# Coeur d'Alene Tribe
# Fisheries Program

# Technician Training Reference Manual

A Companion Volume To
The Coeur d'Alene Tribe Fisheries Program
Research Monitoring and Evaluation Plan

November 2002

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Fisheries Program
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**A companion volume to**
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**Research Monitoring and Evaluation Plan**


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## A. Introduction & Overview

In its broadest sense, monitoring encompasses the routine measurement of environmental indicators to sense the condition and trends of functions and components of an ecosystem (Bisbal 2001). Monitoring may be conducted for a number of different purposes including baseline characterization, risk assessment, trend assessment and performance evaluation (FISRWG, 2001). Further, and more pertinent, the implementation, effectiveness and validation components of performance evaluation provide a process through which it can be determined if proper actions were taken and if these actions were effective in providing the desired results. In this document, the "actions" being monitored and evaluated are habitat restoration or water pollution (nonpoint source) control projects, and the "results" are improved habitat for fish and wildlife. The fact that improved water quality is also a "result" of habitat restoration, and that these "results" also support human "beneficial uses", are assumed corollary benefits that are not specifically evaluated by this Monitoring and Evaluation Plan.

Salmonid fishes, particularly westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and bull trout (*Salvelinus confluentus*) have been determined to be the key organisms which are desirable to provide improved habitat for on the Coeur d'Alene Reservation. Cutthroat and bull trout were two species native to the Lake Coeur d'Alene system that were important in both the sustenance and culture of the Tribe. Both species are currently of special concern regionally due to declining numbers and continued reduction of habitat (Johnson 1987, Spahr et al. 1991).

Six general classes of characteristics determine the suitability of aquatic habitats for salmonids: habitat structure, flow regime, food (energy) sources, biotic interactions, water quality and access (Johnson et al., 2001). The assessment of habitat quality and improvements in habitat are the key focal points of this Monitoring and Evaluation Plan. Habitat quality for the sake of this Plan refers to the extent to which habitat provides a suitable environment for healthy biological communities to exist. This will be determined through site-specific <u>biological assessments</u> (that is, the determination of what organisms are found to be using a habitat) and also through site-specific <u>structural assessments</u> (that is, the physical characteristics of the habitat). The evaluation of chemical characteristics at established stream and lake monitoring sites is on going by the Tribe's Water Resources Program. As a result, no additional chemical monitoring is discussed in this Plan except in constructed ponds or off channel open water areas.

The protocols and procedures described in this document represent a balance of qualitative and quantitative measures judged necessary to adequately ensure consistency, minimize observer bias, and maximize repeatability. Collectively these provide a scientifically defensible process for documenting the habitat conditions. Once field data is collected, a second set of protocols will guide the interpretation and presentation of the collected data.

The parameters described herein are applicable to specific restoration sites as indicated. A summary of the parameters to be measured is presented in **Table 1** below.

**Table 1. Coeur d'Alene Tribe Habitat Restoration Project Monitoring Parameters**

Stream channel Projects:
- Photographic documentation
- Flow (discharge)
- Channel Gradient and Habitat Typing (depth:width ratio, slope, sinuosity, entrenchment)
- Valley Cross Section Profile
- Channel Substrate (gravel, structural complexity, embeddedness, wetted area, riffle:pool ratio)
- Instream cover & food (Large Woody Debris, coarse organic matter)
- Bank /shoreline cover (composition/complexity, abundance, density)
- Canopy cover & shade
- Streambank / shoreline cover
- Biomonitoring fish
- Biomonitoring invertebrates

Pond Projects:
- Photographic documentation
- Sediment trapping
- Physical Water Quality Profiles

Riparian Projects
- Photographic documentation
- Vegetative composition

Upland Projects:
- Photographic documentation
- Woody Vegetation Survival

## 1. Stream channel Projects

**a. Photographic documentation**: Perhaps the easiest and most basic technique that can be used to show the results of habitat restoration efforts is photography. Photographs provide an excellent visual representation of conditions at given points in time and supplement data collection at monitoring sites. While photographs do not provide all the information needed to fully assess the effectiveness of restoration measures on chemical and biological components of streams, they can indicate trends in woody vegetation, streambank stability and cover (US EPA, 1993). There are also methods available for quantifying vertical vegetative cover using photographs and a "profile board" to provide scale (Meyers, 1987). The ability to extract useful information from a photograph will depend on: the photo subject, the quality of the image, proper storage of the image, knowledge of the photo's existence, and the ability to retrieve and view the image (Osprey Environmental Services, 1996). This manual addresses project documentation using only ground-based photography.

Photography as a monitoring tool has become increasingly easy due to advances in camera technology. In particular, the use of digital cameras allows rapid viewing of photographs (both on the camera and on a computer) and also the possibility of attaching a description to each photo. The camera currently in use by the Tribe is the Nikon COOLPIX 950. This is a fully automatic camera with a motor-driven 3x optical zoom which is connected to both an optical viewfinder and an LCD display. Using the automatic focus and exposure control (which includes a flash) produces good, consistent results in virtually all outdoor conditions (Nikon Corporation 1999).

Photographic documentation requires careful planning to provide meaningful information on conditions and trends. Consistency is necessary to assure that photographs taken over time are comparable and this can be achieved through the use of "photo points". The establishment of permanent photo points is based on the presence of either monitoring sites or other points of interest (see below). Photo points should include permanent vertical and horizontal landmarks (such as points on the horizon) whenever possible, so that the scene can be relocated by a different observer. All photo points shall be located using GPS and their coordinates and a description shall be logged into a project data base. Placement of photo points should anticipate the growth of vegetation and the potential for obscuring future views.

The subjects for photo documentation include some required items and some that are optional. All required photos shall be taken from established photo points while optional photos may or may not. All photos taken for monitoring of restoration features must be logged on **Data Form 1. Photograph Log Form**, a copy of which appears in **Appendix A**.

The required photo subjects are:

- Sampling sites (cross sections) for measuring physical and biological parameters,
- Stream channel at upstream end, downstream end and mid-reach of fish survey reaches (one photo looking upstream from mid-channel at the downstream end, one photo looking downstream from mid-channel at upstream end and two photos looking both up and downstream from mid-channel at the mid-reach point),
- Permanent benchmarks, including photo point locations,
- Habitat improvement sites.

Other optional but recommended photograph subjects are:

- Defining characteristics of site or reach,
- All major barriers/obstructions,
- Riparian characteristics,
- Other important habitat components,
- Typical or atypical channel morphology,
- Evidence of bank failure, scouring, major debris or sediment movement events,
- Fish and wildlife uses,
- Other bank features (*e.g.*, undercuts, flood signs, height, slope, texture),
- Substrate characteristics,
- Land uses near site.

In order to further avoid confusion or errors in identifying or filing photographs, a dry-erase marking board will be placed in the view of photographs taken for monitoring purposes whenever possible. The optimum size for this board is 18" x 24". The board must be close enough to the camera to be readable in the view and must be held so the sun is not directly shining on it. On this board will be the following information:

- Date,

- 7-digit location identifier,
- Photo point number (if photo is taken from a photo point), and
- Direction (compass heading) of the view,
- Any pertinent explanatory information.

It is recommended that photographs be downloaded into an appropriate Fisheries Program computer, and the camera's "memory card" emptied, at the end of each day of photographic work. However, as long as the **Photograph Log Form** has been filled out completely as each photo was taken, daily downloading is not a necessity. It is important, however, to keep track of the amount of memory space remaining on the camera "memory card" so that there is enough space for planned photographs.

At the time that digital photographs are downloaded into a computer, each should be given a descriptive file name so that they can be properly filed and retrieved. Until this is done, there will be only a generic file name assigned by the camera attached to the photo file. The protocol for file naming of photographs is as follows. The first seven digits will be the location identifier described in section B. 5. above. The next six digits are for the date with two digits each for month, day and year and these being separated by periods. The next two or four digits indicate if the photograph was taken from a "photo point" (PP) and the number of that photo point, or at a "miscellaneous point" (MP). The final two digits are the sequential exposure at that point on that date. For example, the following photo file name would indicate that this was the second photo taken at photo point #4 on July 23, 2002 at location L_UG0101:

L_UG0101_ 07.23.02_PP04_02

All downloaded photographs will be saved on the designated Fisheries computer and a duplicate of each will be saved on a regularly backed up directory of the Tribe's MIS or GIS network system. All monitoring photographs will be cataloged primarily by site (either restoration or reference / index) and secondarily by date.

The following few points relate to general camera operation. Camera equipment should be kept, clean, dry and at moderate temperatures. Take precautions against dust, grease and scratches on the delicate coating of the lens by always replacing the lens cap when not taking photographs. Don't risk damage to equipment by over-enthusiastic cleaning -- remove dust and fingerprints using a soft, clean, lint-free cloth. Avoid knocks to the camera as this can cause delicate components to move out of alignment. Camera equipment should be transported in padded cases. Cameras are not waterproof unless they are underwater cameras, and even then they are guaranteed only to certain water depths. Avoid getting non-underwater equipment wet. Wipe off any water drops from the surface of the camera before they seep into the joints.

Photographs of channel features should include an item for scale, such as a surveyor's rod, meter stick, or other graduated rule in the view near the primary subject of the photo. If none of these are available, a person should be included in the photograph as a guide to scale. While the dry erase board may work for this purpose, if the primary subject of the photo is more than 40 feet from the camera, it may not be possible to read the board.

Close-up photos may be taken of fish, invertebrates, small plants, or substrate. These should also include an item for scale: a small scaled ruler; a survey notebook that includes a ruler on its cover; or a coin, pen or other easily-recognizable item. Ruled scale items are more useful than non-ruled items. Keep the scale item in the same plane as the subject. Close-up photos are not expected to have the dry-erase board included in the view.

The equipment needed for photographic documentation of stream channel restoration and monitoring sites is as follows:

- Digital camera (with spare memory card, spare batteries, carrying case),
- 18" x 24" Dry erase board & markers,
- Compass (with line-of-sight arrow or mirrored cover, in increments of 1°),
- Notebook with **Photograph Log form**, blank write in the rain paper and pencil.

Complete the **Photograph Log form** for each photograph taken for habitat restoration monitoring with the following information:

- Date,
- Location (using seven-digit identifier),
- Photo point number (if photo is taken from a photo point),
- Direction of view,
- Notes on subject(s) of the photo

**b. Flow (discharge)**: In this section, two protocols, referred to as "Velocity-Area Procedure" and "Neutrally-Buoyant Object Procedure" (both adapted from USEPA 2001), involve measurements that allow the calculation of the amount of water that is moving past a point per unit of time. This is determined in the "Velocity-Area Procedure" by measuring the velocity of the water in units of 'feet per second' within portions or intervals of a cross section based on depth and width that are measured in units of 'feet' (parts of a foot are measured in 'tenths of a foot'). The actual discharge calculation will be performed in the office and is the multiplication of the velocity, width and depth readings for each portion or interval of the cross section and the addition of all portions or intervals. The final measurement units are in cubic feet per second. The "Neutrally-buoyant Object Procedure" is presented as an alternative to be used only in small, shallow streams where the "Velocity-Area Procedure" cannot be applied. In either case, streamflow is measured at one cross section within each monitored stream reach.

The equipment needed for streamflow determinations using the Velocity-Area Procedure and the Neutrally-buoyant Object Procedure is as follows:

- Flexible 50 - 100 foot measuring tape marked in units of 'feet' and subdivided into units of 'tenths of a foot',
- Price Model 625 velocity meter ("Pygmy" meter), Teledyne Gurley Model 1100 digital Flow Velocity Indicator (with connecting cable) and a top-setting wading rod,
- Neutrally-buoyant object (piece of wood, small orange or other),
- Two - two foot long wooden or metal (rebar) stakes and hammer,
- Watch with second hand,

- Calculator,
- Hip or chest waders,
- Notebook with **Data Form 2. Streamflow Data**, blank write in the rain paper and pencil,
- Equipment carrying case or five gallon bucket.

Information on calibration and use of the Price Model 625 velocity meter and Teledyne Gurley Model 1100 digital Flow Velocity Indicator is presented in Rantz 1983.

"Velocity-Area Procedure": Because water velocity and depth vary across the width of a stream, accuracy is achieved by measuring velocity and area of many intervals across a channel. Typically, 15 to 20 intervals are necessary to provide the desired accuracy. In narrow streams the interval width should not be less than four inches (0.3 feet). It is important to choose a channel cross section that is as much like a canal as possible. Other qualities that help make streamflow measurements accurate are depths mostly greater than six inches and velocities mostly greater than 0.5 feet per second, with no eddies, backwaters or excessive turbulence. A straight run or glide area with a "U" shaped cross section that is free of obstructions provides the best conditions for measuring discharge by this velocity-area method. Note that obstructions may be removed from the channel to make the flow measurements easier but this must be done before any depth or velocity measurements are made and not as you proceed across the stream taking measurements.

Before beginning the collection of velocity and depth readings, pound the two stakes into the ground just outside of the wetted portion of the stream channel (solid and stable tree trunks or bush stems can be used if present). Stretch the measuring tape across the channel perpendicular to the direction of flow and secure it tightly to the stakes so that it is tight and approximately one foot above the water surface. The zero end of the tape should be towards the left bank of the stream (as viewed facing downstream).

Set up **Data Form 2.** (see **Appendix A**) for the streamflow cross section by recording the following:

- Location (stream name, reach name, station identifier),
- Technicians names,
- Date,
- Time,
- Weather,
- Measurement reading that is above the left and right waters edge.

Subtract the left edge reading from the right and record the width of the wetted channel. Divide the wetted width by 20 and round the result up to a convenient number; this is the interval for depth and velocity measurements (for example, if the wetted width is 13 feet, dividing by 20 equals 0.65 feet so the interval width would be 0.7 feet). Again, for narrow streams (less than about five feet) use an interval width of 0.3 feet even though there may be less than 15 intervals across the width.

Assemble the flow meter on the wading rod and connect the cable between the meter and the Velocity Indicator as described in Appendix A. Check the spin of the meter; it should spin freely in air for about 45 seconds after a flick of the finger.

Stand downstream of, and facing, the suspended measuring tape at the side of the first interval (closest to the left bank when facing downstream). With the velocity meter raised up about one foot place the wading rod on the stream bottom at the left edge of the stream; record in **Data Form 2.** the following:

- Distance from edge (which will be zero at the edge),
- Depth of water (may be zero at the edge),
- Velocity (may be zero at the edge).

To determine the velocity, lower the meter carefully into the water to a depth of 0.6 times the total depth at that point, as indicated on the wading rod (for example if the depth is 0.4 feet, the measurement depth equals 0.4 x 0.6 or 0.24 feet). Face the flow meter propeller upstream at a right angle to the cross section alignment (even if local flow eddies cause water to hit at oblique angles to the cross section). Wait about 30 seconds for the meter to equilibrate with the flow and then read the velocity readout on the Indicator. Be sure that the velocity units in the readout are in 'feet per second' (F/S). Record the velocity on the Data Form.

Move to the next interval and repeat the depth and velocity measurement steps. Use the suspended tape and wading rod to determine the location of each interval's depth and velocity measurements, and record each measurement after it is made. Continue across the stream until the right edge is reached at which point the depth and velocity may again equal zero. Note that depth and/or velocity can equal zero at any point(s) along the cross section and this should be recorded as such on the Data Form.

"Neutrally-Buoyant Object Procedure": This protocol is to be used only where the previous method will not work due to shallow water or the presence of obstructions in the selected cross section. The measurements taken in the neutrally-buoyant procedure are mean flow velocity and cross-sectional area of the flow, so this is basically very similar to the "Velocity-Area Procedure". Mean flow velocity is estimated using a floating object (for example an orange, stick or leaf; something that floats just at the water surface but does not project up above the water surface) and timing its movement along a measured length of the stream channel. The channel cross sectional area is determined from a series of depth measurements along one or more cross sections.

Before beginning the collection of velocity and depth readings select a segment of the monitored reach that is deep enough to float the neutrally-buoyant object freely and long enough that it will take between 10 and 30 seconds for the object to travel the length. Measure the length of the segment along the shore with the tape and record this on **Data Form 2.** under

- Float Distance.

Using the stopwatch, measure the time it takes for the object to travel the length of the segment on three successive tries. Record on **Data Form 2.** as:

- Float time.

If the channel width or depth changes substantially within the segment, measure widths and depths at three cross sections, one near the upstream end of the segment, one in the middle and one near the downstream end. If there is little change in the channel, measure widths and depths at a single "typical" cross section within the segment. At each cross section, measure the following using the measuring tape and the wading rod and record on **Data Form 2.**:

- Wetted width,
- Water depth at five equally spaced intervals along the cross section

**c. Channel Gradient & Habitat Typing**: This effort involves the measurement of the water surface elevation and width and stream channel bottom elevation along the entire study reach (modified from Peck et al., 2001). This involves the use of a surveyor's level and rod. Operating and note taking procedures for this equipment are described by Harrelson et al 1994. Since the reach will most likely be longer than can be seen from a single level setup, it will also be necessary to use turning points as described below. Also included in this protocol is the determination and documentation of the various habitat types along the reach.

