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WATER QUALITY MONITORING PROTOCOLS - REPORT NO.4

PROTOCOLS FOR EVALUATION AND MONITORING OF STREAM/RIPARIAN HABITATS ASSOCIATED WITH AQUATIC COMMUNITIES IN RANGELAND STREAMS

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INTRODUCTION

As earlier postulated by Chapman (1966), and more recently stated by Wilzbach (1989), fish density in streams is dependent upon food availability, temperature, water chemistry and physical aspects of the stream and channel. Because these major determinants of productivity are strongly affected by riparian land uses, it is appropriate to include riparian and fish habitat parameters in the State's nonpoint source pollution assessment program. This guidance document has been developed to define the appropriate parameters and outline specific protocols for monitoring and evaluation in the agriculture water quality program. It is directed at stream/riparian-related pollutant sources affecting the biological integrity of the State's waters.

SCOPE OF APPLICATION

Stream and riparian habitat monitoring should be tied to factors affecting the aquatic biota. Those factors are distributed spatially both on regional and local scales. The density of trout can be differentiated regionally as demonstrated by Platts and McHenry (1988). In Idaho, for example, the Rocky Mountains Region produces an average of 68.6 lb/acre biomass as compared with 35.6 lb/acre in the Intermountain Sagebrush Region. Local spacial distributions have been differentiated on the basis of geomorphology, i.e.: geologic district, elevation, streamflow, (Nelson et al. 1990; Kozel and Hubert 1989a), stream gradient (Chisholm and Hubert 1986; Kozel, Hubert and Parsons 1989), stream order, and basin relief (Lanka, Hubert, and Wesche 1987).

On a regional scale in Idaho, there are basically two major stream types that are clearly differentiated on factors limiting fish abundance: Stream/riparian systems dominated by forest overstory, and those dominated by grass/shrub riparian vegetation. Forest canopy dominated streams occur primarily in mountain settings in Idaho and occur generally on gradients greater than 1.5 percent, while grass/shrub streams occur in intermontane valleys, mountain meadows, and plains and are graded generally less than 1.5 percent.

Forested mountain streams:

As indicated by Kozel and Hubert (1989b), Moore and Gregory (1989), and Klamt (1976), salmonid production in forested mountain streams is limited primarily by habitat structure. Such streams generally occur on gradients greater than 1.5 percent. Physical habitat diversity seems to be the key to fish production because in steeper gradient streams, resting areas and refugia are physically limited. Fish abundance is often related to overhead bank cover, the numbers of pools, backwater eddies, runs and glides, amount of large woody debris, and sediment accumulation (Kozel and Hubert 1989a; Moore and Gregory 1989). In some cases, canopy closure is limiting primary production and availability of drifting prey due to lack of light energy penetration in these forest streams (Wilzbach 1989). At the pre-emergent stage, sediment accumulations affect embryo survival, because the deposits coincide with low-energy sites used by spawning fish. At rearing stages, sediment accumulations also affect habitat quality in low-energy sites such as pools. Pool filling and de-stabilization as a result of sedimentation of the substrate can alter habitat structure and diversity. The subject of fine sediment effects on salmonids is summarized for the Northern Rocky Mountains in Idaho by Chapman and McLeod (1987).

Forested mountain streams are not the focus of this document. The reader is referred to Water Quality Monitoring Protocols Report numbers 1, 2, and 3 (IDHW, DEQ 1990/91) which address sediment impacts to salmonid incubation, intercobble space, and pool/substrate stability. In addition, an excellent method for monitoring habitat structure and diversity and fish abundance is according to the basin-wide technique developed by Hankin and Reeves (1988).

Rangeland streams:

Rangeland streams are located in meadows and valleys mostly at lower elevation in Idaho. Stream gradients are predominantly less than two percent, and natural riparian vegetation is dominated by grasses and shrubs, with little or no woodland overstory. Light energy inputs and resting and feeding areas are generally not limiting. In fact, too much light penetration can impair productivity. Light is the principle source of heat to these streams resulting from direct solar radiation in summertime. Increases in summer temperature resulting from riparian vegetation removal have been documented by Brown (1983), and Beschta et al. (1987). Such increases are often related to reductions in fish abundance (Platts and Nelson 1989a; Karr and Schlosser 1978; Marcus et al. 1990; Hynes 1970; and Binns 1979).

Removal of riparian vegetation along with mechanical bank damage reduces structural stability of the stream channel with several resultant impacts to fish productivity (Platts and Nelson 1989b). Reduction in bank cover related to overhanging vegetation, root vegetation, and undercut bank is correlated to fish production (Wesche 1980; Binns 1979; Sullivan et al. 1987). Streambank destabilization and resultant erosion can increase substrate embeddedness (Shepard 1989; Nelson et al. in press; Hawkins et al. 1983). Increases in substrate embeddedness impair food production and block refugia for young trout as described in Water Quality Monitoring Protocols Report number 2 (IDHW, DEQ 1991), and documented for livestock grazing impacts in Rinne, 1990.

Several studies have related fish abundance to water width, depth, pools and streamflow (Hynes 1970; Marcus et al. 1990; Binns 1979). Minimum streamflow, pools, water width and depth seem to relate to abundance as they affect total space for rearing. Water depth can also provide hiding cover when in excess of 1.5 feet (Wesche 1980).

MONITORING PARAMETERS FOR RANGELAND STREAMS

In review of the literature, Platts (1989) summarized the effects of grazing on aquatic biota and riparian habitats. This summary serves as a basis for identifying meaningful parameters in the monitoring program. According to this source, there are three basic effects of livestock grazing: water column, streambank and channel, and riparian vegetation. Monitoring parameters important in assessing livestock grazing for each of these include:

1. Water column:

Parameters for monitoring livestock grazing effects on fish within the water column should include: 1. Temperature or equivalent indicator such as solar radiation; 2. Direct phosphorous and nitrogen or equivalent macroinvertebrate indicators of nutrient inputs as well as indicators of primary production in the stream; 3. Direct maximum and minimum streamflow or equivalent indicator based on flow measurements or channel geomorphology (low flow cross section and bankful cross section).

2. Streambank and channel:

Parameters for monitoring livestock grazing effects on fish within the channel should include: 4. Bank stability to assess erosion and sedimentation; 5. Undercut banks and bank vegetation overhang to assess cover; 6. Pool composition and quality. 7. Substrate embeddedness or substrate size distribution or substrate percent fine sediment to assess habitat alteration and food reduction.

3. Riparian vegetation:

Parameters for monitoring livestock grazing effects on riparian vegetation should include: 8. Vegetation composition along the streambanks to assess status and effects to channel stability and shade; 9. Woody regeneration along the banks to assess utilization and recovery trends; 10. Forage stubble height at the end of the growing season to assess utilization; and 11. Soil bulk density to assess grazing effects on soil compaction and productivity in the riparian zone.

I. PROCEDURES

STEP 1: STRATIFICATION (Pre-monitoring) - Reconnaissance level

This step is the reconnaissance level referred to in the Antidegradation monitoring program guidance. It is a pre-monitoring step that allows proper selection and locating of sampling sites.

All streams are not equal. In fact, along the length of individual streams, changes in size, velocity, morphology, erosion/deposition and other factors vary by position in the landscape. The monitoring strategy requires segmenting the stream into individual units based on natural factors, land use, and sampling requirements. Those segments identified by natural features are called "stream/riparian complexes". Land use breaks along the stream delineate the "sub-areas". Within a reach of stream designated by complex and sub-area, the study reach selected as representative of that stream segment is called the "representative reach".

The sampling strategy is called "stratified-systematic" as defined by Gilbert (1987). Using this strategy, the stream is divided into non-overlapping strata. Individual strata are evaluated by systematic sampling. Systematic sampling results in measurements according to spatial pattern of equidistant intervals along the stream channel. Statistical studies indicate this method is preferred over other sampling strategies for estimating means, totals, and patterns (Gilbert 1987). Because individual strata may often be too large, the proposed design is to select a reach within the strata (or stream/riparian complex) representative of the whole complex, and to monument transect studies within that representative reach. This does not allow for uniform coverage of the population, and may result in observer bias.

Hankin and Reeves (1988) have suggested systematic sampling of every 1 in K habitat units along the stream channel (Where K is the number which determines total sample size) to avoid sample bias. Where a large sample is needed to account for high habitat variability (K is low), this technique is preferred to the representative reach technique. Most rangeland stream habitats do not exhibit this high morphological variability, and to avoid high sample costs, the representative reach method is recommended.

As stated above, local factors of geology, geomorphic landform, stream gradient, stream order, streamflow, and elevation effect abundance of aquatic biota. Reaches of stream chosen for monitoring and those chosen for comparison (such as reference or control sites) should match these factors. The U.S. Forest Service, Intermountain Region Riparian Evaluation Procedure (USDA 1990) will be used to classify stream reaches based on these factors. The Valley Bottom, Stream Type (and stream size sub-type), and dominant soil family as used in the Forest Service procedure will be applied. Appendix I outlines each of these classification systems. The riparian classification data sheet (Appendix I, Table 6: Reconnaissance - classification) will be completed as follows:

1. From aerial photographs and topographic maps, delineate the stream into reaches of similar character - called sub-areas. These are based on observable geomorphology, geology, vegetation, stream sinuosity, elevation, gradient, land use, etc. as ascertained from the photos and maps.

2. Conduct a reconnaissance in the field to determine if there are any further refinements in the classification of each sub-area. Complete the riparian classification data sheet (Appendix I, Table 6) in the next steps.

3. Sub-area name: Give a name to the mapped sub-area.

4. Location: Describe boundaries of the sub-area stream segment.

5. Waterbody: Give the name of the stream.

6. Riparian area: Estimate the total acreage within the sub-area.

7. Valley bottom type: from Appendix I - write the code and name.

8. Stream type: From Appendix I, Table 2 - measure stream gradient and estimate dominant substrate size. Measure stream gradient to estimate B or C designation in the code. Estimate substrate size distribution to determine the numeric designation in the code. A pebble count as documented in Appendix II, Table 5, could be used to estimate substrate size distribution. A C3 stream type, for example, is on a stream gradient less than 1.0 percent and contains substrate dominated by gravel with mixture of small cobble and sand (3).

9. Stream size: From Appendix I - measure the bankful width of the stream and enter the stream size code.

10. Stream reach classification: Provide a narrative summary of the stream type, valley bottom type, dominant soil family, and dominant vegetation community.

