Quality Assurance Project Plan

Icicle Creek
Reach Assessment

August 2024

Prepared by

Yakama Nation Upper Columbia Restoration Project

and

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1.0 Background and Project Description

Icicle Creek is a salmon-bearing tributary to the Wenatchee River, that flows from Josephine Lake through Chelan County, WA. The upper portion of the creek is surrounded by the Alpine Lakes Wilderness, which transitions to the Okanogan-Wenatchee National Forest as the creek flows east toward its confluence with the Wenatchee River. Icicle Creek provides habitat for native aquatic species, as well as supports local domestic and agricultural water supplies and the Leavenworth National Fish Hatchery (Ecology, 2019). The Yakama Nation Fisheries is performing a Reach Assessment for 21 miles of Icicle Creek, starting at the confluence of Icicle Creek and the Wenatchee River near Leavenworth, WA. This project is partially funded by the Washington State Department of Ecology.

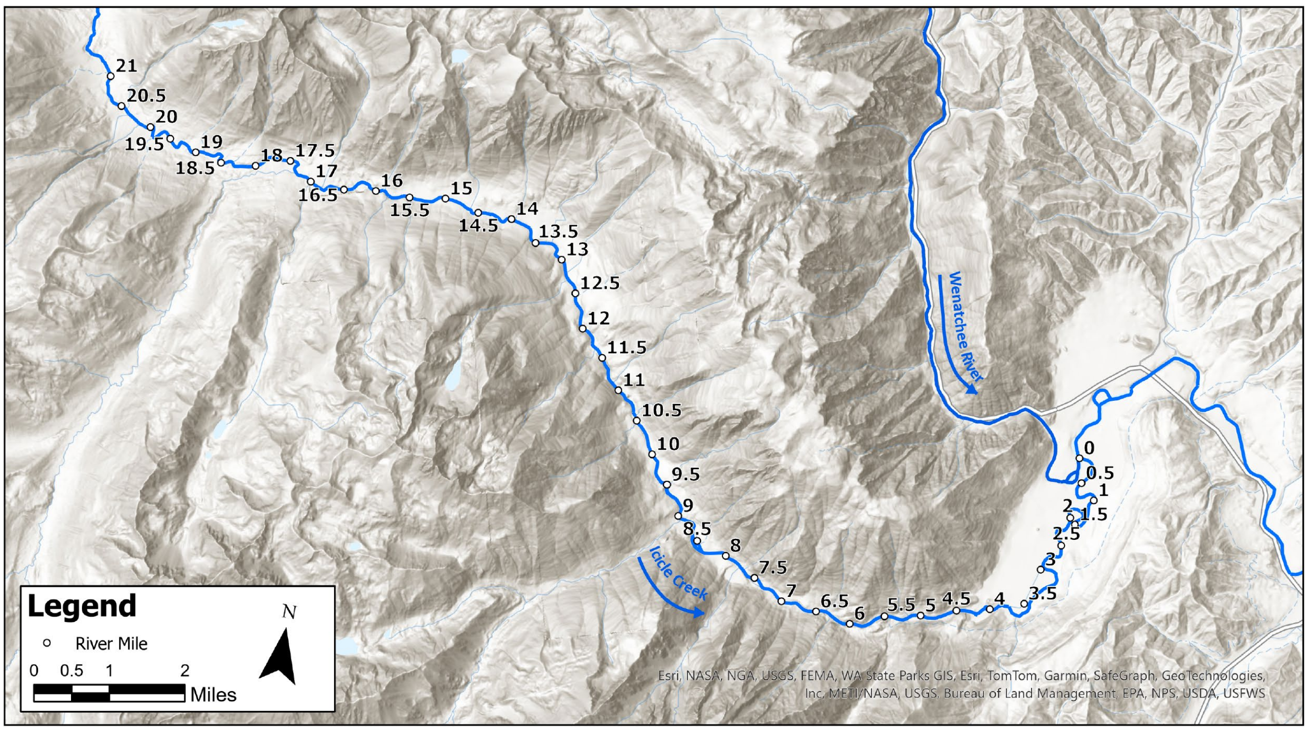

Figure 1. Map of the lower 21 river miles of Icicle Creek in Chelan County, WA.

