Field Manual

Okanogan Monitoring and Evaluation Program

Physical Habitat Protocols

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INTRODUCTION

This Field Manual was developed by the Colville Confederated Tribes to provide specific guidance in the evaluation and monitoring of fish habitat in the Okanogan Subbasin for the 2004 Okanogan Baseline Monitoring and Evaluation Program (OBMEP). The OBMEP is a long term status and trend monitoring program subject to future adaptive management , therefore, this Field Manual should be considered to be a "living document" with the following protocols potentially subject to some level of modification over time as new information becomes available.

The protocols contained within this Manual are closely aligned with the Environmental Monitoring and Assessment Program (EMAP) developed by the Environmental Protection Agency (EPA) as adopted into the Upper Columbia Monitoring and Evaluation Strategy. Through refining these protocols, OBMEP addresses specific program needs and is compatibile with the Ecosystems Diagnosis and Treatment (EDT) Model developed by Mobrand Biometrics Incorporated. EDT is the primary fish habitat assessment tool used by subbasin planners throughout the Columbia Basin and specifically within the Okanogan Subbasin. Periodic updating of EDT input fields with compatible data will be necessary to assess changes which may occur in habitat conditions over time and is the only know method for evaluating these changes verses productivity benefits.

The protocols for conducting field measurements of physical habitat in the Okanogan Subbasin as described in this Field Manual have been adopted to address the following Monitoring Strategy for the Upper Columbia Basin (Hillman, 2004) indicators and EDT attributes:

Field Measurement	UCS Indicator	EDT Attribute
Wetted Width	Wetted Width	Channel Width - Minimum
Bankfull Width	Bankfull Width, Width/Depth Ratio	Channel Confinement - Natural
Bankfull Depth	Width/Depth Ratio	Channel Confinement - Natural
Cross-section Depths	Width/Depth Ratio	
Thalweg Depths	Residual Pool Depths	
Floodplain Width		Channel Confinement - Natural
Floodplain Depth		Channel Confinement - Natural
Canopy Cover	Riparian Condition/Canopy Cover	Riparian Function
Understory	Riparian Condition	Riparian Function
Groundcover	Riparian Condition	Riparian Function
Shading	Canopy Cover	Riparian Function
Riparian Width		Riparian Function
Human Influence	Riparian Disturbance	Channel Confinement -

		Hydromodifications
		Riparian Function
Substrate	Dominant Substrate	
Embeddedness	Embeddedness	Embeddedness
Presence of Fines		Fine Sediment
Large Woody Debris	LWD Frequency	Wood
Habitat Type - In Channel	Pool Frequency	Habitat type - pool tailouts.
		Habitat type - primary pools
		Habitat type - beaver ponds
		Habitat type - backwater pools
		Habitat type - glide
		Habitat type - large cobble/boulder riffles
		Habitat type - small cobble/gravel riffles
Habitat Type - Off Channel	Off Channel Habitat	Habitat type - off-channel habitat factor
*Fish Barriers	Habitat Access	Obstructions to Fish Migrations
*Diversion Structures	Habitat Access	Obstructions to Fish Migrations

* Fish barriers and diversion structures will be flagged under these field procedures but full evaluation will be conducted under a separate set of field protocols.

ACKNOWLEDGEMENTS

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SECTION 1. METHOD FOR DOCUMENTING SAMPLING REACHES

EQUIPMENT

Metric tape measure or laser range finder, handheld GPS/data logger device, 3 - 2 ft. pieces of rebar painted bright orange, engineer flagging tape, waterproof markers, digital camera, field notebook, pocket calculator.

SAMPLING CONCEPT

The concept of EMAP sampling is that randomly selected reaches located on a stream can be used to measure changes in the status and trends of habitat, water quality, and biota over time if taken in a scientifically rigorous manner per specific protocols.

Within each sampled project reach a series of transects A-K are taken across the stream and riparian zone as points of reference for measuring characteristics of the stream and riparian areas. Transects are then averaged to obtain a mean representation of the stream reach.

PROCEDURE

1. Identify the site and obtain lat/long coordinates from EMAP site selection, this will be your center point (also referred to as the "X" point) of the stream reach to be surveyed.

2. Navigate into the sites with a Trimble GPS receiver or other GPS unit if the Trimble cannot locate satellites.

3. Find the center point of the stream reach to be surveyed and mark it on the Trimble GPS.

4. Hammer in 2’ piece of rebar, on the left bank of the stream (left as you are facing downstream) or on the right bank if the left is inaccessible, at the center point of the stream reach.

5. Flag a permanent structure near the area close to the center stake with a permanent flag. Hang flagging tape on either side of the permanent marker to aid in location

6. Measure bankfull width at 5 representative samples (2 upstream, 2 downstream, 1 at the center or X- point). Bankfull width is defined as the high streamflow event occurring on average every 1.5 years. . This is most easily found by looking for a vertical bank inside of the tree line. Calculate the average bankfull width (to the nearest 0.1 meters) from your samples taken.

7. From your Center point of the stream reach go 10 average bankfull widths upstream and 10 average bankfull widths downstream . (Note: if the bankfull width is <7.5m then go 75m upstream and 75m downstream. If bankfull width is >25m go 250m upstream and 250m downstream). .

8. Monument (document) both the upper and lower bounds of the reach with a 2' piece of rebar, on the left bank of the stream (left as you are facing downstream) or on the right bank if the left is inaccessible. Note any changes in stake location in the comments section of the site documentation form. Permanent flags should be placed on prominent structures near the rebar stake and a GPS location taken so the stake can be easily located in the future. Hang flagging tape on either side of the permanent flag to aid in locating the site.