Longitudinal "Thalweg" Profile: "Thalweg" refers to the flow path of the deepest water in a stream channel. The longitudinal thalweg profile is a survey of the stream bottom and water surface elevations along the entire monitoring reach. The optimum reach length for all stream longitudinal profiles has been determined to be 500 feet. With this length there will be a series of 50 measurements collected every 10 feet along the stream, plus measurements at the boundaries between stream habitat types. Data from this survey will allow calculation of the proportion of all habitat types, channel sinuosity, and channel complexity. This procedure will also establish the upstream end of the monitored reach as well as the locations of cross sections that will be used for monitoring other stream characteristics. It is advantageous to have GPS equipment available to document the location of the downstream and upstream ends of the stream reach.

The equipment needed for channel gradient determination using the longitudinal "Thalweg" Profile procedure is as follows:

- Surveyors level and tripod,
- Surveyors rod (in units of feet and tenths of a foot),
- Hip chain with string,
- Two-way radios
- Two foot long wooden stakes and hammer,
- Notebook with **Data Form 3**, blank write in the rain paper and pencil,
- Calculator,
- Hip or chest waders.

The level operator sets up and levels the level on the tripod next to the stream and within view of the downstream end of the reach (preferably within 200 feet). Then, starting at that downstream end of the reach, the rod carrier attaches the hip chain string to a rock or other stationary object at the downstream end of the study reach and resets the counter. The rod carrier then measures the "wetted width" of the stream, which is from waters edge to waters edge perpendicular to the channel. This can be done by placing the base of the rod at one waters edge and laying it down so that the distance to the opposite waters edge can be measured. This distance is reported to the level operator for recording in the survey notebook (it may be helpful to use two-way radios for these communications). The rod holder also reports what habitat type (riffle, pool, run/glide or side channel/shallows) is present at that location. Definitions of the habitat types are provided in **Table 2**. The rod holder then holds the rod vertical and probes the stream to determine the deepest point across its' width (using the water surface as a guide). At the deepest point the rod holder holds the rod still for the level operator to take a reading. The level operator must acknowledge with a hand or voice signal that he/she has the reading before the rod holder moves the rod. The stream channel bottom elevation at this location (the downstream end of the reach) is assumed to be 100.00 unless the actual elevation is known, and the base elevation should be noted in the level operator's notes.

After the level operator has recorded the rod reading for the stream bottom, the rod holder raises the rod so that the base of the rod is at the water surface. As soon as the lever operator has taken this reading he/she again acknowledges that the reading is taken and recorded. The rod holder then moves upstream until he/she reaches a boundary between habitat types, or 10 feet (whichever comes first), to the next reading location (cross section). The distance counter on the hip chain is used to determine distance along the thalweg.

**Table 2. Stream habitat type descriptions (from IDEQ 1999).**

| Habitat type | Description |
|---|---|
| Riffle | A portion of the stream with swiftly flowing, shallow water. The water surface in a riffle is turbulent and this is caused by completely or partially submerged obstructions. Cascades are one class of riffle characterized by swift current, exposed rocks and boulders, considerable turbulence and stepped drops over steep slopes. Riffle areas with standing waves are called rapids. |
| Pool | A portion of the stream with reduced current velocity (average velocity is generally less than 1 foot per second), and often, but not always, with water deeper than surrounding areas. Pools usually have flat water surfaces with no surface agitation and often the bottom is concave such that it would hold water if there was no flow. Pools usually occur at outside bends in the channel and around large obstructions. Water impounded upstream of channel blockages, typically a log jam or beaver dam, is classed as a dammed pool. Pools end where the stream bottom approaches the water surface and this is also known as a "pool tailout". |
| Run / glide | A portion of the stream with moderate to swift velocity and without surface agitation (runs display "laminar" or uniform flow patterns). Runs and glides typically occur immediately upstream and downstream of riffles. Pool tailouts are typically classed as runs in small high-gradient streams. Glides also occur where the channel widens allowing the stream to shallow and slow. Glides are most commonly found in low gradient streams associated with elongated pools. |
| Shallows or side channels | A portion of the stream where side channels enter or leave the main channel and shallow, border areas used by young fish. |

At each 10-foot interval and each change in habitat type, a stream wetted width is measured, rod readings of the stream bottom deepest point and water surface are taken and notes are made of the observed habitat type (riffle, pool, run/glide, or shallow/side channel) or the presence of a boundary. Notes for boundaries should include the downstream habitat type and then the upstream type (for example "pool/run boundary"). Wetted width is measured across and over any mid-channel bars, boulders or other obstructions. If mid-channel bars are present their width should also be measured and recorded. If there is a side channel entering the main channel at the cross section location, this should also be noted. If the water at a cross section is too deep to stand in and hold the rod vertical to get a direct depth measurement, extent the rod to the deepest point and take a "depth measurement" (the reading where the water surface crosses the rod) and also estimate the angle that the rod is held to reach that point (using zero degrees as horizontal and 90 degrees as vertical). Both this "depth measurement" and rod angle must be provided to the level operator to be recorded. The rod reading of the water surface should then be taken as usual.

The level operator should maintain a running tally of the actual stream bottom and water surface elevations (in addition to the rod readings) as the rod holder moves along the stream. For the initial level setup this involves adding the initial rod reading to 100.00, which is the assumed elevation of the bottom at the lower end of the reach, to obtain a "height of instrument" or "HI". All subsequent rod readings at this setup location are subtracted from the HI to obtain the elevation of the base of the rod (either stream bottom or water surface). As the level is moved to continue to see the rod as it is moved up the channel, it will be necessary to establish a "turning point" so that the elevation base (100.00) can be used throughout the reach. The turning point is where the rod holder holds the rod on a fixed point after a level reading is taken so that the level can be moved and take a second reading on the same point. This serves to transfer the 100.00 base elevation to all other reading taken after the turning point. Either the stream bottom or a rock on the shoreline can be used for the turning point but not the water surface.

At six locations along the length of the reach the rod holder should place a temporary stake or surveyors flagging (or both) on each side of the stream above the wetted stream level to mark the approximate location of cross sections for follow-up monitoring. The temporary markers should be placed at 50 feet, 130 feet, 210 feet, 290 feet, 370 and 450 feet from the downstream end of the reach. These cross sections will later be adjusted so that they are located in habitat types proportionally to the percentage of habitat types seen in the entire reach (see section **d. Valley Cross Section Profiles**, below).

Add together all measured lengths and calculate the difference in water surface and stream bottom elevation from beginning to end and record on **Data Form 3 (see Appendix A)**:

- Total stream length in reach (should be 500 feet),
- Overall water surface elevation difference (measured in feet or tenths of a foot),
- Overall channel bottom elevation difference.

The longitudinal profile slope is determined by dividing the "overall water surface elevation difference" by the "total stream length" and this calculated value should be entered on **Data Form 3**.

Add together the total length of each habitat type and indicate the totals on **Data Form 3**:

- Total of each habitat type.

Add together all wetted stream widths and divide this total by the number of width measurements and indicate this on **Data Form 3**:

- Average wetted width (feet),
- Maximum wetted width,
- Minimum wetted width.

**d. Valley Cross Section Profiles**: This protocol will provide information on the shape and elevations of the stream channel "bankfull" area and the adjacent "flood prone area". This information is necessary to complete the determination of channel type for each monitoring reach. The cross section profile will be determined at (or near) the six locations that were staked and flagged during the "thalweg" profile work described in the previous protocol.

The term "bankfull" refers to the flow that fills the channel to the top of it's banks at that point where water begins to spill out onto floodplain (Rosgen, 1996). This generally corresponds to the US Army corps of Engineers field interpretation of "ordinary high water" which is expected to occur every one to two years. The "bankfull stage" refers to the elevation where overflow occurs. The bankfull stage and its corresponding flow are regular enough to serve as consistent indices that can be related to the formation, maintenance, and dimensions of the channel as it currently exists. Unfortunately the location of the bankfull level is not always evident, certainly not often can this be found on both sides of the channel. **Table 3** presents some criteria for identifying the bankfull level.

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**Table 3. Criteria for the identification of the bankfull level in the field (from Leopold, 1994).**

1. The point bar is the sloping surface that extends into the cannel from the convex bank of a curve. The top of the point bar is at the level of the floodplain because floodplains generally result from the extension of point bars as a channel moves laterally by erosion and deposition through time.
2. The bankfull level is usually marked by a change in vegetation, such as the change from bare gravel bar to forbs, herbs or grass. Shrubs and willow clumps are sometimes useful but can be misleading. Willows may occur below bankfull stage but alders are above bankfull, In Idaho the lichens on rocks changes species and thus color at bankfull level. In ephemeral channels the bankfull stage is marked by changes of plant species.
3. There is usually a topographic break at bankfull. The streambank may change from sloping bar to vertical bank. It may change from a to a horizontal plane on top of the floodplain. The change in topography may be as subtle as a change in the slope of the bank.
4. Bankfull is often registered by a change in the size distribution of materials at the surface, from gravel to fine cobbles, from sand to gravel or even finer material. It can change form fine to coarse or coarse to fine but a change is common.
5. Even more subtle are changes in the debris deposited between rocks, such as the amount of leaves, seeds, needles, or organic debris. Such indicators are confirmation rather than primary evidence. Flood-deposited debris alone should not be trusted.

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Because of the importance that bankfull flow has in shaping and controlling the stream channel character, the stage or elevation of bankfull discharge (flow) is considered to be the single most important parameter used in stream type classifications (Rosgen 1996). The bankfull channel width is required to estimate two of the five primary criteria needed to determine stream type using the Rosgen process; that is width to depth ratio and entrenchment ratio. The bankfull elevation and width will be determined by surveying the six cross sections in each monitoring reach.

By comparison, "flood prone area" or "flood plain" is the widest extent that the stream channel gets and it is associated with the infrequent, high magnitude flood discharges (Rosgen 1996). While it is desirable to have the valley cross sections include the full extent of the flood prone area this will not be possible in all areas. The limits on the flood prone area surveying are described below.

The equipment needed for the Valley Cross Section Determination is as follows:
- Surveyors level and tripod.
- Surveyors rod (in units of feet and tenths of a foot),
- Hip chain and string
- Compass
- Calculator with memory function
- Two way radios
- Wooden survey stakes, rebar, surveyors ribbon and hammer
- Survey notebook with **Data Form 4**, blank write-in-the-rain paper and pencil.
- GPS unit (optional).

The key to locating the cross sections is be sure that they are distributed as equally as possible to the proportion of all primary habitat types found in the reach. Thus, if there were found to be 50% riffles and 50% pools in the reach, three of the cross sections should be in riffle habitat and three in pool habitat. If the reach was comprised of 50% riffles, 30% pools and 20% runs or glides, the distribution of cross sections should be three in riffle habitat, two in pool habitat and one in run habitat. If a habitat type occupies less than 20% of the total it should not have a cross section placed through it. So, once the distribution of habitat types is known (and recorded on **Data Form 3**) the initial (temporary) cross section locations must be adjusted as necessary to match this distribution. This adjustment can be performed as the survey crew proceeds upstream during the cross section survey work. It may be that none of the cross section locations will need to be moved and it should not be necessary to move the first one or two cross sections as these can be used to meet the desired proportion no matter what habitat type they are in.

Once the permanent location of each cross section has been determined, a permanent "reference point" should be established on each cross section at a point above the bankfull stage height where the most bankfull area width can be seen. This point can be either on the right or left bank but must be described in the surveyor's field notes and monumented using a rebar driven into the ground, surveyor's flagging and, if possible, a coordinates reading using a GPS unit. It is from this reference point that the cross section profile will begin for this initial survey and all subsequent surveys.

The level and tripod should be set up and leveled on the reference point and the survey notebook should be set up according to the guidelines presented in Harrelson et al. 1994. It is important to have the level be above the bankfull stage height so that it will not have to be moved during the bankfull area surveying. When the level is ready, the alignment of the cross section must be determined using the compass. This involves standing facing the stream channel and estimating a line extending across the channel, perpendicular (90 degrees) to the stream channel alignment. It may help to hold your arms out straight to your sides parallel to the line of the stream and sight on an object that is straight ahead of you.  Use the compass to determine the heading to that object (in degrees) and record this in the survey notebook.  The level operator then uses the compass to set the level on the alignment of the cross section.

Starting at the reference point, the rod carrier ties the end of the hip chain string to the point marker (rebar) and resets the hip chain distance counter.  The rod holder then follows the cross section compass heading as directed by the level operator, and gives the level operator shots on the rod to describe the channel cross section.  This will include shots at all changes in the slope of the land surface across the stream channel as well as at both edges of the water in the stream and at the deepest spot in the wetted stream (that is, on the thalweg).  The level operator's rod readings must be made while the rod is being held stationary and vertical on the ground surface, and the rod must be held in this manner until the level operator indicates that he/she is finished with that reading.  The distance that the rod is from the level must be read from the hip chain counter at each reading point and told to the level operator so this can be recorded in the survey notebook.

The intersection of the stream thalweg and the cross section line is very important as the level reading at this point is used to establish the "height of instrument" (HI).  As soon as this rod reading has been taken, the level operator can begin to calculate the heights of all other level readings by subtracting the other readings from the HI reading.  The result of this calculation is the height (in feet) that the land surface is above the thalweg point.  The level operator should calculate these heights as each shot is recorded and this can be done using the memory function on the calculator.

When the channel cross section is complete and the rod carrier has proceeded to a point that is above the bankfull level on the far side of the stream, a second reference point should be established on the cross section line.  This, again, involves driving a rebar into the ground, attaching surveyors flagging and taking a GPS coordinates reading (if available).

Then the rod carrier may either continue with the survey along that same alignment across the flood plain or return to survey the flood plain on the side of the channel that the level is on.  In either case, the survey must include both sides of the channel with level shots on the ground surface at 10-foot intervals plus at all changes in the ground surface slope.  In re-establishing the direction of the cross section on the side of the channel that the level was first set up on remember to add or subtract 180 degrees from the original compass reading to establish the opposite reading.

In areas of the cross section where an obstruction blocks the view of the level to the rest of the cross section, or when the ground surface rises above the view of the level, it will be necessary to use a turning point and relocate the level to the far side of the obstruction or higher up on the slope.  As described in the longitudinal profile discussion, section **c. Channel Gradient & Habitat Typing**, above, this involves taking a reading on the rod, moving the level while the rod is left in place, and taking a second reading on the rod.  The new HI will reflect the original thalweg point when the turning point rod reading is subtracted from the original HI (which gives the height of the ground at the turning point) and then by adding the second rod reading.  All subsequent rod readings are subtracted from the new HI to obtain the ground surface height as before.

The process of relocating the level is complicated on the cross sections by the need to remain on the cross section alignment. It may be possible for the rod carrier to use the compass to direct the level operator onto the cross section line from the turning point but the level operator may still not be able to see through (or above) the obstruction to take the second rod reading. It may therefore be necessary to make an additional offset turning point. This would involve taking the second rod reading from the level set up a measured distance to the side of the rod (90 degrees off the cross section alignment) and then moving the rod parallel to the cross section line until it is past the obstruction for a second turning point. The second rod reading from this second turning point could then be taken from the level set up back the measured distance onto the cross section alignment. If this procedure is followed, it will be necessary to record the offset distance and distance on the parallel line in addition to the level readings and calculated heights. Be sure not to move the rod from the turning points before the level operator has taken and recorded the second reading. When using the hip chain for measuring these offset distances be sure to attach the string to something (or have the level operator hold it after the level is set up) and to subtract each side move distance from the counter total that is recorded in the survey notebook as distance along the cross section.

Finally, surveyor's flagging should be attached to a stationary object or placed on the ground to mark the rod reading points. This flagging is important because it will mark the cross section location for the riparian vegetation survey that is described in section **3. b. Vegetation Composition**, below.

One of the objectives of this cross section survey effort is to find the height of the flood prone depth and the total flood prone width. The flood prone height is calculated as two times the bankfull height as **Figure 1**. The elevation of "flood-prone area" is defined as twice the maximum depth at bankfull; so the cross section survey must include both the maximim depth (which is the thalweg) and also the bankfull indicators, as described above. In situations where the bankfull height is apparent it will be possible to determine flood-prone area elevation precisely in the field and survey out to this elevation on both sides of the channel and thus measure the flood prone width. In narrow valleys where the flood-prone elevation can be found, this will be the outer end of the cross sections. In broad, relatively flat valleys, it may not be practical to survey out to the full flood prone width so this will have to be determined from a topographic map. In these cases a maximum of 200 feet from the stream channel will be considered the end of the cross section.

