Water Summary and WQI Summary Table but is not used in Water Quality Index.

Additional notes

Class Data Water Summary*

TEST	SITE				
Dissolved oxygen (mg/l)					
Fecal Coliform (mg/l)					
pH Units					
Biological Oxygen Demand (mg/l)					
Total Phosphates (mg/l)					
Nitrates (mg/l)					
Turbidity NTUs					
Total Solids (mg/l)					
Tempera-ture C.					
Alkalinity (mg/l)					
Conductiv-ity micromhos					

*modified from Mitchell and Stapp(1991) and Beckwith(1991)

Water Quality Index*

Stream_____

Station number_____

TEST	UNITS DATA RECORDED IN	CLASS DATA-AVER. RESULTS	Q-VALUE -REFER TO TABLES	WEIGHTING FACTOR	TOTAL Q-VALUE X WT. FAC. = 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. B.O.D.	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	

modified from Mitchell and Stapp(1991) and Beckwith(1991)

WATER QUALITY INDEX

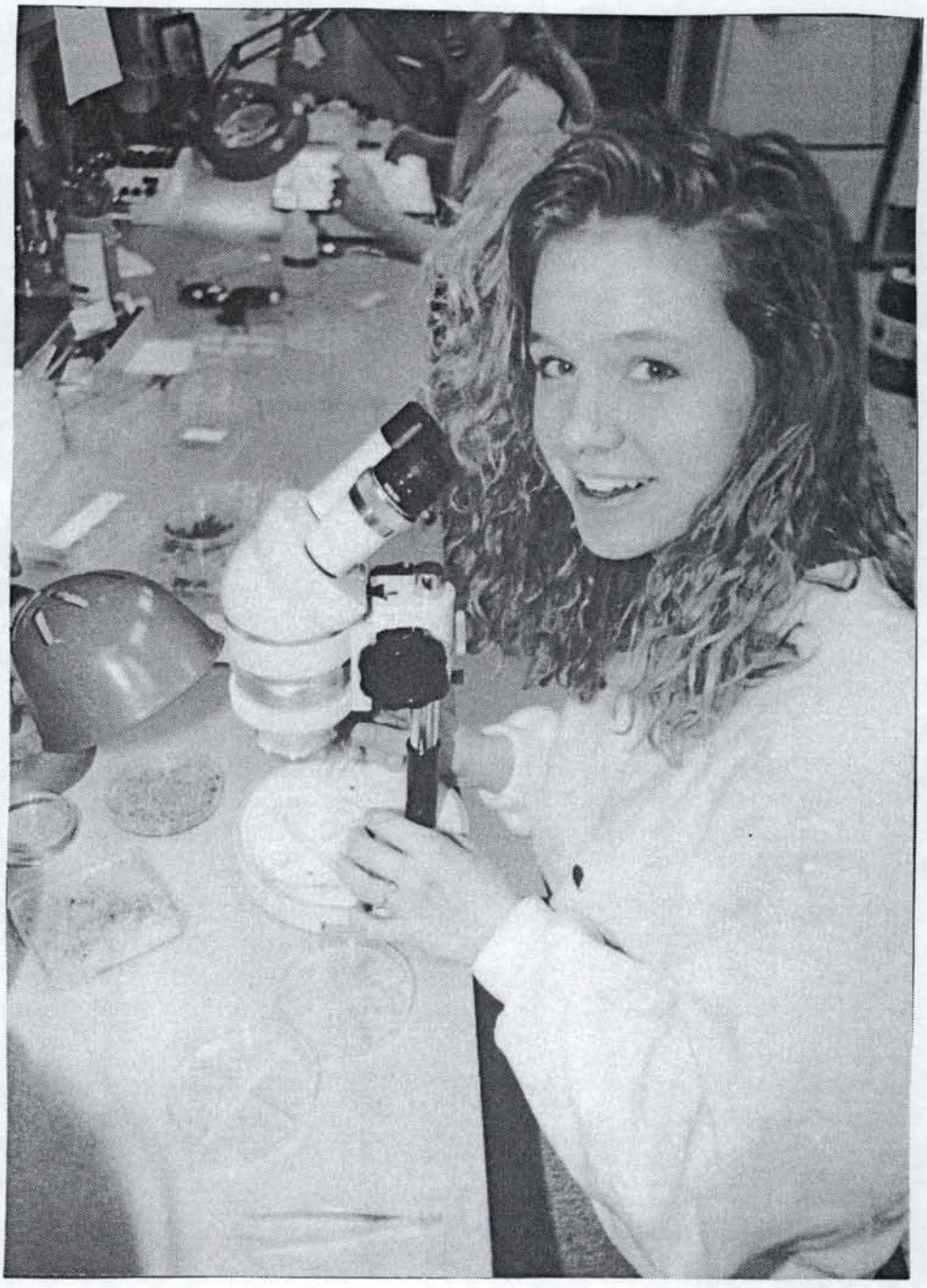
100-90	EXCELLENT
89-70	GOOD
69-50	MEDIUM
49-25	BAD
24-0	VERY BAD