9. Photo document either location by walking from the center stake perpendicular to the center of the stream and photo document the site from the center of the stream by taking a picture downstream at the upper point or upstream at the lower point.. Document the photo #'s in your notebook or on the disk in the computer and record the GPS Latitude and Longitude (Note: make sure the camera is set on full wide angle)

SECTION 2: METHOD FOR LAYING OUT TRANSECTS IN SAMPLING REACHES.

PURPOSE

Dividing the stream reach into transects creates defined increments for measuring habitat characteristics and changes

EQUIPMENT

Measuring tape or hip chain, flagging (striped and solid), permanent marker.

PROCEDURE

Step 1. Go 10 bankfull widths downstream to the rebar you have staked as the end of the stream survey reach. This endpoint is the downstream end of the reach and is flagged as transect "A". Write (label) "A" on the flag with a black permanent felt tip marker so that this location can be easily identified.

Step 2. Using the tape, measure 1/10th of the required stream length upstream from the start point (transect A). Note that this will be equivalent to: a) 2 mean bankfull widths (eg. 170m stream reach /10= 17m) in stream reaches between 150 meters and 500 meters, b) 15 meters in small streams with a total reach length of 150 meters, or c) 50 meters in larger streams with a total reach length of 500 meters. Flag and label this spot as the next cross section or transect (transect B).

Step 3. Intermediate or mid-transect points must also be flagged and labeled. The intermediate point is that point exactly halfway from transect line A to transect line B (eg. transect distance is 17m/2= 8.5 m for mid-transect). This point, located halfway between A and B is flagged and labeled as "A1".

Step 4. Proceed upstream with the tape measure and flag the positions of nine additional transects (labeled "C" through "K" as you move upstream) at intervals equal to 1/10th of the reach length. Flag and label each intermediate point as well (B1, C1, D1,…, J1).

Example Reach Layout. Location: Mainstem Okanogan River. Calculated Reach Length: 500 meters.

Transect A (lower point, start of sample reach) - located 250 meters downstream from the mid-point.
A1- located 25 meters upstream from A.
Transect B - located 50 meters upstream from A and 25 meters upstream from A1.
B1-located 25 meters upstream from B.
Transect C - located 50 meters upstream from B and 25 meters upstream from B1.
C1-located 25 meters upstream from C.
Transect D - located 50 meters upstream from C and 25 meters upstream from C1.
D1 - located 25 meters upstream from D.
Transect E - located 50 meters upstream from D and 25 meters upstream from D1.
E1 - located 25 meters upstream from E.
Transect F (the mid-point) - located 50 meters upstream from E and 25 meters upstream from E1.
F1 - located 25 meters upstream from F.
Transect G - located 50 meters upstream from F and 25 meters upstream from F1.
G1 - located 25 meters upstream from G.
Transect H - located 50 meters upstream from G and 25 meters upstream from G1.

H1 - located 25 meters upstream from H.
Transect I - located 50 meters upstream from H and 25 meters upstream from H1.
I1- located 25 meters upstream from I.
Transect J - located 50 meters upstream from I and 25 meters upstream from I1.
J1 - located 25 meters upstream from J.
Transect K (upper point - end of sampling area) located 50 meters upstream from J and 25 meters upstream from J1.
Transect K (upper point, end of sample reach) - located 50 meters upstream from J and 25 meters upstream from J1.
Within each sampled project reach a series of transects A-K are taken across the stream and riparian zone as points of reference for measuring characteristics of the stream and riparian areas. Transects are then averaged to obtain the mean representation of the stream reach.

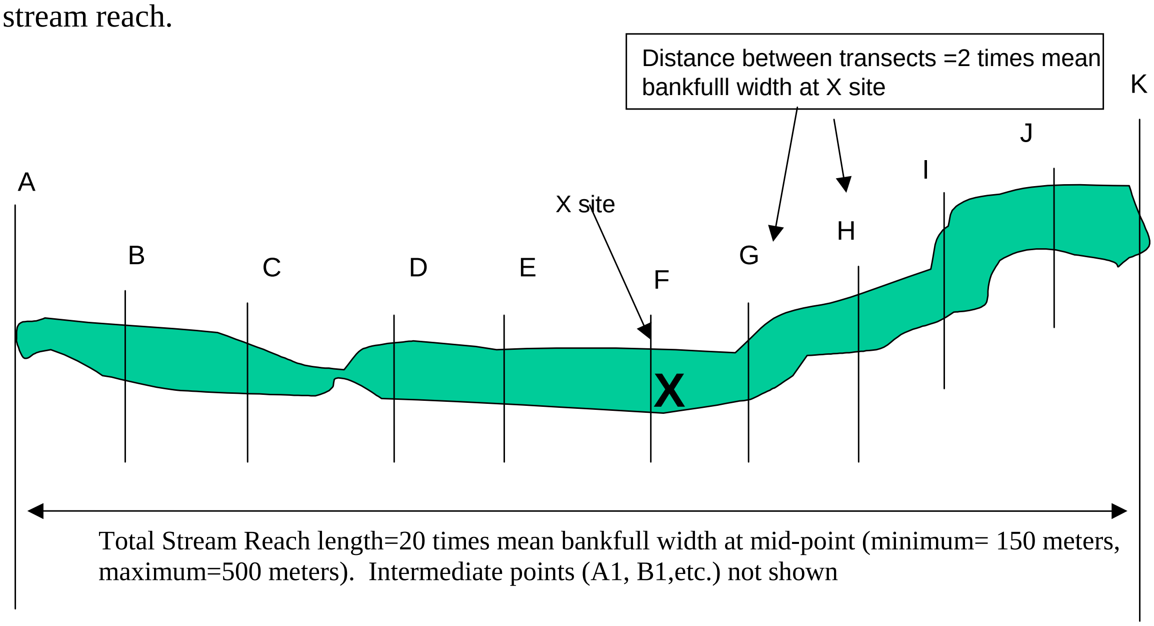

Figure 1. Sampled project reach

SECTION 3. METHOD FOR CHARACTERIZING STREAM MORPHOLOGY AND IN-STREAM HABITAT - THALWEG PROFILE

Protocol adapted from; *Peck et al. (Unpubl.), Table 7-3; Kauffman et al. (1999)*