Set up **Data Form 4.** (see **Appendix A**) and use this for recording survey notes for the valley cross sections:

- <u>Location (Monitored Reach)</u>
- <u>Reference elevation of Benchmark(s)</u>
- <u>Height of Instrument (HI)</u>
- <u>Foresights</u>
- <u>Backights (for turning points)</u>
- <u>Elevations (relative to the Bench Mark)</u>

Use the bottom part of the form to calculate the flood-prone elevation and <u>width:</u>

- <u>Flood-prone area elevation</u>
- <u>Flood-prone area width</u>

Following the completion of the survey of all six cross sections, it will be necessary to plot each in the office. This will be done using a computer and a copy of the Reference Reach Spreadsheet. This spreadsheet has many capabilities but the primary use is to produce a cross section plot and various channel dimensions using survey data. The plot will help expose the bankfull height (or confirm field observations) and allow calculation of the stream channel type criteria discussed in the next section.

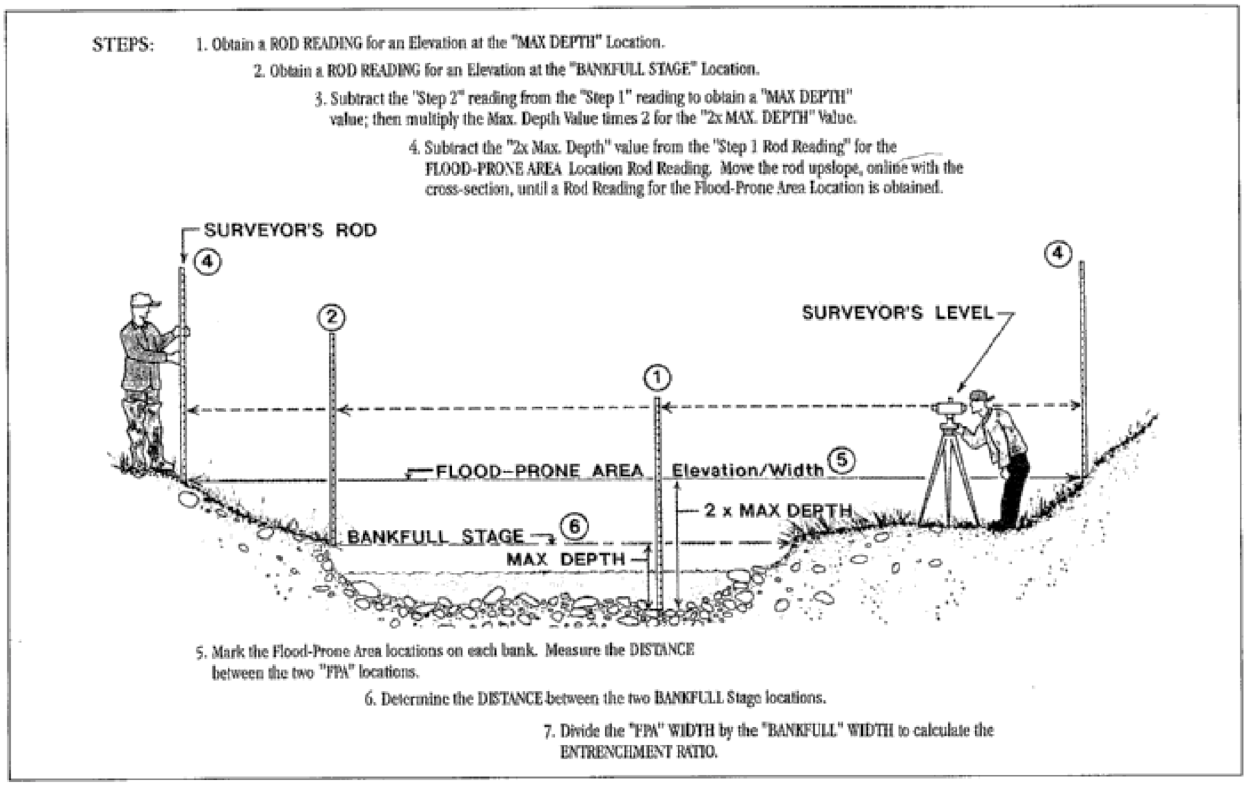


**Figure 1. Determination of "flood-prone area" elevation and width during channel cross section surveys (from Rosgen 1996).**

**e. Channel Type Classifications**: The classification of stream channel types will follow guidelines presented by Rosgen (1996) and will use data collected in sections **c. Channel Gradient** and **d. Valley Cross Section**, above. The objective of classifying streams on the basis of channel morphology is to use discrete categories of stream types so that consistent, reproducible descriptions can be developed. These descriptions must provide a consistent frame of reference to document changes in the stream channels over time and to allow comparison between different streams. The differenct Rosgen classifications are described in **Table 4**.

**Table 4. General stream type descriptions and delineative criteria for broad-level classification (from Rosgen 1996).**

| Stream Type | General description | Entrenchment ratio | W/D ratio | Sinuosity | Slope | Landform/soils/ features |
|---|---|---|---|---|---|---|
| Aa+ | Very steep, deeply entrenched, debris transport streams. | < 1.4 | < 12 | 1.0 to 1.1 | > 0.10 | Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls. |
| A | Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel. | < 1.4 | < 12 | 1.0 to 1.2 | >0.10 | High relief. /erosional or depositional and edrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology. |
| B | Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks. | 1.4 to 2.2 | >12 | >1.2 | 0.02 to 0.039 | Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools. |
| C | Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains. | >2.2 | >12 | >12 | <0.02 | Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology. |
| D | Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. | n/a | >40 | n/a | <0.04 | Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion. |
| DA | Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and W/D ratios. Very stable streambanks. | >2.2 | highly variable | highly variable | <0.005 | Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed geologic control creating fine deposition with well vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment. |

| | | | | | | |
|---|---|---|---|---|---|---|
| E | Low gradient, meandering riffle/pool stream with low W/D ratio and little deposition. Very efficient and stable. High meander width ratio. | >2.2 | <12 | >1.5 | <0.02 | Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well vegetated banks. Riffle/pool morphology with very low W/D ratios. |
| F | Entrenched meandering riffle/pool channel on low gradients with high W/D ratio. | <1.4 | >12 | >12 | <0.02 | Entrenched in highly weathered material. Gentle gradients with a high W/D ratio. Meandering laterally unstable with high bank erosion rates. Riffle/pool morphology. |
| G | Entrenched "gully" step/pool and low W/D ratio on moderate gradients | <1.4 | <12 | >1.2 | 0.02 to 0.039 | Gullies, step/pool morphology with moderate slopes and low W/D ratio. Narrow valleys or deeply incised in alluvial or colluvial materials, I.e. fans or deltas. Unstable, with grade control problems and high bank erosion rates. |

Entrenchment Ratio: Entrenchment ratio is estimated as the typical flood width divided by the bankfull channel width. Bankfull width, or the stream volume at bankfull stage, is determined by the elevation of the top of the "highest depositional feature"; this could be a change in size distribution of substrate or bank particles, a break in the slope of the bank or a stain on rocks in the bank. The bankfull width may not be always evident but should be able to be identified somewhere within the reach, at least on one side of the channel. Flood width is frequently not evident, especially where floodplain features have been obscured by agriculture or other human activities. However, flood width has been defined by Rosgen as the width at the elevation that is twice the maximum bankfull depth.

Subtract the bankfull height reading from the maximum depth reading to obtain the estimated bankfull depth. Multiply the bankfull depth by 2 and subtract this value from the Maximum depth reading to obtain the flood depth reading. Record this on **Data Form 5 (see Appendix A)**:

- Entrenchment ratio for each cross section,
- Average entrenchment ratio for monitored reach.

Width to Depth Ratio: Stream channel width to depth ratio is determined for bankfull discharge condition. It is advantageous for permanent cross sections to be established for long term monitoring of this characteristic. Using the previously determined "bankfull width" and "bankfull depth", calculate width to depth ratio by dividing the width by the depth for the cross section and enter the result on **Data Form 5**:

- Width to depth ratio for each cross section,
- Average width to depth ratio for monitored reach.

Sinuosity: The sinuosity of a stream reach is estimated as the ratio of the stream channel length to the direct basin length. Rosgen (1996) describes this procedure for the entire stream basin but the procedure also applies to a monitored stream reach. Use a 1:24,000 map or orthophoto and a ruler, or GIS map in measure option or GPS to measure the length of the basin as the straight line distance from the where the stream enters the study reach to where it leaves the reach.

Use the "total stream length" in the study reach that was measured for the longitudinal thalweg profile (this should be 500 feet) and calculate the sinuosity by dividing this length by the reach length. The result should be entered in **Data Form 5**:

- <u>Sinuosity for the monitored reach</u>,

<u>Stream Classification</u>: The Rosgen stream type classification is determined using the results of the longitudinal profile (slope), average entrenchment ratio, average width to depth ratio and sinuosity analyses described above. These calculated characteristics should be compared to the stream type descriptions presented in **Table 2** and the most appropriate stream type (closest match) should be entered on **Data Form 5**:

- <u>Rosgen stream channel type for the reach</u>.

**f. Channel Substrate**: Stream channel bed and bank materials influence the cross section, plan and longitudinal profile of the stream. The assessment of bed and bank materials also provides insight into sediment transport along the stream. Most important, however, substrate materials size is a key determinant of habitat character for fish and macroinvertebrates. In addition to individual particle size, substrate embeddedness is the degree to which larger particles are surrounded or covered by fine sediment. Fine sediment can fill the "interstitial" spaces between the larger particles (boulders, cobbles or pebbles) and block water flow that is an important aspect of good stream habitat.

The equipment needed for the Channel Substrate assessment is as follows:

- Pointed measuring stick or pole marked in units of feet and tenths of a foot
- Survey notebook with **Data Form 6**, blank write-in-the-rain paper and pencil.

<u>Substrate</u>: The protocol outlined below is a modification of the pebble count method described by Wolman (1954). The modified method accounts for both bank and in-channel material, for rock, sands and smaller particle sizes and for bedrock. The modified method also adjusts the material sampling locations so that various bed features are sampled on a proportional basis along a given stream reach. This requires that the Longitudinal Thalweg Profile has been completed and that the six cross sections have been established and are distributed as equally as possible to the proportion of all primary habitat types found in the reach. The number of profile intervals where riffles, pools or runs were seen forms the proportion for the substrate sampling as described in **Section d**. above.

The pebble count substrate analysis is to be performed along the six cross sections set up within the monitored reach. At each cross section the actual substrate materials are determined at 20 points across the cross section. These points are to be spaced as uniformly as possible across the channel, between left bank bankfull height and right bank bankfull height. At each of these points the measuring stick is placed on the substrate and the particle that is at the base of the stick is picked up (if possible) and measured. To avoid potential bias in the size of particle chosen for measurement, each particle should be selected based on a blind touch of the stick; that is, do not look to see where the stick is aimed. This is best done by stopping at the area where a particle is to be samples and looking to one side while letting the stick drop onto the substrate.

Following the original method, particle size is determined as the length of the "intermediate axis" of the particle; that is the middle dimension of its length, width and height. With this in mind, the substrate size classes that will be recorded are presented in **Table 5.**

**Table 5. Stream channel substrate particle size classes (from Rosgen 1996).**

| Class Name | Size Range* | Description |
|---|---|---|
| Silt/Clay | <0.062 mm | Silt / Clay |
| Sand | 0.062 - 0.125 mm | Very fine sand |
| " | 0.125 - 0.25 mm | Fine sand |
| " | 0.25 - 0.50 mm | Medium sand |
| " | 0.50 - 1.0 mm | Coarse sand |
| " | 1.0 - 2.0 mm | Very coarse sand |
| Gravel | 2.0 - 4.0 mm | Very fine gravel |
| " | 4.0 - 5.7 mm | Fine grave |
| " | 5.7 - 8.0 mm | Fine gravel |
| " | 8.0 - 11.3 mm | Medium gravel |
| " | 11.3 - 16.0 mm | Medium gravel |
| " | 16.0 - 22.6 mm | Coarse gravel |
| " | 22.6 - 32.0 mm | Coarse gravel |
| " | 32.0 - 45.0 mm | Very coarse gravel |
| " | 45.0 - 64.0 mm | Very coarse gravel |
| Cobble | 64.0 - 90.0 mm | Small cobble |
| " | 90.0 - 128 mm | Small cobble |
| " | 128 - 180 mm | Large cobble |
| " | 180 - 256 mm | Large cobble |
| Boulder | 256 - 362 mm | Small boulder |
| " | 362 - 512 mm | Small boulder |
| " | 512 - 1024 mm | Medium boulder |
| " | 1024 - 2048 mm | Large - very large boulder |
| Bedrock | >2048 mm | Bedrock |

* Measured as median dimension, not largest or smallest)

Record the particle size classes for each cross section on **Data Form 6**:

- Substrate particle size class

Embeddedness: Embeddedness is the fraction (percent) of a particle's surface that is surrounded by (buried in) sand or finer sediments on the stream bottom. This technique is simple to conduct although the visual assessment of embeddedness is not highly accurate (Bain & Stevenson 1999). However, it is not known what level of embeddedness is optimal for many fish species so a course estimation is considered sufficient. If in doubt about the percent of embeddedness that is being observed, use a ruler and calculator to make a more accurate determination.

Conduct the embeddedness assessment after taking the particle size measurement in the center (1/2 of the width) of each of the six substrate cross sections. This is performed on all particles within a radius of six inches around the substrate sampling point (the tip of the measuring stick). For particles larger than sand, pick up the particle (if possible) and examine their surfaces for stains, markings or algae that indicate the surface of fine particles. Estimate the percent of these particles that is buried in fine material. If it is not possible to pick up the larger particles (either because they are too large or heavily buried in fines) it will be necessary to dig into the fine substrate materials to obtain an estimate of percent embedded. By definition, sand and fines alone are embedded 100% and bedrock or hardpan are embedded zero percent.

Record the estimated embeddedness for each of the six substrate cross sections on **Data Form 6**:
- Embeddedness (%)

**g. Instream Cover & Food**: Organic debris plays an important role in the character and productivity of stream habitats. Organic debris ranges in size from barely visible decomposing plant parts to whole trees. Streamside vegetation and its contribution to streams is an integral part of aquatic ecosystems while human input or removal of woody material also can have significant effects on streams. Large pieces of debris can augment habitat by providing structure for fish shelter as well as pools for resting and feeding. Fine organic inputs (leaves and needles) may serve as the primary source of organic carbon in the nutrient budget of streams. Organic matter is commonly described in four size categories: dissolved organic material less than 0.02 inch in diameter, fine particulate matter between 0.02 and 0.09 inch in diameter, coarse particulate matter greater than 0.1 inch but less than four inches in diameter and large woody debris greater than four inches in diameter. The monitoring performed under this Plan will focus on the inventory of the two larger size classes modified from methods described by Platts et al. (1987).

This survey of monitored stream reaches is an inventory of the number and size of individual pieces of woody material observed along a longitudinal transect through the reach. For the Large Woody Debris (LWD) this data will be converted into volumes of material so it will be necessary to collect data on the lengths and diameters of the material to allow this calculation. Tree root wads will be tallied separately as these typically provide additional habitat benefits because of their size and complexity. For this protocol the definition of a root wad is that it is dead, that it is detached from its original position, that it has a diameter where the tree trunk meets the roots of at least eight inches and that it is less than six feet long from the base of the root ball to the farthest extent of the trunk (Schuett-Hames, 1999).

The equipment needed for the Instream Organic Debris inventory is:
- Calipers or yardstick divided in feet and tenths of a foot or meters and centimeters.
- Survey notebook with **Data Form 7**, blank write-in-the-rain paper and pencil.
- Directional compass
- GPS unit

The organic debris survey transect will be a walked along the thalweg starting at the downstream end of the reach.  All coarse material that crosses the line of the thalweg shall be counted and recorded on Data Form 6.  All LWD (organic material that is greater than 4 inches in diameter at the small end) shall be tallied and measured whether or not it crosses the line of the transect.  While this should include material that is suspended above the water surface and may extend outside of the wetted stream width, it is not intended to include living trees or shrubs that may hang over the water.

For all observed LWD, orientation shall be noted by taking a compass heading (degrees) looking from the large end of the piece towards the small end.  Other measurements to be taken of all LWD are the diameter at the large end, diameter at the small end and the length between these two ends. The small end diameter will not be less than four inches even though the LWD may have parts that are less than this.  The length will be of the portion that is greater than four inches diameter.  The large end diameter shall be measured immediately above the roots, if there are roots attached.

Since root wads are especially important, these will be tallied separately as to their presence, their location (using GPS if possible) and whether they are connected to (part of) a piece of LWD (for example the rest of the tree) that is more than six feet long.   If a root wad is connected to part of a tree but is less than six feet long overall, it is considered to be "not connected".  The diameter of root wads (whether or not they are the large end of a piece of LWD) should be at least eight inches just above the roots.

This assessment requires that the observer determine when course debris that crosses the transect is connected to the same unit (branch or plant).  For example, whether one twig or 10 twigs of a single branch cross the transect, the tally would only indicate one item.  This is especially important when small branches or even roots that cross the transect are actually part of a large tree that fits within the large woody debris category (that is, has a small end diameter of at least four inches).  In this case, the large unit would need to be measured and recorded as LWD even though the larger portion (that portion with a diameter greater than 4 inches) did not actually cross the transect.  (In the case of a whole tree the length would be measured between the large end and the point where the diameter was four inches.)