Alkalinity mg/l_____

Conductivity micromhos_____

REMARKS:

BIOMONITORING



BIOMONITORING

The objectives of this module are to 1) learn about sampling macroinvertebrates, 2) processing the samples, 3) identifying the macroinvertebrates, and 4) analyzing the data as relates to the structure and function of macroinvertebrate communities.

The biomonitoring methodology is developed from the Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (Klemm et al. 1990).

Macroinvertebrates are animals without backbones large enough to be seen by the unaided eye and live at least part of their life upon or within substrates in an aquatic medium. They are retained in a U.S. Standard No. 30 sieve screen comprised of 28 meshes per inch (O.6 mm openings).

They attach to any available substrate such as rocks, soft sediment, plants, logs, and detritus in the stream channel.

Macroinvertebrates consist primarily of insects. Other representatives include snails, clams, leeches, aquatic earthworms, flatworms, freshwater shrimp and crayfish.

Some macroinvertebrates are associated with the grazing food chain where they consume algae and plant material. Others specialize in utilizing detritus or dead plant material conditioned by bacteria and fungi in the stream.

Macroinvertebrates provide an important indice in detecting changes in water quality brought about by point and non-point sources of pollution. Some species are sensitive to perturbation or stress whereas others are more tolerant to changes in the environment.

Macroinvertebrates often live as long as one to two years and usually remain in one location for quite a while. As a result their presence or absence provides us with an indication of the health of a stream since they are exposed to changing conditions of flowing water over a period of time.

Systematic sampling is employed here to correspond with a qualitative approach to biomonitoring. Non-random samples are collected from a number of different habitat types using a variety of sampling gear.

Klemm et al. (1990) mentions that the objective of qualitative biomonitoring is to make within or between station comparisons to detect the presence or absence of macroinvertebrates that are sensitive or tolerant to perturbation and obtain information about the richness of taxa (different kinds of species or organisms).

The approach to sampling qualitatively is to collect as many taxa as possible in a reasonable period of time. The different habitat types from which these macroinvertebrates are collected are recorded and associated with the organisms sampled. Habitat types include riffles, pools, aquatic plants, coarse particulate material, and soft sediments.

Often times habitat types are destroyed or altered by physical impairment of the environment. This impact in turn is responsible for a decrease in the species richness of the macro-invertebrate community. In other words habitat destruction leads to reduced biological diversity.

Sampling and the processing of samples is less time consuming in qualitative sampling as compared to quantitative sampling.

Sampling Macroinvertebrates

Riffles and Runs- The number of riffles or runs sampled depend upon the size of the stream and the time and resources available. A minimum of three sampling sites at each station are recommended when using a stream-net sampler.

The stream reach has already been surveyed and habitat types identified to sample. Approach the site from downstream to avoid disrupting the collecting area above.