11. Dominant soil families: Examine the soil profile either by excavating pits or by observing soils along cutbanks in the stream channel. Use Appendix I, Table 4 to estimate the dominant soil families.

12. Percent composition of soil families: Record estimated percent composition of each soil family by correlating observations in pits and cutbanks to the estimated vegetation composition as determined in step 11.

13. Species list: The right side of the form provides space to list any riparian community types encountered in the area. This list is used to estimate potential community types that are currently not in the major plant composition.

14. Dominant riparian vegetation communities: List names of all major vegetation community types based on classes as defined in Padgett, et al. (1989) or equivalent, their percent composition (to nearest 5%), and name(s) of potential natural communities expected to occupy the site in potential natural condition.

STEP 2: SAMPLING SET-UP - Locating representative reaches

Having inventoried the stream and mapped the classified stream/riparian reaches, it is necessary to determine an appropriate location for the sampling. It is desirable that the habitat be representative of the entire reach. The sampling scheme for selecting and laying out the representative study reach within a classified stream/riparian area is as follows:

1. On a map or sketch of the stream channel showing the entire reach, walk the stream and record the locations of all pools and riffles (see Appendix III). Record only pools whose width equals or exceeds about half the average stream width. Show on the map, pool and riffle lengths. or.. pace along the linear orientation of the stream, the lengths of all pools and riffles in the stream reach.

2. Determine the average density of pools and riffles by adding up their total lengths, and divide each by the total stream reach length. If, for example, you measured 200 feet of pools over a stream distance of 1000 feet, the density equals 200/1000, or 0.2 per foot.

3. Select a representative reach having the same pool and riffle density as in the overall reach sample.

4. The representative reach length should be equal to or greater than 20 times the bankful width of the stream. Thus a stream 25 feet wide would have a reach of at least 25 X 20 or 500 feet. If the bankful width is less than 18 feet, then the minimum representative reach length is 360 feet.

5. At the downstream starting point on the representative reach, move upstream 10 feet and place a marker stake for the study site on either side of the stream, and above the high water level. A steel fence post or equivalent sized stake makes an excellent site marker.

6. Place 20 transect stakes (2 on each cross-channel transect) on both sides of the stream equidistant from the marker to the upper end of the representative reach. The 10 pairs of stakes are located above the high water level of the stream and oriented so that the line which connects them is roughly perpendicular to the thalweg flow line of the stream at high water level. If a representative reach equals 1000 feet, for example, the 10 transects would be located at 100 feet intervals along the channel.

7. Clearly mark each cross-channel transect stake with fluorescent paint to simplify relocation. It is also suggested that each transect be identified by number using a metal number tag. The numbered transect can then be recorded in the notes for future reference. If stakes are lost after initial installation, relocate and replace. Relocating stakes is accomplished by measuring distances using the previously established (and recorded) spacing. Thus it is important to record head stake and transect locations and spacing in the field notes.

STEP 3: MONITORING - Intensive level assessment

Having established the monitoring station(s), sampling is conducted to collect baseline and trend data over time. According to Coffey et al. (1991), baseline monitoring before implementation of nonpoint source controls is usually required to show causality. They suggest at least 2 years of pre-implementation monitoring to calibrate the site to the reference condition. Less time may be needed with parameters that integrate temporal variability, such as physical habitat, macroinvertebrates, and fish.

Parameters strongly tied to streamflow such as chemical constituents require significant time for baseline monitoring because of large temporal variability. With these parameters, it is difficult to detect a statistically significant treatment effect without sufficient baseline data.

Coffey et al. (1991) state that monitoring comparable to reference sites is the most effective design for sensing treatment effects. The strategy for cause-and-effect assessment using reference sites is discussed in Section III - Evaluation. Monitoring is conducted at both the present and reference sites to separate the impacts of treatment from natural effects.

Select a reference area by locating the nearest stream/riparian reach which matches the classification from step 1 at the treatment site. Follow the same procedures as in Step 2 to locate the representative reach within the reference site. The reference does NOT have to be in natural, undeveloped condition, but rather in DESIRED condition. Such sites often receive grazing - but at intensities protective of stream/riparian conditions. Reference areas on the same stream upstream of pollutant activities are preferred, but due to the absence of desirable conditions, nearby streams of the same classification may be used.

II. MONITORING PROTOCOLS

The monitoring protocols for riparian and fish habitat parameters are presented. Field data entry forms for these are contained in Appendix II. Only descriptions of the measurement technique are presented here. Data analysis and evaluation are presented in Section III. Habitat type definintions are in Appendix III.

Each of the following parameters are considered functional determinants of salmonid abundance in Idaho rangeland streams. Each is related to livestock grazing as explained, and therefore are considered sensitive indicators of management.

WATER COLUMN

1. **Temperature or equivalent:** As indicated by Binns, (1979) mid to late summer maximum temperatures account for a large proportion of the variation in salmonid abundance. Measuring maximum and minimum temperatures requires installing a water temperature recorder, thermograph, or max-min thermometer during the hot season (June through September). If this method is used, record the maximum temperature, and the period of time temperature exceeded 22 degrees C, and the number of days in which the average daily concentration exceeded 19 degrees C (the state water quality criteria for cold water biota).

Temperature is highly variable over time because it is strongly related to climate. Habitat impairments affecting temperature are those which alter thermal inputs to the stream, i.e., shade and water surface area exposed. As a surrogate measure of maximum temperature, stream canopy and water width are measured to evaluate solar radiation inputs to the stream. Several approaches to stream canopy measurement have been documented by Platts and Nelson (1989b). These include: Canopy density, light intensity, unobstructed sun arc, and average potential daily thermal input. The technique for each method is documented in Platts et al. (1987). This same reference documents a technique for predicting maximum water temperature from thermal inputs. In Idaho rangeland streams, canopy density and thermal input had the greatest correlation to trout biomass (Platts and Nelson 1989b), therefore either of these techniques is recommended:

A. **Canopy density** is a measure of overstory vegetation shading the stream. It can be measured using a spherical densiometer as described in Platts et al. (1987, pages 58-60). Measurements of canopy closure are made at each transect in the representative reach, and reported as % canopy closure.

or..

B. **Canopy density, Vegetative overhang** - A surrogate measure of overstory vegetation is that documented in the COWFISH technique (LLoyd 1986). For vegetative overhang, measure the percent of streambank along the entire representative reach supporting overhanging vegetation tall enough to provide cover on the water surface. The percent overhanging vegetation is recorded as the total length of bank measured as overhanging vegetation divided by the total length of the bank on both sides. It is recommended that this parameter always be measured at the end of the grazing period or growing season (whichever is later).

or..

C. **Thermal input** is estimated using a solar pathfinder following techniques documented by Platts et al. (1987). This instrument consists of a transparent dome mounted on a tripod that gives a reflected image of the shading objects surrounding the observer. The measurement allows a quick estimate of the radiation energy entering the stream at any given date. Diagrams are provided which provide a means of estimating sunpath and average energy values for specific locations and times of year. Thus solar input as influenced by riparian vegetation and other shading objects can be estimated fairly accurately at any time of day or season of the year. Consequently past, present, and future vegetation conditions can be effectively linked to water temperature conditions. The results are reported in percent of potential solar radiation striking a given area of water surface. The solar pathfinder measurements are made rapidly and at each transect in the representative reach.

2. **Nutrients, bacteria, or indicators of chemical pollution:** Riparian vegetation not only acts as a filter for phosphorous adsorbed fine sediments in flood waters and adjacent upland overland flows (Yarbro 1979; Cooper and Gilliam 1987; and Cooper et al. 1987), but it also acts to control nutrient loading to streams by denitrification of soil waters (Coats et al. 1976; Rhodes et al. 1985). Data from Northeastern Oregon (Green and Kauffman 1989) have shown livestock impacts to riparian vegetation increased soil water nutrient concentrations. The increased loading of nutrients and ultimate organic enrichment in the stream adversely affects salmonids by increasing algal growths and reducing dissolved oxygen needed for respiration. Direct measurement of nutrients in the representative reach is complex and costly. It is recommended that biological indicators of organic enrichment be substituted for assessing these impacts. Filamentous algae and aquatic mosses provide primary attachment sites for filtering collectors (Plafkin et al. 1989). The percent of EPT and Chironomidae to total populations, as well as the trophic classes - filterers and scrapers are excellent indicators of organic enrichment and related impacts to aquatic biota according to Plafkin et al. (1989). The reader is referred to EPA's rapid bioassessment protocols for the specific techniques (Plafkin et al. 1989).

3. **Streamflow variation and space:** Stream width and depth provides a measure of total space available for fish. In addition, these measures made for both low and bankful flow levels in the stream provide an estimate of the annual flow variation which, as reported by Binns (1979), strongly influences salmonid production. Overgrazed riparian areas often reduce total living space and the quality of that space by causing stream channel alterations (Platts & Nelson 1989a; Platts 1989; Lloyd 1986). This alteration proceeds from narrow and deep in desired condition to wide and shallow in impaired condition. In addition, channel downcutting caused by riparian degradation, lowers local water tables, and reduces the volume of base streamflow delivered to the stream. Such reductions in low flow increase annual streamflow variation. There are two approaches to channel morphology and streamflow estimation: Direct measurement and rapid measurement. Direct measurement is more reliable, but the rapid measurement may suffice if time is limiting.

a. **Direct measurement:** Select the best cross channel transect within the representative reach for measuring stream discharge. At this site, the bankful level of stream discharge should be easily identifiable, and the channel should be straight and uniform. The cross-sectional profile of the bankful channel is measured using a standard rod-and-level survey. The profile is oriented lengthwise perpendicular to the bankful streamflow direction. Elevations are recorded at each slope break across the transect. The locations of bankful and present shorelines must be noted. Within the present wetted channel, velocity measurements are made using a velocity current meter. Make at least 10 velocity recordings at points equidistant across the transect, or at intervals of .5 foot whichever results in the greatest number of measurements. Outputs from the survey are entered into IHAB to estimate present streamflow rates and calculate coefficients needed to predict bankful streamflow rate. Record the ratio of present streamflow to bankful streamflow, present and bankful stream widths, and present and bankful stream depths.

or..

b. **Rapid measurement:** Because streamflow is a function of stream width, stream depth, stream gradient, and channel roughness, if gradient and roughness are assumed to be constant at varying levels of discharge in the channel, the stream width and average depth can represent predictors of streamflow. Using this technique, present and bankful stream width and depth are measured on each of the ten transects in the representative reach. Present and bankful water depths are measured at the deepest point in the channel cross section. Record all widths and depths, and the ratio: (water width X water depth) / (Bankful width X Bankful depth).

