RAPID ASSESSMENT OF SALMONID HABITAT PROTOCOL

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Coastal Mendocino County Salmonid Life Cycle and Regional Monitoring Project

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Introduction

The Rapid Assessment of Salmonid Habitat methods have been in development since the summer of 2011. The protocol was originally developed in order to quickly census the entirety of summer instream habitat available to salmonids in Caspar and Pudding Creeks, and to allow for a random selection of channel units to be electrofished as part of the Caspar/Pudding Creeks BACI Project. Data collected during these habitat and electrofishing surveys is then analyzed together to determine summer abundance, survival, and growth, and to develop relationships between salmonid abundance and different habitat variables. These relationships are explained/displayed as habitat suitability curves. In the summer of 2014 the data collection methods were adjusted in order to expand surveys beyond Caspar and Pudding to the wider region of Coastal Mendocino County.

The goal of the Regional Salmonid Habitat Monitoring effort is to estimate the volume of preferred habitat available to juvenile salmonids in six watersheds in coastal Mendocino County. We will estimate the total area and volume of stream habitat available in all survey reaches, as well as. At the end of the season we will apply the values from the Caspar/Pudding Creek suitability curves to the volume estimates in order to provide an idea of how much preferred habitat volume is available to juvenile salmonids. Eventually, with more crew resources we hope to strengthen our fish-habitat preference suitability curves with more observations, in order to provide fishery managers and restoration practitioners with the best information possible to guide restoration efforts.

Study Area

We will be surveying stream reaches from the six independent Coho Salmon populations in Coastal Mendocino County. An independent population is described “as one for which exchanges with other populations have negligible influence on its extinction risk” (Bjorkstedt et al. 2005). These independent populations include: Ten Mile River, Noyo River, Big River, Albion River, Navarro River and Garcia River. We are concentrating our survey efforts to these six independent populations because crew resources are limited, and because these populations will likely contribute more fish towards recovery of the Coho Salmon than dependent streams.

From the six independent populations we aim to sample a total of 47 reaches. A representative sample of reaches will be surveyed within each watershed. A minimum of six reaches will be surveyed in each watershed, even if this exceeds the representative sample. This is the minimum number of surveys needed to produce statistically valid results. No reaches are surveyed that are less than half a kilometer in length.

Equipment

Flagging
Permanent markers
30m or 50m Tape - measure wetted and bankfull widths
100m Tape - measure lengths
Stadia Rod - measure depths
Clinometer - measure water surface gradient
Stake Flags - mark additional attribute transects
Fines Grid - measure pool tail fines
GPS Unit - navigation, recording waypoints
SPOT Unit - GPS messenger for safety/communication
Rite-n-Rain Notebook - keeping unit type tallies, field notes
PDA with Custom Pendragon Forms

Methods

Working in crews of 2-3 people, collect habitat data working upstream for the entire length of each selected GRTS reach. The goal is to census the summer habitat of at least 47 reaches spread proportionally throughout six independent watersheds; the watersheds include Albion River, Big River, Garcia River, Navarro River, Noyo River, and Ten Mile River.

To find the start of survey, locate the bottom of the GRTS reach and walk upstream until you reach the first clear change in channel unit type (example: riffle crest boundary between a riffle and a scour pool). If the downstream end of the reach consists of dry stream channel then begin the survey directly at the downstream boundary of the GRTS reach. Fill out the header information, record water and air temperatures, and take your first waypoint.

For every channel unit identified record channel unit type, thalweg length, channel unit length, estimated average wetted width, estimated average depth, an estimate of fish cover available, an estimate of ocular substrate composition, large woody debris counts, and identify if the unit is an adjacent unit and measure the pool tail crest depth for all pools.

Systematic Sampling of Habitat Units

Additional attribute information will be collected for each channel unit type at the first occurrence and every 10th occurrence thereafter (Figure 1). Measurements from this sub sampled set of habitat units will be used to calibrate visual estimates of habitat metrics for the entire reach (Hankin and Reeves 1988). Because off-channel habitats occur rarely in our study streams and are vitally important to the survival of salmonid fishes, record additional attribute data for every Off-Channel unit encountered.

At the upstream boundary of each GRTS reach, channel units that start in the lower reach and extend into the next reach are surveyed to completion (no partially surveyed units) and recorded as part of the lower reach.

Channel Unit Classification

Working upstream, delineate each channel unit using the dichotomous keys and specified criteria outlined by the Columbia Habitat Monitoring Program protocol (CHaMP 2013; Appendix 1, Section 6). Units are classified using a two-tiered hierarchical system, first identifying units as Tier I Slow Water or Fast Water unit types and further categorizing units into Tier II unit types (Appendix 1, Figure 15). Only Tier II channel unit types will be recorded. In addition to the unit types per CHaMP (2013), we have added a dry channel unit type to capture areas of disconnected flow within the active stream channel.

Dry Channel Units

During summer low flow periods, it is common to see sections of dry creek bed within the bankfull channel where the water flow has ceased or has gone subsurface (beneath the streambed gravels). Record these sections as dry channel units. For each dry channel unit, measure the channel unit length following the center line of the bankfull channel, and record this as both thalweg length and channel unit length. Also record all qualifying dry wood pieces within the bankfull channel following the methods of CHaMP 2013. No other information will be recorded in dry channel units.

Side Channels

Follow Appendix 1, Section 7.1, Steps 1-3i, (CHaMP 2013) for identifying side channels. Qualifying side channels are separated from the main channel by an island that is at or above the bankfull elevation for a length ≥ the average bankfull width. Side channels that are separated by island-like features which are below bankfull elevation (bars) and/or are not as long as the bankfull width are considered to be part of the main channel. Be sure to identify any channel units that are located within a qualifying side channel. Assign channel unit numbers by first following the main channel and then returning to the start of the side channel and continuing sequential numbering of channel units. Do not designate segment numbers for side channels. See Figure 1 for further instruction on channel unit numbering in side channels.

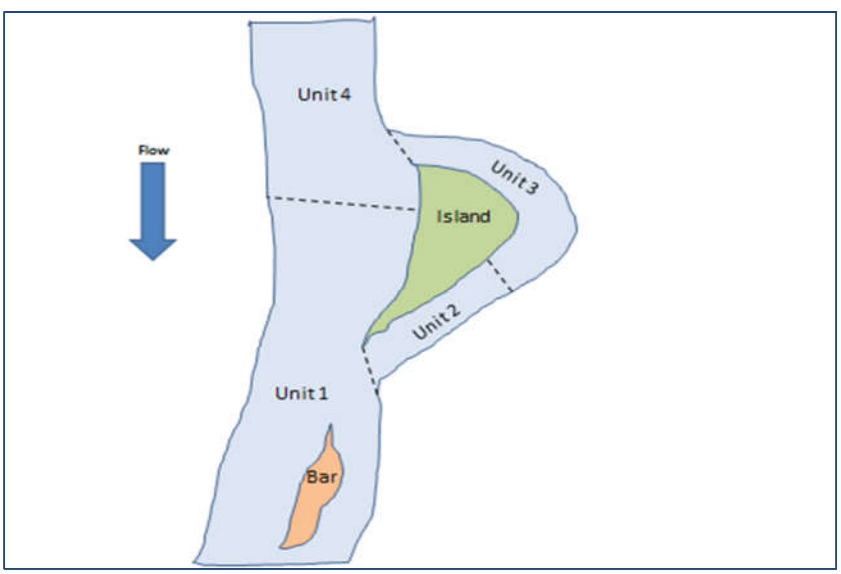

Figure 1. Numbering channel units sequentially in main channels and side channels.