Record a mark (tally) for each course organic material piece (0.1 to 3.9 inches in diameter) that crosses the transect on **Data Form 7**:

- Course pieces

Measure and record the presence of all LWD on **Data Form 7**:

- Small end width
- Large end width
- Is large end a root wad?
- Length between large and small ends
- Orientation to line of channel
- GPS coordinates of large end

Record information on the presence of tree root wads on **Data Form 7**:

- Diameter just above roots

- Connected / Not Connected
- GPS coordinates
- Located within wetted width?

**h. Streambank / shoreline cover**: Streambanks are important transition zones between aquatic and terrestrial systems. When in good condition and well vegetated, these areas provide cover and refuge for both fish and wildlife. Human and natural disturbances reduce bank vegetation, resistance to erosion, structural stability and fish cover value. This, in turn, causes increases in sediment loading and water temperature, which further reduces habitat use. Streambank restoration measures are instituted to return the stream corridor to a well vegetated and stable condition with cool and clear water. Bank condition is assessed by evaluating cover provided by shoreline vegetation and by the shape of the bank itself. Measurement of streambank angle and undercutting reflects erosion rates and stability, but this is also relevant for documenting the undercut habitats used by many fishes. Riparian canopy cover over streams is important not only for its role in moderating stream temperatures through shading, but also as an indicator of conditions that control bank stability and the potential for inputs of course and fine organic material. As indicated in the previous section, organic inputs from riparian vegetation become food for stream organisms and structure for complex channel habitat.

The equipment needed for the Bank / shoreline cover and stability assessments is:
- Convex Spherical Densiometer (Model B) taped to limit grid intersections to 17
- Clinometer
- Surveyors rod
- Survey notebook with **Data Form 8**, blank write-in-the-rain paper and pencil.

Canopy Cover: Vegetative canopy cover (or shade) is determined using a Conical Spherical Densiometer, Model B as described by Platts et al. (1987, see **Figure 3**). The Densiometer determines relative canopy "closure" or canopy density, depending on how the readings are taken. This monitoring will be only for canopy density which is the amount of the sky that is blocked within the closure by vegetation. Canopy density can change drastically through the year if the canopy vegetation is deciduous.

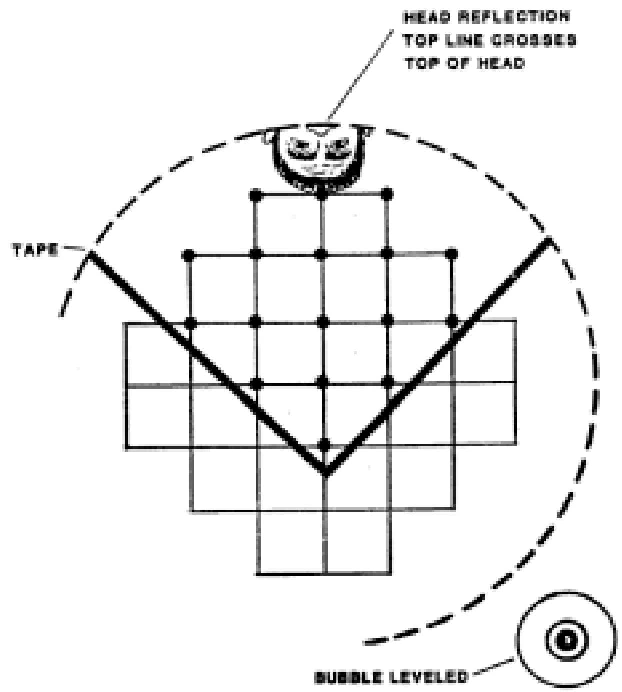


**Figure 2. The concave spherical densiometer (from Platts et al. 1987).**

Canopy cover over the stream is determined at each of the six cross sections established during the longitudinal thalweg survey. At each cross section, densiometer readings will be taken at the following locations: once standing at the water's edge facing the left bank, once facing upstream at the middle of the channel, once facing downstream at the middle of the channel and once standing at the water's edge facing the right bank.

Record the number of densiometer grid intersection points that are covered with vegetation (maximum of 17 at each reading location) at four locations across each of six stream cross sections on **Data Form 8**:

- Number of points covered at each reading location

**i. Biomonitoring Fish**: Monitoring of fish populations has been and will continue to be a primary focus of the Tribe's natural resource management efforts. This importance stems from the Tribe's traditional reliance on the fishery for sustenance, and consequently is an important part of the Coeur d'Alene people's cultural heritage. More generally, the importance of fish population monitoring is reflected in the aquatic life use-support designations of many states (Barbour et al., 1999). Narrative expressions such as “maintaining coldwater fisheries”, “fishable” or “fish propagation” are prevalent in state standards. Assessments of fish populations must measure the overall structure and function of the fish community to adequately evaluate biological integrity and protect surface water resource quality. Fish bioassessment data quality and comparability are assured through the utilization of qualified fisheries technicians and consistent methods.

The Rapid Bioassessment Protocol (RBP) for fish presented in this manual is directly comparable to RBP V in Plafkin et al. (1989). The principal evaluation mechanism utilizes the technical framework of the Index of Biotic Integrity (IBI), a fish assemblage assessment approach developed by Karr (1981). The IBI incorporates the "zoogeographic", ecosystem, community and population aspects of the fish assemblage into a single ecologically-based index. Calculation and interpretation of the IBI involves a sequence of activities including: fish sample collection; data tabulation; and regional modification and calibration of metrics and expectation values

From Barbour et al. (1999, Chapter 3) the advantages of monitoring fish communities include:

- Fish are good indicators of long-term (several years) effects and broad habitat conditions because they are relatively long-lived and mobile.

- Fish assemblages generally include a range of species that represent a variety of trophic levels (omnivores, herbivores, insectivores, planktivores, piscivores). They tend to integrate effects of lower trophic levels; thus, fish assemblage structure is reflective of integrated environmental health.

- Fish are at the top of the aquatic food web and are consumed by humans, making them important for assessing contamination.

- Fish are relatively easy to collect and identify to the species level. Most specimens can be sorted and identified in the field by experienced fisheries professionals, and subsequently released unharmed.

- Environmental requirements of most fish are comparatively well known. Life history information is extensive for many species, and information on fish distributions is commonly available.

- Aquatic life uses (water quality standards) are typically characterized in terms of fisheries (coldwater, coolwater, warmwater, sport, forage). Monitoring fish provides direct evaluation of "fishability" and "fish propagation", which emphasizes the importance of fish to anglers and commercial fishermen.

- Fish account for nearly half of the endangered vertebrate species and subspecies in the United States.

The collection or observation of a representative sample of the fish assemblage is essential, and fish monitoring procedures must address all habitat types in a sampled stream reach. However, effort should be made when setting up monitoring reaches to avoid regionally unique natural habitat. Each sampled reach should contain riffle, run and pool habitat, when available. Whenever possible, monitoring reaches should be located sufficiently upstream of any bridge or road crossing to minimize the hydrological effects on overall habitat quality. Other aspects of habitat assessment should be performed and physical parameters measured concurrently with fish sampling to document and characterize available habitat specifics within the monitored reach.

Alternatives for the designation of fish monitoring reach length include either fixed distance or proportional distance options. From Barbour et al. (1999) the fixed-distance designation involves a standard length of stream that may be used to obtain a representative sample. Conceptually, this approach should provide a mixture of habitats in the reach and provide, at a minimum, duplicate physical and structural elements such as riffle/pool sequences. As examples, 100 meter (328 feet) set reaches are used in Massachusetts and 150 to 200 meter (490 to 656 feet) reaches are used in Ohio. The proportional-distance designation involves using a standard number of stream channel "widths" to measure the stream study reach. For example, 40 times the stream width is defined by the EPA Environmental Monitoring & Assessment Program (EMAP) for sampling fish populations. This approach allows variation in the length of the reach based on the size of the stream. Application of the proportional-distance approach in large streams or wadeable rivers may require the establishment of sampling program time and/or distance limits (for example no more than 3 hours of electrofishing or 500-meter reach per sampling site.

<u>The Tribe's fish population monitoring protocols, which are described below, are based on a fixed-distance reach length of 200 feet to correspond with existing Tribal methods used at fish population index sites</u>. This reach length is a continuous length (not broken up according to habitat units) and shall be included within the 500-foot reach length described in the longitudinal profile section of this manual. The fish monitoring reaches should begin and end at a similar habitat unit (preferably at flow barriers such as at the downstream ends of a pools) and as close as possible to the prescribed 200 foot reach length. Fish monitoring reaches shall be measured, flagged and the ends GPS located prior to the actual sampling (or observation in the case of snorkeling). During sampling/observation both upstream and downstream ends of the sampling reach must have nets placed across the channel to prevent fish from entering or leaving the study reach.

This manual describes two fish sampling protocols: electrofishing and snorkeling. Electrofishing involves using an electrical current generator to shock (stun) fish that are then collected, measured and released. Snorkeling is the direct observation (but not collection) of fish in their habitats by divers floating along the water surface.

While all fish sampling methods can be considered selective to some degree, electrofishing is considered to be the most comprehensive and effective single method for collecting stream fishes. Some of the reasons for this are that electrofishing allows greater standardization of catch per unit of effort, it is appropriate in a variety of habitats and it is generally less selective than seining (collecting fish with nets) for different fish species (Barbour et al., 1999). However, sampling efficiency can be affected by turbidity and conductivity in the water (as these affect the flow of electricity) and certain fish species behavioral and anatomical differences (especially size) determine their vulnerability to electrofishing. Electrofishing is also a hazardous operation that can injure field personnel if proper safety procedures are not followed. Pulsed DC (direct current) is the electrofishing method of choice as described below.

Snorkeling has the advantage of being the least disruptive and logistically simplest way of documenting fish populations in the field. Typically, swimmers float at the surface using masks and snorkels, fins and wet suits recording information on slates or cuffs. Snorkeling is effective for obtaining data on abundance, distribution, habitat preferences and behavior of fishes in many habitats (Helfman, 1983). Snorkeling has the obvious limitation that water clarity must exceed the water depth and also fish (particularly small or bottom dwelling species) are hard to observe in areas with heavy vegetation or dark bottoms. Further, estimating fish lengths and species from a distance involves inherent errors.

Fish population monitoring should be performed once per year at a minimum and the recommended time of year for sampling is during July and August (Hayslip, 1993). It is also important to note ambient temperature (air and water) and weather conditions at the time of fish collection on the field data form. With either electrofishing or snorkeling, the upstream and downstream ends of the sampling reach must be netted to prevent fish from entering or leaving the reach.

Electrofishing: The following protocol is taken from Peck et al., 2001 with additional equipment considerations from the electrofisher manuals (Smith-Root, Inc. 1993).

To collect fish by electrical means it is necessary to establish an electrified zone in the water of sufficient strength to stun fish. To accomplish this, an electric current produced by a backpack generator is passed between submerged electrodes. When a fish is between these electrodes, it forms part of the closed circuit through which the current flows. This current can frighten, lead, stun or damage the fish. When a fish comes in contact with an electrical current (DC or pulsed DC) it tends to turn toward the anode and will start to swim toward it until it reaches it or encounters an electrical field strong enough to stun it. Pulsed DC, which is obtained by interrupting a steady DC current with an electronically controlled switch, has a greater anode attraction than continuous DC. Fish stunned by the electrofisher will usually float to the surface where they can be collected using dip nets and placed in buckets or a livewell for temporary storage until they can be measured and released.

The following protocol describes the basic operating procedure for using the Smith-Root Type VII-POW backpack electrofisher; the complete operating instructions are described by Smith Root (1993). The units used by the Tribe are powered by either a battery or by gas driven generator that is also attached to a pack frame, the total unit weighing about 30 pounds. As a safety feature, these units must have a tilt switch to shut off the power if the unit is tipped more than 45 degrees from vertical. In addition the backpack frame is constructed of an insulating material (fiberglass) and has an emergency release to quickly separate the operator from the equipment.

These electrofishing units utilize two electrodes. The cathode is a wire that is insulated for four feet from the unit and then bare for four feet that hangs off the back of the unit into the water. The anode is a circular metal ring attached to a six-foot long insulated pole that is held out in front to the operator and attracts the fish. The anode pole has a switch that must be pressed to allow electricity to flow to the anode.

The Type VII-POW electrofisher contains the capability of generating a number of different electrical outputs (POW means "programmable output waveforms"). The results of controlled electrofishing studies indicate that "current density" is the electrical parameter most directly related to the effects of electricity on fish. Current density is greatest near the anode and decreases rapidly with distance from the anode. High current densities will kill fish, moderate densities will stun them and low densities will allow them to escape. The objective of this effort is, as stated above, to stun and collect the fish.

Different species and sizes of fish have difference tolerances to electrical current. Because a fish has resistance, a given current density received at one end of its body will result in a lowered density at the other end, producing a voltage gradient in the fish. Voltage gradients of 0.1 to 1.0 volts per centimeter are most effective for stunning fish and this range of gradients can be maintained in typical fresh waters (those having an electrical conductivity of 100 to 500 μmhos per cm) by adjusting circuit voltage to produce a current of three to six amperes (Reynolds, 1983). With these typical conditions, the voltage setting on the electrofisher should be between 500 and 800 volts (Peck et al., 2001). In waters where strong-swimming fish are expected (that is, fish longer than about eight inches) use a pulse rate of 30 Hertz (Hz) with a pulse width (time) of two milliseconds (msec). If mostly smaller fish are expected use a pulse rate of 60 to 70 Hz (Peck et al., 2001).

In addition to the electrofisher operator, one or two people with long handled non-conductive dip nets are needed to collect stunned fish. NEVER ELECTROFISH ALONE AND ALWAYS WEAR INSULATED GLOVES AND WADERS! Other safety considerations are listed below.

The equipment needed for the fish collection by electrofishing is:

- Backpack electrofisher (either battery or gas powered) with 2 hand-held electrodes mounted on fiberglass poles, one positive (anode) and one negative (cathode)[Smith Root, Inc. Type VII-POW]
- Dip nets
- Block nets (2, 1 cm mesh)
- Elbow-length insulated waterproof gloves
- Chest waders (equipped with felt soled boots)
- Polarized sunglasses
- Buckets/livewells
- Fish identification key
- Measuring board (500 mm minimum, with 1 mm increments)
- Scale (battery powered, 1,200 gram capacity, 0.1 gram increments)
- Numbered 'spaghetti' tags and inserter
- Fish scale envelopes
- Tape measure (100 ft minimum)
- Thermometer with pocket case (0° to 50°C range, in 1°C increments)
- Survey notebook with **Data Form 9**, blank write-in-the-rain paper and pencil.
- First aid kit

Prior to starting fish collection set up the two block nets across the channel at the upstream and downstream ends of the sampling reach. These must be anchored securely to the channel bottom and be supported above the water surface as well.

Fish collection using electrofishing begins with a "calibration run" downstream of the sample reach. With all safety gear on, the sampling crew enters the water, starts the electrofisher, sets the timer and presses the switch on the anode pole to start shocking. As the operator walks slowly along the stream in an upstream direction, he/she swings the anode pole slowly from side to side bringing the anode within three feet of all areas of the sampled habitat unit. If fishing success is poor, increase the pulse width first and then the voltage. Increase the pulse rate last to minimize mortality or injury to large fish. If mortalities do occur, first decrease the pulse rate, then voltage then pulse width.

Once the settings of the electrofisher are adjusted properly to sample effectively and minimize injury to the fish, begin the sampling at the downstream block net. With the anode power switch pressed, slowly sweep the anode pole from side to side while moving in an upstream direction, as described above. Shock close to (within three feet of) cut bank areas and also snags found in the sampled habitat unit. Fish sampling using electrofishing can be improved by using an intermittent process; it is better not to move through the water with the shocker power on continuously but rather to fish primarily in likely habitat. Fish can be extracted from areas of heavy cover by inserting the anode into the cover with the power off, pressing the power on switch and withdrawing the anode (and attracted fish) slowly towards a netter. In wide streams work from the middle of the channel towards the banks and in stretches with deep pools fish the margins as much as possible being careful not to step or slide into deep water. Keep the cathode wire near the anode if fish catch is low.

The netter(s), using short-handled (four foot, fiberglass) dip nets, follow closely beside the operator with the net held within a foot or two of the downstream side of the anode. A bucket is carried by each netter for netted fish to be placed in with water.

Immediately after completing the first pass through the fish monitoring reach all collected fish should be processed. The minimum processing for all captured fish includes measuring length (in millimeters), weight (in grams) and clipping the dorsal fin. For fish that are 200 mm or more in length a "dart" tag is attached near the dorsal fin, the code number for this tag recorded and scale samples are collected. After processing, all fish are released outside of the study reach enclosure.