PURPOSE

The Thalweg profile can detect changes in the stream morphology associated with habitat restoration projects designed to improve pool-riffle relationships, provide velocity changes and other structure beneficial as hiding and holding habitat for salmonids.

EQUIPMENT

Surveyor's telescoping rod, 50 m measuring tape or range finder, stadia rod, Abney hand level or laser level, laser range finder, fisherman's vest with lots of pockets, chest waders, data logger and appropriate waterproof forms.

SITE SELECTION

The sample reach is laid out according to Section 1.

SAMPLING DURATION

Sampling should occur during July-September.

PROCEDURE

The Thalweg Profile is a longitudinal survey of depth, habitat class, presence of soft/small sediment deposits, and off-channel habitat at 100 equally spaced intervals along the centerline between the two ends of the sampling reach. "Thalweg" refers to the flow path of the deepest water in a stream channel. Wetted and bankfull width is measured and substrate size is evaluated at 21 equally spaced cross-sections (at 11 regular Transects A through K plus 10 supplemental cross-sections spaced mid-way between each of these - A1 through J1).

Step 1: Determine the interval distance between measurement stations by dividing the reach length by 100 (eg. 170m reach/100-1.7m between Thalweg measurements).

Step 2: Complete the header information on the data form. Record the reach length (as determined under Section 1) and the increment length (as determined in Step 1) on the data form.

NOTE: *If a side channel is present that is capable of caring 25% or more of flow, establish a secondary cross-section transect. Use separate field data forms to record data for the side channel, designating each secondary transect by checking both "X" and the associated primary transect letter (e.g., XA, XB, etc.). Collect all channel and riparian cross-section measurements from the side channel*

Step 3: Measure the wetted width, and bankfull width at station "0" and station "5". Widths are measured across and over mid-channel bars and boulders. Record the width on the field data form to the nearest 0.1 m. For dry and intermittent streams, where no water is in the channel, record zero for wetted width.

NOTE: *If a mid-channel bar is present at a station where wetted width is measured, measure the bar width and record it on the field data form.*

Step 4: Begin at the downstream end (station “0”) of the first transect (Transect “A”). Measure the bankfull height (centimeters) on either the left or right bank at the most well defined point. Bankfull height is the vertical distance from the water surface at the wetted edge to the point of maximum flow elevation occurring on a 1.5 year cycle (denoted by the start of permanent vegetation and the first terrace above the stream channel). This can be measured directly with a stadia rod in areas where the wetted edge is close to the first terrace. Use of the Abney hand level or laser range finder with the stadia rod may be necessary in areas where the wetted edge is distant from the first terrace. Record this measurement in the "Bankfull Height" section of the field form. Add the Bankfull Height to the "Thalweg Depth" (as measured at station 0) to determine the Bankfull Depth.

Multiply the Bankfull Depth by 2 to determine the Floodprone Depth. Enter both the Bankfull Depth and Floodprone Depths in the appropriate sections of the field form.

Visually estimate the Floodprone Width (valley width at floodprone depth) based upon the floodprone depth calculated above. Enter the entrenchment ratio code in the appropriate section of the field form.

With the laser range finder shoot a gradient measurement between Transect A and Transect B. Repeat these steps between each transect and record on the field form.

Step 5: At station “5” classify the substrate particle size at the tip of your depth measuring rod at positions 20%, 40%, 60%, 80% and 100% of the distance across the bankfull width of the stream starting from the left bank. This procedure is identical to the substrate size evaluation procedure described for regular channel cross-sections A through K (See Section 3).

Step 6: At each Thalweg Profile station, use a meter ruler or a calibrated pole or rod to locate the deepest point (the “thalweg”), which may not always be located at mid-channel. Measure the thalweg depth to the nearest cm, and record it on the Thalweg Profile form. Read the depth on the side of the ruler while the stadia rod is in the channel to avoid inaccuracies due to the wave formed by the rod in moving water.

NOTE: In nonwadable streams the use of an elctronic depth finder should be used to locate and measure the thalweg. Calibrate all electronic devices to calibrate them with measures of a stadia rod at a minimum of 20 measuring points.

Step 7: At the point where the Thalweg depth is determined, observe whether unconsolidated, loose (“soft”) deposits of small diameter (<16mm), sediments are present directly beneath your ruler, rod, or pole. Soft/small sediments are defined here as fine gravel, sand, silt, clay or muck readily apparent by "feeling" the bottom with the staff. Record presence or absence (X for present) in the “SOFT/SMALL SEDIMENT” field on the field data form. Note: A thin coating of fine sediment or silty algae coating the surface of cobbles should not be considered soft/small sediment for this assessment. However, fine sediment coatings should be identified in the comments section of the field form when determining substrate size and type.