Thalweg Length

The thalweg is the line of greatest flow and lowest elevation in a stream channel. It is the line that connects the lowest points along the length of a river bed to where there is active flow. For the purposes of this protocol, we will measure this line as it follows the general direction of stream flow. Measure the thalweg length to the nearest decimeter for every unit (except adjacent units and units within side channels) from the downstream end of a primary unit to the downstream end of the next primary unit immediately upstream. This will give us the total stream length surveyed without including the overlap from adjacent units or side channels. See Figure 2 for examples of how to measure thalweg length. Often the thalweg length and channel unit length will be the same for an individual unit. Sometimes the unit length will be longer than thalweg length, but thalweg length is never longer than unit length. If the stream channel is split by an island or bar, the thalweg will be measured in the channel section or side channel with the greatest amount of flow.

Habitat Unit Area and Volume Measurements

Measure the length of every channel unit following the centerline of the channel to the nearest decimeter. The unit length is being measured in addition to thalweg length to provide the most accurate estimate of a channel unit's true area and volume. Channel unit length may be equal to or longer than the thalweg length for a given unit; but thalweg length will never be greater than channel unit length. Visually estimate the average wetted width and average depth of all channel units encountered on a survey. Measure wetted widths to the nearest decimeter and average depths to the nearest hundredth of a meter. Include any portion of the wetted channel underneath an undercut in your estimate of the average wetted width. Unit lengths, average width, and average depths will be used to calculate estimated area and volume for each channel unit.

For every pool encountered, measure the maximum pool depth and the pool tail crest depth to the nearest hundredth of a meter. The pool tail crest depth is measured at the deepest point along the pool tail crest. Visualize this point as the depth of the downstream most spot along the pool tail crest that would have flowing water before water stops flowing out of the pool entirely (Heitke et al. 2011). Residual pool depth and residual pool volume (maximum depth and volume of the pool after it becomes disconnected from channel units immediately up/downstream) will be calculated from these measurements. In areas with disconnected flow, if a dry unit is directly downstream of a pool tailout, the tail crest depth of the pool is recorded as zero.

Adjacent Channel Units

In areas where multiple channel unit types overlap in the wetted channel, it is necessary to identify the overlapping channel units as Adjacent Units to ensure that only one thalweg length is recorded. For the purposes of this protocol, the thalweg length is used to estimate a total stream length and should therefore have no overlapping measurements. The channel unit that is furthest downstream and/or the channel unit containing the greatest percent of the flow will be considered the primary unit and is recorded as normal. The secondary unit(s) will be identified as Adjacent Unit(s), and thalweg length will not be recorded for adjacent units. Off-Channel units are always considered Adjacent channel units. See Figure 2 for examples of adjacent units.

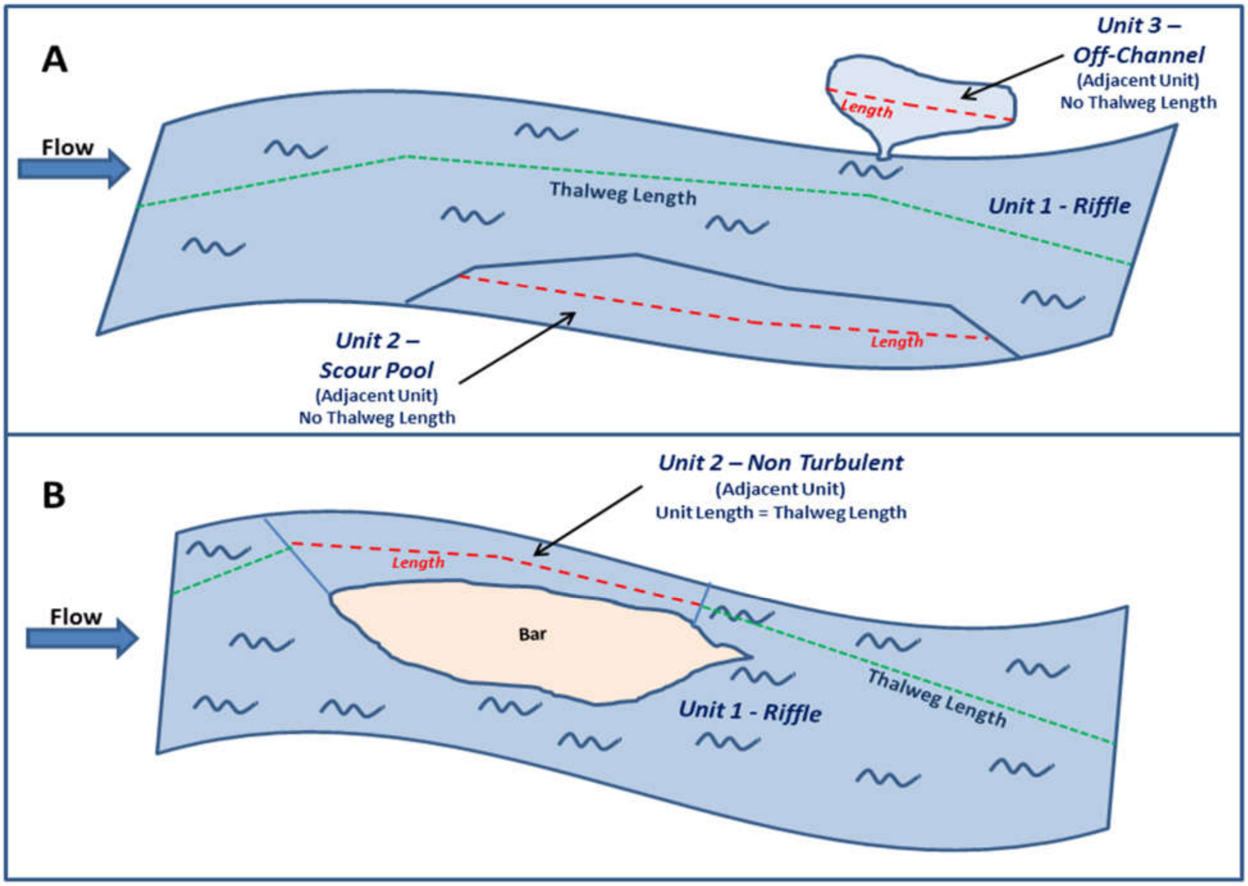

Figure 2. Identifying and measuring adjacent channel units and thalweg length. A) Unit 1 (Riffle) is the primary channel unit and Unit 2 (Scour Pool) and Unit 3 (Off-Channel) are the adjacent units. The thalweg does not run through either adjacent unit and is only recorded in Unit 1. B) Unit 1(Riffle) is the primary unit and Unit 2 (Non-Turbulent) is identified as an adjacent unit. Here the thalweg happens to run through the center line of Unit 2 resulting in equal length measurements for the thalweg and unit; however they will still be recorded separately. To measure the thalweg length of Unit 1 add the length measured downstream of Unit 2 to the length measured upstream of unit 2.

Fish Cover

For every wetted channel unit, visually estimate the proportion of the unit area that provides refuge to salmonids by cover type. This includes cover within the wetted channel ≤ 1 m above the water's surface. The five types of fish cover to estimate are: dead woody debris (no size requirement; includes sticks, dead redwood fronds, large wood, boards, railroad ties, etc.), live overhanging vegetation (e.g. tree roots), aquatic vegetation (e.g. algae), undercut banks, and artificial structures (e.g. tires, cars, concrete, impoundments, etc.). Also, estimate the proportion of the channel unit that is open space and does NOT provide cover of any type, including boulders (boulders will be included in substrate estimates). Round each estimate to the nearest 5%. Total fish cover of a channel unit should be at least 100%. If there are overlapping cover types, (i.e. a huckleberry bush overlapping a small woody debris aggregate) and the area of the overlap is greater than or equal to 5% of the total channel unit, measure each form of cover as though the other did not exist. This will result in a total cover value greater than 100% by a quantity equal to the area of overlap. See Appendix 1, Section 7.2, Fish Cover, CHaMP (2013).

Ocular Substrate Composition

In every channel unit, visually estimate the substrate composition by size class within the wetted surface area as per CHaMP (2013). Substrate size is determined by estimating a measurement along the b-axis, or intermediate axis, of a stream particle. The b-axis is described as the smallest width of a hole that the particle could pass through (Heitke et al. 2011). See Figure 3 for an example of a particle's b-axis. Record the percentage of each substrate class (Table 1) and round to the nearest 5%. The total of all size classes should be 100%. See Appendix 1, Section 7.3, CHaMP (2013).