The Icicle Creek Reach Assessment aims to evaluate the aquatic habitat conditions and functions of the creek. These data can then be used to support salmonid recovery efforts in the region, in support of the Upper Columbia Basin Spring Chinook Salmon and Steelhead Recovery Plan and related Biological Strategy, which identifies the target species and life-stages as well as the priority types of needed habitat improvements (UCRTT, 2022; UCSRB, 2007). Several key data collection tasks will be carried out to provide the information needed for the Icicle Reach Assessment. First, stream habitat surveys will be conducted using the US Forest Service (USFS) Stream Inventory Protocol (see Appendix A) to describe current channel and riparian habitat conditions along Icicle Creek, which involves conducting USFS Level II Aquatic Ecosystem Inventory surveys. This includes identifying and counting habitat unit types (e.g. pools and riffles), characterizing riparian vegetation species composition and structure, counting pieces of large woody debris and grouping by size category, and characterizing the type and amount of substrate (within categories) present along the reach (USFS, 2020). Preliminary hydraulic modeling will also be conducted with available topographic and bathymetric data and will include developing a two-dimensional (2D) hydraulic model based on LiDAR data and local streamflow gage data. This will help the team gain a better understanding of how human features impact Icicle Creek's floodplain, the level of flood risk to surrounding infrastructure, as well as current and future hydraulic and sediment transport conditions. The information gathered in these different tasks will then be used to determine regional Reach-Based Ecosystem Indicator (REI) metric ratings (as defined in Attachment A of Appendix B) for subreaches within the Icicle Creek Reach Assessment area. The goal is to use the metric ratings to inform the identification of potential project opportunities for salmonid habitat improvement in accordance with the goals and targets in the Upper Columbia Salmon Recovery Plan's Biological Strategy. For Icicle Creek, the Upper Columbia Regional Technical Team has identified that the following priority action categories are needed to address habitat limiting factors: channel modification, instream flow enhancement, and water quality improvement. The information obtained from the surveys will also help further confirm, and identify additional, habitat limiting factors that exist in the study segment. Finally, the information will be compiled into a report detailing the background, methods, and results of the Icicle Creek Reach Assessment, which the Yakama Nation, Upper Columbia Regional Technical Team, and other project collaborators will review.

The reach assessment methods will follow established protocols that have been used for multiple past reach assessments throughout the Upper Columbia River Basin. This protocol is outlined in the Upper Columbia Salmon Recovery Board – Regional Technical Team's Reach Assessment Guidance document (Appendix B; UCRTT, 2022). The team performing this work has performed numerous past reach assessments following these protocols, including throughout the Wenatchee, Entiat, Methow, and Yakima River basins. Since this team has performed these assessments in the past, and Icicle Creek itself has been surveyed in the past in this manner, we do not anticipate any significant constraints on the study design, or logistical problems. Landowner access, rough terrain, and streamflow are the biggest potential challenges. The landowner access is being addressed by contacting landowners where we will ingress and egress the channel. As for the terrain, we will be performing these surveys in pairs, for safety, and allowing sufficient time to carefully perform the surveys. The current streamflow is low for this time of year, and so we do not anticipate any significant limitations posed by streamflow.

2.0 Organization and Schedule

The reach assessment work will be performed by staff members of Inter-Fluve. Inter-Fluve staff leading this effort have been involved with multiple past reach assessments in the Upper Columbia since at least 2010 and have helped to develop the reach assessment guidelines and protocols (UCRTT, 2022) in collaboration with the Yakama Nation, the Upper Columbia Salmon Recovery Board's Regional Technical Team, and the US Bureau of Reclamation. The staff performing this work have or will be trained on performing the USFS Stream Inventory Protocol by an AFS-accredited Certified Fisheries Biologist with past experience performing these surveys, including with the US Forest Service. Hydraulic modeling will be overseen by a WA-State licensed professional hydraulic engineer.