Step 8: Determine the habitat type code for the station Record this on the field data form using the following codes:

G=Glide
SCR=Small Cobble/Gravel Riffle
LCR=Large Cobble/Boulder Riffle
P=Primary Pool
PT=Pool Tailout
BP=Beaver Pond
RA=Rapid
DR=Dry
CA/FA=Cascade or Falls

For dry and intermittent streams where no water is in the channel, record habitat type as dry channel. For primary pools, determine if the station is in the pool or pool tailout (the ascending portion of the pool to the pool crest) and enter the appropriate code. Note that for a pool to be counted it must: 1) occur within the channel Thalweg 2) be wider than one half the wetted width, and 3) have a maximum depth equal to or greater than 1.5 times the crest depth. Glides can seem similar to pools in that they are often slow water areas but glides have consistent depths while pools will have a defined deep stop and tailout. Glides will always be longer than they are wide while with pools this may not necessarily be true. Record riffles as either Large Cobble/Boulder or Small Cobble/Gravel based upon the dominant substrate present (see substrate classifications in Section 3). Beaver ponds should include the entire area affected by the beaver pond from the upstream dam face to the end of the inundation impacts. Rapids are whitewater areas without defined vertical drops if vertical drops exist then these areas would be classified as falls/cascades. Specific definitions of habitat types can be found in Section 7.
NOTE: It is important to consider habitat designations within the context of the entire stream by taking a broad view of the entire visible stream reach most dominate habitat designations should be rather obvious within the natural pool/riffle sequence.

Step 10: Indicate the presence of a side channel at the station's cross-section in the "SIDE CHANNEL" field on the field data form.

Step 11: Indicate the presence of quiescent off-channel aquatic habitats, including backwaters, sloughs, alcoves and backwater ponds or pools, or oxbows in the "BACKWATER" column of the field form.

Step 12: Waterfalls and cascades present potential barriers to anadromous fish migration. Therefore, baseline data should be collected in the field when these habitats are encountered to allow managers to determine if an additional full barrier assessment is

warranted (for full barrier assessment protocols see WDFW 2000). Note that waterfalls with a vertical drop exceeding 3.7 meters or cascades with a gradient exceeding 20% (16% in streams with bankfull widths less than 0.9 meters) for 160 meters or more are considered to be complete blockages to anadromous salmonids (WDFW 2000).
If a waterfall or cascades is present, measure and record the following information:

Waterfalls: Measure the vertical drop from water surface to water surface to the nearest 0.1 meter using a stadia rod placed vertically at the base of the falls. Measure the horizontal length from the base of the falls from this stadia rod to the crest of the falls using a second stadia rod. Record in the appropriate section of the field form.

Cascades: Measure the length of the cascade (up to a maximum of 160 meters) and record the length in meters. The entire length of cascades (up to 160 meters) should be measured even if the cascades extends outside of the sampling reach. Convert this measurement to centimeters by multiplying by 100 and record in the appropriate section of the field form. Position one person at the upstream end and one person at the downstream end of the cascade (or at 0 and 160 meters for cascades 160 meters or more) and determine the elevation change in centimeters. This will require the use of an Abney hand level and two stadia rods. Each person will stand on the same bank and will position their respective stadia rods at the water surface along the wetted edge. The person upstream will hold the Abney hand level against the stadia rod and backsite to the stadia rod downstream after noting the elevation of the hand level in centimeters above the water surface. The person at the downstream end will assist the person upstream by moving a finger up and down the stadia rod until the person upstream indicates level. The person downstream will then note the elevation at level (location of his/her finger along the stadia rod). Note: A laser level or laser range finder can measure both gradient and length much more easily but requires following the appropriate methods for the equipment being used.
For long cascades where a single line of sight measurements cannot be made, break the cascade into measurable length increments and measure respective elevation changes for each increment. Record both the increment length with each corresponding change in elevation (i.e., 62cm X 30meters, 127cm X 25meters, etc.).

To calculate the percent slope, subtract the upstream elevation of the Abney hand level (centimeters) from the downstream elevation at level (centimeters) and divide by the length of the cascade (centimeters). Note: These calculation may not be necessary if using laser levels or rangefinders.

Step 13: Proceed upstream to the next station and repeat Steps 4 through 11.

Step 14: Repeat Steps 4 through 12 until you reach the next transect. At this point, complete Channel/Riparian measurements at the new transect. Then begin a new Thalweg Profile and repeat Steps 2 through 12 for each of the reach segments, until you reach the upstream end of the sampling reach (Transect “K”).

SECTION 4. METHOD FOR MEASURING SUBSTRATE

Protocol taken from: ***Peck et al. (Unpubl.), Table 7-7 modified Wolman pebble count***

PURPOSE

Determining the changes in the percentage of fines and embeddedness within the sample reach in order to determine any significant changes.

EQUIPMENT

Meter stick, surveyor's rod, metric tape, or laser range finder.

SITE SELECTION

The sample reach is laid out according to Section 1.

SAMPLE DURATION

Counts should be taken during summer low flow period when turbidity and visibility is normally at its best.

PROCEDURE

Step 1: Substrate size class is estimated for a total of 105 particles taken at 5 equally-spaced points along each of 21 cross sections. Depth is measured and embeddedness estimated for the 55 particles located along the 11 regular transects A through K. Cross sections are defined by laying the surveyor's rod or tape to span the wetted channel. This can also be done with a laser range finder by pointing the primary unit at a target or reflector and reading the distance between the two.