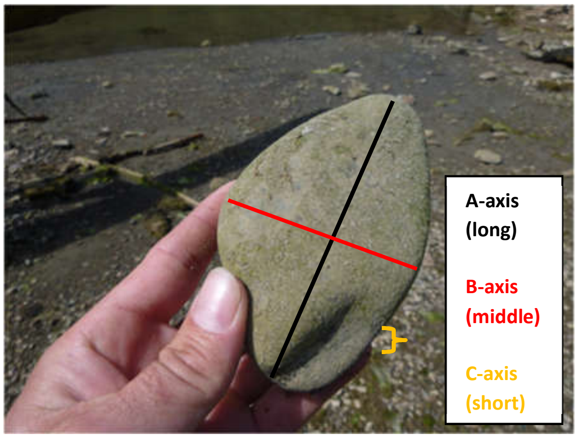

Figure 3. How to estimate/measure b-axis of a substrate particle.

Table 1. Substrate size classes

Substrate Type	Size Class (mm)	Description
Bedrock	na	Exposed bedrock surface
Boulders	>256	Basketball size and greater
Cobbles	64 - 256	Tennis ball to basketball size
Coarse Gravel	16 - 64	Marble to tennis ball size
Fine Gravel	2 - 16	Small pebble to marble size
Sand	0.06 - 2	Smaller than ladybug size, but visible as particles and gritty
Fines	<0.06	Silt, clay, muck and not gritty between fingers

Large Woody Debris (LWD)

Record qualifying Large Woody Debris (LWD) within the bankfull channel and bankfull prism in all channel units identified, as per CHaMP (2013). Qualifying LWD pieces must have a diameter ≥10 cm, measured at the midpoint of the piece, and a length of ≥1m. Classify the LWD as either "wet", if a portion of the piece with the diameter of ≥10 cm actually touches the water within the wetted channel, or as “dry”, if a portion of the piece with the diameter ≥10 cm is within the bankfull channel but outside of the wetted channel. Tally each piece, including those found within a large wood jam, into the appropriate size category according to Table 2. Use diameter first and length second to determine the size category. For example, a piece of wood within the wetted channel, with a diameter of 25 cm and a length of 12 m, would be tallied in the “Wet” Medium-Large category. Since we also have the unique opportunity to capture LWD that is considered “Old Growth”, we have included an additional size category for any piece that has a midpoint diameter of >120 centimeters and is at least 1 meter long. If an Old Growth piece is identified, note whether it qualifies as “wet” or “dry”, and measure and record the actual length of the piece to the nearest decimeter. Also record the diameter at the midpoint of the piece in centimeters. See Appendix 1, Section 7.5, CHaMP (2013) for more information on qualifying Large Woody Debris.

Table 2. Select large woody debris size categories, using diameter first and length second.

Size Category	Diameter (cm)	Length (m)
Small	10 to 15	1 to 3
Medium	15 to 30	3 to 6
Large	30 to 60	6 to 15
XL	60 to 120	>15
Old Growth	>120	

Additional Attributes

Collect additional attribute data from the first unit of each channel unit type and every 10th occurrence thereafter, and from every Off-Channel unit encountered. This means you will do additional attributes on the 1st Scour Pool encountered, the 11th Scour Pool encountered, the 21st Scour Pool encountered, etc. on each reach. If additional attribute unit counts begin to drift from every 10th occurrence, get back on track with the original count as soon as possible. For example, if you accidentally measured the 23rd Scour Pool and not the 21st, make sure the next Sour Pool measured is the 31st and not the 33rd. The selection will never change; it will remain 1,11,21,31,41, and so on throughout each reach. A small rite-in-the-rain field notebook is very useful to keep a running tally of each unit type.

Additionally, correct unit counts will be needed on the next survey day if the reach takes multiple days to complete. If it is going to take more than one day to survey a single reach, hang some flagging on a sturdy tree or bush at the unit break where surveying ends for the day. Include on the flag: “CDFW end of day”, GRTS reach #, date, total number of units surveyed in GRTS reach thus far, and number of each type of unit surveyed thus far. Also record and save a waypoint where you hang the end-of-day flag. This will ensure that another survey crew can come back the next day and continue the survey in the correct spot with correct unit counts.

Measured Width, Depth, and Bankfull

For each additional attribute unit, rigorous transect measurements will be recorded for widths and depths in addition to visual estimates. Before width and depth measurements are collected it is **critical** that visual estimates of the average wetted width and average depth of the unit are collected FIRST! This will minimize estimate biases and allow for a more accurate calibration of visual estimates from measured values.

Width: Measure the wetted width perpendicular to the stream channel at three transects located at 25%, 50% and 75% of the channel unit length.

Depth: Take depth measurements at points 25%, 50%, and 75% across the wetted channel at each width transect.

Bankfull Width: Measure the bankfull widths perpendicular to the stream channel at three transects located at 25%, 50% and 75% of the channel unit length. If a transect crosses an island-like feature (bar) that is bellow bankfull, you will still measure the entire width since that feature would be underwater at bankfull flows. If a transect crosses an island that does not meet length requirements resulting in a non-qualifying side channel, measure the bankfull width of each channel and add them together. See Appendix 1, Table 1, CHaMP (2013) for descriptions of bankfull indicators.

Pool Tail Fines

Follow CHaMP (2013) for measuring pool tail fines in Scour Pools and Plunge Pools requiring additional attribute data collection. Identify the pool tail crest and notice the shape of it. Place the grid at 25, 50, and 75% of the distance across the wetted channelwidth, making the grid parallel to the shape of the pool tail crest. The grid should be placed upstream of the tail crest a distance equal to 10% of the length of the pool unit or 1 m, whichever is less. See Appendix 1, Section 7.4, Figure 22, CHaMP (2013) for guidance on how to place the grid. The fines grid has 49 evenly distributed intersections; using the top right corner of the grid will provide a total of 50 measurements. Record the total number of intersections that overlay fine sediment with <2mm and the total number of intersections that overlay sediment 2-6mm as measured at the b-axis of each particle. If any intersections of the grid land on substrate >512mm (b-axis), aquatic vegetation, organic debris, roots, or wood covering substrate so that size cannot be identified, attempt to move the debris without disturbing the substrate beneath. If the debris cannot be removed without disturbance then count those intersections as Not Measureable. Do not overlap grids; it is ok if only 1 or 2 grids will fit across the wetted channel. Record the number of grids used to ensure that the correct percentages are calculated. Be sure to record any anomalies encountered during a survey (e.g. proportionally large amounts of data that are not measureable, etc.) in your notes for the survey reach.

Waypoints

Take and record a waypoint for every channel unit with Additional Attribute measurements. Save the GPS point as the GRTS reach number followed by the channel unit number. For example, the GPS point for the eleventh channel unit of reach 181 will have the following naming convention: 181.11. These waypoints are collected in order to observe the spatial distribution of channel units, so it is important to save the waypoints correctly and download them at the end of the day.

References

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Heitke, J.D., E.K. Archer, R.J. Leary, B.A. Bouwes, and B.B. Roper. 2011. Effectiveness monitoring for streams and riparian areas: sampling protocol for stream channel attributes. PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program, Logan, UT.

Appendix 1, CHaMP 2013 Selected Sections:

CHaMP (Columbia Habitat Monitoring Program) 2013. Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program. Prepared by the Integrated Status and Effectiveness Monitoring Program and published by Terraqua, Inc., Wauconda, WA. selected sections.

BANKFULL ELEVATION INDICATORS

Table 1. Types of indicators used to determine the bankfull elevation at a site.