The Icicle Creek Reach Assessment is scheduled to start in the Summer of 2024. Before fieldwork begins in July of 2024, Interfluve will attend the reach assessment initiating meeting relevant to the Icicle Creek project with Yakama Nation Fisheries Staff and other collaborators to discuss the goals and objectives of the reach assessment and finalize methodologies to meet the project goals. During this time survey preparation will also take place, ensuring that all required equipment for different field tasks is acquired or reserved and properly calibrated, that staff are trained in their use, and that all field campaigns are tentatively scheduled. Fieldwork is scheduled to occur from the beginning of July to the end of September 2024. During this time, teams will conduct stream habitat surveys and stream geomorphology assessments on-site along the study area of Icicle Creek. The data collected during these surveys and from other available sources will be compiled and analyzed during September and October of 2024. Restoration Strategy development and potential project identification will take place between October and November. All the information collected and compiled in this project will then be synthesized into a Draft Report by the end of December 2024, and submitted to the Yakama Nation Fisheries, Upper Columbia Regional Technical Team, and others for review and comment. The Final Report is scheduled to be completed by the end of February 2025.

This schedule may have to shift and adjust as the project progresses. Site access and traversing conditions at Icicle Creek may be physically challenging, so teams will likely need to plan to have sufficient time to conduct surveys while also maneuvering safely through different reaches. In addition, external factors have the potential to constrain or alter the above schedule, especially concerning the timely completion of the fieldwork component of this project. Heat waves can occur during summer in the Pacific Northwest Region increasing the risk of dehydration and heatstroke for field crews. They could disrupt the field schedule of the project if temperatures get dangerously high in the region. In addition, wildfires and wildfire smoke in and around the Icicle Creek area could result in poor air quality and other safety risks, restricting site access.

Table 1. Icicle Creek Reach Assessment Project Schedule

Tasks	**Expected Completion Dates for Project Tasks**
Acquire Available Assessment Data	October 2024
Survey Prep	June 2024

Habitat Surveys	September 2024
Geomorphology Assessment	September 2024
Data Compilation and Analysis	October 2024
Restoration Strategy Development	November 2024
Draft Report	December 2024
Final Report	February 2025

3.0 Quality Objectives

Table 2. Icicle Creek Reach Assessment Measurement Quality Objectives

Task/Analysis	Method	Accuracy/Range of acceptability	Source
Habitat Survey 1. Channel Unit Type 2. Wetted Width 3. Maximum Depth Measurement 4. Large Woody Material 5. Bank Survey	USFS Aquatic Ecosystem Inventory (See Appendix A for full detail of Level 2 survey methods) 1. Hawkins method (slow water, fast water, side channel, tributary, other) 2. Fabric measuring tape stretched perpendicular across channel when logistic and safety conditions permit to do so, otherwise estimated 3. Standard wading rod if depth is less than 4 ft., depth is estimated if greater than 4 ft. 4. Number of small, medium, large wood pieces per channel unit. Additional collection for wood jams, including number, location, and characteristics. 5. Note actively eroding banks, which side of the channel , and length (ft.)	Not applicable. This is an inventory of conditions following the USFS protocols. See discussion for more information. 1. N/A 2. Nearest 0.5 ft. 3. Nearest 0.1 ft. 4. First 5 pieces of wood per day are measured to calibrate surveyor's eye, rest are estimated. 5. Nearest 5 ft.	(USFS, 2020)
Habitat Survey - Nth Unit	1. Fabric tape measurer when logistic and safety conditions	1. ±0.5 ft. 2. ±0.5 ft.	(Komelon USA, 2024; USFS, 2020)