Step 2: Fill in the header information on page 1 of a channel riparian cross-section form. Indicate the cross-section transect. At each transect, extend the surveyor's rod across the channel perpendicular to the flow, with the zero end at the left bank (facing downstream). If the channel is too wide for the rod, stretch the metric tape or use a laser range finder in the same manner. Record both the bankfull width and wetted widths for each transect.

Step 3: Divide the bankfull channel by 5 to locate substrate measurement points on the cross section. In the "DISTLB" fields of the form, record the distances corresponding to 2**0% , 40% , 60% , 80% , and 100%** of the measured bankfull width starting on the left bank. Record these distances at transects A-K.

Step 4: Place your sharp-ended meter stick or calibrated pole at the 20% location. Measure the depth and record it on the field data form. (Cross section depths are measured only at regular transects A-K, not at the 10 mid-way cross sections.)

Step 5: Pick up the substrate particle that is at the base of the meter stick (unless it is bedrock or boulder), and visually estimate its particle size according to the following table. Classify the particle according to its median diameter (the middle dimension of its length, width, and depth). Record the size class code on the field data form. (Cross section side of form for transects A-K; special entry boxes on Thalweg Profile side of form for mid-way cross-sections.).

Table 2. Substrate classes and size ranges.

SUBSTRATE SIZE CODES		Embeddedness%
RS =	**Bedrock Smooth (Larger than a car)**	**0**
RR =	**Bedrock (Rough) – (Larger than a car)**	**0**
BL =	**Boulder (250 to 4000 mm) (Basketball to car)**	
LCB=	**Large Cobble(127 to 250 mm) (Softball to Basketball)**	
SCB =	**Cobble (64 to 127 mm) (Tennis ball to Softball)**	
GC =	**Coarse Gravel (16 to 64 mm) (Marble to Tennis ball)**	
GF =	**Fine Gravel (2 to 16 mm) (Ladybug to Marble)**	
SA =	**Sand (0.06 to 2 mm) (Gritty up to Ladybug size)**	**100**
FN =	**Silt/Clay/Muck (Not Gritty)**	**100**
HP =	**Hardpan (Firm, Consolidated Fine Substrate)**	**0**
WD =	**Wood (Any Size)**	
OT =	**Other (Write comment below)**	

Step 6: Evaluate substrate embeddedness as follows at 11 transects A-K: a) Estimate the average percentage embeddedness of particles in the 10 cm circle around the measuring rod. b) Record this value on the field data form. By definition, sand and fines are embedded 100 percent, bedrock and hardpan are embedded 0 percent. Embeddedness is the extent that boulders, larger cobbles or gravel are surrounded by or covered by fine sediment, such as sands, silts, and clays. Determine the extent (as an average %) that boulders, cobble, and gravel particles on the substrate surface are buried by fine sediments.

Step 7: Move successively to the next location along the cross section. Repeat steps 4 through 6 at each location. Repeat steps 1 through 6 at each new cross section transect.

SECTION 5. METHOD FOR MEASURING LARGE WOODY DEBRIS (LWD)

Modified Protocol taken from: ***Peck et al. (Unpubl.), pp. 115-117, Table 7-5; Kauffman et al. (1999), AREMP (2004).***

PURPOSE

These methods are used to tally "large woody debris" (LWD). The tally includes all LWD that are in the baseflow channel (the active channel) and LWD that span the channel but are outside the bankfull channel. The active channel is defined as the area that is wetted under ordinary baseflow conditions. This is usually denoted by the start of terrestrial vegetation. LWD in the active channel is tallied over the entire length of the reach, including between the channel cross-section transects.

EQUIPMENT

Measuring tape, LWD measuring rod and waterproof sampling forms.

SAMPLING DURATION

Counts should be taken during summer low flow (when visibility is at its best) in conjunction with other instream measurements such as Thalweg profile.

PROCEDURE

Note: *Tally pieces of LWD within each segment of stream at the same time the Thalweg profile is being determined. Include all pieces whose large end is located within the segment in the tally. Usually these counts are collected by the person recording the data while the second crew member(s) are measuring widths and depths, etc..*

Step 1: Scan the stream segment between the two cross section transects where Thalweg profile measurements are being made.

Step 2: Tally all LWD pieces within the segment that are at least partially within the active channel. Determine if a piece is LWD (large end diameter 10cm (4 in.); length 1.0 m (5 ft.).

Step 3: For each piece of LWD, determine the class based on the diameter of the large end and the length.

- >0.1 m(4 in) large end diameter and >1 m(3.28 ft) long
- >0.1 m(4 in) large end diameter and >2 m (6.56 ft) long

If the piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with circular cross section that would have the same volume.

When estimating length, include only the part of the LWD piece that has a diameter greater than 10 cm (4 in.).

When counting large woody debris:

1. Wood that is imbedded within the stream bank is counted if the exposed portion meets the length and width requirements.

2. Do not count a piece if only the roots (but not the stem/bole) extend within the active channel.

3. Some pieces crack or break when they fall. Count the entire length of the piece when the two pieces are still connected at any point along the break, and only the portion within the active channel when they are no longer connected.

4. For determining lengths, consider only the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.

5. Trees that are still alive but leaning into the active channel are not to be counted only count dead trees.

6. Count dead trees that span the stream channel but may not be in the active channel.

Step 4: Place a tally mark in the appropriate diameter X length class tally box in the “Large Woody Debris" portion of the form.

Step 5: After all pieces within the segment have been tallied, write the total number of pieces for each diameter X length class in the lower right hand corner of each tally box and circle it.

Step 6: Repeat Steps 1 through 4 for the next stream segment.