Indicator	**Description**
Change in Slope	The change from a vertical bank to a horizontal surface is the best identifier of bankfull, especially in low-gradient meandering streams. Many banks have multiple breaks, so examine banks at several sections of the site for comparison. Slope breaks also mark the extent of stream terraces, which are old floodplains above the active bankfull. Terraces will generally have soil structure and perennial vegetation. Avoid confusing the elevation of the lower terrace with that of bankfull; they may be close in elevation.
Top of Point Bars	Point bars consist of bed material deposited on the inside of meander bends. The top elevation of point bars usually indicates the lowest possible bankfull stage. Multiple point bar elevations may be left from flows both above and below the bankfull elevation.
Changes in Vegetation	Look for the lower limit of perennial vegetation on the bank, or a sharp break in the density or type of vegetation. Often willow and alders form root lines near the bankfull elevation. The lower limit of mosses or lichens on rocks or banks, or a break from mosses to other plants may also help identify the bankfull elevation.
Change in Bank Materials	Look for changes in bank particle size, usually from coarse particles to a finer particle matrix (which is often associated with a change in slope).
Bank Undercuts	Look for bank sections where the perennial vegetation forms a dense root mat. Feel up beneath this root mat and estimate the upper extent of the undercut. This is usually slightly below bankfull stage. Bank undercuts are best used as indicators in steep channels lacking floodplains.
Stain Lines	Look for water lines on rocks that indicate where rocks are frequently inundated. Stain lines are often left by lower, more frequent flows, so stain lines should only be used to assist in identifying bankfull along with another indicator or when no other indicators exist at a site.

Several indicators should be examined to properly determine bankfull height.

i. Indicators should be more distinguishable at non-constrained channel types where the tops of point bars, changes in substrate, and permanent vegetation may be the most reliable indicators.

ii. In constrained channels, especially those dominated by boulders and bedrock substrate, indicators may be more difficult to identify. Under these circumstances the crew may have to depend on stain lines, or move further up or downstream to find reliable indicators.

SECTION 6: CHANNEL UNITS

References: Hawkins et al. (1993), Bisson et al (2006)
Equipment: Flagging, sharpie, depth rod, clinometer
Objective: Delineate channel unit boundaries and classify channel units.

6.1 Channel Unit Classification

The interactions among stream flow, sediment load, and channel resistance contribute to the formation of distinct areas (units) within the stream channel. These channel units, as a result, can be distinguished by their morphology (gradient, depth, shape), hydraulic properties (velocity & turbulence), and bed roughness (substrate size). Many fish habitat attributes are measured at the channel unit level.

Channel units are classified using a two-tiered hierarchical system (Figure 15). At the coarsest level, Tier I units are distinguished by gradient, relative stream velocity, and/or turbulence and include three classes: Fast Water Turbulent, Fast Water Non-Turbulent, and Slow Water/Pool. Tier I Fast Water Turbulent and Slow Water/Pool units are further subdivided into Tier II subclasses. Tier II subclasses are differentiated by hydraulic properties as well as the primary processes that form them. Below is a general definition of each Tier I class:

Fast Water Turbulent channel units are topographical high points in the bed profile that feature moderate to steep gradients, coarse substrate, and tend to have consistently turbulent flow. The bedform of these units generally lacks longitudinal and/or lateral concavity (Figure 16).

Fast Water Non-Turbulent channel units feature low gradients, dominantly sand to cobble substrate, and smooth laminar flow. Often, fast water non-turbulent units have a gentle slope, similar to pools, but are distinguished from pools by their general lack of lateral and longitudinal concavity. These channel units are generally deeper than riffles.

Slow Water/Pool units are topographical low points in the bed profile that feature very low gradients, smooth laminar flow, and possess lateral and longitudinal concavity. Also included in this class is the subclass of off-channel units. Off-channel units include backwaters and alcove type units that are connected to the main channel but have little to no flow.

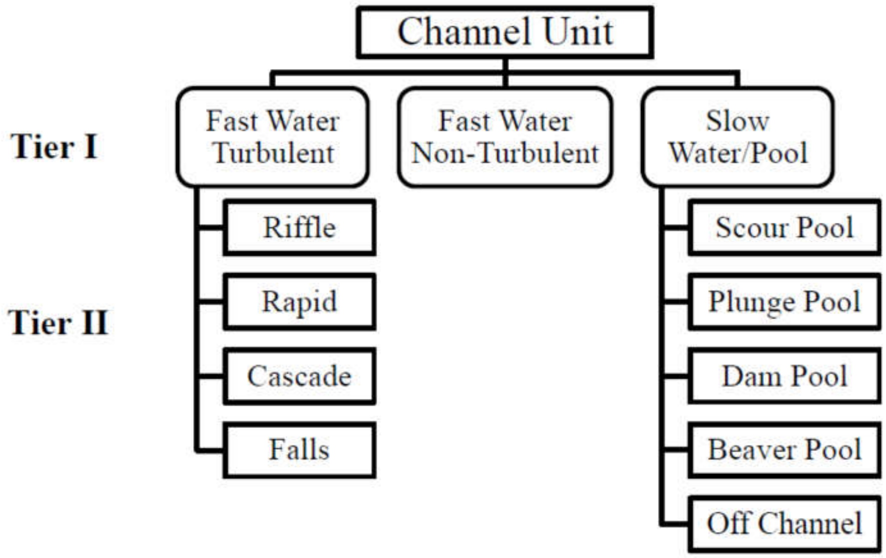

Figure 15. Two-tiered hierarchical classification system used to identify channel units. The classification structure is a modification of the system developed by Hawkins et al. (1993) as reported in Bisson et al. (2006).

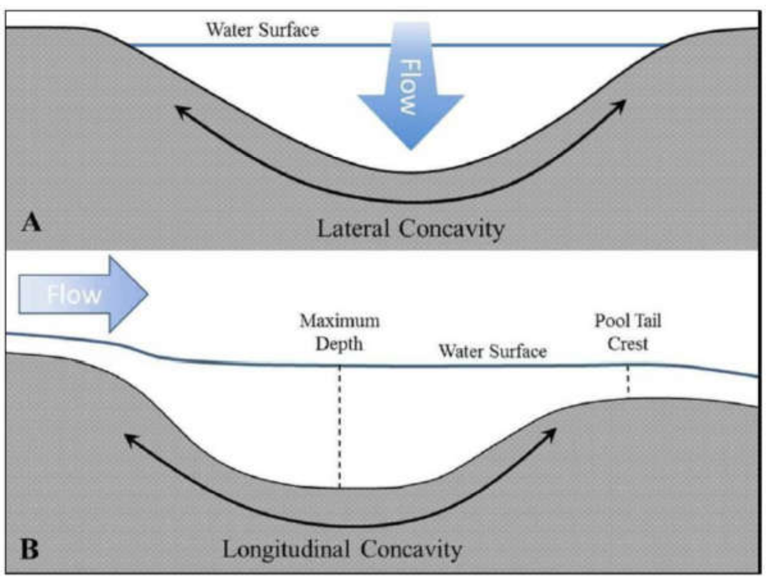

Figure 16. Representation of Pool A) cross-sectional (lateral) and B) longitudinal concavity.

Step 1. Identify channel units and their boundaries.
Use the following criteria as a guide when identifying distinct channel units.

i. In general, ***channel units are at least as long as the wetted channel width.***

ii. Channel units are relatively homogeneous, localized areas of the stream channel characterized by four elements (Figure 17):
   a. Water surface gradient
   b. Bedform (concavity)
   c. Bed material composition
   d. Flow characteristics (e.g., velocity, turbulence)

   Look for distinct changes in these components (Table 5) to determine unit boundaries.

iii. Use the descriptions found in Table 5 as well as the dichotomous keys to assist in classifying all channel units, including Tier I (Figure 18) and Tier II (Figures 19 and 20). The classification trees are read from top to bottom.

iv. Flag the unit boundaries and assign a unique number to each unit (e.g., *u1*, *u2*, etc.). Communicate the number of channel units and any details about complex unit boundaries to the crew members conducting the topographic survey, so unit perimeters can be surveyed correctly.

Figure 17. An example of channel unit delineations.

Table 5. Criteria used to delineate and classify Tier I channel units.