STREAMBANK/CHANNEL

4. **Streambank stability:** Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, page 13). The modification allows for measuring bank stability in a more objective, fashion. This measure can be made rapidly without any specialized equipment. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

The streambank represents that part of the channel between the present and bankful shore lines, excluding gravel (sand) bars. The streambank must be envisioned as that part of the channel which would be most susceptible to erosion during high water events if vegetation were removed, therefore it represents the steeper-sloped sides of the stream channel. Bank cover is generally viewed at the vegetative greenline located below the bankful level but above any natural undercutting bank scour. Using a measuring tape, measuring rod, or measuring wheel; record the length of streambank on both sides of stream in the representative reach represented by each of the following stability classes.

1. **Mostly covered and stable (non-erosional).** OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or banks are OVER 50 percent covered by materials that do not allow bank erosion. Streambanks are stable, that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.

2. **Mostly covered and unstable (vulnerable).** OVER 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or banks are OVER 50 percent covered by materials that do not allow bank erosion. Streambanks are unstable, that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Banks showing present erosion must be vertical or near-vertical in form.

3. **Mostly uncovered and stable (vulnerable).** LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are stable, that is, they DO NOT SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping. Such banks are bare, but are not slumping or in a vertical or near vertical bank angle.

4. **Mostly uncovered and unstable (erosional).** LESS THAN 50 percent of the streambank surfaces are covered by vegetation in vigorous condition, or banks are LESS THAN 50 percent covered by materials that do not allow bank erosion. Streambanks are unstable, that is, they DO SHOW indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping.

5. **Undercut streambank:** Fish use streambank areas for the edge effect and protective cover they provide. Streambank cover is estimated by measuring undercut bank following a technique suggested by Lloyd (1986). An undercut bank is defined as follows: that bank which has been cut by the stream so that a protrusion of the upper portion of the bank overhangs the water surface. The water level does not influence this reading.

Using a measuring tape, measuring rod, or measuring wheel record the length of streambank on both sides of stream in the representative reach represented by undercut bank as defined above.

6. **Rearing habitat:** The proportions of slow to fast water velocity and pool complexity (quality) have often been used to assess fish rearing quality (Platts, Megahan, & Minshall 1983). Platts (1974) found a good relationship between fish densities and pools. The two parameters - slow/fast ratio and pool complexity are measured and recorded separately.

a. **Slow/fast ratio:** Slow waters are generally defined as those with velocity less than 1 foot per second, and fast waters are therefore greater than 1 fps. Slow waters normally represent pools of all kinds, while fast waters represent all other habitat types. The preferred way to quantitatively measure slow/fast ratio is the **thalweg profile survey** as documented in Monitoring Protocols Report No. 3. The thalweg profile survey is conducted with rod and level along the channel thread line (or thalweg) of the representative reach. This profile survey gives a measure of residual pool depth representing slow water area and is an excellent indicator of impacts by sediment filling and bed instability. As a surrogate, more rapid technique, measure along the linear orientation of the stream, the lengths of all pools (slow water) in the representative stream reach. Record total length of slow waters, total length of fast waters, and ratio of slow to fast water in the stream.

and...

b. Pool complexity: Pool complexity is defined primarily by cover elements. As cover is added, and becomes more diverse, its use by various life stages of fish increases. At each of the 10 cross channel transects in the representative reach, extend a measuring tape from bank to bank and tie off the ends on the two transect stakes. For each pool over which the transect line (tape) is intercepted, classify that pool according to the following:

1. **Depth:** Depth is defined as residual pool depth, that is: maximum depth of the pool minus pool spill-out depth. Record a single digit code for the depth as follows - if depth is less than .5 feet, code = 0. If depth is between .5 and 1.5 feet, code = 1. If depth is greater than 1.5 feet, code = 2.

2. **Substrate:** Record the substrate code as follows - If dominated by gravel size material or smaller (< 2.5 inches) then code = 0. If dominated by cobble sized material (> 2.5 inches and < 10 inches) then code = 1. If dominated by boulder size material (> 10 inches) then code = 2.

3. **Overhead cover:** Record the code for overhead cover (OC) created by terrestrial vegetation or turbulence. If OC is less than 10 percent by area of the surface of the pool, then code = 0. If OC is between 10 and 25 percent of the surface area, code = 1. If OC is greater than 25 percent of the surface area, code = 2.

4. **Submerged cover:** Record the code for submerged cover (SC) created by large organic debris, small woody debris, and other forms below or on the water surface. If SC is less than 10 percent by area of the surface of the pool, then code = 0. If SC is between 10 and 25 percent of the surface area, code = 1. If SC is greater than 25 percent of the surface area, code = 2.

5. **Bank cover:** Record the code for bank cover (BC) created by undercuts in the bank, stumps, large roots, and other along the pool margins. If BC is less than 25% of the length of the bank then code = 0. If BC is between 25 and 50 percent of the total bank length, then code = 1. If BC is greater than 50 percent of the bank length on the pool then code = 2.

Pool complexity for the reach is then determined by summing the codes over all 5 factors. Thus, for example if a pool received ratings of: depth = 2, substrate = 0, overhead = 2, submerged = 0, and bank = 1; then the pool complexity equals 2+0+2+0+1 = 5. Pool complexity ratings range between 0 and 10 with low values indicating low complexity, and high values high complexity.

7. **Substrate sedimentation:** Several studies indicated that substrate embeddedness by fine sediment was a major determinant of salmonid productivity (Nelson et al. in press; Shepard 1989; Hawkins et al. 1983; and Rinne 1990). Substrate embeddedness can be estimated using the detailed measurement techniques described in Water Quality Monitoring Protocols Report Number 2 (IDHW, DEQ in press). Using this technique, at least two embeddedness hoops are placed randomly on each of the cross channel transects in the representative reach. The amount of fine sediment filling interspaces in substrate habitat is measured using a framed grid on the embeddedness hoop. We have found measurements of areal percent fine sediment measured in this fashion to be strongly correlated to percent fine sediment in these low-gradient, mostly gravel/sand rangeland streams. Therefore, percent fines is suggested as a surrogate and rapid measure of substrate sedimentation. There are three techniques for measuring fine sediment: Areal fines from the framed grid, Wolman pebble counts (Wolman 1954), and visual analysis along the transect line. Each method is offered as an option as follows:

a. **Grid method:** The framed grid, or screen, is placed at random on at least 2 plot locations along each cross channel transect. Count all squares under the grid in which fine sediments (sands and silts) dominate the surface area in the square. Sum all counted squares, and divide by the total number of squares in the grid to determine percent fine sediment. The grid can be used in conjunction with the hoop embeddedness measurement technique.

b. **Wolman pebble counts:** This method is based on Wolman (1954). Use the technique described in Appendix II, part 5. Record percent fines by dividing the number of particles less than 6 mm diameter by the total particles in the sample. Pebbles for the count are taken from the substrate at even intervals along the cross channel transect line of all ten transects in the representative reach.

c. **Transect line visual analysis:** This method is based on Platts, Megahan, and Minshall (1983). The measuring tape stretched between the end points of each transect is used to evaluate substrate size distributions. Along the wetted length of the tape, project by eye vertically to the stream bottom and observe the materials immediately beneath the transect line. Record the number of inches on the tape of boulder (greater than 10 inches in diameter), length in inches of cobble (2.5 to 10 inches in diameter), the number of inches of coarse gravel (1 to 2.5 inches in diameter), the number of inches of fine gravel (.3 to 1 inch diameter), and the number of inches of fine sediment in sand and silt (less than .3 inches in diameter). The percent in each size class can then be calculated as total length represented by a size class along the tape divided by the present stream width.

RIPARIAN VEGETATION

8. **Greenline vegetation ecological status:** The degree of similarity between current greenline vegetation and desired vegetation condition (determined on the greenline at a reference site) determines ecological status (USDA, Forest Service 1990). Riparian community composition along the streambanks is measured within the representative reach. The same measurements are made within the like-classed reference reach. The degree of similarity defines vegetation ecological status.

The greenline is the first continuous cover of perennial vegetation is encountered above the low water level on or on top of the streambank. The greenline may be at water's edge, or possibly way back from the stream above a gravel bar, vertical bank, or other feature. Hydric plant species forming the greenline are normally those most desired for control of nonpoint sources of pollution (sediment, thermal, nutrients, etc.). Non-hydric (upland) species may exist on the greenline. The width of such communities along the green line may be only one or a few feet, but community lengths may run many hundreds of feet adjacent to the stream channel.

Measuring vegetation conditions on this greenline, where the forces of stream erosion play their most dominant role, provides the earliest indication of riparian condition trend following application of BMPs. Along the greenline, water is not limiting vegetation productivity, and regardless of outside forces, there is a continual effort by nature to grow green, water-loving plants at this site.

Use Table 6 in Appendix II to record the data. The following steps describe the greenline vegetation survey:

1. Begin on either side of the stream at the marker stake. Proceed along the greenline using a measuring tape, measuring rod, or measuring wheel and measure the lineal length of each community type in the greenline, adjacent to the waters edge, and parallel to the stream to the ending stake. The representative reach consists of ten (10) subareas delineated by markers. Hydric shrub and tree species with a canopy area of one (1) foot or more are considered a change in community type. Measure the distance from the edge of the canopy from one side of the shrub or tree to the opposite edge. Record the community type.

2. Measure and record lengths for each community type change (record each change in community type of one (1) foot or more) along the greenline to the end of the representative reach (last stake). Record Woody Plant Regeneration (see No. 9, Woody Regeneration) at this time for all woody hydric vegetation within six (6) feet of the waters edge (low stream level). Record data on form, "7. Woody Species Regeneration."

The exact position of the community type along the greenline is not recorded, rather the length of each community type.

3. Cross the stream and repeat the procedure along the opposite bank.

4. The total number of feet of each community type encountered along the greenline is determined and composition of each is computed as: total feet of community type divided by total length of all measurements on both sides of the channel.

Composition of the dominant community types is recorded in percent of total composition along the greenline.