SECTION 6. METHOD FOR CHARACTERIZING RIPARIAN VEGETATION STRUCTURE

Protocol taken from: ***Peck et al. (Unpubl.), Table 7-10; Kauffman et al. (1999)***

PURPOSE

This protocol is designed to determine the changes in riparian vegetation.

EQUIPMENT

Concave spherical densitometer, datalogger/field waterproof forms.

SITE SELECTION

The sample reaches are those laid out according to the methods described in Section 1.

SAMPLING DURATION

Sampling should occur during July-August when vegetation is at its maximum growth.

PROCEDURES FOR MEASURING RIPARIAN VEGETATION AND STRUCTURE

1. Standing in mid-channel at a cross-section transect (A-K), estimate a 5m distance upstream and downstream (10m length total).
2. Facing the left bank (left as you face downstream), estimate a distance of 10m back into the riparian vegetation.
3. Within this 10 m X 10 m area, divide the riparian vegetation into three layers: a canopy layer (>5 m [16ft] high), an understory (0.5 to 5 m [20 inches to 16ft.] high), and a ground cover layer (<0.5 m high).
4. Within this 10 m X 10 m area, determine the dominant vegetation type for the canopy layer as either **Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None.** Consider the layer mixed if more than 10% of the areal coverage is made up of the alternate vegetation type. Indicate the appropriate vegetation type in the "Vegetation Type" section of the Riparian Vegetation Form.
5. Determine separately the aerial cover class of large trees (>0.3 m [1ft] diameter breast height [DBH]) and small trees (<0.3m DBH) within the canopy layer. Record the appropriate cover class on the field data form (**"0"= absent: zero cover, "1"= sparse: <10%, "2"= moderate: 10-40%, "3"=heavy: 40-75%, or "4"= very heavy: >75%)**.
6. Look at the understory layer. Determine the dominant vegetation type for the understory layer as described in Step 4.
7. Determine the aerial cover class for woody shrubs and saplings separately from non-woody vegetation within the understory, as described.
8. Look at the ground cover layer. Determine the areal cover class for woody shrubs and seedlings, non-woody vegetation, large woody debris, and the amount of bare ground present as described in Step 5 for large canopy trees. . Note that unlike the Understory and Canopy fields, the four ground category rankings should add to at least 100% as ground cover will include woody or non-woody vegetation, large woody debris, or bare ground.
9. Measure the riparian width to the nearest 0.1 meter at transects A, F, and K.
10. Repeat steps 1 through 9 for the right bank.
11. Repeat steps 1 through 10 for all cross-section transects, using a separate field data form for each transect.

PROCEDURES FOR MEASURING CANOPY COVER

Canopy cover is determined for the stream reach at each of the 11 cross section transects (A through K). A concave spherical densitometer is used. Six measurements are obtained at each cross section transect at mid-channel.

1. At each cross-section transect, stand in the stream at mid-channel and face upstream.
2. Hold the densitometer 0.3 m (1 ft.) above the stream. Hold the densitometer level using the bubble level. Move the densitometer in front of you so that your face is just above the top of the taped "V".
3. Count the number of grid intersection points within the "V" that are covered by either a tree, a leaf, or a high branch. Record the value (0-17) in the CENUP field of the canopy cover measurement section of the form.
4. Face toward the left bank (left as you face downstream). Repeat steps 2 and 3, recording the value in CENL field of the data form.
5. Repeat steps 2 and 3 facing downstream, and again while facing the right bank (right as you look downstream). Record the values in the CENDWN and CENR fields of the field data form.
6. Repeat steps 2 and 3 again, this time facing the bank while standing first at the left bank, then the right bank. Record the value in the Left Bank and Right Bank fields of the data form.
7. Repeat steps 1-6 for each cross-section transect (A-K). Record data for each transect on a separate data form.
8. If for some reason a measure cannot be taken, indicate in the "Flag" column.

Each of the measures taken at the center of the stream are summed for all 11 transects and converted to a percentage based upon a maximum score of 17 per transect. The results are then averaged to produce a mean % canopy density at mid-stream .

Each of the measures taken at the banks of the stream are summed for all 11 transects and converted to a percentage based upon a maximum score of 17 per transect. The results are then averaged to produce a mean % canopy density at the stream bank.

SECTION 7. METHOD FOR MEASURING HUMAN INFLUENCE

PURPOSE

This field documents the presence and proximity of various important types of human land use activities in the stream riparian area to be used in combination with mapped watershed land use information to assess the potential degree of disturbance of the sample stream reaches.

PROCEDURE

At each of the 11 detailed Channel and Riparian Cross-Sections, crews evaluate the presence/absence and the proximity of 11 categories of human influences:

1. Walls/ dikes/ revetments/riprap/dam
2. Buildings
3. River access site
4. Pavement/roads/railroads
5. Pipes (inlet/outlet)
6. Garbage pile
7. Cleared lot/lawns
8. Orchard/Row crops
9. Pasture/range/hay fields
10. Logging operations
11. Mining activities
12. Diversion Structure

Observations are confined to the stream and riparian area within 5 m upstream and 5 m downstream from each cross-section transect. The presence of each of these human activities and their proximity to the stream channel are evaluated and recorded separately for the left and right sides of the channel and banks. Proximity is distinguished according to whether the activity is within the channel or its margin, within the 10 m × 10m riparian plot, or farther than 10 m from the bank. Rate the presence of these activities as either O=not present, B=on the bank, C=present within 10 meters, or P=present between 10 and 30 meters.