The Surber Sampler consists of two frames hinged together that fold up compactly for carrying. One frame marks the boundary of the area from which the sample is taken, and the other supports the net stretched downstream by the flow of water.

The net material is usually nylon and a variety of mesh sizes is available. A mesh size of 0.35 mm retains most instars of aquatic insects.

Work the frame securely into the substrate with the opening of the net facing upstream. Hold the sampler in position while at the same time picking out larger stones washing any organisms into the net. After the larger material has been discarded, use a trowel or garden fork to work over the smaller rocks and gravel to a depth of about four inches.

During cold weather or working in polluted water, wear a pair of rubber gloves.

Use a standard Surber Sampler in larger streams and a modified smaller version in a small second or third order stream.

A Hess Sampler or modified Hess is used in place of the Surber in deeper water or where weed beds are sampled.

The collected material is transferred from the net to a labeled ziplock bag. Place the bags in an ice chest and return to the lab. One advantage of keeping specimens alive is that their movement makes them easier to see in the sorting process. Also some groups such as leeches are easier to identify alive. A disadvantage in working with live specimens is they should be processed no later than 24 hours following collection.

If sampling a stream with very coarse rubble or boulders, use a kick screen or sein which consists of hardware cloth with a mesh size of about one mm stretched between two pieces of lathe one meter in width.

Approach the area to be sampled from downstream so as not to disturb the site.

Hold the screen in the current while facing upstream. Position it at a proper angle so organisms have a more difficult time escaping underneath.

A second person carefully approaches the site to be sampled from the side and uses a meter stick to measures one meter upstream from where the first person is standing with the screen.

The second person then kicks the stream bed vigorously, working their way towards the net. One square meter of substrate is disturbed to correspond with the width of the screen. Remove the net with a forward scooping action so as to keep the sample intact.

Transfer the screen to a relatively flat area. Bring the two handles together grasping them with one hand and dash them downward against the other hand held stiffly over an enamel pan. The jolt discharges some organisms. In addition splash water on the screen to wash invertebrates off. Expect to use forceps or tweezers to collect those forms still attached.

Transfer sample into properly labeled ziplock bags, place in ice chest, and return to lab.

Sample as many riffles as indicated on reach map using appropriate sampling gear. Make a composite sample from however many samples collected.

Only one riffle or run is collected at each station when using the kick screen method.

Additional notes

Dip net samples- Use a dip net to sample underneath and along the sides of banks, pools, and macrophyte beds where any of these sites exist along the reach. The habitat types are identified on the reach map together with suggested locations of sampling sites. Always work upstream.

In sampling shore macrophytes and undercut banks, make three complete sweeps with the dip net as far as you can reach out not moving from your position. A complete sweep consists of dragging the net forward right below the water surface and back again so that you cover about a meter of water space on each side of you. Practice this maneuver before actual sampling. Be careful to not drag the bottom of the net along the bottom.

Sample macrophyte beds and undercut banks from the stream channel rather from shore since the channel position provides a better angle. When sampling channel macrophytes, only sweep the net upstream three times.

Collect as many samples as indicated on the reach map from different habitat types present. Make a composite sample of each habitat type sampled with the dip net.

Transfer contents to a properly labeled ziplock bag. Place in an ice chest and return to lab.

Additional notes

Assorted samples- Collect coarse and fine litter and sediment when present along the stream reach. These habitat types are identified on the reach map.

Collect fine litter consisting of leaves, conifer needles, or small twigs in small ziplock bags until the bag is full. Refer to the reach map for the number of samples to collect.

Coarse woody material submersed in the stream is placed in a screen-bucket. It is best to select pieces partially decomposed resembling wood pulp. Choose about five pieces that fit the bucket.

Next wash down the material by raising and lowering the bucket in the stream. Remove each piece of wood and break apart to search for invertebrates. Place any organisms found into the ziplock bag containing the fine litter material.

Sediment is collected along the reach from the upper two inches of the bottom substrate using a small glass jar as a scoop. Place sample or samples in a screened bucket and wash down. Transfer the remains in the bucket to a labeled ziplock bag.