Tier I Classification	Gradient	Bedform Profile	Substrate Composition	Flow Character
Fast Water Turbulent	> 1%	Topographic high points in the bed profile	Generally have coarse substrate (cobbles and boulders)	Fast, turbulent flow
Fast Water Non-Turbulent	< 1%	Uniform depth, low complexity	Generally small cobble, gravels, and fine substrate	Smooth, even flow (laminar), minimal surface turbulence
Slow Water/Pool	0 - 1%	Pools are laterally and longitudinally concave (Figure 16). Off channel units have little to no flow through them	Variable; generally smaller sorted substrate	Generally laminar flow

Tier I Classification Tree

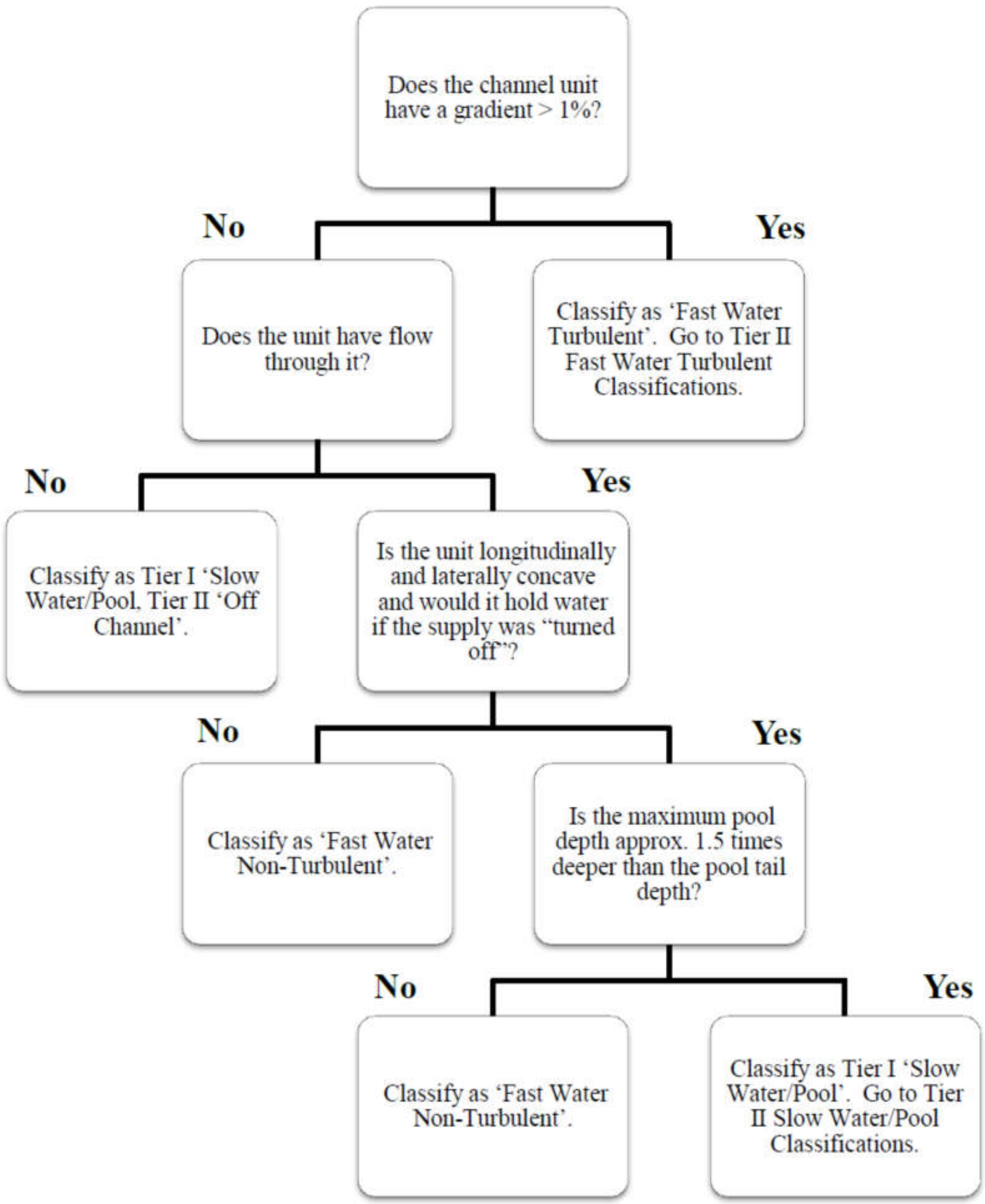

Figure 18. Dichotomous key of criteria used to classify Tier I (slow-water and fast water) channel units.

Tier II Classification Trees

Fast Water

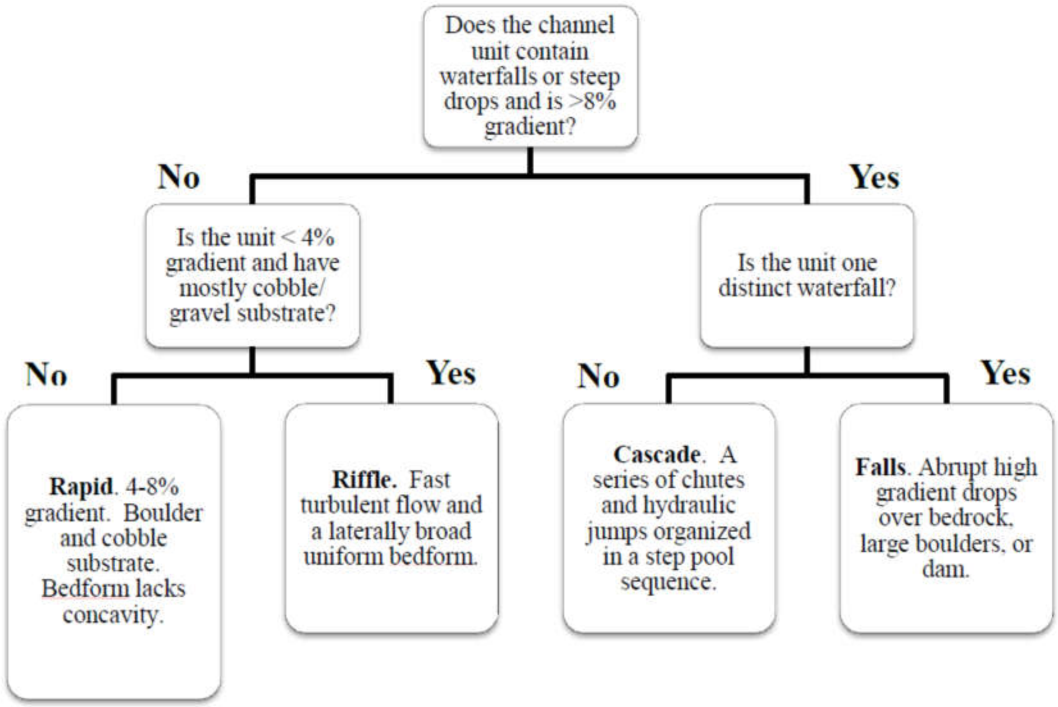

Figure 19. Dichotomous key of criteria used to classify Tier II fast water channel units.