The procedure for collecting fish scales is that presented by Jearld (1983). Only scales from particular areas on a fish are suitable for aging. The area generally used for bass and trout species is the middle of the side of the body just below the dorsal fin. Before collecting scales, mucus, dirt and epidermis must be removed from the sampling area by wiping or gently scraping in the direction of the tail with the blunt side of a knife. Then, scales are loosened by a quick, firm scraping motion in the direction of the head using the sharp side of a knife. Insert the knife blade with the collected scales on it into an opened and labeled paper scale envelope and press the envelope closed over the blade as it is withdrawn. Scale envelopes should be pre-stamped with a blank label so that date, fish length, weight and species abbreviation and tag number can be recorded.

Fish population estimates require that a minimum of two shocks be made through the study reach. In addition, if the catch from the second pass is greater than 50% of the first pass a third and fourth pass must also be made. These additional passes ensure that all fish within the study reach are collected and documented.

Complete **Data Form 9** after each pass through the sampling reach:
- Ambient temperature (air and water)
- Weather conditions

- <u>Total electrofishing time and total shocking time</u>
- <u>Anode configuration</u> (shape, diameter)
- <u>Shocking details</u> (wave form, volts, watts, amps, pulse rate and pulse width)
- <u>Fish collected</u> (species, length, weight, fin clipped/tagged, recapture fin clipping/tag number)

Additional safety considerations for electrofishing: Considering the electrical current and voltage used in electrofishing, and the fact the electricity is being transmitted throughout the water in which the sampling crew is standing, there are a number of important safety considerations that must be followed. The following key points are taken from the Smith-Root equipment manual that is included in Appendix A:

- There must be a minimum of two properly trained people for every stream electrofishing crew.
- All electrofishing personnel shall receive training in the fundamentals of electricity and safety.
- All crew members shall wear linemans gloves which are 5000 volt minimum rated.
- No crew member shall reach into the water near either electrode ever if gloves are being worn.
- Hip boots or chest waders with non-skid soles must be worn by all crew members; and if any crew member gets water in their boots/waders they shall immediately leave to stream and obtain dry gear.
- The electrofisher operator shall make sure that all other personnel are clear of the anode before turning on the power and shall be constantly aware of netters in the anode area.
- All crew members shall be especially careful in turbid water where it is difficult to see the stream bottom and any obstacles or drop-offs.
- Operate slowly and carefully, most falls occur when crew members are hurrying …

<u>Snorkeling</u>: As indicated above, direct observation of fish populations using snorkeling techniques has certain advantages over fish collection methods. However, added training or experience is necessary to work underwater to accurately identify fish species, to estimate their lengths and to accurately record observations.

The following protocol is taken from Thurow (1994) and this method typically involves one or two observers (snorkelers) to count all fish in a single pass through a stream reach or habitat unit. From Thurow (1994), there are several criteria that should be strictly adhered to for this method to be used appropriately. These criteria are:

- Water clarity: snorkeling should occur when underwater visibility is greater than about 10 feet and in no case should snorkeling occur when the visibility is less than the maximum depth of the sampled stream.
- Minimum temperature: snorkeling should be conducted when water temperature is greater than 9° C (50° F).
- Minimum depth: the depth must be at least sufficient for the snorkeler to completely submerge his/her dive mask.
- Lighting: snorkeling should occur when the sun is out and directly overhead (from late morning to early afternoon).
- Timing: snorkeling should occur between the stabilization of streamflows in late June and the onset of cooler water temperatures in September. It is during this period that fish travel is minimal and counts can be the most reliable.

The primary fish population estimate that is obtained through snorkeling is the direct enumeration (counting) of all fish present in a sampling area. This requires that the snorkeler(s) search for fish throughout the sampling area, including along stream margins and cover components (woody debris, boulders, undercut banks etc.). This can be accomplished by one snorkeler who zig-zags from bank to bank or by multiple snorkelers who each inspect a portion of the stream width. With two snorkelers it is recommended that they stay close together near the middle of the stream, concentrate their attention on the area between themselves and the nearest bank and only count fish that they pass.

If it is not possible to directly inspect the entire width of a fish monitoring area, due to limited visibility or turbulence for example, an "expansion estimate" can be made to estimate the total population of fish in the reach. This involves snorkeling homogeneous section(s) of the stream habitats, determining the surface area surveyed (which would be based on the extent of visibility) and the total surface area of the reach. The fish count for each species and size increment can then be divided by the percent of the stream surface area that was surveyed to give an estimate of the total population of fish. This technique would add a high degree of error to the population estimate, however.

The primary aspects of training that can significantly improve fish population estimates using snorkeling are fish identification and fish length estimation. Basic identification training should involve familiarization with expected fish species by reviewing drawings or photographs. Perhaps more beneficial is to have an experienced trainer point out various fish during an actual in-the-water training session. The need for good lighting conditions to clearly show fish colors and shapes is the reason that the late morning-early afternoon time frame is recommended for snorkeling.

For the length determination it is important to realize that objects viewed underwater are magnified approximately 30% so a six inch (15 cm) long fish would appear about eight inches (20 cm) long. Training in length determination should include in-the-water work estimating the lengths of known objects (dowels, fish models etc.) that are suspended in the water. It is also possible to note a stationary object in the water near a fish and actually measure the object using a short ruler carried by the snorkeler. To simplify the length estimation process, specific length intervals will be used as indicated on **Data Form 9**.

There are a variety of options for recording data while underwater. These involve using a clipboard with underwater paper, a writing cuff that is worn on the snorkelers forearm and a writing scroll with polyester drafting film (Helfman, 1983). In each option a ruler and pencil sharpened at both ends is attached to the media to avoid their being lost. The preferred method for snorkeling work performed by the Coeur d'Alene Tribe is the writing cuff because it allows the snorkeler to have both hands free. The writing cuff is an eight to nine inch (15 to 20 cm) section of four inch diameter thin walled, dark colored PVC pipe or conduit. The surface of the pipe is lightly roughened with sandpaper for easier writing. After a survey or when the cuff is full of writing, all notes must be transferred to **Data Form 9** and the cuff cleaned using scouring powder. The cuff can be fitted with length of surgical tubing which is threaded through three pairs of holes driller through the pipe near one end. Each pair of holes is equidistant from the other two pairs so that the tubing forms a triangle inside the pipe through which the snorkeler's arm is passed (see Helfman, 1983). Again, a pencil is attached to the cuff with a string that allows writing on all parts of the cuff and a ruler is glued along the edge of the pipe.

As with other field monitoring efforts snorkeling work should not be performed alone. If only one snorkeler is in the water at a time, there should be someone nearby to provide help as needed. This is a safety consideration but is helpful for data recording and other tasks.

The equipment needed for the fish collection by snorkeling is:
- Dive gear: wetsuit with hood, gloves & booties, fins, mask, snorkel, 10 - 20 pound weight belt
- Thermometer with pocket case (0° to 50°C range, in 1°C increments)
- Writing cuff with pencil & ruler (in 1 cm increments)
- Scouring powder (for cleaning writing cuff)
- Fish identification key
- Block nets
- Survey notebook with **Data Form 9**, blank write-in-the-rain paper and pencil.
- First aid kit

Prior to starting the snorkeling effort, set up the two block nets across the channel at the upstream and downstream ends of the sampling reach. These must be anchored securely to the channel bottom and be supported above the water surface as well.

Each monitored reach must be completed in a single pass through the reach so more than one snorkeler may be needed depending on the water clarity (visibility). Visibility should be determined once a snorkeler is suited up and in the water by looking to from one bank to the opposite bank; if it is not possible to see from one bank to the other, additional snorkelers will be needed. <u>If you cannot see the stream bottom across the entire width of the stream it is too turbid or too deep to survey using snorkeling</u>.

Start at the downstream end of the monitoring reach and work upstream. If one snorkeler is used, scan the water column from side to side while slowly swimming upstream. Zig-zag from side to side as needed to inspect around all obstructions in the channel and record the species and estimated length of all fish observed. If two snorkelers are used, they should stay close together in the center of the stream and scan only to their respective sides of the stream. If one snorkeler must change course to inspect around an obstruction, the second snorkeler should wait for the first to come back to the center of the stream before proceeding upstream. If more than two snorkelers are used all should swim at the same speed and divide each observation area so that fish can not pass between any two divers unobserved.

Complete **Data Form 9** after completing each monitoring reach or when writing cuff is full:
- <u>Ambient temperature</u> (air and water)
- <u>Weather conditions</u>
- <u>Underwater visibility</u> (feet)
- <u>Fish observed</u> (species & length)

**j. Biomonitoring Macroinvertebrates**: "Macroinvertebrates" are a group of animals that have no backbone but a hard external covering ("exoskeleton"). Macroinvertebrates are small but large enough to be seen without magnification and be retained on a 0.02 inch (US #30) screen (Bain & Stevenson, 1999). Benthic macroinvertebrates inhabit the sediment or live on the bottom substrates of streams, wetlands, ponds and lakes. Benthic macroinvertebrate species (referred to as 'populations') typically have a patchy distribution in streams, that is, their abundance varies by the location in a stream based on favorable combinations of physical and chemical conditions (Plotnikoff, 1998).

A community is a grouping of several macroinvertebrate populations. The population assemblages reflect the overall biological integrity of the benthic community and monitoring these assemblages is useful in assessing the status of the water body and discerning trends. Analysis of the benthic macroinvertebrate community provides direct evaluation of stream ecosystem condition. Community attributes (characteristics) address the type and quality of available food, physical stream channel condition and riparian condition.

From Barbour et al. (1999, Chapter 3) the advantages of monitoring benthic macroinvertebrates include:

- Macroinvertebrate assemblages are good indicators of localized conditions. Because many benthic macroinvertebrates have limited migration patterns or a sessile (attached to the bottom) mode of life, they are particularly well suited for assessing site-specific impacts.

- Macroinvertebrates integrate the effects of short-term environmental variations. Most species have a complex life cycle of approximately one year or more. Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.

- Macroinvertebrates are relatively easy to identify to family; many "intolerant" species can be identified to lower taxonomic levels with ease.

- Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects.

- Sampling is relatively easy, requires few people and inexpensive gear, and has minimal detrimental effect on the resident biota.

- Benthic macroinvertebrates serve as a primary food source for fish, including many recreationally and commercially important species.

Monitoring of the benthic macroinvertebrate assemblage is most frequently performed using the Rapid Bioassessment Protocols (RBPs) developed by the USEPA. The original RBPs (Plafkin et al. 1989) emphasized the sampling of a single habitat, in particular riffle/run habitat, as a means to standardize assessments among streams having those habitats. This approach is still valid because macroinvertebrate diversity and abundance are usually highest in cobble substrate (riffle/run) habitats. Where cobble substrate is the predominant habitat, this sampling approach provides a representative sample of the stream reach. However, some streams naturally lack cobble substrate.

In cases where cobble substrate represents less than 30% of the sampling reach in reference streams alternate habitat(s) will need to be sampled (Barbour et al., 1999). The appropriate sampling method should be selected based on the habitat availability of the reference condition and not of potentially impaired streams.

The objective of the Coeur d'Alene Tribe benthic macroinvertebrate monitoring is to evaluate the biological integrity of wadable streams within habitat restoration areas and reference stream reaches. To accomplish this, two protocols, modified from Peck et al. (2001) are presented: a "targeted riffle" sampling and a "reach-wide" sampling. The targeted riffle sampling is focused on riffle areas only (if no riffles are present, no sample is collected) while the reach-wide sampling is performed at the five monitoring cross sections established for the channel characterization (thalweg profile) effort described in section **C. Channel Gradient,** above. Both protocols will use a rectangular kick net to collect the samples and both protocols will involve compositing (combining) the individual sub-samples. Sample compositing and preservation is described in the Sample Processing section below.

The equipment needed for the benthic macroinvertebrate sample collection is:

- Rectangular kick net, 12 inch x 18.5 inch opening with 48 inch handle, net mesh opening of 200 micrometers (μm) and sieve bucket with 500 micrometer (μm) opening mesh
- Sample bucket (2 gallon) with lid
- Sample bottles (250 mL, 500 mL and 1 L), sample bottle labels
- Forceps (tweezers)
- Standard sieve with 200 μm mesh opening
- Survey notebook with **Data Form 10**, blank write-in-the-rain paper and pencil.
- 95% ethanol
- Plastic tape (electrical tape)
- Waders (chest-high or hip boots)
- Rubber gloves (arm-length)

Field Sampling Protocol for Targeted Riffle Sampling: Before sampling, survey the stream reach to estimate the total number and size or length of riffle habitat "units" in the study reach. This survey can also be done by reviewing field notes used to complete the Stream Gradient & Habitat Worksheet (**Data Form 3**) for the reach. To be considered as a "unit" the area of a riffle must be larger than 1.5 square feet (the area of a single kick net sample). Poorly represented habitats should not be sampled so if a reach has less than 7.5 square feet of riffle habitat (the area of five kick net samples) do not collect a targeted riffle sample. If there is more than one distinct riffle unit in the reach but less than five units, it will be necessary to collect more than one sample per unit. Conversely, if there are more than five units it will be necessary to spread the sample site throughout the reach as uniformly as possible.

Begin sampling at the most downstream riffle unit and continue upstream sampling units as they are encountered to minimize instream disturbance. At each riffle unit, visually define a core area to locate the sample site in. The core area should avoid edges along the channel margins and upstream / downstream edges. The optimal buffer between the edge and the core area is three feet wide. In some cases, the riffle unit may be so small that is will not be feasible to avoid an edge and this should be noted on **Data Form 10**.

At each riffle unit to be sampled, visually divide the core area into nine equal area sub-units (a three by three grid) and randomly select one of the nine sub-units to sample. While this process is somewhat imprecise, the object is to not sample the same relative position within the unit every time. Make a note of the predominant substrate type and determine if there is sufficient flow to use the kick net; if no, randomly pick up ten submerged rocks from the sub-unit area and wash all organisms directly into the sample bucket. Note that the sample was collected "by hand" on **Data Form 10**.

The kick net procedure starts with securing the sample cup to the opening in the net and checking to make sure that there are no organisms or other material in the net. Then, place the bottom of the kick net (the side of the frame opposite the handle) quickly and securely on the stream bottom so it is perpendicular to the direction of flow and minimizes gaps between the frame and the stream bottom. The mesh net should be spread out downstream of the frame. Visually define the area to be sampled, which is the width of the kick net frame and a distance upstream of the frame equal to the height of the kick net opening.

While one person holds the kick net in place, the second person picks up any loose rocks or substrate materials that are larger than golf ball sized and more than half inside the sample area. Use hands or a small scrub brush to dislodge any organisms so that they are carried into the net and then place the scrubbed material outside the sample area. Large rocks or other materials that are less than halfway into the sampling area should be pushed outside of the sample area. Then, still holding the kick net firmly in place, one person vigorously kicks the remaining material <u>within the sample area for 30 seconds</u>. It is helpful if the person who is holding the net in place help with the timing.

As soon as the kicking is completed, lift the kick net out of the water being careful not to let material (especially organisms) float out. Holding the kick net handle and frame horizontal, dip the net in the stream several times to remove fine sediment and to concentrate the organisms in the sample cup. Carefully remove the sample cup and pour it into the sample bucket, then use a wash bottle filled with stream water to rinse the net and the cup and wash any organisms into the bucket. It may also be necessary to use the forceps (tweezers) to pick any organisms that are clinging to the net or cup and place them in the bucket.

Place the lid on the sample bucket and move to the next sample site. A total of five samples will be collected and all collected organisms will be composited in the sample bucket. Complete **Data Form 10** after collecting each sample:

- <u>Nearest cross section and distance up- or downstream</u>
- <u>Sample collection using kick net or by hand</u>
- <u>Sample location within 3 x 3 grid</u>
- <u>Predominant substrate type (silt, sand, gravel, cobble, other)</u>
- <u>Was sample collected within three feet of an edge?</u>

Proceed with processing of the composite sample (see below).

Field Sampling Protocol for Reach-wide Sampling: In this protocol, a kick net sample is collected on each of the six cross sections that were established during the stream channel characterization (thalweg profile) effort. At each cross section the habitat type (riffle, pool, run etc. as described in **Table 2**) and predominant substrate (silt, sand, gravel, cobble etc. as described in **Table 5**) must be noted.

The location of the sample on the cross section must be determined and noted on the Data Form. This location is referred to as "left", "center" or "right" with left being 25% across the wetted channel from the left bank (looking downstream), center being in the middle and right being 75% across from the left bank. The location of the first cross section sampled is determined randomly by looking at a watch and if the minute hand is pointing between 12 and 4 go to the left location, if it is between 4 and 8, go to the center and if it is between 8 and 12 go to the right. After the first sample is collected use a sequential spacing proceeding from left to center to right to left etc. Note that at sampling locations assigned a "center" point where the stream is less than two net widths wide, pick either a "left" or "right" location instead. If the stream is only one net wide at a cross section, place the net across the stream and indicate that the sampling point is "center". It the sampling point is located in water that is too deep or otherwise unsafe to wade, select an alternate location along the same cross section or as near as possible to the cross section.