9. **Woody regeneration:** Determination of woody shrub age class composition is a good indicator of vegetative trend on the greenline. In a survey of 250 miles of National Forest riparian areas (USDA, Forest Service 1987) reduction of shrubs was apparently caused by grazing of young reproduction age classes. The presence of a high proportion of sprouts, young, and early mature shrubs indicates upward trend in a grazed, shrub-dominated riparian zone. Low proportions of these plants indicates downward trends. The woody regeneration survey is applicable to stream/riparian areas where shrubs such as willow are potentially significant in the greenline vegetation composition.

Woody regeneration along the streambanks is measured within the representative reach. The same measurements can be made within the like-classed reference reach. The degree of similarity defines woody regeneration status as described in Section III.

1. Begin on either side of the stream at the marker stake. Use a 6 foot rod which has the center marked. Proceed down the greenline holding the rod center directly over the edge of the greenline adjacent to the stream channel. The greenline edge is where regeneration is most likely to occur and effects water quality.

2. All woody plants rooted underneath the extent of the rod (3 feet on either side of rod center) are assessed, classed, and tallied for each side of the stream as follows:

Number of stems	**Age class**
Number of stems = 1	: sprout
Number of stems = 2 to 10	: young
Number of stems > 10, > 1/2 alive	: mature
Number of stems > 10, < 1/2 alive	: decadent
0 stems alive	: dead

3. Add up and record the total number of shrubs in each age class encountered along the greenline on both sides of the representative reach. Record the composition of each age class as percent of the total number of shrubs measured in the reach.

10. Soil compaction: Soil compaction by grazing animals in the riparian zone reduces the vegetative productivity and bank stability needed to protect the stream. Compaction often restricts plant growth in riparian areas by reducing aeration, because soils in riparian zones will tend to be more water saturated for longer periods of time (Chow 1964). Compaction on the greenline also provides an estimate of the degree of bank stress being applied by trampling. Measures of compaction are therefore made along the greenline of the representative reach as well as along the reference reach. The difference represents the relative degree of stress from trampling. Compaction can be estimated from either bulk density core sampling or soil penetrometer measurements.

Sampling for soil bulk density is usually time consuming and can be quite difficult, particularly in clayey or gravelly soils. If done properly and with satisfactory duplication within community types, it provides an absolute measure of the degree of compaction and aeration.

Soil penetrometer measurements give a measure of soil strength and, indirectly compaction. They are quick and easy to perform and large sample data sets can be gathered. Because this measure is influenced by soil texture and moisture content, it should be taken in the same season and particularly under similar moisture conditions from year to year. Good correlations between penetrometer and bulk density can often be obtained.

1. Sample at the cross-channel transect marker stakes. These intervals will represent initial points of reference for compaction sampling. Measurements will be taken at a distance far enough from the stake so as to be away from disturbance associated with it, but still within the greenline community type associated with the stake location. Bulk density will be acquired from these representative vegetation community types along the greenline.

2. At each of the twenty stake locations proceed the selected distance along a random azimuth. Take penetrometer measurements at two locations, six inches apart. Measurements at each location should be taken at three inch depth intervals to a total depth of one foot.

3. Obtain bulk density samples as close to the penetrometer measurements as possible, and only after penetrometer measurements have been taken. The objective of bulk density sampling will be to acquire 4 cores representing each major greenline community type. Use a random number generator to select those transect stakes on dominant community types, and select only 4 locations for each dominant community.

4. Care should be taken to not advance the corer too far below ground surface to avoid compacting the sample. Place bulk density core samples in double zip-loc bags and mark appropriately. In the lab the moist weight of the core should be recorded. The core is then oven-dried overnight at 110 degrees C and then reweighed. The oven dry weight divided by the volume of the core will determine the bulk density. The moisture content of the core, that is, the amount of water in the core divided by the volume of the core, should also be determined.

III. STREAM/RIPARIAN EVALUATION

EVALUATION STRATEGY

Once the classification has been determined and documented (Step 1, above), a reference condition site must be located which matches the classification. This reference site will serve as an index of desired future condition and function as a control during the monitoring period. Paired comparisons with the reference site will indicate changes in the managed site over time relative to natural changes (due to climate, for example) encountered in the reference site. The reference site also establishes a baseline condition against which the impacted site can be evaluated to quantify its present condition.

Monitoring comparable treatment and reference sites is a very effective design. The reference site provides the data to separate the impact of treatment from the variability shared by both systems. As stated by Meals (1991), "evaluation of NPS watershed projects can rarely be treated as a simple short-term before/after or above/below exercise." Statisticians require paired comparison for monitoring to control effects of climatic and hydrologic variability on stream/riparian conditions. Year to year variations in precipitation, for example, will obscure real changes in phosphorous export or substrate sedimentation over time. Use of multiple references can also be applied to provide stronger statistical evidence of cause-effect.

DESCRIBING CONDITION OR STATUS

An excellent approach to describing condition or status is to compare similarity of a parameter at the treatment site to that same parameter in a reference site as described by Winward (1989). The "desired condition" is determined by the reference site. Similarity values between the "desired" and the "present" indicate current condition. Similarity values are expressed in percent of desired condition. When "present" equals "desired", the value is 100 percent. If "present" condition is less than 100, then the parameter is considered less than "desired". When the "present" is greater than 100, then the parameter is considered better than "desired".

If the reference site is in "natural" condition, usually the "desired" condition is something less than this. It has been suggested that for vegetation, a value of 75 percent similarity to potentially natural condition be used to define desirable condition (Winward 1989). For other parameters, the desired value may be different than 75 percent depending on sensitivity to treatment effects. In many cases, streambank condition must be higher than 75 percent of potential natural condition to reach "desired" for purposes of beneficial use protection.

The method for determining similarity is presented below for each parameter in the protocols as listed in Section II:

1. Maximum temperature: The recorded output is in degrees C. Higher maximum temperature equates to lower condition. The equation for similarity is:

$$\%S = [Tr - (Tt-Tr)]/Tr \times 100$$

Where: %S = Percent similarity or condition
Tr = Max temperature at reference
Tt = Max temperature at the treatment

Note that percent similarity exceeds 100 when the max temperature at the reference is greater than max temperature at the treatment site.

1a. Canopy closure: The recorded output is percent of riparian vegetation canopy shading the stream. This value is higher in reference areas than treatments so the equation for similarity is:

$$\%S = [\%Cr - (\%Cr-\%Ct)]/\%Cr \times 100$$

Where: %S = Percent similarity or condition
%Cr= Percent canopy cover at reference
%Ct= Percent canopy cover at the treatment

Note that percent similarity exceeds 100 when the canopy cover at the reference is less than canopy cover at the treatment site.

1b. Overhanging vegetation: The output is in percent of streambank with overhanging vegetation. This value is higher in reference areas than treatments so the equation for similarity is:

$$\%S = [\%Or - (\%Or-\%Ot)]/\%Or \times 100$$

Where: %S = Percent similarity or condition
%Or= Percent overhanging vegetation at reference
%Ot= Percent overhanging vegetation at the treatment

Note that percent similarity exceeds 100 when overhanging vegetation at the reference is less than the treatment site.

1c. Thermal input: The output is in thousands of BTU's per unit area of stream. As with maximum temperature, thermal input is higher in treatment areas than in reference areas thus:

$$\%S = [THr - (THt-THr)]/THr \times 100$$

Where: %S = Percent similarity or condition
THr = Thermal input at reference
THt = Thermal input at the treatment

Note that percent similarity exceeds 100 when thermal input at the reference is greater than at the treatment site.

2. Nutrient enrichment: Nutrient concentrations are recorded in milligrams per liter (mg/l), but the biotic metrics for enrichment are recommended for this evaluation since they indicate effects from both dissolved and solid sources of nutrients. The index values are recorded in whole numbers, with higher values for better biological condition:

$$\%S = [Br - (Br-Bt)]/Br \times 100$$

Where: %S = Percent similarity or condition
Br = Biotic index at reference
Bt = Biotic index at treatment

Note that when biotic indices at the treatment exceed those at the reference, the percent of similarity exceeds 100.

3. Direct or estimated Streamflow ratio: The ratio of low to high streamflow is a value between 0 and 1. It is calculated from direct streamflow measurements, or estimated for cross-sectional hydraulics in the channel as explained in Section II. As the ratio approaches 1, streamflow variation improves. The similarity index is:

$$\%S = [Qr - (Qr-Qt)]/Qr \times 100$$

Where: %S = Percent similarity or condition
Qr = Streamflow ratio at the reference
Qt = Streamflow ratio at the treatment

Note that as the ratio at the treatment exceeds that of the reference, percent similarity exceeds 100.

4. Streambank condition: The composition of the streambank relative to each of the 4 bank condition classes is calculated and reported as percent of each class. Similarity between the present and reference condition is calculated as sum of the percentage of composition in common in each condition class. The following example serves to illustrate the calculation of "common" values:

Condition class	Reference site	Treatment site	Amount in common
> 50% cover/stable	87%	40	40
> 50% cover/unstable	5	25	5
< 50% cover/stable	8	10	8
< 50% cover/unstable	0	25	0
Totals	100	100	53

%S = 53%

5. Undercut bank: The amount of undercut bank is a percentage of the total length of streambanks. The calculation of similarity is:

$$\%S = [\%Ur - (\%Ur - \%Ut)]/\%Ur \times 100$$

Where: %S = Percent similarity or condition
%Ur= Percent undercut bank at reference
%Ut= Percent undercut bank at treatment

Note that percent similarity exceeds 100 when undercut bank at the treatment exceeds the reference site.

6a. Slow/fast water ratio: The slow/fast ratio is analogous to the streamflow ratio. As pools increase in total composition of habitat types, the value approaches 1. The optimum value in a stream is 0.5 which allows for maximum habitat diversity. Therefore, evaluation is in terms of the reference reach similarity to optimum (or 0.5).

$$\%S = [|Pr-.5| - (|Pr-.5|-|Pt-.5|)/|Pr-.5| \quad \times 100$$

Where: |Pr-.5| is the absolute value of slow-fast ratio minus .5 at the reference
|Pt-.5| is the absolute value of slow-fast ratio minus .5 at the treatment
%S is the similarity index or condition

Note that as the ratio at the reference site differs from .5 more than at the treatment site, the similarity index exceeds 100%.