1. Measured wetted width 2. Bankfull width 3. Vegetation Survey	permit to do so, otherwise estimated 2. Fabric tape measurer when logistic and safety conditions permit to do so, otherwise estimated 3. Class and species name of dominant overstory and understory species based on average of both bank's designated 100ft wide riparian zones.	3. N/A	
Pebble Count	Wolman Pebble Count with gravelometer (see USFS Handbook)		(USFS, 2020)
Unit and Reach Length and Location Documentation	Juniper Systems Geode real-time GNSS/GPS data (GNS2 & GNS3S)	Sub-meter (<60 cm 2DRMS)	(Juniper Systems, 2021, 2023)
Stream Discharge Measurements	Marsh-McBirney flowmeter (Model 2000 Flow Mate) and standard wading rod	2% of reading + zero stability (± 0.05 ft/sec)	(Marsh-McBirney, 1990)
Stream Temperature Measurements	Handheld Digital Thermometer	Accurately measures to 0.1 ºF (between -40ºF and 500ºF)	(Taylor USA, 2024)

The data collected in this reach assessment will be directly compared to past and possible future reach assessments conducted according to USFS Aquatic Ecosystem Inventory methods, so utilizing these habitat survey methods is a requirement for the Icicle Creek Reach Assessment (UCRTT, 2022). USFS Aquatic Ecosystem Inventory survey methods have been deemed sufficient to maintain the quality and consistency of data collection required for the Icicle Creek Reach Assessment (USFS, 2020). These protocols have been refined over many years and are well-established as the standard for stream habitat inventory surveys. It is acknowledged that such surveys have unavoidable biases in how habitat units are determined and classified, but USFS Stream Inventory Protocols have strived to utilize quantitative measures for attributes such as streamflow, substrate, bank instability, and channel dimensions to reduce the impact of surveyor bias, as well as a set of ten surveying standards to ensure the consistency of data and to calibrate field estimation. All of these methodologies and standards, including but not limited to the consistency of observers for surveys, uniform bank orientation, and prioritizing direct measurements over estimations whenever safely possible, will be followed during the Icicle Creek Reach Assessment. Contacts for the reach assessment (the observer and the recorder) will be recorded so any questions about inconsistencies or possibly erroneous data points can be addressed to those who conducted the survey. All data collected should be at least as accurate as specified by the Region 6 (Pacific Northwest Region) protocol, outlined in the USFS Handbook (USFS, 2020).

Hydrologic analysis will be used to model the water surface elevation and velocity of flow events with return intervals of 2, 5, 10, 25, 50, and 100 years. These data will be used in the hydraulic model (discussed below) and to provide a general characterization of the hydrologic condition of the study area. A multiple-lines-of-evidence approach will be used to estimate peak streamflows for this portion of Icicle Creek. This includes utilizing existing hydrologic analyses for the Wenatchee Basin (e.g. Sutley 2008) coupled with a new analysis using more recent stream gage data following the methods described in Mastin et al., which uses stream gage peak flow data fitted via a Log Pearson III statistical distribution with the regional weighted skew for the Pacific Northwest (Washington, Oregon, and Idaho) and the USGS regional regression equations to obtain hydrologic estimates (2016). The analysis methods will include standard error values for the estimates. No specific criteria for acceptable error are provided since the analysis is wholly contingent on the available data. The verification/calibration of the hydraulic model, discussed below, provides another check on the accuracy of the hydrologic estimates. The variability in the estimates from the different approaches, and the standard error values, will be discussed in the context of the implications to the reach assessment objectives and the effect on the accuracy of the hydraulic modeling.

Model Quality Objectives

Preliminary hydraulic model quality will be obtained through model calibration. Model verification and calibration are performed by utilizing evidence of high-water marks (obtained through surveying, identification by residents or other observers, and photographs) and known flood event discharges, which allow the model to be properly adjusted so the water surface elevations match those estimated by the model.