Once the sampling location on the cross section is determined, the kick net sample is collected. If the habitat type at the cross section is a riffle or run the procedure described above for the "targeted riffle" is followed. Again, if there is too little water to use the kick net, randomly pick up ten submerged rocks and wash or pick all attached organisms into the sample bucket.

For pool or glide habitat types, again, secure the sample cup to the opening in the net and check to make sure that there are no organisms or other material in the net. Then visually describe the sampling area as the width and height of the kick net opening. Before placing the kick net on the bottom, however, inspect the sampling area for any heavy organisms such as mussels or snails. Collect these organisms by hand and place them either in the sample bucket (with some water) or in the net. Then pick up any loose rocks or other large substrate materials and use hands or a scrub brush to rub any clinging organisms off the substrate materials and into the net. This is best accomplished by holding the net horizontal just above the water surface (so the net is in the water) and scrubbing the items in the water within the net. After scrubbing, discard these larger particles outside of the sampling area.

Since there will likely be too little current in a pool or glide to carry dislodged organisms into the net, the net must be pulled through the space just above the bottom in the sample area while the area is disturbed. The sample area is disturbed by vigorous kicking with the feet or the hands, again for 30 seconds. The net must be kept moving during the kicking to prevent organisms from swimming out of it. If there is too little water depth to use the kick net, stir up the substrate with gloved hands and use a sieve with 200 μm openings to collect the organisms in the same way that the net would have been used. After the 30 seconds remove the kick net or sieve from the water with a quick upstream motion to wash any organisms to the bottom of the net/screen.

Place the lid on the sample bucket and move upstream to the next cross section sample site. A total of five samples will be collected and all collected organisms will be composited in the sample bucket. Complete **Data Form 10** after collecting each sample:

- Habitat type at each cross section (riffle, run, pool, glide etc.)
- Predominant substrate type (silt, sand, gravel, cobble, other)
- Sample location on cross section ("left", "center", "right")
- Was sample collected within three feet of an edge?

Proceed with processing of the composite sample.

Sample Processing: Pour the entire contents of the sample bucket through a sieve with a 200 μm mesh size. Remove any large objects and wash any clinging organisms off into the sieve before discarding the objects. Using a wash bottle filled with stream water rinse all organisms from the bucket into the sieve. The sieve now contains the composite sample of macroinvertebrates.

Estimate the total volume of the sample in the sieve and determine how large a bottle will be needed for the sample (250 mL, 500 mL or 1 L). Avoid using more than one bottle for each composite sample. Fill in a sample bottle label indicating if the sample is "Targeted Riffle" or "Reach-wide", the sampled reach ID and date of collection. Attach the completed label to the sample bottle.

Wash the contents of the sieve to one side by gently agitating the sieve while it is partly submerged in the water (either in the stream itself or in a bucket). Wash the sampled organisms into the sample bottle using as little water from the wash bottle as possible. Use a large funnel if necessary. The sample bottle should not be more than 1/4 full so it may be necessary to pour off some of the water (through the sieve to avoid losing organisms). Carefully examine the sieve for any remaining organisms and use the forceps to place them into the bottle.

Place a waterproof label inside the bottle with the following information:

- Stream reach ID number
- Type of sampler and mesh size used
- Habitat type (riffle or pool)
- Date of collection
- Collectors initials
- Number of sub-samples in composite

Completely fill the bottle with 95% ethanol so that no airspace is left. Note that the ethanol can be added when back at the vehicle if more convenient. Replace the cap on the sample bottle. Slowly tip the jar to a horizontal position and gently rotate the bottle to mix the ethanol throughout the sample. Do not shake the bottle. After mixing, seal the bottle with plastic tape. Store the labeled composite sample bottles in a container with packing material that is suitable for use with 95% ethanol until transport/shipment to the laboratory.

Laboratory Sample Methods: Macroinvertebrate samples collected by either protocol, i.e., "Targeted Riffle" or "Reach-wide", are best processed in a laboratory under controlled conditions. Since laboratory analyses will likely be performed by professional analysts (not Tribal staff) the following summary is presented for information only. Detailed Rapid Bioassessment methods are described by Barbour et al. (1999). Aspects of laboratory processing include sub-sampling, sorting, and identification of organisms.

Sub-sampling reduces the effort required for the sorting and identification aspects of macroinvertebrate surveys and provides a more accurate estimate of time expenditure. The RBPs use a fixed-count approach to sub-sampling and sorting the organisms from the sample matrix of detritus, sand, and silt. The protocol is based on a 200-organism sub-sample, but it could be used for any sub-sample size (100, 300, 500, etc.). The sub-sample is sorted and preserved separately from the remaining sample for quality control checks.

Sub-sampling involves spread the sample evenly across a pan marked with grids approximately 6 cm x 6 cm. A random number generator is then used to select four numbers corresponding to squares (grids) within the gridded pan. All material (organisms and debris) is removed from the four grid squares and placed in a shallow white pan with a small amount of water to facilitate sorting and identification. If the number of organisms in this sub-sample is 200 (plus or minus 20%) the sub-sample is submitted for identification. If there are more than 240 organisms contained in the original four grids, those original organisms must be transferred to a second gridded pan and four more randomly selected grids chosen. This process must be repeated until 200 organisms ± 20% are found.

Organism identification can be at any taxonomic level, but should be done consistently among samples. In the original RBPs, two levels of identification were suggested — family (RBP II) and genus/species (RBP III) (Plafkin et al. 1989). Genus/species provides more accurate information on ecological/ environmental relationships and sensitivity to impairment so this level of identification will be preformed on Coeur d'Alene Tribe samples. Family level provides a higher degree of precision among samples and taxonomists, requires less expertise to perform, and accelerates assessment results. In either case, only those taxonomic keys that have been peer-reviewed and are available to other taxonomists should be used.

<u>2. Pond Projects</u>

**a. Photographic documentation**: General information on photographic documentation is presented in Section 1. a., above. The subjects for pond project photo documentation include some required items and some that are optional. All required photos shall be taken from established photo points while optional photos may or may not be taken from photo points. All photos must be logged on the **Photograph Log (Data Log Form 1)**, a copy of which appears in **Appendix A**.

The required photo subjects for ponds are:

- Permanent benchmarks, including photo point locations,
- Habitat improvement features.

Other optional but recommended photograph subjects are:

- Defining characteristics of site,
- Other important habitat components,
- Wildlife uses,
- Land uses near site.

The equipment needed for photographic documentation of pond construction and monitoring sites is as follows:

- Digital camera (with spare memory card, spare batteries, carrying case)
- 18" x 24" Dry erase board & markers
- Compass (with line-of-sight arrow or mirrored cover, in increments of 1°)
- Notebook with **Data Form 1**, blank write in the rain paper and pencil.

Complete the **Data Form 1** for each photograph taken for habitat restoration monitoring with the following information:

- Date,
- Location (using seven-digit identifier),
- Photo point number (if photo is taken from a photo point),
- Direction of view
- Notes on subject(s) of the photo

**b. Sediment Trapping**:

Ponds are typically constructed in low-flow or intermittent-flow areas where they can provide open water which enhances wildlife habitat both directly and indirectly (through support of wetland vegetation). The trapping of sediment materials that become suspended in overland runoff is also an important benefit that is specifically designed for in restoration ponds. Sediment that is carried from low- and intermittent-flow drainageways to permanent, fish bearing (or potentially fish bearing) streams can be deposited within the stream channel degrading fish habitat. Sediment also carries with it nutrients and other materials that can degrade water quality. Sediment has been documented to be a primary pollutant of concern in several watersheds on the Reservation as documented by the State/EPA list of "impaired" water bodies; that is those not meeting water quality standards or not supporting designated "beneficial uses" (IDEQ 1994, 1996, 1998)

Because ponds are designed with sediment trapping in mind, it is important to be able to monitor the effectiveness in achieving this. The method that will be used to do this follows Retell and Child (1996) and involves the placement of sediment "collectors" at various depths and locations within a pond and allowing these to stay in the pond for a period of time. The sediment collectors are then removed and the collected sediment is sent to a laboratory to be dried and weighed. A typical sediment trap setup is shown in **Figure 1**. Up to three collectors are suspended on a rope that is anchored to the pond bottom and held vertical by a float. Up to three sediment collector setups are placed in any given pond, depending on the size and shape of the pond. For this setup to work properly, the float must be large enough to keep a strong upward tension on the suspending rope and the weight must be heavy enough to hold everything in place. In addition, so that the float is not effected by wave action, it should be placed at least one foot below the water surface; it should also be no closer than two feet above the nearest collector.

The equipment needed for pond sediment trapping monitoring is as follows:

- Assembled sediment collector units, suspension rope, anchor, float and marker buoy,
- Spare rubber stoppers and wide tape for sample pickup and shipping to the laboratory,
- Portable boat, oars or paddles, life jackets,
- Notebook with **Data Form 11**, blank write in the rain paper and pencil.

Sediment collectors are made of a six-inch diameter funnel and a plastic (Plexiglas) tube that fits snugly over the spout of the funnel and has a rubber stopper plugging the bottom. This rests inside a wide-mouth plastic sample bottle which is attached to the suspension rope through a spacing block. The block allows the sample bottle and funnel / tube to be held vertical in the water.

While some constructed ponds will have inflow entering through culverts or existing channels, some water and sediment may be delivered directly through overland runoff. If either of these sources comes from active agricultural areas there is a good potential to carry high sediment loads into the pond. However, because the sediment collectors will be left in the pond for an extended time (typically one month) there is a chance that wind action may cause the re-suspension of sediment that was previously deposited on the pond bottom. If this material enters the sediment collectors an overestimation of sediment trapping would result. Therefore, depending on the total depth at the collector location, more than one collector will be placed at different depths in the pond to allow the calculation of the average sediment trapping capacity of the pond. The general guideline for the placement of collectors on a setup line is that no collector should be closer than 3.0

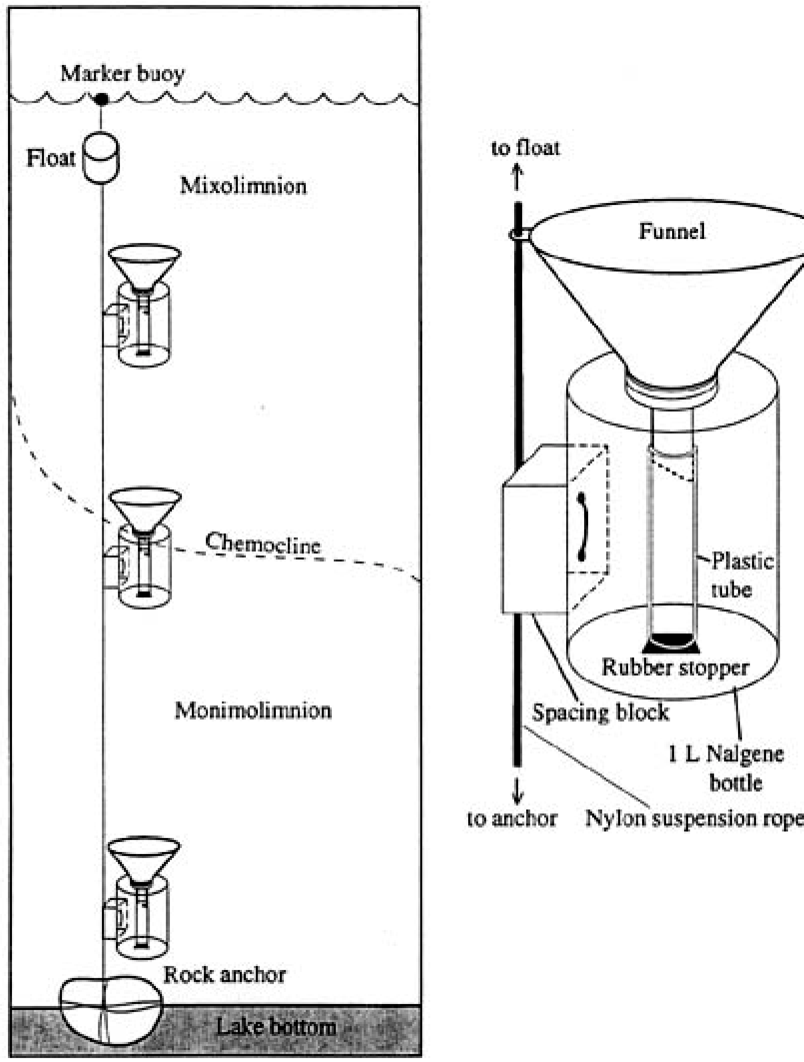


**Figure 3. Typical sediment collector setup to be used in monitoring ponds for sediment trapping efficiency (after Retell and Child 1996).**

feet from either the water surface or from the pond bottom. Following this, collector setups should not be placed where the total depth is less than 6.0 feet. More specifically, the following collector depths are based on the total depth:

| | |
|---|---|
| For total depth less than 6.0 feet: | no collectors |
| For total depths between 6.0 and 12.0 feet: | place one collector at 1/2 depth |
| For total depths between 12.0 and 20.0 feet: | place collectors at 1/4 depth and 3/4 depth |
| For total depths greater than 20.0 feet: | place collectors at 1/4 depth, 1/2 depth and 3/4 depth. |

Location of sediment collector setups within a pond is based on the size and shape of the pond. For ponds of generally triangular shape with one inlet channel the following rule applies:

| | |
|---|---|
| For ponds less than 1/4 acre (10,890 square feet): | one collector setup |
| For ponds 1/4 to 1/2 acre (21,780 square feet): | two collector setups |
| For ponds larger than 1/2 acre: | three collector setups. |

Typically, one collector setup will be located at the deepest part of the pond. If other collectors are needed they should be spaced as uniformly as possible based on the shape of the pond. Pond depths must be considered in this since sediment collector setups should not be placed where the depth during the sampling period will be less than 6.o feet.

Sediment collectors should be placed at the beginning of the runoff period and typically be left in place for one month. However, the objective is to have the collectors in place only during the time that the pond is discharging (has outflow). If the collectors are left in place for a full month, it may be necessary to inspect them at least once prior to sample pickup to make sure that the setup is still in proper alignment.

To pick up the collectors it will be necessary to carefully lift the entire setup into the boat and to lift each collector funnel / tube part out of the wide mouth bottle as they reach the surface. The tube containing the sediment should be removed from the funnel and a second rubber stopper placed into the top end. BE VERY CAREFUL NOT TO CAUSE THE LOWER RUBBER STOPPER TO BE PUSHED OUT AS THE TOP STOPPER IS INSERTED. Once both stoppers are firmly in place dry off the outside of the tube and secure the stoppers with tape for shipment to the laboratory.

Complete the **Data Form 11** with the following information:

- Pond location (using seven-digit identifier),
- Date and time of collector setup placement,
- Depths of collectors at each setup,
- Date and time of sample pick up,
- Any pertinent notes regarding pond conditions that were observed to possibly affect the sediment collection.

**c. Physical Water Quality Profiles**: The physical habitat of surface water bodies, especially standing water bodies such as lakes and ponds, can be strongly influenced by the character of the water itself. There are many constituents of water that can affect the habitat quality and that can be monitored, including biological, chemical and physical constituents. The physical parameter temperature is especially pertinent in that improvements in riparian area vegetative cover can directly affect (lower) water temperature. In pond systems, "conductivity" (the capacity to conduct an electrical current) and oxygen content also provide useful references on the usability of the water by fish and invertebrates.

Water temperature strongly influences the composition of aquatic communities and is perhaps the most commonly recorded habitat attribute (Bain & Stevenson, 1999). Temperature influences oxygen solubility, nutrient availability and the decomposition rate of organic matter. Although temperature is dependent on direct solar radiation, it is also influenced by water movement and elevation.

The monitoring of water quality in ponds will be performed using an electronic water quality testing probe and data transmitter. This device determines the levels or concentrations of various parameters "in-situ"; that is, in place, without having to remove a sample of water for analysis outside the pond. The results of these in-situ analyses are transmitted through a connecting cable to an electronic data collecting device (a "data logger") for temporary storage. Thus, a series of analyses can be performed quickly and accurately through the entire water column to help managers understand how the pond is functioning.

The water testing devices that will be used for the pond profiles are the Hydrolab MiniSonde® and the PRO4000® or Allegro® dataloggers. MiniSonde® use is described in Hydrolab Corporation (1997) and datalogger use in Juniper Systems (1997). The MiniSonde® has sensors on its' lower end to test for the following parameters: conductivity, dissolved oxygen, pH and temperature. There is also a depth sensor on this unit. A summary of calibration and operating procedures for the MiniSonde® and datalogger follows; the detailed Users Manuals must be referred to for specific questions about these devices.

The equipment needed for water quality profile monitoring at pond sites is as follows:

- MiniSonde® water quality testing probe and data transmitter
- PRO4000® or Allegro® datalogger
- Boat with oars or motor, life jackets
- Notebook with **Data Form 12**, blank write in the rain paper and pencil.