6b. Pool complexity (quality) index: The pool complexity index is a value between 0 and 10, with 10 highest complexity (quality), and 0 lowest quality. The similarity index is:

$$\%S = [PQr - (PQr-PQt)]/PQr \times 100$$

Where: %S = Percent similarity or condition
PQr = Pool complexity at the reference
PQt = Pool complexity at the treatment

Note that as pool complexity at the treatment exceeds that of the reference, percent similarity exceeds 100.

7. Percent embeddedness and percent fine sediment: Sediment, whether in Percent embeddedness or in Percent substrate fine sediment is evaluated in the same manner. The similarity index is:

$$\%S = [SEDr - (SEDt-SEDr)]/SEDr \times 100$$

Where: %S = Percent similarity or condition
SEDr = Sediment (embeddedness or fines) at reference
SEDt = Sediment (embeddedness or fines) at the treatment

Note that percent similarity exceeds 100 when Percent sediment at the reference is greater than at the treatment site.

8. Greenline vegetation composition: The composition of greenline vegetation is expressed in percent by community type. The evaluation of percent similarity is calculated as the sum of community composition in common with the reference as follows:

Veg. Community Type	Reference site	Treatment site	Amount in common
Booth willow (SABO)	45%	10	10
Nebraska sedge (CANE)	35	5	5
Blue grass (POPR)	5	80	5
Booth willow/bluegrass	15	5	5
Totals	100	100	25

%S = 25%

9. Woody vegetation: The output is in composition of shrubs by age class. As with greenline vegetation composition, the evaluation of condition is in terms of total composition in common with the reference site:

Woody age class	Reference site	Treatment site	Amount in common
Sprouts	40%	5	5
Young	25	10	10
Early, mature	20	35	20
Late, mature	10	30	10
Dead or decadent	5	20	5
Totals	100	100	50

%S = 50%

10. Soil compaction: Soil compaction is calculated using either soil bulk density or penetration of the densiometer (in inches). In either case, an average value of compaction can be calculated for each vegetation community type. The total similarity is the average of the individual percentage of reference values for each community type.

DESCRIBING TREATMENT EFFECTS OVER TIME

There are several statistical methods recommended for assessing treatment effects or trends over time. Detailed descriptions of these methods are not repeated here. Refer to a good environmental pollution monitoring statistical methods text such as Gilbert (1987) for the specific equations and testing approaches.

The simplest approach is the time regression. Using this technique, the slope of a regression line of percent similarity of each parameter against time is tested. A significant slope is indicative of trend.

An effective approach is the paired regression suggested by Meals (1991). A regression relationship between treatment and reference sites is developed prior to treatment (calibration relationship). After application of nonpoint source controls, a similar regression is derived, and significant difference in slope between the two regressions indicates the effects of treatment.

Non-parametric techniques allow for comparing levels of similarity at different times and places. Tests do not require that data follow the normal (or any other) distribution. Also, the tests allow for the inclusion of missing data. Some of the more commonly applied techniques are the seasonal Kendall, Mann-Whitney, and Spearman rank tests.

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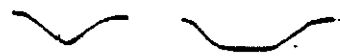
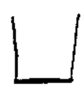
APPENDIX I

LEVEL II RECONNAISSANCE - CLASSIFICATION

1. Valley bottom classification
2. Criteria for stream type classification
3. Criteria for stream sub-type: Stream size
4. Criteria for dominant soil family
5. Riparian data sheet - level I
6. Level II a Reconnaissance - classification
7. Level II b Reconnaissance - habitat

1. VALLEY BOTTOM CLASSIFICATION

VALLEY FORM:

U-Shape	1000	
V-Shape	2000	
Trough-Like	3000	
Flat Bottom	4000	
Box Canyon	5000	

VALLEY BOTTOM GRADIENT:

Very Low	< 2%	100
Low	2 - 4%	200
Moderate	> 4 - 6%	300
High	> 6 - 8%	400
Very High	8%	500

VALLEY BOTTOM WIDTH:

Very Narrow	< 10 m	10
Narrow	10 - 30 m	20
Moderate	30 - 100 m	30
Broad	100 - 300 m	40
Very Broad	> 300 m	50

VALLEY SIDE SLOPES:

Low	< 30%	1
Moderate	30 - 60%	2
Steep	> 60%	3

CHANNEL CLASSIFICATION

Stream Types

STREAM TYPE	GRADIENT[1]	SINUOSITY[2]	W/D RATIO[3]	DOMINANT PARTICLE SIZE OF CHANNEL MATERIALS[4]	CONFINEMENT[5]	LANDFORM FEATURE-SOILS/STABILITY[6]
A1	4-10	1.0-1.1	10 or less	Predominately bedrock with some large boulders.	Well confined 1.5 or less	Deeply incised bedrock drainage way w/steep side slopes and/or vertical rock walls.
A1-a	10 +	(Criteria same as A1)				
A2	4-10	1.1-1.2	10 or less	Large and small boulders w/mixed cobbles.	Same as A1	Steep wide slopes w/ predominately stable material.
A2a	10 +	(Criteria same as A2)				
A3	4-10	1.1-1.3	10 or less	Small boulders, cobble, coarse gravel. Some sands.	Same as A1	Steep, depositional features with predominantly coarse-textured soils. Debris avalanche is the predominant erosion process; stream-side slopes are rejuvenated with extensive exposed mineral soil.
A3-a	10 +	(Criteria same as A3)				
A4	4-10	1.2-1.4	10 or less	Predominantly gravel, sand, and some silts.	Same as A1	Steep side slopes with mixture of either depositional landforms with fine textured soils such as glaciofluvial or glaciolacustrine deposits or highly erodible residual soils such as grussic granite, etc. Slump-earthflow and debris avalanche are dominant erosional processes stream-adjacent slope are rejuvenated.
A4-a	10 +	(Criteria same as A4)				
A5	4-10	1.2-1.4	10 or less	Silt and/or clay bed and bank materials.	Same as A1	Moderate to steep side slopes; fine-textured cohesive soil. Slump-earthflow erosional processes dominate.
A5-a	10 +	(Criteria same as A5)				
B1-1	1.5-4.0	1.3-1.9	10 or greater (X:15)	Bedrock bed; banks are cobble, gravel, some sand.	Moderate confinement 1.5-2.5	Bedrock controlled channel with coarse-textured depositional bank materials.
B1	2.5-4.0 (X:3.5)	1.2-1.3	5-15 (X:10)	Predominantly large boulders and very large cobble.	Moderately confined 1.5-2.5	Moderately stable, coarse-textured resistant resistant soil materials; river terrace.
B2	1.0-2.5 (X:2.0)	1.3-1.7	8-20 (X:14)	Predominantly large cobble mixed w/few small boulders and gravel.	Moderately confined 1.5-2.5	Coarse textured, alluvial terrace with stable, moderately steep side slopes.
B3	1.5-4.0 (X:2.5)	1.3-1.7	8-20 (X:12)	Cobble bed w/mixture of gravel and sand, some small boulders.	Well confined 1.5 or less	Glacial outwash terrace and/or rejuvenated slopes. Unstable, moderate to steep slopes; unconsolidated, coarse-textured unstable banks; depositional landforms.
B4	1.5-4.0 (X:2.0)	1.5-1.7	8-20 (X:10)	Very coarse gravel w/ cobbles sand and finer material.	Well confined 1.5 or less	Relatively fine grained river terrace. Unconsolidated coarse to fine depositional material; steep slopes; highly unstable banks.

CHANNEL CLASSIFICATION Continued

B5	1.5-4.0 (X:2.5)	1.5-2.0	8-25 (X:15)	Silt/clay.	Well confined 1.5 or less	Cohesive fine-textured soils; slump-earthflow erosional processes.
B6	1.5-4.0	1.8 to 2.8	0.1-8.0	Predominantly small cobble w/large gravel mixed w/sand.	Slightly confined 2.5 or greater.	Narrow and deep meandering coarse-grained channel with well vegetated banks and with accessible flood plain.
C1-1	1.5 or less (X:1.0)	1.5-2.0	10 or greater (X:30)	Bedrock bed, gravel, sand, or finer banks.	Slightly confined 2.5 or greater.	Bedrock-controlled channel with depositional fine-grained bank material.
C1	1.0-1.5 (X:1.3)	1.5-2.0	10 or greater (X:18)	Cobble/coarse gravel bed gravel/sand banks.	Slightly confined 2.5 or greater.	Predominantly coarse textured with stable high alluvial terraces.
C2	0.3-1.0 (X:0.6)	1.3-1.5	12-30 (X:20)	Large-cobble bed w/ mixture of small boulders and coarse gravel.	Moderately confined 1.5-2.5	Overfit channel, deeply incised in coarse-grained alluvial terraces or other depositional features.
C3	0.1-1.0 (X:0.5)	1.8-2.4	10 or greater (X:25)	Gravel bed w/mixture of small cobble and sand.	Slightly confined 2.5 or greater.	Predominantly moderate to fine textured multiple low river terraces; unstable banks, unconsolidated, noncohesive soils.
C4	0.1-1.0 (X:0.3)	2.5 +	5 or greater (X:25)	Sand bed w/mixture of gravel and silt, no bed armor.	Slightly confined 2.5 or greater.	Predominantly fine-textured, alluvium with low flood terraces.
C5	1.5 or less (X:0.5)	2.5 +	5 or greater (X:10)	Silt/clay w/mixture of medium to fine sand, no bed armor.	Slightly confined 2.5 or greater.	Low, fine-textured alluvial terraces, delta deposits, lacustrine, loess or other fine-textured soils; predominantly cohesive.
C6	1.5 or less.	2.5 +	5 or (X:3)	Sand bed w/mixture of silt and some gravel.	Slightly confined 2.5 or greater.	Same as C4 except has ore resistant vegetated banks.
D1	1.0 or greater (X:2.5)	N/A Braided	30 +	Cobble bed w/mixture of coarse gravel and sand and small boulders	No confinement 2.5 or greater	Glacial outwash, coarse depositional material, highly erodible; excess sediment supply of coarse size material.
D2	1.0 or less	N/A Braided	30 +	Sand bed w/ mixture of small to medium gravel and silt.	No confinement 2.5 or greater	Fine-textured depositional soil, very erodible; excess of fine-textured sediment.
F1	1.5 or less	1.3 +	10-40	Bedrock bed with few boulders, cobble and gravels.	Well confined 1.5 or less	Flat-gradient, confined meandering bedrock stream. Highly weathered bedrock where stream has been deeply incised.
F2	1.5 or less	1.3 +	10-40	Boulders with small amounts of cobble, gravel, and sands.	Same as F1	Flat-gradient, confined, meandering boulder bed stream; weathered bedrock and/or very coarse depositional or residual material such as talus; deep stream incision.
F3	1.5 or less	1.3 +	10-40	Cobble/gravel bed with locations of sands in depositional sites.	Same as F1	Flat-gradient, confined, meandering cobble/gravelbed streams. Weathered bedrock or depositional coarse-grained terraces where stream is deeply incised.