4.0 Study Design

The Icicle Creek Reach Assessment is designed to supply the information needed to develop a robust Restoration Strategy for Icicle Creek, informing what areas are good candidates for fish habitat improvement and what restoration activities would be most effective to implement (UCRTT, 2022). These project opportunities will be informed by past assessments, desktop analyses, stream surveys and observations performed as part of this effort, and hydrology and hydraulics analyses. These various sources of information will be used to inform the rating of metrics in the Reach-based Ecosystem Indicators matrix (REI) for subreaches within the Icicle Creek Reach Assessment area and to identify project opportunities. REI metrics compare current site conditions with established habitat thresholds for species of interest (salmonids in the case of Icicle Creek Reach Assessment). This study framework is displayed in the figure below.

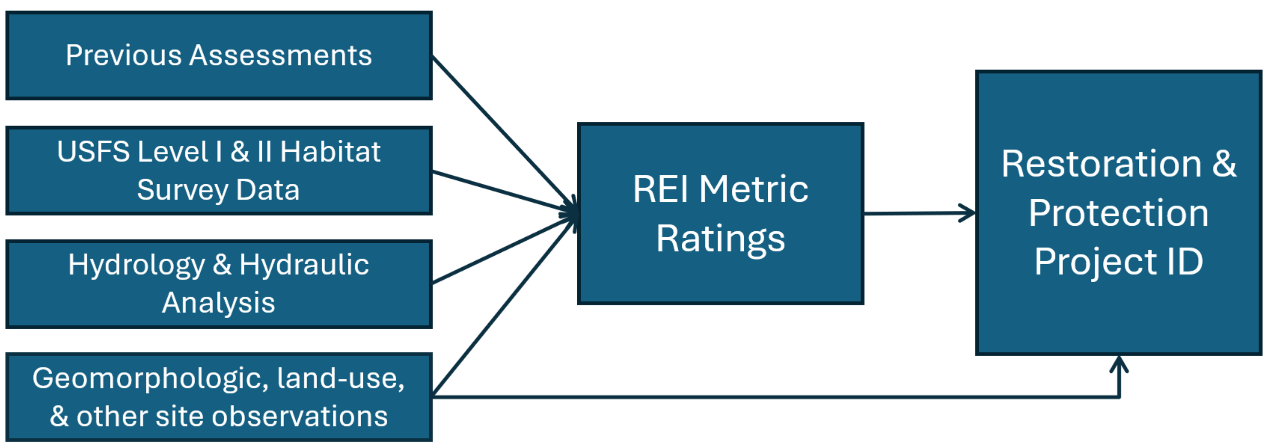

Figure 2. Process diagram of the Icicle Creek Reach Assessment Study Design.

Data collected during stream surveys along the reach will be consolidated to inform a set of rating metrics for the REI, which will categorize a given reach's condition as "Adequate", "At Risk", or "Unacceptable" based on how its description fits into those shown in Table A1, as seen in attachment A in Appendix B. This, in turn, will be used to portray the habitat conditions within each reach of Icicle Creek, which will inform current and future restoration projects within the Icicle Creek study area and prioritize management and restoration in areas at greatest risk of degradation or those with the highest potential for habitat improvement.

The guidelines prescribed by the USFS Stream Inventory Protocol, which will be used as the basis for this assessment, are sufficient for determining the REI ratings described above and are believed to provide a reasonable representation of reality and a solid basis from which to identify potential restoration actions and projects (UCRTT, 2022; USFS, 2020).

Modeling and analysis design

Peak flow hydrology of the site will be developed using the multiple-lines-of-evidence approach previously described in the Quality Objectives section, estimating stream peak discharge for 2-100-year flood events. These discharge estimates will then be used in tandem with terrain developed with 2015-2020 LiDAR topobathy data available for the site to create a 2D hydraulic model in the US Army Corps of Engineers' Hydrologic Engineering Center's River Analysis System software (HEC-RAS). This preliminary model will help the team gain a better understanding of the impact of human features (e.g. bridges, levees) on site conditions, and the potential effectiveness of different types of restoration actions.