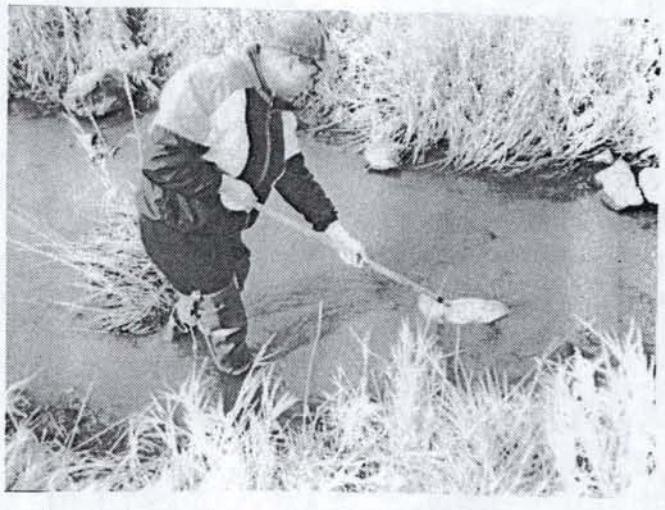
Optional collections are made of filamentous algae and macrophytes (aquatic plants) if present.

Note dominant vegetation especially tree and shrub type.

Photographs taken of the stream system are of value in interpretation of the riparian vegetation.

Additional notes

Use of Surber Sampler in collecting macroinvertebrates from riffle area



Collection of macroinvertebrates from aquatic vegetation using dip net

Use of kick screen to sample macroinvertebrates from coarse rubble and boulders

Processing

Remove ziplock bags containing live organisms from the refrigerator.

Samples should not remain refrigerated more than one day otherwise the organisms die and may spoil.

Transfer materials from ziplock bags to a U.S. Standard No. 30 sieve (0.6 mm diameter screen).

Run tap water through screen to reduce volume and remove mud and silt.

Concentrate material at one edge by tilting screen and running tap water through it.

Next transfer sample from screen to a flat tray.

Mix sample well and divide into four equal parts.

Throw a dice to select one of the parts.

Place a tablespoon of material from the portion selected in a white enamel pan or flat glass baking dish filled partially with water.

Examining a small amount of sample enables you to better see the organisms since the material is spread out more rather than being layered.

The use of an illuminated magnifier is helpful in locating specimens.

Place similar appearing forms together in a partitioned ice tray containing preservative.

Use flat more pliable forceps to transfer soft bodied organisms such as mollusks (snails and clams).

Fast moving forms such as freshwater shrimp can be sucked up by the use of a small pipette.

Leeches, aquatic earthworms, and flatworms are placed in water rather than preservative for ease in identification.

If large numbers of organisms such as aquatic earthworms are present, you may want to further subsample these groups especially if time is a limitation.

However pick out all the less dominant taxa from the remaining quadrant or quadrants.

Have an instructor check to see that specimens were not overlooked-a means of practicing quality control.

If you have not counted about 100 specimens, begin on the second quadrant. Once you begin processing a quadrant, always finish it even though you have picked out over 100 organisms.

Record the number of quadrants processed from each sample.

Different habitat types are to be kept separate in partitioned ice trays or glassware.

Cover with Saran wrap to prevent alcohol from evaporating.

Additional notes

Data Evaluation

Some basic instruction is provided in the use of keys to be used in the identification of immature aquatic insects, leeches, flatworms, and gastropods. Insect identification is to the family level.

Remove a specimen from those in the partitioned ice tray and place in a shallow dish containing preservative.

Use a dissecting microscope to observe the organisms and attempt to identify them. Appropriate keys for the macroinvertebrates will be made available.

Teasing needles and forceps enable you to manipulate or turn the organism around in the dish as you work on it.

After the specimen is identified and checked for accuracy by the instructor, record the taxa and the number of individuals belonging to that taxa on a form specifying the stream, station number, date, insect or non-insect group, and habitat type.