The MiniSonde® must be calibrated according to the manufacturer's specifications each day prior to use in the field and then at the end of the day to monitor drift in sensor sensitivity. The calibration is performed with the datalogger connected to the MiniSonde® as the software on the datalogger guides this operation. The calibration for conductivity involves immersing the sensor in a solution of known conductivity (a "standard" solution) and adjusting the reading on the datalogger. The calibration for dissolved oxygen involves exposing the sensor to the air within an enclosed cup and typing the current barometric pressure into the datalogger. The calibration for pH involves immersing the sensor in solutions of known pH (buffer solutions) and adjusting the readings on the datalogger. The temperature sensor is factory-set and does not need calibration. The depth calibration is performed by zeroing the sensor on the datalogger at the surface of the water at the monitoring site.

Once calibrated, the MiniSonde® and attached datalogger are ready to collect data. When turned on at the monitoring sites, the datalogger will activate the MiniSonde® to prepare to collect data and will prompt the operator for certain information which must be typed into the datalogger using the keypad. This information includes site and location codes and the operator's initials. The date and time are displayed automatically on the screen. Then the MiniSonde® is lowered into the water, suspended from the connecting cable, as close as practical to the bottom (approximately two feet assuming that the depth has been determined beforehand) and then raised in **one meter intervals**, to record a profile of the variables being recorded. At each depth interval the MiniSonde® must be held stationary until the parameter readings (which are displayed on the datalogger screen) settle on a constant reading. When all readings are constant the data are stored in the datalogger memory by pushing the Enter button.

Monthly maintenance of the MiniSonde® and sensors will be performed unless a problem arises. All calibrations and maintenance will be logged and kept on file. As soon as possible after returning from a field data collection trip all data will be transferred ("downloaded") to a designated Fisheries Program computer for interpretation, summarization etc.

Since the Hydrolab data is collected on the datalogger there is no paper Data Form to fill out. However, the following information should be input into the datalogger:

- Date,
- Location (using seven-digit identifier),
- Testing results for conductivity, dissolved oxygen, pH and temperature,
- Depths of all readings

3. Riparian Projects

**a. Photographic documentation**: General information on photographic documentation is presented in **Section 1. a.**, above. The subjects for riparian photo documentation include some required items and some that are optional. All required photos shall be taken from established photo points while optional photos may or may not. All photos taken for monitoring of restoration features must be logged on the
**Data Form 1**, a copy of which appears in **Appendix A**.

The required photo subjects are:

- Each end of vegetation cross sections and transects (including where cross sections cross the stream channel),
- Permanent benchmarks, including photo point locations,
- Habitat improvement sites.

Other optional but recommended photograph subjects are:

- Defining characteristics of site or vegetative cross sections / greenline,
- Unusual or obviously disturbed areas,
- Other important habitat components,
- Wildlife uses,
- Land uses near site.

The equipment needed for photographic documentation of riparian restoration and monitoring sites is as follows:

- Digital camera (with spare memory card, spare batteries, carrying case)
- 18" x 24" Dry erase board & markers
- Compass (with line-of-sight arrow or mirrored cover, in increments of 1°)

- Notebook with **Data Form 1**, blank write in the rain paper and pencil.

Complete the **Data Form 1** for each photograph taken for habitat restoration monitoring with the following information:

- Date,
- Location (using seven-digit identifier),
- Photo point number (if photo is taken from a photo point),
- Direction of view
- Notes on subject(s) of the photo

**b. Vegetation Composition**: There are several criteria that have been developed for characterizing riparian zones; one practical definition describes these habitats as "terrestrial areas where the vegetation complex and microclimate conditions are products of the presence and influence of perennial or intermittent water" (Bain & Stevenson, 1999). The extent of the riparian zone can thus be identified by patterns of vegetation growth that are related primarily to soil moisture. Riparian areas can support complex plant groupings ("communities") that are associated with the diverse soil and hydrologic conditions (Platts et al., 1987). However, riparian areas are also characterized as being geomorphically active; places where periodic disturbances (especially floods and movement of the stream channel) affect soil and hydrological characteristics. A common characteristic of the plant communities within riparian areas involves the gradual movement or shifting of stands of community types. As stream channels move about within a valley area (like when a meander breaks and forms a stream channel in a new area) plant communities develop to fit the newly created environments. Over time, plant associations will drift to new locations within the riparian area so that the overall riparian community is not significantly changed.

The result of these disturbances and shifts in community structure is that riparian characterization monitoring must focus on present community types rather than potential (climax) vegetation (Platts, et al 1987). Riparian vegetation community types are closely related to substrate characteristics, valley bottom gradient and width, general elevation as well as the size and pattern of "water forces" so monitoring of vegetation is a valid indicator of health and relative stability of these areas (Winward, 2000).

A variety of vegetation will grow in healthy riparian zones and this vegetation is important to the quality of the stream habitats and the water that flows through them. For example, shrubs and long-lived tree species provide nutrients and organic matter to the stream, regulate solar radiation inputs (heating) to the stream and moderate the forces of water. Grasses and forbs (non-woody broad-leaved plants) provide early stabilization of soils, filter sediment and chemicals out of the water and provide food and cover for wildlife. Without vegetation riparian areas deteriorate, streambanks are more susceptible to erosion and sediment delivery to the channel will increase. The assessment of riparian vegetation composition and structure therefore, provides useful management information.

The two protocols presented in this Section allow characterization of the basic structure of the riparian vegetation through the documentation of the percent coverage of various plant communities. The first protocol, "Vegetation Cross-Section Composition" is performed across the monitoring reaches perpendicular to the stream channel, and the second protocol, "Greenline

Composition" is performed along the streambank through the study reaches. Both protocols are taken from Winward (2000) and both require trained surveyors to identify the dominant plant species.

The equipment needed for the riparian vegetation community monitoring is:

- Plant identification key or book
- Measuring tape (optional)
- GPS unit (optional)
- Survey notebook with **Data Form 13**, blank write-in-the-rain paper and pencil.

<u>Vegetation Cross-Section Composition</u>: This procedure is designed to quantify the percentage of plant communities found across a riparian area and the data collected may be used to indicate how much change (disturbance) has occurred in the riparian area or how closely that area compares to a desired condition. The survey is performed along the six cross sections that extend across the entire riparian area as described in **Section 1. d.,** above. The extent of each plant community along the cross sections are measured either by using a measuring tape or by counting the number of steps or paces that is occupied by a community. Pacing cross sections has been found to be as reliable as using a measuring tape for calculating the community type composition using this protocol (Winward 2000). This is because either the measured distance or number of steps is ultimately calculated to percent so length of each step does not need to be known as long as one person performs all of the pacing on any given cross section. A hand-held tally counter is helpful in keeping track of the counts.

Community type composition is calculated by taking the number of steps encountered (or measured distance) for each apparent community for all six cross sections divided by the total number of steps taken (or total distance). The "community" could be a single species or a group of species. Determination of plant species requires that the surveyors have a basic knowledge of the dominant plants in and around the Coeur d'Alene reservation or experience in plant identification. In either case having a plant identification key is available is important for when unknown species are encountered.

Follow each cross section along the line of flagging placed for the valley cross section profile. To avoid the need to cross the stream on each cross section, **Data Form 13** is set up so that the left and right portions of the cross section can be walked separately. When encountering a obstacle along that line sidestep perpendicular to the line of travel so that the length can be counted in the direction of travel only and then sidestep as soon as possible back to the cross section line. When pacing the cross section, begin and end recording the extent of shrub and tree communities at the outer edges of the foliage (the drip line). It will be helpful to be aware of the vegetation along each side of the cross section as it is walked as this will help determine where community boundaries are for sparse or clumpy growth plants.

Photographs should be taken at each permanent cross section end stakes and should show the general setting of the cross section. Photographs should also be taken where the cross section crosses the stream and at other locations along the cross section where a pictoral record will be useful in visualizing specific features of the area. Follow the protocol presented in **Section 3. a.**, above, for taking and documenting photographs.

Record each apparent plant community type across the riparian area along all six valley cross sections and the number of steps (paces) that each is encountered on **Data Form 13**:

- Plant community types
- Number of steps (paces) for each community type.

Greenline Composition: The "greenline" is "the first perennial vegetation that forms a lineal grouping of community types on or near the waters edge (Winward 2000). Most often this occurs at or slightly below the bankfull stage. Sampling plant communities along this streamside boundary provides useful information over that collected in the cross section survey. The presence of water nearby makes the this area favorable to plant growth and this allows land managers to make early evaluations of the effects of both restoration or disturbance. Perhaps most importantly, however, there has been found to be a strong relationship between the amount and kind of vegetation along the greenline and bank stability. The majority of naturally occurring plant species in this area have rooting characteristics that enhance bank stability. The greenline survey protocol outline below also includes documentation of other stabilizing factors such as LWD and large rocks.

As indicated, the greenline is most often found at or near the bankfull stage height. This is due to the natural tendency of vegetation to grow near or in the water, balanced by the cutting action of flood waters which tends to scour away this vegetation. Thus the location of the greenline depends the erosive features of the riparian area, particularly the slope and substrate materials. In entrenched streams with exposed downcut banks, the greenline may be located well above the low flow water level. In any event, the greenline is the closest continuous vegetation to the stream and does not include patches of vegetation such as might be found on a gravel bar.

The greenline survey for the purposes of this Monitoring & Evaluation Plan will be performed along each streambank through the entire 500 foot long monitoring reach. The greenline transect will begin on the right bank (looking downstream) and will use the step / pace approach described above for the cross section protocol. If interruptions to the greenline are encountered these must also be paced off and recorded. Examples might be tributaries entering the stream being studies, vehicle crossings or grazed areas.

When encountering a obstacle along the greenline, sidestep perpendicular to the line of travel so that the length of the obstacle can be counted in the direction of travel only, and then sidestep as soon as possible back to the greenline. When pacing the greenline, begin and end recording the extent of shrub and tree communities at the outer edges of the foliage (the drip line).

Record each apparent plant community type along both banks of the stream and the number of steps (paces) that each is encountered on **Data Form 13**:

- Plant community types
- Number of steps (paces) for each community type
- Number of steps (paces) for LWD, bedrock or large boulders or other interruptions.

4. Upland Projects

**a. Photographic documentation**: General information on photographic documentation is presented in Section **1. a**., above. The subjects for upland project photo documentation include some required items and some that are optional. All required photos shall be taken from established photo points while optional photos may or may not. All photos must be logged on the **Data Form IV-A Photograph Log,** a copy of which appears in **Appendix C**.

The required photo subjects for upland areas are:

- Permanent benchmarks, including photo point locations,
- Vegetation monitoring plots.

Other optional but recommended photograph subjects are:

- Defining characteristics of site,
- Other important habitat components,
- Wildlife uses,
- Land uses near site.

The equipment needed for photographic documentation of pond construction and monitoring sites is as follows:

- Digital camera (with spare memory card, spare batteries, carrying case)
- 18" x 24" Dry erase board & markers
- Compass (with line-of-sight arrow or mirrored cover, in increments of 1°)
- Notebook with **Data Form 1 Photograph Log**, blank write in the rain paper and pencil.

Complete **Data Form 1** for each photograph taken for habitat restoration monitoring with the following information:

- ➢ <u>Date</u>,
- ➢ <u>Location</u> (using seven-digit identifier),
- ➢ <u>Photo point number (if photo is taken from a photo point)</u>,
- ➢ <u>Direction of view</u>,
- ➢ <u>Notes on subject(s) of the photo</u>.

**b. Woody Vegetation Survival**: Monitoring of the survival of woody vegetation planted in upland areas will follow procedures currently in use by the Tribe's Forestry Program. While timber "cruising" procedures are most often applied to harvest planning efforts, these surveys are easily adaptable to monitor the survival of restoration plantings. The standard procedure in "cruising" is to measure a portion of a stand of timber and assume that the volume of trees in the area sampled is the same as the average volume of the entire stand. The sampled volume is then extended to the total stand area to obtain an estimate of volume of timber in the stand. In this method, the larger the sampled area is in relation to the total area, the more closely the sample volume is to the stand average. The sample is usually taken in the form of plots or strips uniformly distributed over the stand area. In the case of survival monitoring, the protocol described by Dilworth (1979) is adapted so as not to focus on volume of timber but on number, species, height and condition of the woody vegetation.

The vegetation survival survey adapted for the Coeur d'Alene restoration monitoring will be performed using a uniform "intensity"; that is area sampled per area of restoration plantings. In the Pacific Northwest, the practice has been for most timber cruises to use a 20% intensity for an "accurate" cruise (Dilworth, 1979). This means that 20% of the total upland planting area will actually be monitored. The 20% area will be divided into circular plots within which woody vegetation data will be collected and which will be established as permanent monitoring sites.

The actual placement of the plots will involve the use of GIS maps of the planting areas, the placement of 100-foot interval grids over these maps and the random selection of grid intersections as plot centers. GPS equipment will then be used to locate the chosen plot centers in the field. This plot establishment work will be performed by Tribal Biologist staff and will not be a responsibility of the technicians.

The monitoring plots must be sized and spaced to optimize the data collected and the available technician budget. The smaller the plot, the greater the accuracy of the estimate of vegetation survival for a given intensity of monitoring. Dividing the total sampling area into a larger number of plots will permit "samples" to be distributed more widely over the planted area with a greater chance of all conditions being represented. For this monitoring work a standard plot size of 1/50 acre has vbeen chosen which is a circle with a radius of 16.7 feet. Using this size of plot and the 20% monitoring intensity will require that 25 plots be monitored per planted acre.

The equipment needed for the upland vegetation survival monitoring is:

- Spring-loaded (retractable) "loggers tape" or 25-foot carpenter's tape measure
- Tree / shrub identification key or book
- Survey notebook with **Data Form 14**, blank write-in-the-rain paper and pencil.

Once the plot center points have been set (marked with flagged rebar) a team of two people will survey each plot. This will involve one person holding the zero end of the measuring tape at the plot center while the other person walks the full radius and circumference of the plot circle recording the species, size and status of all woody vegetation on **Data Form 14**. During the early stages following restoration planting work, it may be possible to make the walk around very quickly, as the vegetation will be low to the ground. As the vegetation becomes taller and the tape can no longer be passed over it, it will be necessary for the walker to move back in to the center of the plot to get around the tall vegetation.

Common woody vegetation species expected in the Coeur d'Alene Reservation restoration areas are listed on **Data Form 14**. These include the trees Ponderosa Pine, Douglas Fir, Western Larch, Grand Fir, Lodgepole Pine and Western Red Cedar; and the shrubs Douglas Hawthorn, Alder species, Aspen species, Willow species, Red Osier Dogwood and Serviceberry. The species codes listed on the data form should be used in the spaces provided. Other species of trees or shrubs, as well as unknown species, should be indicated on the data form as "other" and the number of these recorded. The "status" of each tree or shrub should also be noted and the status options indicated on the data form are "live", "dead", "browsed" and "sick". Finally, the height of the woody vegetation should be indicated using the height interval codes given on the data form. Normally there will be more than one tree or shrub that fit in the same categories (species, size range, status) so it is not necessary to write a separate line in the form for each; simply use the "number" column to tally all woody vegetation seen.

Complete **Data Form 14** with the following information:

- Plot Number,
- Number of plants,
- Species (using codes given)
- Height range (using codes given),
- Status (using codes given).

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# Appendix A. Field Data Forms

COEUR D'ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 1. Photograph Log.

| DATE | LOCATION (use project ID #) | PHOTO POINT # | DIRECTION OF VIEW | SUBJECT |
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COEUR D'ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 2. Stream Flow.

Date: ____________ Monitored Reach: ______________________

Personnel: ________________________ Weather: ____________

## STREAMFLOW USING VELOCITY-AREA PROCEDURE

Tape reading at left waters edge: ______ft.

} Wetted Width: _______ft.

Tape reading at right waters edge: _____ft.

| DISTANCE FROM EDGE | DEPTH | VELOCITY |
|---|---|---|
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |
| ___________ft. | ______ft. | _______ft./sec |

# ALTERNATIVE STREAMFLOW PROCEDURE USING NEUTRALLY-BUOYAND OBJECT PROCEDURE

Floating object used: ____________

Stream channel length: ___________

Float times: _____ _____ _____ Average: _____

Cross section #1:

Distance from edge: _____ _____ _____ _____ _____ _____ _____ _____
Depth: _____ _____ _____ _____ _____ _____ _____ _____

Cross section #2:

Distance from edge: _____ _____ _____ _____ _____ _____ _____ _____
Depth: _____ _____ _____ _____ _____ _____ _____ _____

COEUR D’ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 3. Stream Gradient & Habitat Typing Worksheet.

Date: ________ Monitored Reach: ___________________________

Personnel: _______________________ Weather: ______________

* Fill out this page using completed SURVEY NOTES (attached)

## A. LONGITUDINAL "THALWEG" PROFILE

Total Water Surface Elevation Difference: _______ft.
(Between upstream and downstream ends of reach)

Total Stream Length: ________ft. }SLOPE : ____ft./ft.