5.0 Field Procedures

A USFS stream inventory survey is conducted in three key phases, an office phase, a field phase, and a data consolidation, analysis, and report phase(USFS, 2020). These phases will be completed according to the survey guidelines laid out in the Stream Inventory Handbook developed by the United States Forest Service, attached as Appendix A. The first two of these phases are discussed in greater detail below.

5.1 Office Phase

Before teams visit the Icicle Creek area to begin conducting stream habitat surveys, they will complete the Survey Form and the Preliminary Reach Form to collect preliminary data and prepare for fieldwork at the site (USFS, 2020). These forms will be completed following the procedures laid out in Chapter 2 of the USFS Stream Inventory Handbook (Appendix A), with information supplied by aerial photos, orthophotographs, and geospatial data and software. A 1:24,000 scale USGS topographic map of the Icicle Creek study area as well as a LiDAR-based Digital Elevation Model (DEM) will be utilized to plan field efforts and orient field crews to points of interest in the area (e.g., access points, road crossings, dams, diversions), as well as subdivide the study area into sub-reaches. Reach breaks identified by the UCSRB or identified as a part of previous habitat surveys will be utilized wherever possible. Where reach breaks have not yet been identified as a part of previous surveys, the office-based analysis as described in Chapter 2 of the USFS Stream Inventory Handbook (Appendix A) will be used to determine reach breaks for the field phase.

The Stream Inventory Handbook provides different protocols for “Eastside” and “Westside” watersheds that reflect the varied ecological conditions found in streams that are East of the Cascade Mountains compared to streams to the West of the Cascades. Conditions in Icicle Creek will be evaluated during the office phase and a protocol selected. The Stream Inventory Handbook also provides several “Forest Options” for the collection of large wood and riparian vegetation data. Data collection methods, including which (if any) Forest Options are preferred, will be determined during the office phase.

A series of maps will be developed that cover the entire Icicle Creek study area and will be available to field crews for reference while conducting the stream inventory. A map of the Icicle Creek area will also be developed to identify private property boundaries and potential access points in the study area.

5.2 Field Phase

In the field, teams will conduct stream habitat surveys according to the procedures for the Aquatic Ecosystem Inventory laid out in Chapters 3 and 4 of the Stream Inventory Handbook (Appendix A; USFS, 2020). Data collection will include reach and channel unit data, stream discharge recordings, and channel substrate observations throughout the 21 miles of Icicle Creek included in the study area. Temperature will be recorded for each study area as part of the channel unit data. Within the main channel, it will be recorded at the same time Riparian Vegetation is collected, every tenth channel unit. It will also be collected at the start and end of each survey day, as well as at each tributary. The Stream Inventory Handbook provides a series of specific data collection forms to be filled out during the stream survey, including:

- Channel Unit Form
- Final Reach Form
- Special Cases Form
- Discharge Form
- Wolman Pebble Count Form
- Comments Form

Digital versions of the above forms will be completed by field crews using a tablet (i.e., iPad) with geolocation capabilities.

All protocols described in the Stream Inventory Handbook will be followed when safe to do so. Reach location data and channel unit data will be collected for Icicle Creek and recorded in Channel Unit Forms for each unit, and a Final Reach Form, Special Cases Forms, Discharge Forms, and Wolman Pebble Count Forms for each reach within the study area. Comments Forms will be used where necessary.

The general methods to be used in the field will include:

Recording channel unit characteristics. Field crews will walk the study area from downstream to upstream boundaries, delineating each qualifying channel habitat unit type. Channel habitat unit types will be determined based on definitions provided in the Stream Inventory Handbook and a corresponding sequence order number (SO) will be assigned to each unit. Pools are defined as "slow water" units that include dam, scour, or plunge pools. Riffles are "fast water – turbulent" features that are in general relatively shallow and glides are "fast water -nonturbulent" units, which tend to be deeper than riffles. "Side-channels" are considered to be naturally wetted flow paths connected to the mainstem channel at their upstream and downstream ends at average annual flow. Side channel units will be identified when the main channel splits to form a stable island with soil or fine sediment accumulations and established vegetation. Each side channel will be recorded as a fast or slow type channel, and its average width and length measured. Both total and wetted lengths will be recorded using GPS. The Special Cases Form will be utilized for any channel units characterized by unique handmade or natural structures within the Icicle Creek Reach.