Once all the previously sorted specimens have been identified and recorded on the above form, analyses of the data can be determined.

Species richness is the total number of different taxa (kinds) of organisms present in the sample. There may be more than one kind of species belonging to some groups identified. In that case, the taxa are listed as Species A, Species B, etc under that group.

Many species often indicates a healthy stream community.

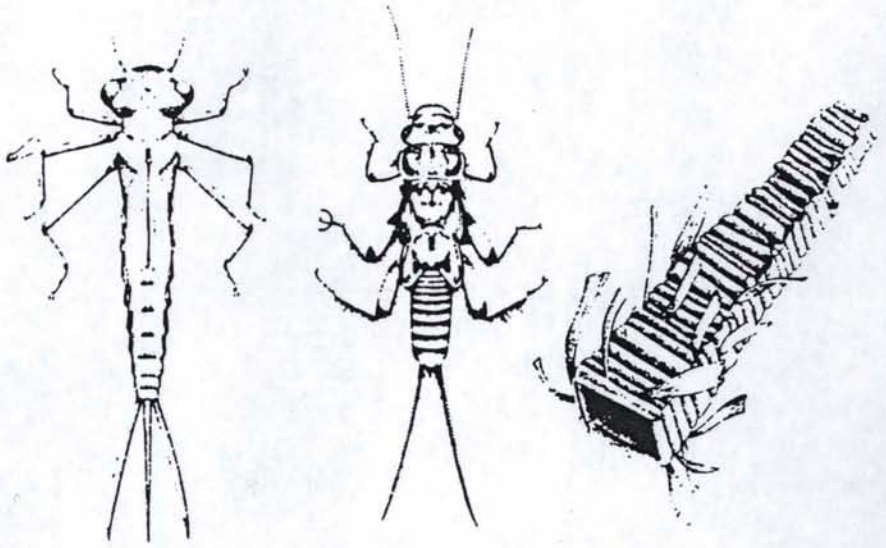
Some streams contain more non-insect species than insects. Non-insect forms are often more tolerant to pollution than insect species.

Expect to find a high species richness where a large diversity of habitat types exist (riffles, pools, aquatic plants, coarse particulate matter, etc.).

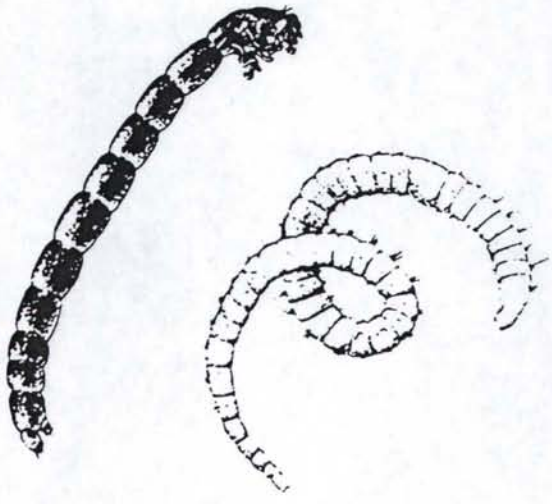
EPT Index is the total number of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisworms) found in the sample. Specimens belonging to these three insect orders are for the most part relatively sensitive to pollution.

Stream stations having a high EPT Index are those waters associated with clean water and an unimpacted habitat.

Biotic Index is value given to an organism depending upon its tolerance to pollution. Low values indicate organisms sensitive and not tolerant to pollution. High values indicate organisms more tolerant and less sensitive to stress.



Ephemeroptera(mayflies), Plecoptera(stoneflies)
and Trichoptera(caddisworms)
These organisms often are very sensitive to pollution



Chironomidae(fly larvae)
These organisms often have high tolerance to pollution

$$HBI = \Sigma \frac{n_i \, a_i}{N}$$

Where n_i = number of individuals in each taxa

a_i = index value of that taxa

N = total number of individuals in sample

A family level biotic index (Hilsenhoff, 1988) is available to record values in the formula above. Values from 0 to about 4 are considered to exhibit low tolerance and values over 6 have high tolerance to environmental conditions.