Tier II Classification Trees continued

Slow Water/Pools

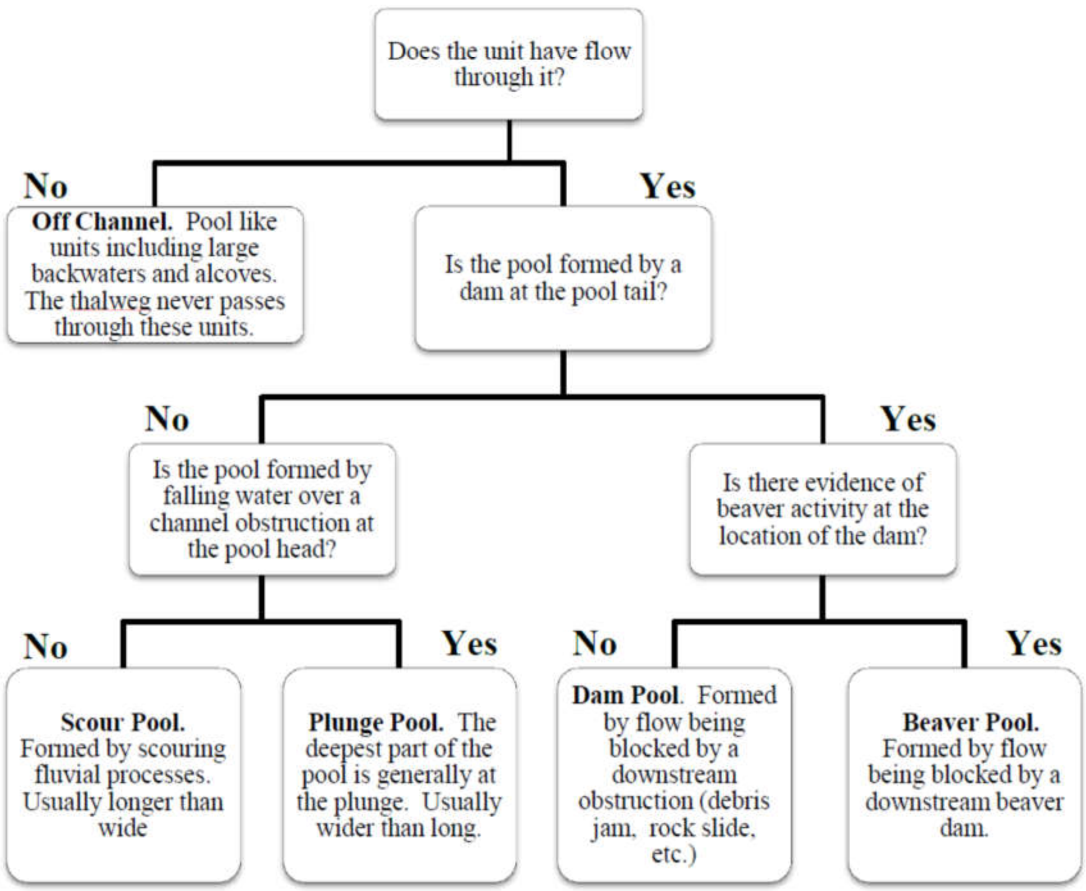

Figure 20. Dichotomous key of criteria used to classify Tier II slow water channel units.

SECTION 7: CHANNEL UNIT LEVEL ATTRIBUTES

7.1 Channel Segment Numbers

Objective: Identify and label the main channel and different side channel types.

Channel segment numbers are used to differentiate the main channel from qualifying side channels. Assign a channel segment number to all channel units within the main channel and qualifying side channels.

Step 1. Identify the main channel.

i. Main (primary) channel: Contains the greatest amount of stream flow.

ii. Designated as "Segment 1" throughout the site (Figure 21).

Step 2. Identify side channels.

i. Side channel: Separated from the main channel by an island that is at or above the bankfull elevation for a length ≥ the average bankfull width.

  a. If a side channel is separated from the main channel by an island that is shorter than the average bankfull width, then consider the side channel part of the main channel (Segment 1).

  b. If a side channel is separated from the main channel by an island like feature below bankfull (i.e. bar), then consider the side channel part of the main channel (Segment 1).

Step 3. Identify side channel types.

i. Qualifying vs. non-qualifying side channels.

  a. Stream Flow: Visually estimate stream flow both at the upstream and downstream end of the side channel.

    i. If either end has >16% flow, it is a **qualifying** side channel. Qualifying side channels contain between 16% and 49% of the total flow at a site.

    ii. If there is <16% flow, it is a **non-qualifying** side channel. There are two types of non-qualifying side channels: Type I and Type II.

ii. Type I vs. Type II non-qualifying side channels.

  a. Type I: Channel is located within the active bankfull channel.

  b. Type II: Channel located outside the active bankfull channel and possesses one or more of the following characteristics:

    i. The elevation of the channel's streambed is above bankfull at any point.

    ii. Channel lacks a continuously defined streambed or developed streambanks.

    iii. Channel contains terrestrial vegetation.

Step 4. Assign segment numbers to qualifying side channels.

i. The first qualifying side channel encountered when laying out the site (moving upstream) is designated as "Segment 2". Designate additional side channels sequentially (2, 3, 4, etc.) until all qualifying side channels have been uniquely numbered (Figure 21).

ii. DO NOT assign segment numbers to non-qualifying side channels.

Note: If a qualifying side channel continues downstream beyond the bottom of site, begin surveying the side channel in line with the bottom of site. Likewise, end surveying a side channel in line with the top of site.

Note: If a qualifying side channel splits and each channel contains >16% of the total stream flow, assign the original segment number to the largest channel and assign a new segment number to the second channel. If a qualifying side channel splits and flow in either channel is <16% of the total flow, assign the original channel segment number to the largest channel, but do not assign a new segment number to the smaller channel (now considered a non-qualifying side channel).

Step 5. Record measurements for each side channel type.

i. Qualifying side channels: Delineate channel units, collect channel unit attributes, and conduct topographic survey in all qualifying side channels.

ii. Non-qualifying side channels: For each non-qualifying side channel, identify the channel unit where the side channel enters the main or qualifying side channel and estimate the length and width of the side channel.

   a. Type I: Conduct topographic survey. Do not delineate channel units or collect channel unit attributes EXCEPT for Large Woody Debris (Section 7.5).

   b. Type II: Do not conduct topographic survey but capture the area where it enters/exits the main channel or qualifying side channel. Do not delineate channel units or collect any channel unit attributes.

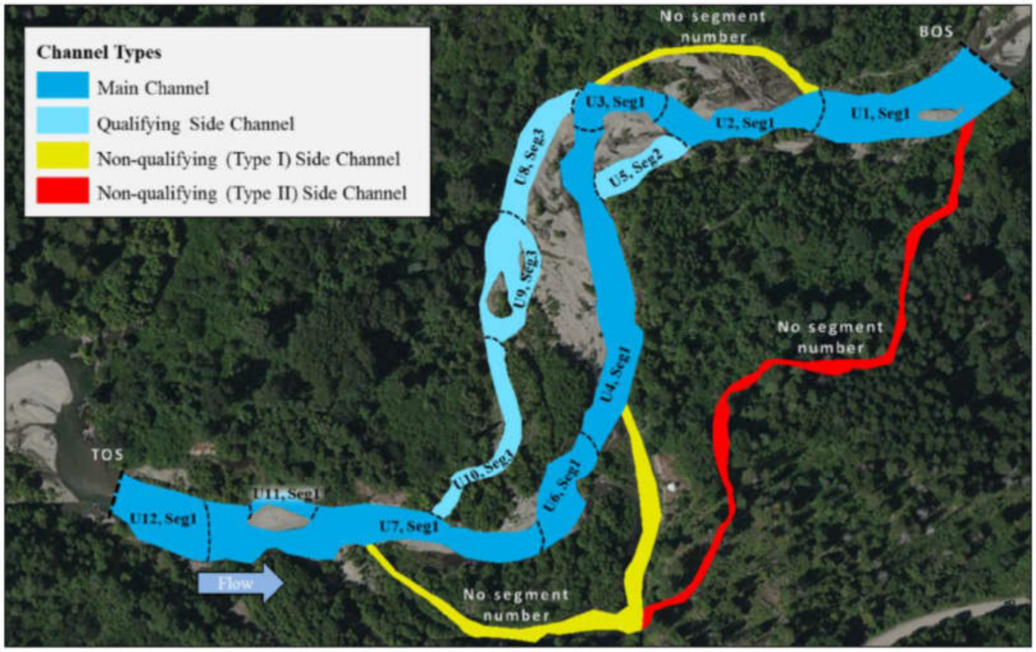

Figure 21. How to number channel segments within a site. The main channel is Segment 1 throughout the site and qualifying side channels are sequentially assigned numbers working upstream. Do not number non-qualifying side channels. U1-U12 indicates channel unit numbers and Seg1-Seg3, channel segment numbers.