The field "observer" will perform ocular estimates of channel metrics. The field observer will remain consistent throughout the entire Icicle Creek study area. To calibrate the ocular estimates, a subset of units will be measured and compared to ocular estimates. These measured subset units are called "nth" channel units. The measurement frequency applied in the field for data collection will be every 5th unit (one in five) or more frequent (e.g., every 3rd unit) if necessary to meet the minimum requirement of 10% in the Stream Inventory Handbook. At nth units, the surveyors will perform both an ocular estimate of the wetted channel width and measure the wetted channel width with a 100-foot tape. The depth of pools, riffles, and glides will be measured using a graduated stadia rod carried by the observer.

Photographs of unique features recorded in the Stream Inventory Protocol (e.g., significant log jams, tributaries confluences, fish passage barriers) will be collected. Geolocation data will be recorded for photographs. The respective SO will be recorded where each photo was captured.

At the upstream end of each reach, a Final Reach Form will be filled out.

Documenting Large Woody Material. Large woody material (LWM) will be counted in the mainstem and side channels following the size class characterizations described in the Stream Inventory Handbook. Log jams will be documented within the study area, including the GPS location of the jam and an approximate number of pieces of large wood within the jam.

Collecting Stream Discharge Data. Stream discharge data will be collected once for Icicle Reach within 10 days of the start of the stream habitat survey near the downstream end of Icicle Creek near its confluence with the Wenatchee River near the city of Leavenworth, WA and reported using the Discharge Form (Appendix A; USFS, 2020). Velocity collected and reported in the Discharge Form will be measured using a Marsh-McBirney flowmeter. The procedure outlined in the USFS Handbook for collecting stream discharge data is specific to low-flow conditions, unlike the procedure described by the Department of Ecology which can be used in varying stream conditions (Ecology, 2018). The basic equation for discharge, Q=VA, and the use of cross-sectional areas with velocity measurements are consistent with both procedures.

Collecting Pebble Count Data. Wolman Pebble Counts will be conducted following the procedures described in the Stream Inventory Handbook (Appendix A; USFS, 2020) along characteristic riffles within each reach. Locations for pebble counts in each reach will depend on locations of suitable riffle units, however, field crews will aim to collect pebble count data at approximately one-third and two-thirds of each reach within the study area. Pebble axis measurements will be taken using standard gravelometers or measuring tapes.

Several modifications to the protocol will be utilized to reflect current geospatial and geolocation data capabilities: reach and habitat unit lengths will be measured during post-processing utilizing field-recorded GPS data collected with a high-accuracy Juniper Systems Geode unit instead of measuring the distance between unit breaks with a tape in the field. Using the Geode paired with the tablet with an air photo basemap allows for real-time checking of proper geolocation in the field. Floodprone width will be measured in the field using tape measures or a laser range-finder, and in some cases assessed during post-processing in ArcGIS Pro using LiDAR and high-resolution orthomosaic imagery.

For a more detailed explanation of field methods, please see the Stream Inventory Handbook (Appendix A; USFS, 2020).

5.3 Invasive Species Contamination

As the movement of field crews between watersheds has the potential to be a pathway for the spread of invasive species, the team conducting the Icicle Creek Reach Assessment is encouraged to follow the following protocols before and after entering the area of the reach assessment, in addition to visual inspection for aquatic invasive species.

It is recommended that at a minimum, WDFW's Level 1 Decontamination Protocol is used. If there has been travel from known high-risk areas or if there is additional concern regarding the transfer of invasive species, then additional Level 2 protocols should be considered, including chemical decontamination (see WDFW, 2022). Level 1 protocols consist of the following steps (WDFW, 2022):

- Clean off any attached sediment, organisms, or debris from surface areas that were in contact with the water, underwater bottom, or wetted perimeters immediately upon leaving a water body. Use the brush, boot pick, and water of origin to help remove heavy deposits. For multi-piece gear, it is critical to remove attachments and boots to allow for full cleaning coverage.