The presence of sensitive or intolerant organisms provides evidence of environmental quality whereas tolerant macroinvertebrates may be found in both polluted and clean water so their presence is of less significance.

Dominance is where a large number of individuals belonging to one or two species exists in the community. High dominance in a community usually relates to an impacted habitat or poor water quality conditions. Dominant forms such as certain aquatic earthworms and fly larvae (Chironomidae) are often tolerant and therefore able to exist under environmental conditions unsuitable to more sensitive forms such as stoneflies.

Species richness is usually lower where high dominance exists. List what you might consider dominant forms from the samples collected at different stations.

Functional Types various functions or activities are associated with different macroinvertebrates in a stream. If a number of different types are present then this condition reflects a healthy ecosystem as compared to a stream with only a few functional types.

The following is a list of functional types:

Scraper	-scrape algae and diatoms off substrate
Shredder	-utilize coarse particulate organic matter
Collector-Gatherer	-utilize fine particulate organic matter mostly detritus or bottom material
Collector-Filterer	-utilize fine particulate organic matter filtered in water column
Predator	-pierce or engulf prey species
External Parasite	

Once you identify organisms in your sample, refer to Merritt and Cummins (1984) as to the functional type of each taxa.

Index of Similarity indicates the similarity of taxa between two communities. If one community is highly perturbed by poor water quality as compared to a reference stream

where the quality of water is satisfactory, then one would expect a low similarity (S) between the two communities or a high index of dissimilarity

$$S = \frac{2C}{A + B}$$

Where

A = number of species in sample
B = number of species in sample
C = number of species common to both samples

Abundance values are qualitative where rare is equal to 1-2 individuals in the sample, common 3-9, abundant 9-15, and very abundant greater than 15 individuals in the sample.

Additional notes

INSECT LIST

Investigator _____ Stream _____

Tray No. _____ Station _____

Date _____

Habitat Types

Taxa	Riffle-Run (gravel-sand)	Riffle-Run Rubble-Boulders	Bank Macro-phytes	Channel Macro-phytes	Undercut Banks	CPOM	Leaf Packs	Sedi-ments
Ephemeroptera								
Plecoptera								
Trichoptera								
Diptera								
Coleoptera								
Hemiptera								
Odonata								
Other								

NON-INSECT LIST

Investigator _____ Stream _____

Tray No. _____ Station _____

Date _____

Habitat Types

Taxa	Riffle-Run (gravel-sand)	Riffle-Run Rubble-Boulders	Bank Macro-phytes	Channel Macro-phytes	Under-cut Banks	CPOM	Leaf Packs	Sedi-ments
Platyhelminthes								
Oligochaeta								
Hirudinea								
Gastropoda								
Pelecypoda								
Amphipoda								
Other								

Summary of Data Evaluation

Stream_____

Metric	Station_____	Station_____	Station_____
Species Richness			
EPT Index			
Biotic Index			
Dominance			
Functional Types(%) Scrapers Shredders Collector-gatherers Collector-filterers Predators Parasites			
Index of Similarity			

EQUIPMENT

Sampling
field book
net sampler
kick screen
dip net
screen bucket
small sediment jar
ziplock bags (labeled)
ice chest
garden fork
rubber boots or waders
pencils
marking pen
meter stick
forceps
pack to carry gear

Identification
Keys to macroinvertebrates
dissecting microscope and lamp
teasing needles, forceps
glass dish
partitioned trays
squirt bottle-80% alcohol
soda water
forms

Processing
0.6 mm screen
flat tray
enamel pan
dice
tablespoon
illuminated magnifier
ice trays
squirt bottle-80% alcohol
squirt bottle-water
clicker
jars for live specimens
Saran wrap
forceps
teasing needles, small pipette

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