7.2 Fish Cover

References: Peck et al. 2001.

Objective: Estimate the type and total area of cover available to fish within each channel unit.

Fish cover is defined as the proportion of the channel unit area that provides refuge to salmonids.

Step 1. Visually estimate the proportion of the wetted surface area within each channel unit that is covered by each of the fish cover elements listed in Table 6.

i. All fish cover elements must be within the wetted channel or ≤ 1 m above the water's surface.

ii. Round measurements to the nearest 5%.

iii. The sum of all fish cover elements should be at least 100%. If fish cover of different categories overlaps, count overlapping areas twice, resulting in a total percentage >100%.

Table 6. Definitions of fish cover elements evaluated at each channel unit.

Cover Element	Cover Element Definition
Woody debris	Wetted area of the channel unit covered by dead woody debris. There is no size requirement for woody debris to be considered fish cover. Include boards, railroad ties, wood placed for restoration purposes, etc.
Overhanging vegetation and live tree roots	Wetted area of the channel unit covered by live, terrestrial vegetation. Live tree roots suspended over the water and/or submerged.
Aquatic vegetation and algae	Wetted area of the channel unit covered by aquatic macrophytes and filamentous algae.
Artificial structures	Wetted area of the channel unit covered by artificial structures including materials discarded in the stream (tires, old cars, concrete, etc.), or those placed in the stream for diversions, impoundments, channel stabilization, or other purposes. Rip-rap and logs placed for restoration purposes are not included in this category.
Total NO fish cover	Wetted area of the channel unit (i.e., open water) that does NOT provide fish cover by any of the above elements or boulders and undercuts.

7.3 Ocular Substrate Composition

Objective: Eisually estimate the substrate composition of each channel unit and record the percentage of each size class.

Step 1. Estimate the percentage of each substrate size class.

i. Visually survey the substrate composition of each channel unit and record the percentage of each substrate class (Table 7) within the wetted surface area.

ii. Round estimates to the nearest 5%.

iii. You may not be able to see the entire wetted surface area of a channel unit due to visual obstructions (aquatic vegetation, wood, or other debris). When this occurs, estimate the area you can see.

iv. The total of all classes should equal 100%.

Table 7. Ocular substrate size classes. Estimate b-axis diameter of particles.

Substrate Type	Size class (mm)	Description
Bedrock	na	Exposed bedrock surface
Boulders	>256	Basketball size and greater
Cobbles	64 to 256	Tennis ball to basketball size
Coarse gravel	16 to 64	Marble to tennis ball size
Fine gravel	2 to 16	Small pebble to marble size
Sand	0.06 to 2	Smaller than ladybug size, but visible as particles and gritty between fingers
Fines	< 0.06	Silt and clay that is not gritty between fingers

7.4 Pool Tail Fines

References: Heitke et al. (2008).
Equipment: Fines grid, underwater sighting tube or snorkel and mask.

Objective: Quantify the percentage of surface substrate <2 mm and between 2-6 mm at the tails of pools and non-turbulent channel units.

Step 1. Identify measurement locations.

i. Collect measurements at the first 10 scour and plunge pools encountered within the main channel and qualifying side channels (16-49% flow) while moving from the bottom of site upstream. Do not sample in dam pools.

ii. If fewer than 10 pools exist at a site, extend sampling into only main channel non-turbulent units until ten measurements are collected or there are no more qualifying units. Sample at the bottom end of non-turbulent channel units in a similar fashion to pool tails.

Step 2. Sample surface fines.

i. Assess surface fines using a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid for a total of 50 intersections.

ii. Take 3 measurements per pool or non-turbulent unit.

   a. Place the center of the grid at 25, 50, and 75% of the distance across the wetted channel, making sure the grid is parallel to the shape of the pool tail crest (Figure 22).

   b. The bottom edge of the grid should be upstream from the pool tail crest a distance equal to 10% of the pool's length or one meter, whichever is less.

   c. If a portion of the fines grid lands on substrate 512 mm or larger in size (b-axis), record the intersections affected as non-measurable.

   d. Do not overlap fines grid placements/measurements at a pool tail. If all three grids do not fit within the pool tail without overlapping, record the overlapping grid as "not measured". State in notes that "grids overlapped".

iii. Record the number of intersections that are underlain with fine sediment or sand < 2 mm in diameter at the b-axis.

iv. Record the number of intersections that are underlain with sediment 2-6 mm in diameter at the b-axis.

v. Aquatic vegetation, organic debris, roots, or wood may be covering the substrate. First attempt to identify the particle size under each intersection. If this is not possible, then record these intersections as non-measurable.

vi. Do not count substrate that is suspended in aquatic vegetation or surface algae.

vii. Enter the channel unit number where measurements were collected.

Note: If the grid is located in an area that has greater than 75% non measureable intersections, shift the grid to a location where more grid measurements can be made.

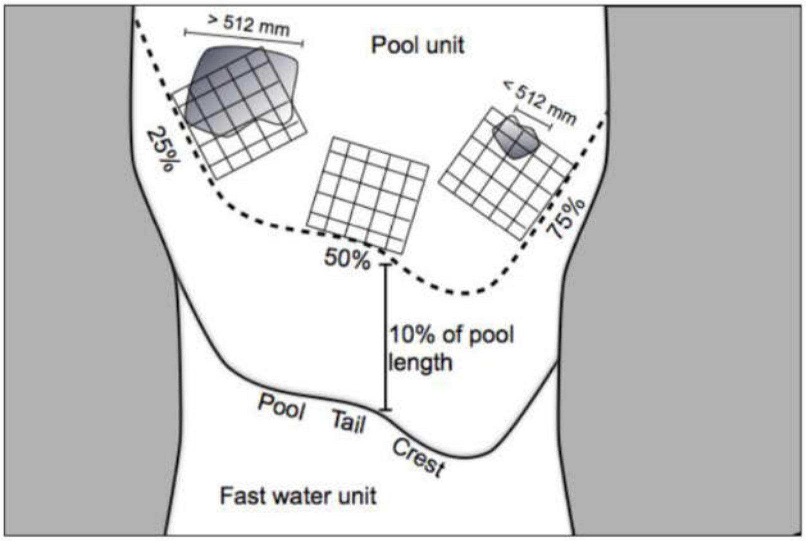

Figure 22. Location and orientation of pool tail fines grids relative to the pool tail crest. In this figure, all intersections of the fines grid at the 50% and 75% placements will be counted and recorded. For the 25% placement, the intersections of the fines grid that land on the boulder (substrate ≥512 mm) will be recorded as non-measurable.

7.5 Large Woody Debris (LWD)

Objective: Quantify the number and dimensions of qualifying LWD pieces within the site.

Step 1. Identify qualifying LWD within the bankfull channel and prism.

i. LWD and root wads must be dead with the exception of newly fallen trees that are uprooted from the bank but still have green foliage.

ii. LWD size qualifications:

   a. Must have a b-axis diameter ≥10 cm, measured at the midpoint of the piece. For LWD with attached roots, the diameter is measured at the midpoint between where the main stem joins the root mass (e.g., root collar) and the top of the piece (Figure 23).

   b. Must be ≥1 m in length. The length of LWD with attached roots is measured from the end of the main root mass to the top of the trunk.

iii. For LWD embedded in the stream bank, the exposed portion must meet the minimum length and diameter requirements to qualify. Quantify the length and diameter of the exposed portion of the piece.

iv. If a LWD piece is broken or cracked, consider it one piece if the two pieces are attached at any point along the break.