F4	1.5 or less	1.3 +	10-40	Sand bed with smaller amounts of silt and gravel.	Same as F1	Flat-gradient, confined meandering, sand-bed channel; highly weathered bedrock or fine-textured depositional and/or residual soil where the stream has been deeply incised.
F5	1.5 or less	1.3 +	10-40	Silt-clay bed and banks with smaller amounts of sands.	Same as F1	Flat-gradient, confined, meandering, silt/clay streams; highly weathered bedrock or fine-textured depositional and/or residual soil areas where stream has deeply incised.

1. Gradient is defined as the change in water surface slope. Measurement made on-site using rod and level.
2. Sinuosity is defined as the stream length divided by the valley length. Measurements are made using USGS map or aerial photo.
3. W/D Ratio is defined as the bankfull width divided by the average bankfull depth. Measurement are made on-site.
4. Dominant Particle Size is most appropriately determined through a pebble count but can be determined through visual observations.
5. Confinement is defined as the ratio of the width of flood plain divided by the bankfull width. Measurements are made on-site.
6. Adjacent landform features are determined visually.

Delineative criteria for stream sub-types

ORGANIC DEBRIS/Channel Blockages

(In Active Channel)

D-1 None

D-2 Infrequent debris, what's present consists of small, floatable organic debris.

D-3 Moderate frequency, mixture of small to medium size debris affects less than 10% of active channel area.

D-4 Numerous debris mixture of medium to large sizes - affecting up to 30% of the area of the active channel.

D-5 Debris dams of predominantly large material affecting over 30% to 50% the channel area and often occupying the total width of the active channel.

D-6 Extensive, large debris dams either continuous or influencing over 50% of the channel area. Forces water onto flood plain even with moderate flows. Generally presents a fish migration blockage.

D-7 Beaver dams - few and/or infrequent. Spacing allows for normal streamflow conditions between dams.

D-8 Beaver dams - frequent. Back water occurs between dams - stream flow velocities reduced between dams.

D-9 Beaver dams - abandoned where numerous dams have filled in with sediment and are causing channel adjustments of lateral migration, evulsion, and degradation etc.

D-10 Man made structures - diversion dams, low dams, controlled by-pass channels, baffled bed configuration with gabions, etc.

RIPARIAN VEGETATION

V1 - Rock

V2 - Bare soil, little to no vegetative cover

V3 - Annuals, forbs

V4 - Grass - perennial bunch grasses

V5 - Grass - sod formers

V6 - Low brush species

V7 - High brush species

V8 - Coniferous trees

V9 - Deciduous trees

V10 - Wetlands

a. bog
b. fen
c. marsh

Note: Combinations of grass and brush understories with a coniferous overstory can be designated by combining sub-type numbers, i.e., (V4,7,8.)

Subscript letters may be used to identify specific vegetative associations, speciation, habitat types, or riparian types based on level of detail required by stream type user.

STREAM SIZE (S)

S-1 Bankfull width less than 1 foot.

S-2 Bankfull width 1-5.

S-3 Bankfull width 5-15.

S-4 Bankfull width 15-30.

S-5 Bankfull width 30-50.

S-6 Bankfull width 50-75.

S-7 Bankfull width 75-100.

S-8 Bankfull width 100-150.

S-9 Bankfull width 150-250.

S-10 Bankfull width 250-350.

S-11 Bankfull width 350-500.

S-12 Bankfull width 500-1000.

S-13 Bankfull width 1000+·

FLOW REGIMEN

General Category

E. - Ephemeral stream channels - flows only in response to precipitation.

S. - Subterranean stream channel - flows parallel to and near the surface for various seasons - a sub-surface flow which follows the stream channel bed.

I. - Intermittent stream channel - one which flows only seasonally, or sporadically. Surface sources involve springs, snow melt, artificial controls, etc.

P. - Perennial stream channels. Surface water persists year long.

Specific Category

1. Seasonal variation in streamflow dominated primarily by snowmelt runoff.
2. Seasonal variation in streamflow dominated primarily by stormflow runoff.
3. Uniform stage and associated streamflow due to spring fed condition, backwater etc.
4. Stream flow regulated by glacial melt.
5. Regulated stream flow due to diversions, dam release, dewatering, etc.

DEPOSITIONAL FEATURES (BARS)

B-1 Point Bars

B-2 Point Bars with Few Mid Channel Bars

B-3 Many Mid Channel Bars

B-4 Side Bars

B-5 Disposal Bars

B-6 Main Branching with Many Mid Bars and Islands

B-7 Mixed Side Bar and Mid Channel Bars Exceeding 2-3% Width

B-8 Delta Bars

MEANDER PATTERNS

M-1 Regular Meander

M-2 Tortuous Meander

M-3 Irregular Meander

M-4 Truncated Meander

M-5 Unconfined Meander Scrolls

M-6 Confined Meander Scrolls

M-7 Distorted Meander Loops

M-8 Irregular with Oxbows, Oxbow Cutoffs

2. CRITERIA FOR STREAM TYPE CLASSIFICATION

STREAM TYPE	GRADIENT %	SINUOSITY	W/D RATIO	DOMINANT PARTICLE SIZE OF CHANNEL MATERIALS	CHANNEL ENTRENCHMENT—VALLEY CONFINEMENT	LANDFORM FEATURE — SOILS/STABIL
A1	4 - 10	1.0 - 1.1	10 or less	Bedrock.	Very deep/very well confined.	Deeply incised bedrock drainageway w/ s side slopes and/or vertical rock walls.
A1-a	10+	(Criteria	same	as A1)		
A2	4 - 10	1.1 - 1.2	10 or less	Large and small boulders w/ mixed cobble.	Same.	Steep side slopes w/ predominantly stabl materials.
A2-a	10+	(Criteria	same	as A2)		
A3	4 - 10	1.1 - 1.3	10 or less	Small boulders, cobble, coarse gravel.	Same.	Steep, depositional features w/ predomin coarse textured soils. Debris avalanche is predominant erosional process. Stream a cent slopes are rejuvenated with extensiv posed mineral soil.
A3-a	10+	(Criteria	same	as A3)		
A4	4 - 10	1.2 - 1.4	10 or less	Predominantly gravel, sand, and some silts.	Same.	Steep side slopes w/ mixture of either de tional landforms with fine textured soils s as glaciofluvial or glaciolacustrine deposi highly erodable residual soils such as gr granite, etc. Slump-earthflow and debris avalanche are dominant erosional proces Stream adjacent slopes are rejuvenated.
A4-a	10+	(Criteria	same	as A4)		
A5	4 - 10	1.2 - 1.4	10 or less	Silt and/or clay bed and bank materials.	Same.	Moderate to steep side slopes. Fine textu cohesive soils, slump-earthflow erosional cesses dominate.
A5-a	10+	(Criteria	same	as A5)		
B1-1	1.5 - 4.0	1.3 - 1.9	10 or greater (X:15)	Bedrock bed, banks, cobble, gravel, some sand.	Shallow entrenchment. Moderate confinement.	Bedrock controlled channel with coarse t tured depositional bank materials.
B1	2.5 - 4.0 (X:3.5)	1.2 - 1.3	5 - 15 (X:10)	Predominantly small boulders, very large cobble.	Moderately entrenched/well confined.	Moderately stable, coarse textured resist soil materials. Some coarse river terrace
B2	1.5 - 2.5 (X:2.0)	1.3 - 1.5	8 - 20 (X:14)	Large cobble mixed w/ small boulders and coarse gravel.	Moderately entrenched/moderately confined.	Coarse textured, alluvial terraces with st moderately steep, side slopes.
B3	1.5 - 4.0 (X:2.5)	1.3 - 1.7	8 - 20 (X:12)	Cobble bed w/ mixture of gravel and sand—some small boulders	Moderately entrenched/well confined.	Glacial outwash terraces and/or rejuvena slopes. Unstable, moderate to steep sloc Unconsolidated, coarse textured unstabl banks. Depositional landforms.
B4	1.5 - 4.0 (X:2.0)	1.5 - 1.7	8 - 20 (X:10)	Very coarse gravel w/ cobble mixed sand and finer material.	Deeply entrenched/well confined.	Relatively fine river terraces. Unconsolid coarse to fine depositional material. Ste side slopes. Highly unstable banks.
B5	1.5 - 4.0 (X:2.5)	1.5 - 2.0	8 - 25 (X:15)	Silt/clay.	Same.	Cohesive fine textured soils. Slump-ear erosional processes.

2. CRITERIA FOR STREAM TYPE CLASSIFICATION

STREAM TYPE	GRADIENT %	SINUOSITY	W/D RATIO	DOMINANT PARTICLE SIZE OF CHANNEL MATERIALS	CHANNEL ENTRENCHMENT—VALLEY CONFINEMENT	LANDFORM FEATURE — SOILS/STABILITY
C1-1	1.5 or less (X:1.0)	1.5 - 2.5	10 or greater (X:30)	Bedrock bed, gravel, sand, or finer banks.	Shallow entrenchment, poorly confined.	Bedrock controlled channel with depositional fine grained bank material.
C1	1.2 - 1.5 (X:1.3)	1.5 - 2.0	10 or greater (X:18)	Cobble bed with mixture of small boulders and coarse gravel.	Moderately entrenched/moderately confined.	Predominantly coarse textured, stable high alluvial terraces.
C2	0.3 - 1.0 (X:0.6)	1.3 - 1.5	15 - 30 (X:20)	Large cobble bed w/ mixture of small boulders and coarse gravel.	Moderately entrenched/well confined.	Overfit channel, deeply incised in coarse alluvial terraces and/or depositional features.
C3	0.5 - 1.0 (X:08)	1.8 - 2.4	10 or greater (X:22)	Gravel bed w/ mixture of small cobble and sand.	Moderately entrenched/ slight confined.	Predominantly moderate to fine textured multiple low river terraces. Unstable banks, unconsolidated, noncohesive soils.
C4	0.1 - 0.5 (X:03)	2.5	5 or greater (X:25)	Sand bed w/ mixtures of gravel and silt (no bed armor).	Moderately entrenched/slight confined.	Predominantly fine textured, alluvium with low flood terraces.
C5	0.1 or less (X:05)	2.5	5 or greater (X:10)	Silt/clay w/ mixtures of medium to fine sands (no bed armor).	Moderately entrenched/slight confined.	Low, fine textured alluvial terraces, delta deposits, lacustrine, loess or other fine textured soils. Predominantly cohesive soils.
C6	0.1 or less (X:05)	2.5	3 or greater (X:5)	Sand bed w/ mixture of silt and some gravel.	Deep entrenched/ slight confined.	Same as C4 except has more resistant banks.
D1	1.5 or more (X:2.5)	N/A Braided	N/A	Cobble bed w/ mixture of coarse gravel and sand and small boulders.	Slight entrenched/no confinement.	Glacial outwash, coarse depositional material, highly erodable. Excess sediment supply of coarse size material.
D2	1.5 or less (X:1.0)	N/A Braided	N/A	Sand bed w/ mixture of small to medium gravel and silts.	Slight entrenched/no confinement.	Fine textured depositional soils, very erodable - excess of fine textured sediment.