If diversion structures are present fill in additional information on data sheet by answering the following questions:

1) Is the diversion screened (yes or no). If yes, does the screen meet NOAA specifications for anadromus fish (3/32") and mark yes or no.
2) What type of diversion structure is it?
    a. Pump
    b. Rock Dam
    c. Concrete Dam
    d. Head Gate
    e. Ditch
    f. Other (Describe to the best of your ability)
3) Does the diversion span the entire channel (Yes or No). If yes, you should do barrier assessment following protocols in WDFW 2000.

Note: That if a Diversion Structure (Category 12) is present, and requires a separate assessment. Protocols for diversion structure assessment are described in WDFW 2000.

SECTION 8. QUALITY ASSURANCE/QUALITY CONTROL

PURPOSE

The purpose of this section is to minimize sampling error that may be associated with the implementation of the procedures detailed in sections 2 through 6.

PROCEDURE

At the conclusion of the habitat survey for each sample stream reach and prior to review of the data collected, the field crew supervisor will randomly select one of the ten sampled transects and repeat the habitat measures detailed in Sections 2 through 6. The supervisors name followed by "QA/QC" will be indicated in the "Observers" section of each data form. Upon completion of these repeat measurements, the field crew supervisor will then cross check the repeat survey data with that originally obtained by the field crew. Differences in the two data sets will be discussed and resolved in the field. If in the judgement of the field crew supervisor substantial differences exist between the two data sets which may ultimately introduce an unacceptable level of error into the survey results, then the entire habitat survey or appropriate portions thereof may need to be repeated.

DEFINITION OF TERMS

Active Channel
Short term geomorphic feature, defined by the bank break, that marks a change to permanent vegetation. (2) The portion of a channel in which flows occur frequently enough to keep vegetation from becoming established. An active channel is formed and maintained by normal water and sediment processes (Armantrout 1998). The active channel is defined as the channel area wetted under ordinary baseflow conditions. This is usually denoted by the start of terrestrial vegetation (Williams and Thom 2001, Nightengale and Simenstad 2001, Konar 1998).

Backwater
(1) Water backed up or retarded in its course compared with its normal or natural condition or flow. (2) A naturally or artificially formed arm or area of standing or slow moving water partially isolated from the flow of the main channel of a river. (3) Seasonal or permanent water bodies found in the lowest parts of floodplains, typically circular or oval in shape (Armantrout 1998).

Backwater Pools
Backwater pools are habitat units located along the channel margins but are otherwise enclosed—though still connected to the main channel (or side channel). Note: backwater pools as defined here include "alcoves" as described by Nickleson et al.(1992).). 2) Backwater pools-a pool type formed by an eddy along channel margins downstream from obstructions such as bars, rootwads or boulders, or resulting from an obstruction blockage. (Berkley.edu 2004)

Bankfull Depth
Depth of water measured from the surface to the channel bottom when the water surface is even with the top of the streambank (Armantrout 1998). This is equivalent to the Thalweg depth plus the bankfull height during low flow conditions.

Bankfull Height
The bankfull height can be identified through examination of the reach for the following indicators as described below. Note that all six indicators are rarely present at an individual site.

- Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the current water level.
- Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
- A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.
- A defined elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
- Examine the ceiling of undercut banks. This elevation is normally below the bankfull elevation.
- Stream channels actively attempt to reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators. (AREMP 2004)

Bankfull Width
Channel width between the tops of the most pronounced banks on either side of a stream reach (Armantrout 1998).

Bar

A submerged or exposed ridge-like accumulation of sand, gravel, or other alluvial material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition (Armantrout 1998). .

Beaver Pond
Ponds containing water impounded by a dam built by a beaver (Armantrout 1998).

Braided Stream
A complex tangle of converging stream channels separated by sand bars or islands. Characteristic floodplains where the amount of debris is large in relation to the discharge (Streamnet 2004).

Canopy Cover
Percentage of ground or water covered by shade from the outermost perimeter or natural spread of foliage from plants. Small openings within the canopy are excluded if the sky is visible through them. Total canopy coverage may exceed 100% due to the layering of different vegetation strata such as understory and groundcover (Armantrout 1998).

Cascade
1)Highly turbulent series of short falls and small scour basins with very rapid water movement as it passes over a steep channel bottom with gradients exceeding 8%. Most of the water surface is broken by short irregular plunges creating white water, frequently characterized by very large substrate, and a well defined stepped longitudinal profile that exceeds 50% in supercritical flows (Armantrout 1998). 2) Water movement is rapid and very turbulent over steep channel bottom. Most of the water surface broken in short irregular plunges, mostly whitewater (Kaufman et al. 1999). 3) A habitat type characterized by swift current, exposed rocks and boulders, high gradient and considerable turbulence and surface agitation, and consisting of a stepped series of drops (AFS 1985).

Clay
Substrate particles that are smaller than silt and generally less than 0.004 mm in diameter (Streamnet 2004).

Cobble
Substrate particles that are smaller than boulders and are generally 64-256mm in diameter. Can be further classified as small and large cobble. Commonly used by salmon in the construction of a redd (Streamnet 2004).

Confluence
1) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. 2) The stream or body of water formed by the junction of two or more streams. (Streamnet 2004).

Dam

A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir (Streamnet 2004).

Dike
1) (engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands, a levee (Streamnet 2004). 2) A tabular body of igneous rock that cuts across the structure of adjacent rocks. A massive wall or embankment built around a low-lying area to prevent flooding (Bates and Jackman 1984).

Diversion
The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system (Streamnet 2004).

Diversion Dam
A barrier built to divert all or part of the water from a stream into a different course (Streamnet 2004).