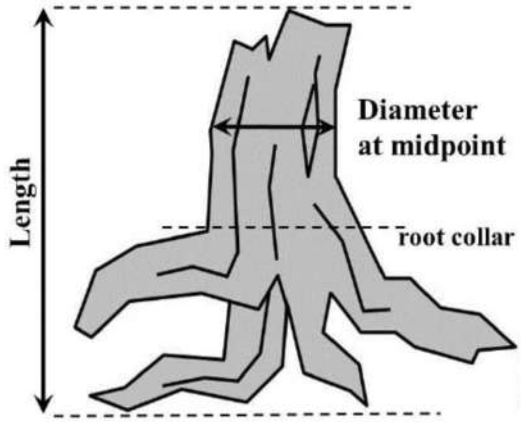

Figure 23. Depiction of diameter and length measurement locations for LWD with attached roots.

Step 2. Classify qualifying LWD as "wet" or "dry".

i. All LWD located within the bankfull channel is classified as either "wet" or "dry" (Figure 24).

   a. Classify piece as "wet" if a portion of the main stem or root touches the water and is ≥10 cm in diameter (Figure 24).

   b. Classify piece as "dry" if a portion of the main stem or root ≥10 cm in diameter is within the bankfull channel but outside of the wetted channel (i.e. would get wet at bankfull flows).

ii. Consider pieces outside the bankfull channel but within the bankfull prism (Figure 24) as "dry" if they meet <u>both</u> of the following criteria:

   a. A ≥10 cm portion of the main stem or root is within the bankfull prism.

   b. Piece is suspended within the bankfull prism by another qualifying piece and the piece would fall into the bankfull channel if the other was removed (Figure 24).

   Note: These pieces frequently occur in large wood aggregates or "jams".

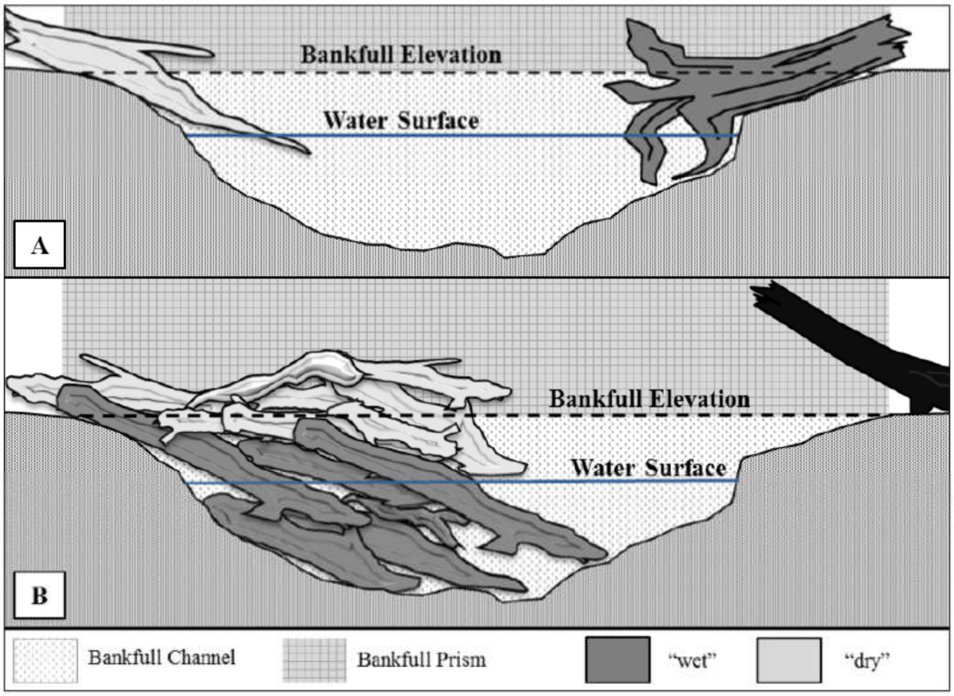

Figure 24. Cross-section view depicting LWD wet/dry scenarios. Grey pieces are considered "wet" and light grey pieces "dry". **Panel A)** LWD piece at left is "dry" because the portion of the main stem touching the water is < 10 cm. LWD piece at left is "wet" because a root ≥ 10 cm diameter touches the water. **Panel B)** Note that "dry" pieces above the bankfull elevation are supported by other qualifying pieces (see Step 2).

Step 4. Count LWD pieces and assign them to a channel unit.

i. Count and estimate the length and diameter of all qualifying pieces of LWD. Place each LWD piece into one of the length and diameter size classes outlined in Table 8. Diameters are estimated at the midpoint of each piece on the b-axis.

ii. Assign each piece of LWD to a channel unit. If a piece of LWD is present in two or more channel units, assign it to the unit that contains the highest proportion of the piece's volume.

iii. If a piece of LWD is outside designated channel units but within the bankfull channel, assign it to the nearest channel unit or non-qualifying side channel.

Note: Tally all qualifying LWD pieces within the entire bankfull channel including all qualifying and Type I non-qualifying side channels. Attribute LWD pieces in non-qualifying side channels to the non-qualifying side channel it falls in.

Appendix 2: Paper Data Forms

Habitat Overview

Date: / / page # _____ of_____

Stream Name: | Surveyors:

HU# | GRTS#: | 0.5 km Section: | E: | N: | Error:

Segment Number:											
Habitat Unit Number:											
Habitat Unit Type:											
Adjacent Unit? (Y/N)											
Unit Length (m):											
Width 25% (m)											
Width 50% (m)											
Width 75% (m)											
Average Width (m)											
Avg Depth 25% (m)											
Avg Depth 50% (m)											
Avg Depth 75% (m)											
Average Depth (m)											
Pools	Tailcrest Depth										
	Max Depth										
% Fish Cover	Woody Debris										
	OverhangingVeg										
	Aquatic Veg										
	Artifical										
	Undercut Banks										
	No Cover										
Large Woody Debris: **Wet**	Small Small										
	Small Med										
	Small Large										
	Small X-Large										
	Med Small										
	Med Med										
	Med Large										
	Med X-Large										
	Large Small										
	Large Med										
	Large Large										
	Large X-Large										
	X-Large Small										
	X-Large Med										
	X-Large Large										
	XL X-Large										
Large Woody Debris: **Dry**	Small Small										
	Small Med										
	Small Large										
	Small X-Large										
	Med Small										
	Med Med										
	Med Large										
	Med X-Large										
	Large Small										
	Large Med										
	Large Large										
	Large X-Large										
	XLarge Small										
	X-Large Med										
	X-Large Large										
	XL X-Large										

Abbr:	NT	RI	RA	FA	CA		SP	PP	DP	BP	OC	
Tally:												

Additional Attribute Data

page#_____ of_____

Surveyors:	Stream Name:	GRTS #:	0.5 km Section:

Date											
Habitat Unit Number											
Unit Type											
Bankfull Width 25% (m)											
Bankfull Width 50% (m)											
Bankfull Width 75% (m)											
Avg Bankfull Width (m)											
% Occular Substrate	% Bedrock										
	% Boulders										
	% Cobbles										
	% Coarse Gravel										
	% Fine Gravels										
	% Sand										
	% Fines										
Pool Tail Fines	# Of Grids Used										
	# fines < 2mm										
	# fines 2-6mm										
	# Not measurable										

Remember - Pool Tail Fines are only taken on Scour and Plunge Pools

*Not measurable means the intersection has landed on substrate >512mm (Boulder or Bedrock), or on organic matter, vegetation, roots, or wood, under which you cannot determine the substrate size.

Notes:

Name:	Non-turb	Riffle	Rapid	Falls	Cascade	Scour	Plunge	Dam	Beaver	Off Channel
Abbr:	NT	RI	RA	FA	CA	SP	PP	DP	BP	OC

Substrate Type	Size Class (mm)	Description
Bedrock	na	Exposed bedrock surface
Boulders	>256	Basketball size and greater
Cobbles	64 - 256	Tennis ball to basketball size
Coarse Gravel	16 - 64	Marble to tennis ball size
Fine Gravel	2 - 16	Small pebble to marble size
Sand	0.06 - 2	Smaller than ladybug size, but visible as particles and gritty
Fines	<0.06	Silt, clay, muck and not gritty between fingers