E. Estuarian Streams (Deltas)

E1. **High Constructive** - Lobate shaped deltas with a wide, well defined delta plain and numerous distributary channels.

E2. **High Constructive** - Elongate deltas with a narrow delta plain with lateral distributary channels.

E3. **High Destructive** - Tide dominated deltas.

E4. **High Destructive** - Wave dominated deltas.

G. Glacial Streams

G1. Streams incised in glacial ice with mixture of tills involving coarse textured materials including boulders, cobble, gravels, sands, and some silt.

G2. Streams incised in glacial ice with materials of silts, clays, and some sands. Typical of glacial lacustrine deposits.

2. CRITERIA FOR STREAM TYPE CLASSIFICATION

STREAM TYPE	GRADIENT %	SINUOSITY	W/D RATIO	DOMINANT PARTICLE SIZE OF CHANNEL MATERIALS	CHANNEL ENTRENCHMENT— VALLEY CONFINEMENT	LANDFORM FEATURE — SOILS/STABILITY
C1-1	1.5 or less (X:1.0)	1.5 - 2.5	10 or greater (X:30)	Bedrock bed, gravel, sand, or finer banks.	Shallow entrenchment, poorly confined.	Bedrock controlled channel with depositional fine grained bank material.
C1	1.2 - 1.5 (X:1.3)	1.5 - 2.0	10 or greater (X:18)	Cobble bed with mixture of small boulders and coarse gravel.	Moderately entrenched/moderately confined.	Predominantly coarse textured, stable high alluvial terraces.
C2	0.3 - 1.0 (X:0.6)	1.3 - 1.5	15 - 30 (X:20)	Large cobble bed w/ mixture of small boulders and coarse gravel.	Moderately entrenched/well confined.	Overfit channel, deeply incised in coarse alluvial terraces and/or depositional features.
C3	0.5 - 1.0 (X:08)	1.8 - 2.4	10 or greater (X:22)	Gravel bed w/ mixture of small cobble and sand.	Moderately entrenched/ slight confined.	Predominantly moderate to fine textured multiple low river terraces. Unstable banks, unconsolidated, noncohesive soils.
C4	0.1 - 0.5 (X:03)	2.5	5 or greater (X:25)	Sand bed w/ mixtures of gravel and silt (no bed armor).	Moderately entrenched/slight confined.	Predominantly fine textured, alluvium with low flood terraces.
C5	0.1 or less (X:05)	2.5	5 or greater (X:10)	Silt/clay w/ mixtures of medium to fine sands (no bed armor).	Moderately entrenched/slight confined.	Low, fine textured alluvial terraces, delta deposits, lacustrine, loess or other fine textured soils. Predominantly cohesive soils.
C6	0.1 or less (X:05)	2.5	3 or greater (X:5)	Sand bed w/ mixture of silt and some gravel.	Deep entrenched/ slight confined.	Same as C4 except has more resistant banks.
D1	1.5 or more (X:2.5)	N/A Braided	N/A	Cobble bed w/ mixture of coarse gravel and sand and small boulders.	Slight entrenched/no confinement.	Glacial outwash, coarse depositional material, highly erodable. Excess sediment supply of coarse size material.
D2	1.5 or less (X:1.0)	N/A Braided	N/A	Sand bed w/ mixture of small to medium gravel and silts.	Slight entrenched/no confinement.	Fine textured depositional soils, very erodable excess of fine textured sediment.

E. Estuarian Streams (Deltas)

E1. **High Constructive** - Lobate shaped deltas with a wide, well defined delta plain and numerous distributary channels.

E2. **High Constructive** - Elongate deltas with a narrow delta plain with lateral distributary channels.

E3. **High Destructive** - Tide dominated deltas.

E4. **High Destructive** - Wave dominated deltas.

G. Glacial Streams

G1. Streams incised in glacial ice with mixture of tills involving coarse textured materials including boulders, cobble, gravels, sands, and some silt.

G2. Streams incised in glacial ice with materials of silts, clays, and some sands. Typical of glacial lacustrine deposits.

3. Criteria for stream sub-type: Stream size

STREAM SIZE (S)

S-1 Bankfull width less than 1 foot.

S-2 Bankfull width 1-5.

S-3 Bankfull width 5-15.

S-4 Bankfull width 15-30.

S-5 Bankfull width 30-50.

S-6 Bankfull width 50-75.

S-7 Bankfull width 75-100.

S-8 Bankfull width 100-150.

S-9 Bankfull width 150-250.

S-10 Bankfull width 250-350.

S-11 Bankfull width 350-500.

S-12 Bankfull width 500-1,000.

S-13 Bankfull width 1,000+.

4. CRITERIA FOR DOMINANT SOIL FAMILIES

SOIL FAMILY: Groupings of soils within the subgroup level of the soil classificatio system. Soils are grouped on the basis of similar physical and chemic properties that affect their responses to management and manipulation fc use. These properties are important to factors that affect soil productivit and resistance to stream erosion.

Properties that define soil families are:

1. Particle-size distribution in horizons of major biologic activity below a dept of about 10".

2. Mineralogy of the same horizons as in 1.

3. Temperature regime.

4. Thickness of the soil penetrable by roots.

Dominant riparian soil families are thus classified to the subgroup level plus the fou characteristics listed above. Ussually, criterium 3 and 4 change very little within typical riparian project area. Particle size class and mineralogy then become importan

SUBGROUP EXAMPLE: Typic Cryaquolls.

In this case the Typic modifier difines the subgroup of Cryaquolls.

Family examples for the above subgroup:

Fine-loamy, mixed typic Cryaquoll

Fine, monmorillonitic, Typic Cryaquoll

In practice, key criteria for differentiating soils in the field in riparian areas will typicall include texture, amount of coarse fragments, presence and degree of mottling, gleyin or other features indicative of soil moisture regime, and the presence and thicknes of surface organic layers.

5. LEVEL I. BAS.. DATA SHEET

Stream name ______________________________ Date ______________________________

Stream complex (strata) ____

Quad name ______________________________ Size ______________________________ miles

Geomorlhphic setting:

Stream order ______________________ Gradient ______________________

Dominant stream substrate ______________________ Stream type (Rosgen) __________

Valley bottom type ______________________ Aspect ______________________

Elevation range: Lower ______________________ Upper ______________________

Geology/soils:

Geologic parent material ______________________ Soil map units ______________

Landform characteristics ____

Dominant riparian vegetation:

Conifer __________ Deciduous __________ Shrub __________ Herb/graminoid __________

Non-vegetated __________

Sub areas:

ID (on map) ______________ Dominant land use ______________________________

ID (on map) ______________ Dominant land use ______________________________

ID (on map) ______________ Dominant land use ______________________________

STREAM COMPLEX (STRATA) CLASSIFICATION ______________________________________

6. LEVEL II a. RECONNAISSANCE - CLASSIFICATION

1. Sub- area name: ____________________ 2. Location: ____________________

3. Waterbody: ____________________ 4. Riparian area: ____________________

5. Valley bottom type: ____________ 6. Rosgen Stream Type: ____________________

7. Rosgen Stream size sub-type: __________ 8. Stream reach classification: __________

Dominant Soil Families	Composition of dominant soil families (percent)

Dominant riparian vegetation communities	Composition of vegetation communities (percent)

SPECIES LIST

Trees

____
____
____
____

Shrubs

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Graminoids

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Forbs

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7. LEVEL II b - RECONNAISSANCE - HABITAT

I. CANOPY DENSITY ESTIMATE: Percent canopy cover (densiometer estimate):

1st: ________ 2nd: ________ 3rd: ________

4th: ________ 5th: ________ 6th: ________

Average: ________

II. SUBSTRATE SIZES: Wolman pebble count estimate

No. of particles:
Sand/silt (<.1"): 1st________2nd________3rd________

4th________5th________6th________

Gravel(.1-2.5"): 1st________2nd________3rd________

4th________5th________6th________

Cobble (2.5-10"): 1st________2nd________3rd________

4th________5th________6th________

IV. POOL COMPLEXITY INDEX (for selected pools) - 1st: ________ 2nd: ________

3rd: ________ 4th: ________ 5th: ________ 6th: ________

Average pool complexity index: ________

V. STREAMFLOW VARIATION: Bankful width: 1:______2:______3:______4:______5:______6:______

Bankful depth: 1:______2:______3:______4:______5:______6:______

Lowflow width: 1:______2:______3:______4:______5:______6:______

Lowflow depth: 1:______2:______3:______4:______5:______6:______

W/D ratio bankful: ______ W/D ratio lowflow: ______

VI. % EMBEDDEDNESS (occular): Riffles: ___ ___ ___ Runs: ___ ___ ___ Pools: ___ ___ ___

VII. BANK CONDITION : % covered/stable: 1:______2:______3:______4:______5:______6:______

% covered/unstable: 1:______2:______3:______4:______5:______6:______

% uncovered/stable: 1:______2:______3:______4:______5:______6:______

% uncovered/unstable: 1:______2:______3:______4:______5:______6:______

VIII. BANK TYPE AND VEGETATIVE OVERHANG

% bank undercut: 1:______2:______3:______4:______5:______6:______

% overhang veg: 1:______2:______3:______4:______5:______6:______

% bank length gently sloping

(>135 degrees): 1:______2:______3:______4:______5:______6:______

8. LEVEL II - HABITAT DIVERSITY (Hankin & Reeves method)

STREAM NAME: ______________________ DATE: ______________________

INVESTIGATORS: ______________________ STREAM REACH DESCRIPTION: ______________________

____

HABITAT UNIT #:												
(V) visual or (M) measured:												
Length of unit (ft):												
Habitat type:												
Canopy density %:												
Dominant substrate type:												
Pool complexity index:												
Mean water depth (ft):												
Mean water width (ft):												
Mean bankful depth (ft):												
Mean bankful width (ft):												
Embeddedness estimate %:												
Dominant bank stability type:												
Percent undercut bank:												
Percent overhanging veg:												