Embeddedness
The extent that boulders, larger cobbles or gravel are surrounded by or covered by fine sediment, such as sands, silts, and clays. Embeddedness is determined by examining the extent (as an average %) that boulders, cobble and gravel particles on the substrate surface are buried by fine sediments (Lestelle 2004).

Ephemeral Flow
Streamflows in channels that are short lived or transitory and occur from precipitation, snow melt, or short term water releases (Armantrout 1998).

Falls
1) Free falling water with vertical or nearly vertical drops as it falls over an obstruction. Falling water is turbulent and appears white in color with trapped air bubbles (Armantrout 1998). 2) Free falling water over vertical or near vertical drop into plunge pool, water turbulent and white over high falls (Kaufman et al. 1999).

Floodplain
The area that parallels the stream course and that is inundated by flood waters on an infrequent basis (more then every 2 years on average to once in 100 years or more). The floodplain is typically confined by topographic features and can cover the entire valley floor from terrace to terrace or only a small portion when dikes or levees are present.

Floodprone Depth
Equal to two times the bankfull depth (Rosgen 1996).

Floodprone Width
Equal to the valley width at floodprone depth (Rosgen 1996).

Geomorphology
The shape or form of a natural surface or object, also, the study of the land surface and the processes producing them (e-streams 2004).

Glides
Hawkins et al. (1993) indicates that there is a general lack of consensus regarding the definition of glides, despite a commonly held view that it remains important to recognize a habitat type that is intermediate between pool and riffle. The ODFW habitat survey manual (Moore et al. 1999) defines a glide as an area with generally uniform depth and flow with no surface turbulence, generally in reaches of < 1% gradient. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. They are generally deeper than riffles with few major flow obstructions and low habitat complexity (Lestelle 2004). Glides generally appear as low turbulent moving water with smooth, unbroken surface (Kaufman et al. 1999).

Gradient
Average change in vertical elevation per unit of horizontal distance (e-streams 2004).

Intermittent Flow
Flows that occur at certain times of the year only when groundwater levels are adequate but may cease entirely in low water years or be reduced to a series of separate pools (Armantrout 1998).

Large Woody Debris (LWD)
LWD is defined here as non-living woody material with small end diameter of at least 10 cm (4 inches), and length of at least 1.5 m (5 ft) (Kaufman et al. 1999).

Mid-Channel Bar
Bar formed in the mid-channel zone, not extending completely across the channel. (Armantrout 1998). The highest elevation of a bar often indicates the lowest possible elevation for bankfull stage.

Pool Tailout
Defined as a distinct break or "crest" in streambed slope occurring downstream from a pool (AREMP 2004).

Primary Pool
1) Have a maximum depth equal to or greater than 1.5 times the crest depth. Pools are generally characterized by still water, low velocity, smooth, glassy surface, and deep compared to other parts of the channel (Kaufman et al. 1999).

AREMP (2004) further describes pool characteristics as observed under low flow conditions as follows:

1. Pools are depressions in the streambed that are concave in profile, laterally and longitudinally.

2. Pools are bounded by a head crest (upstream break in streambed slope) and a tail crest (downstream break in streambed slope).
3. Pools have a water surface gradient close to “0” and are associated with “slower” flowing water.
4. Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
5. Pool span at least 90% of the wetted channel width at any location within the pool.
6. Pool length, measured along the thalweg, is greater than its width, measured perpendicular to the thalweg, at the widest point.
7. Maximum pool depth is at least 1.5 times the pool tail depth.

Rapids
1) Moderately steep stream area (4-8% gradient) with supercritical flow between 15% and 50%, rapid and turbulent water movement, surface with intermittent whitewater, with breaking waves, coarse substrate, with exposed boulders at low flows and a planar longitudinal profile (Armantrout 1998). 2) Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves (Kaufman et al. 1999).

Revetment
A sloped facing built to protect existing land or newly created embankments against erosion or wave action, currents, or weather. Revetments are usually placed parallel to the natural shoreline (e-streams 2004)

Riffle
1) Shallow reaches with low sub-critical flow (1-4% gradient) in alluvial channels of finer particles that are unstable, characterized by small hydraulic jumps over rough bed material, causing small ripples, waves and eddies without breaking the surface tension. Stable riffles are important in maintaining the water level in the pool immediately upstream of the pool (Armantrout 1998). 2) Riffles can be generally characterized by moving water with small ripples, waves and eddies -- waves not breaking, surface tension not broken (Kaufman et al. 1999).

Rip Rap
Boulders or rubble used to construct a jetty or revetment (California Coastal Comm. 1987)

Riparian Vegetation
Vegetation that is growing on or near the banks of a stream that is more dependent on water than vegetation that is found further upslope (Armantrout 1998).

Run
An area of swiftly flowing water without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach (AFS 1985). Runs are considered to be part of the glide designation for this program.

Sediment

Fine grained material and organic material in suspension, in transition or deposited by air, water, or ice on the earth's surface (California Coastal Comm. 1987)

Side Channel
A side or secondary channel is any channel separated directly from the main channel at the upstream end by an island/bar with an elevation above bankfull. There must be clearly defined bankfull indicators at some point along the side channel (AREMP 2004).

Substrate
Mineral and organic material forming the bottom of a waterway (Armantrout 1998).

Thalweg
Path of a stream that follows the deepest part of the channel (Armantrout 1998).

Thalweg Depth
Vertical distance from the water surface to the deepest point of a channel cross-section (Armantrout 1998).

Wetted Width
Width of water surface measured perpendicular to the direction of flow at a specific discharge. Widths of multiple channels are summed to represent the total wetted width (Armantrout 1998).

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