## B. HABITAT TYPE SUMMARY

Total length of each habitat type seen in reach and percent of total:

Riffle: _____ft. Pool: _____ft. Run/Glide: _____ft. Shallows: ___ft.
_____% _____% _____% _____%

## C. WETTED WIDTH SUMMARY

Maximum wetted width: _____ft. Minimum wetted width: _____ft.

Average wetted width: _____ft.

Page 1

## **Longitudinal Profile Survey Data** Monitored Reach: _______________

Reference elevation of Benchmark(s): ______ ft.

| | Distance or Station **STATION** ft. | Back-Sight **BS** ft. | Height of Instrument **HI** ft. | Fore-Sight **FS** ft. | Height or **ELEVATION** ft. | Habitat Type | Wetted Width ft. | Notes |
|---|---|---|---|---|---|---|---|---|
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## **Longitudinal Profile Survey (continued)** Monitored Reach: ___________

Reference elevation of Benchmark(s): _____ ft.

| | Distance or Station **STATION** ft. | Back-Sight **BS** ft. | Height of Instrument **HI** ft. | Fore-Sight **FS** ft. | Height or **ELEVATION** ft. | Habitat Type | Wetted Width ft. | Notes |
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# COEUR D'ALENE TRIBE, FISHERIES PROGRAM
## Restoration Project Monitoring

## DATA FORM 4. Valley Cross Sections.

Date: _________ Monitored Reach: _________________________

Personnel: ________________________ Weather: ____________

**CROSS SECTION # (circle one): 1 2 3 4 5 6**

Reference elevation of Benchmark(s): _____ ft.

| | Distance or Station **STATION** ft. | Back-Sight **BS** ft. | Height of Instrument **HI** ft. | Fore-Sight **FS** ft. | Height or **ELEVATION** ft. | Notes |
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## Valley Cross Section Data (continued) Reach: _______________
## Cross Section#: ___

Reference elevation of Benchmark(s): _____ ft.

| | Distance or Station **STATION** ft. | Back-Sight **BS** ft. | Height of Instrument **HI** ft. | Fore-Sight **FS** ft. | Height or **ELEVATION** ft. | Notes |
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**Valley Cross Section Plot** **Reach:** ___________________
**Cross Section#:** ___

## GRAPH CROSS SECTION AND FIND THE FOLLOWING:

Bankfull Elevation: __________ ft. Bankfull Width:_________ ft.
Flood Prone Zone Elevation: ________ ft.
Flood Prone Width: __________ ft.

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Restoration Project Monitoring

# DATA FORM 5. Channel Type Classifications.

Date: ________ Monitored Reach: ______________________
Person completing this form: _____________________________

** USE FIELD DATA FROM CROSS SECTION PROFILES, DATA FORM 3, FOR THIS MONITORED REACH

## A. ENTRENCHMENT RATIOS

Cross Section #1: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

Cross Section #2: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

Cross Section #3: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

Cross Section #4: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

Cross Section #5: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

Cross Section #6: Flood Prone Zone Width: _____
Bankfull Width: _____ RATIO: _____

AVERAGE ENTRENCHMENT RATIO FOR REACH: _____

## B. WIDTH TO DEPTH RATIOS

Cross Section #1: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

Page 1

Monitored Reach: _______________________________

Cross Section #2: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

Cross Section #3: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

Cross Section #4: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

Cross Section #5: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

Cross Section #6: Bankfull Width: _____
Bankfull Depth: _____ RATIO: _____

AVERAGE WIDTH TO DEPTH RATIO FOR REACH: _____

## C. SINUOSITY

TOTAL REACH LENGTH: _____ ft. (from Data Form 3)
Divided by:
BASIN LENGTH: _____ ft. (from 1:24,000 scale topo map, straight-line distance from upstream to downstream ends of reach)
= SINUOSITY: _____

## D. STREAM CHANNEL TYPE

Use reach slope (from Data Form 3), average entrenchment ratio, average width to depth ratio and sinuosity to choose Channel Type from Table 4 in Technician Manual: _____

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Restoration Project Monitoring

# DATA FORM 6. Stream Substrate Particle Size Worksheet.

Date: _______ Monitored Reach: ___________________________

Personnel: _____________________ Weather: _______________

**Cross Section # (circle one): 1 2 3 4 5 6**

PEBBLE COUNT

Site: Reach:

Party: Date:

| Inches | PARTICLE | Millimeters | | particle count 1 | 2 | 3 | PEBBLE COUNT Reach: Date: TOT # | ITEM % | % CUM | PEBBLE COUNT Reach: Date: TOT # | ITEM % | % CUM | PEBBLE COUNT Reach: Date: TOT # | ITEM % | % CUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Silt / Clay | < .062 | S/C | | | | | | | | | | | | |
| | Very Fine | .062 - .125 | SAND | | | | | | | | | | | | |
| | Fine | .125 - .25 | | | | | | | | | | | | | |
| | Medium | .25 - .50 | | | | | | | | | | | | | |
| | Coarse | .50 - 1.0 | | | | | | | | | | | | | |
| .04 - .08 | Very Coarse | 1.0 - 2 | | | | | | | | | | | | | |
| .08 - .16 | Very Fine | 2 - 4 | GRAVEL | | | | | | | | | | | | |
| .16 - .22 | Fine | 4 - 5.7 | | | | | | | | | | | | | |
| .22 - .31 | Fine | 5.7 - 8 | | | | | | | | | | | | | |
| .31 - .44 | Medium | 8 - 11.3 | | | | | | | | | | | | | |
| .44 - .63 | Medium | 11.3 - 16 | | | | | | | | | | | | | |
| .63 - .89 | Coarse | 16 - 22.6 | | | | | | | | | | | | | |
| .89 - 1.26 | Coarse | 22.6 - 32 | | | | | | | | | | | | | |
| 1.26 - 1.77 | Very Coarse | 32 - 45 | | | | | | | | | | | | | |
| 1.77 - 2.5 | Very Coarse | 45 - 64 | | | | | | | | | | | | | |
| 2.5 - 3.5 | Small | 64 - 90 | COBBLE | | | | | | | | | | | | |
| 3.5 - 5.0 | Small | 90 - 128 | | | | | | | | | | | | | |
| 5.0 - 7.1 | Large | 128 - 180 | | | | | | | | | | | | | |
| 7.1 - 10.1 | Large | 180 - 256 | | | | | | | | | | | | | |
| 10.1 - 14.3 | Small | 256 - 362 | BOULDER | | | | | | | | | | | | |
| 14.3 - 20 | Small | 362 - 512 | | | | | | | | | | | | | |
| 20 - 40 | Medium | 512 - 1024 | | | | | | | | | | | | | |
| 40 - 80 | Large-Vry Large | 1024 - 2048 | | | | | | | | | | | | | |
| | Bedrock | | | | | | | | | | | | | | |
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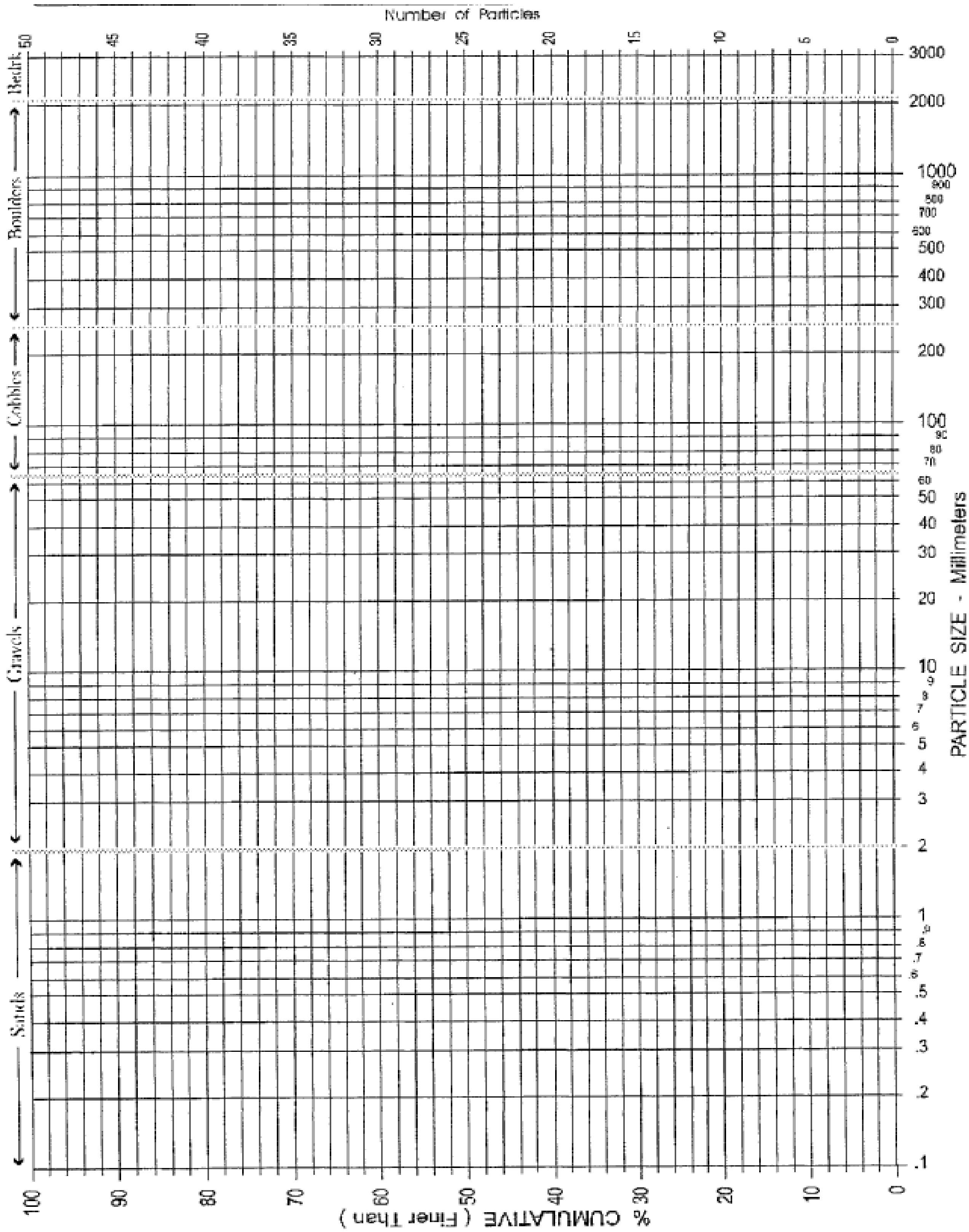


**Embeddedness**: _________ % (determined at the center of the channel)

COEUR D’ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 7. Instream Organic Materials (Woody Debris).

Date: ______ Monitored Reach: ___________________________

Personnel: ______________________ Weather: ______________

| | | Large Woody Debris** | | | | |
|---|---|---|---|---|---|---|
| Station (feet) | Coarse Material* (count) | Length (feet) | Small end diameter (in) | Large end diameter (in) | Orientation*** (degrees) | Root wad connected? |
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* Only coarse material (less than 4 inch width) crossing the line of the zig-zag path is to be recorded
** All large woody debris (greater than 4 inch width) visible from the zig-zag path is to be recorded
*** Orientation is compass heading (degrees) looking from large end to small end

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Restoration Project Monitoring

# DATA FORM 8. Streambank / Shoreline Cover.

Date: _______ Monitored Reach: ___________________________

Personnel: _____________________ Weather: ________________

**VEGETATIVE COVER**

Record conical densiometer readings:

| Cross Section # | Left Bank | Center facing upstream | Center facing downstream | Right Bank | AVERAGE |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
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| 6 | | | | | |

Overall average reading for the reach = ______

Conversion to Density (x 1.5) = ________ %

Correction (subtract 1 if the density is
30 - 65%; subtract 2 if density
is 66 - 100 %) = _______ %

COEUR D’ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 9. Stream Fish Populations.

Date: _______ Monitored Reach: ___________________________

Personnel: ______________________ Weather: ______________

## A. ELECTROFISHING

Ambient temperature: air: _____ water: _____
Total Shock time: _____ sec. Total fishing time: _____ min.
Wave Form (circle one): AC DC Pulsed DC
Anode shape: _____ Anode diameter: _____ in.
Shocker settings: Volts: _____ Watts: _____ Amps: _____
Pulse rate: _____ Pulse Width: _____

Fish species collected: NOTE: Population estimates require a minimum of two shocks for each reach regardless if trout are captured in the first shock. If more than 50% fewer fish are captured during the second shock a third and fourth passes must be made.

**Shock #1** Shock Time: _______

| Species | Length (cm) | Weight (gm) | Tag # | Recapture? |
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**Shock #2** Shock Time: _______

| Species | Length (cm) | Weight (gm) | Tag # | Recapture? |
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## B. SNORKELING

Ambient temperature: air: _____ water: _____
Water visibility: _____ ft.
Percent of reach surveyed: _____ %

Fish species observed:

| Species | Estimated Length |
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Use these length intervals:

1 0 - 3 in (0 - 8 cm)
2 3 - 6 in (8 - 15 cm)
3 6 - 9 in ( 15 - 23 cm)
4 9 - 12 in (23 - 30 cm)
5 12 - 15 in (30 - 38 cm)
6 Greater than 15 in (38 cm)

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COEUR D'ALENE TRIBE, FISHERIES PROGRAM
Restoration Project Monitoring

# DATA FORM 10. Stream Macroinvertebrates Sampling Log.

Date: _______ Monitored Reach: __________________________
Personnel: ____________________ Weather: _______________

## A. TARGETED RIFFLE SAMPLING

**Sample #1.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

**Sample #2.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

**Sample #3.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

**Sample #4.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

**Sample #5.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

**Sample #6.**
The nearest cross section # ___ is located ___ ft. upstream or downstream (circle one)
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream (circle one): left third center third right third

Monitored Reach: ________________________________

## B. REACH WIDE SAMPLING

**Sample #1.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

**Sample #2.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

**Sample #3.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

**Sample #4.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

**Sample #5.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

**Sample #6.**

Sample collected at Cross section # ____
Habitat type (circle one): riffle run glide pool
Sample collected using (circle one): kick net by hand
Sample collected within 3 ft. of waters edge?: yes no
Predominant substrate: fine sand gravel coarse other
Sample location across stream: left third center third right third

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# DATA FORM 11. Pond Sediment Trapping Worksheet.

Pond Location (use 7-digit site identifier): ______________________

Personnel for collector placement: ___________________________

Personnel for collector pickup: ______________________________

Date of collector placement: #1: ______ #2: ______ #3: ______

Depths of collectors: #1: ______ #2: ______ #3: ______
______ ______ ______
______ ______ ______

Date of collector pickup: #1: ______ #2: ______ #3: ______

Laboratory results: #1: ______ #2: ______ #3: ______ (units: ___)
______ ______ ______
______ ______ ______

NOTES:
_________________________________________________________
_________________________________________________________
_________________________________________________________
_________________________________________________________
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# DATA FORM 12. Pond Water Quality Profiles.

Date: ________ Pond Location: ____________________________

Personnel: _____________________ Weather: _______________

| Depth (m) | Conductivity (umhos/cm) | Dissolved Oxygen (mg/L) | pH | Temperature ( C) |
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# COEUR D'ALENE TRIBE, FISHERIES PROGRAM
## Restoration Project Monitoring

# DATA FORM 13. Riparian Zone Vegetation.

Date: _______ Monitored Reach: ___________________________

Personnel: _____________________ Weather: _______________

## A. CROSS SECTION COMPOSITION

| | NUMBER OF STEPS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross Section # > | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 |
| Side of channel > | right | left | right | left | right | left | right | left | right | left | right | left |
| Plant Community Observed* | | | | | | | | | | | | |
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*Plant community based on one or two predominant species

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Monitored Reach: ______________________________

## B. GREEN LINE COMPOSITION

| | Number of steps or measured distance (ft) | | |
|---|---|---|---|
| Plant Community Observed* | Left Bank Transect | Right Bank Transect | TOTALS |
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# DATA FORM 14. Upland Vegetation.

Date: __________ Monitored Site: ________________________
Personnel: ______________________ Weather: ______________

Use the following codes for this survey:

* Species Codes: PP = Ponderosa Pine, LP = Lodgepole Pine, WP = White Pine, DF = Douglas Fir, WL= Western Larch, GF = Grand Fir, RC = Red Cedar, H= Hemlock.
** Height Codes: 1 = 0 - 3 ft., 2 = 3 - 6 ft., 3 = 6 - 9 ft., 4 = 12 - 25 ft and 5 greater than 25 ft.
*** Status Codes: 1 = Live, 2 = Browsed, 3 = Sick, and 4 = Dead.

| Plot Number | Number of Trees | Species* | Height** | Status*** |
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| Plot Number | Number of Trees | Species* | Height** | Status*** |
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