Notes:

APPENDIX II

LEVEL III - QUANTITATIVE MONITORING

1. Field data forms: Canopy density and thermal input
2. Field data form: Streamflow
3. Field data form: Streambank/channel
4. Embeddedness field data form
5. Determining bed material particle size distribution
6. Field data form: Greenline vegetation
7. Field data form: Woody regeneration
8. Field data form: Soil compaction
9. Field data form: Rearing habitat quality

1. CANOPY DENSITY AND/OR THERMAL INPUT

Stream/riparian reach name: ______________________

Date: ______________ Examiners: ______________________

PARAMETER	TRANSECT #									
	1	2	3	4	5	6	7	8	9	10
CANOPY DENSITY RIGHT BANK										
CANOPY DENSITY LEFT BANK										
THERMAL INPUT site % - June										
THERMAL INPUT site % - July										
THERMAL INPUT site % August										
THERMAL INPUT site % - Sept										
THERMAL INSO site % obstruc										

CANOPY DENSITY AVERAGE OVER ALL TRANSECTS: ______________

THERMAL INPUT AVERAGE OVER ALL TRANSECTS:

June: ______________

July: ______________

Aug.: ______________

Sept: ______________

THERMAL INSOLATION AVERAGE OVER ALL TRANSECTS: ______________

1. CANOPY DENSITY AND/OR THERMAL INPUT

Stream/riparian reach name: ______________________

Date: ______________ Examiners: ______________________

PARAMETER	TRANSECT #									
	1	2	3	4	5	6	7	8	9	10
CANOPY DENSITY RIGHT BANK										
CANOPY DENSITY LEFT BANK										
THERMAL INPUT site % - June										
THERMAL INPUT site % - July										
THERMAL INPUT site % August										
THERMAL INPUT site % - Sept										
THERMAL INSO site % obstruc										

CANOPY DENSITY AVERAGE OVER ALL TRANSECTS: ______________

THERMAL INPUT AVERAGE OVER ALL TRANSECTS:

June: ______________

July: ______________

Aug.: ______________

Sept: ______________

THERMAL INSOLATION AVERAGE OVER ALL TRANSECTS: ______________

2. STREAMFLOW VARIATION - FIELD DATA SHEET

TRANSECT #	PRESENT WATER WIDTH (ft)	PRESENT WATER DEPTH (ft)	BANKFUL WATER WIDTH (ft)	BANKFUL WATER DEPTH (ft)
TOTALS:				

3. STREAMBANK/CHANNEL DATA

Stream/riparian reach name: ______________________ Date: ______________

Drainage: ______________________ Photo #: ______________

Examiners: ______________________

Location: ______________________

X-CHANNEL TRANSECT #	DISTANCES (FEET). - BANK CONDITION					
LEFT SIDE:	COVERED-STABLE Not eroding	COVERED-UNSTABLE Vulnerable	UNCOVERED-STABLE Vulnerable	UNCOVERED-UNSTABLE Eroding	UNDERCUT BANKS	OVER-HANGIN
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
RIGHT SIDE:						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

4. COBBLE EMBEDDEDNESS FIELD FORM

Stream____________________ Crew____________________

Transect Number____________________ Date____________________

Transect spacing____________ ft

HOOP #'s:			
Distance from right bank:			
Percent surface fines:			
Habitat:			
Water Depth:			

								Hoop #
								Hoop #
								Hoop #

COMMENTS:

5. PEBBLE COUNT FOR PARTICLE SIZE DISTRIBUTION

Stream/riparian reach name: ______________________________

Date: ________________ Examiners: ______________________

SIZE CLASS	TRANSECT #									
	1	2	3	4	5	6	7	8	9	10
< .1 In										
.1 - .6 In										
.6 - 1.3 In										
1.3 - 2.5 In										
2.5 - 5 In										
5 - 10 In										
10 - 20 In										
20 - 40 In										
40 - 80 In										
80 - 120 In										

Notes:

6. RIPARIAN GREEN LINE VEGETATION

Stream/riparian reach name: ______________________ Date: ____________

Drainage: ______________________ Photo #: ____________

Examiners: ______________________

Location: ______________________

TRANSECT DATA											
COMMUNITY TYPE	DISTANCES (ft)										
	1	2	3	4	5	6	7	8	9	10	TOTAL
TOTAL FEET:											

NOTES:

7. WOODY SPECIES REGENERATION

Stream/riparian reach name: ______________________ Date: ____________

Drainage: ______________________ Photo #: ____________

Examiners: ______________________

Location: ______________________

GREENLINE WOODY REGENERATION DATA						
SPECIES	DISTANCES (ft)					
	Seed/sprout	Young/sap	Mature	Decadent	Dead	TOTAL
TOTAL						

NOTES:

8. SOIL COMPACTION FIELD FORM

Stream/riparian reach name: ______________________ Date: ____________

Length of greenline transect: ______________________

Station interval (distance between stakes): ______________________

Comments: ______________________

SAMPLE LOCATION	VEGETATION COMMUNITY TYPE	BULK DENSITY	PENETROMETER READINGS			
			3"	6"	9"	12"
LEFT SIDE:						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
RIGHT SIDE:						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

9. REARING QUALITY - POOL COMPLEXITY

Stream/riparian reach name: ______________________ Date: ____________

Drainage: ______________________ Photo #: ____________

Examiners: ______________________

Location: ______________________

CODE DATA

POOL COVER TYPE	TRANSECT 1	2	3	4	5	6	7	8	9	10	TOTAL
DEPTH											
SUBSTRATE											
OVERHEAD											
SUBMERGED											
BANK											
TOTALS											

LENGTH CHANNEL PREDOMINANTLY SLOW WATER:

LENGTH OF CHANNEL PREDOMINANTLY FAST WATER:

APPENDIX III

DEFINITIONS OF AQUATIC COMMUNITY HABITAT TYPES

DEFININTIONS OF AQUATIC COMMUNITY HABITAT TYPES

By: Timothy A. Burton

Aquatic habitats have been variously defined in the literature. The following is an attempt to bring together the commonalities of the various definitions and provide for a more consistent approach to delineating them. The definitions were derived from: Western Division, American Fisheries Society (1985), Platts, Megahan, and Minshall, 1983, and Bisson and others (1981). These are sources frequently cited for habitat definition and characterization.

A habitat type as used here is a unit of stream having a unique structure and function important to fish. There are two subdivisions of habitat types: Macro- and Micro-habitat types. Micro-habitats are distinct units of the stream whose length is less than one channel width and whose width is less than one-half channel width. All distinct units larger than this are considered macro-habitats.

I. POOL

- An area of the stream that has reduced water velocity
- Water depth is deeper than surrounding areas
- The water surface gradient at low flow is often near zero
- The bed is often concave in shape and forms a depression in the thalweg profile
- Pools are formed by features of the stream that cause local deepening of the channel. This results from lateral constrictions in flow or by sharp drops in the water surface profile. They include:
    - Plunge pool created by water passing over or through a complete or nearly complete channel obstruction, scouring out a basin below. They are often associated with large debris and are usually macro-habitat
    - Dammed pools impounded upstream of a complete or nearly complete channel blockage caused by log jams, beavers, rockslides, boulders, etc. They are usually macro-habitat
    - A meander or corner pool is a lateral scour pool resulting from a sudden shift in channel direction and occurs along the outcurves of channel meanders. These are usually macro-habitat.

- Backwaters caused by an eddly along the channel margin or by back-flooding upstream from an obstruction such as large woody debris, boulders, root wads, etc. - usually micro-habitat

- Trenches or slot-like depressions formed usually in bedrock channels in long linear shapes - usually micro-habitat

- Lateral scour around local obstructions such as wing deflectors, boulders, individual logs, etc - usually micro-habitat

II. RIFFLE

- Water flows faster than surrounding stream area

- Water is shallower than surrounding stream (< 20 cm or .6 ft in depth)

- Water surface is agitated relative to the surrounding stream

- Water surface gradient is steeper than the surrounding stream

There are three types of riffles:

- Low gradient: Water is shallow (< 20 cm or .6 ft deep), water velocity is moderate at 20-50 cm/sec, water surface gradient is less than 4% and water flows mostly on gravel or cobble substrate.

- Rapids: Water is swiftly flowing (> 50 cm/sec), turbulence is considerable, water surface gradient is greater than 4%, and substrate is mostly boulders or cobbles.

- Cascades: A series of steps or small waterfalls associated with bedrock or boulders. There is considerable water surface gradient, and small plunge pools may be associated with the type.

III. GLIDE

- Too shallow to be a pool (< 30 cm deep), and too slow to be a run (< 20 cm/sec)

- Water surface gradient is nearly zero

- No pronounced turbulence on the water surface

- Substrate is typically gravel and cobble

As micro-habitat, glides usually occur at the downstream transition between pools and riffles. As macro-habitat, glides occur in long, low gradient stream reaches with stable banks and no large flow obstructions.

IV. RUN

- Too deep to be a riffle (> 30 cm deep), and too fast to be a pool (> 20 cm/sec)
- No pronounced water surface agitation
- The slope of the water surface is roughly parallel to the overall stream reach gradient
- Substrate is typically gravel and cobble

As micro-habitat, runs usually occur at the downstream transition between pools and riffles. As macro-habitat, runs usually occur along the length of gradual channel constrictions where deepening is not associated with bed scour or bed depressions.

V. POCKET WATERS

- An area of stream forming a series of small pools surrounded by swiftly flowing water
- The small pools form behind boulders, rubble, or logs and create shallow habitats where fish feed and rest away from faster waters surrounding the pockets
- Distinguished from riffles by the prevalence of small pools associated with the type