- Drain any water back into the water body from which it came.
- Rinse all surface areas with potable water. Rinse water can be kept in a 3-5 gallon (10.5-17.5 L) water tank in your field vehicle (e.g., water cooler, pressurized tank sprayer; solar shower).
- Dry aquatic conveyances, or allow time to dry, before being used at another site. To dry aquatic conveyances completely, either wipe down with a clean rag/towel or hang up or lay out in a way that allows for drying over time.

6.0 Quality Control

Data collected in the field during the Icicle Creek Reach Assessment need to accurately represent the conditions along Icicle Creek since these data will be the foundation on which the reach's restoration strategy and future management actions will be based. Several quality control measures will be employed in the preparation of fieldwork as well as in the field.

Table 3. Icicle Creek Reach Assessment Quality Control Steps

Parameter	Steps	Frequency	Corrective Actions
Proper and regular equipment calibration, storage, and maintenance	Juniper Systems Geode devices, models GNS2 & GNS3S, will be transported and stored in waterproof Pelican cases to minimize damage to the units. Regularly clean and calibrate the Model 2000 Flow Mate flowmeter (Marsh-McBirney, 1990). Handheld Digital Thermometers will be checked with a second thermometer for consistency of readings.	Any time devices are not in use. Clean as needed. Calibrate prior to each use. At the start of each stream survey.	NA
Channel Unit metrics	See Chapters 3 and 4 of the Stream Habitat Inventory for calibration and QA/QC steps to be taken in the field (USFS, 2020).	Every 5th unit	Greater frequency of nth units if needed to achieve a calibration subset of 10%.
Discharge	Calibrate the flowmeter in the field using still water prior to velocity measurements per equipment Zero Check and Zero Adjust directions. Utilize Fixed Point Averaging (FPA) on the	Prior to each use of the flowmeter, the field crew will calibrate to a bucket of still (no velocity) water. Each velocity reading will be an	NA

	flowmeter to account for minor variations in readings (Marsh-McBirney, 1990).	average of 30, 1-second readings.	

6.1 Steps in Preparation of Fieldwork

Preparatory fieldwork measures will be implemented to support the quality and reliability of the data gathered in these surveys by checking that equipment is in optimal working condition before going into the field and has the power and memory space needed to record data in a consistent manner.

Surveying equipment storage and maintenance procedures will be used. Juniper Systems Geode devices (two GNS2 and two GNS3S units) will be regularly cleaned after use, and the risk of damage to the units will be limited by storing and transporting them in padded waterproof Pelican cases. The Marsh-McBirney flowmeter (Model 2000 Flow Mate) measurement accuracy will be confirmed by following Zero Check and Zero Adjust protocols before each batch of velocity measurements in the field (Marsh-McBirney, 1990). The flowmeter will also be cleaned regularly between field expeditions to avoid the build-up of oils and other substances that can result in noisy readings. Protocols to ensure equipment is sufficiently charged or backup batteries are available will be implemented so surveying teams can use consistent methods and equipment across the reach assessment. Devices with longer-lasting batteries, such as radios and the Model 2000 Flow Mate flowmeter, will be checked at the start of the field season, and extras packed. iPad Tablets, Juniper Systems Geode Devices, and Handheld Cameras will be charged before entering the field, as well as each night of the reach assessment. Juniper Systems Geode Devices will be fully charged at least once a month to ensure the unit remains in working order (Juniper Systems, 2021, 2023).

Field-based training with direction from professionals with extensive experience with USFS Stream Inventory Protocol will take place for all field crew staff to improve the accuracy of observations and reduce variability in data across the study reach. Standardized data forms from the Stream Inventory Handbook (Appendix A; USFS, 2020) will be created and uploaded to field tablets for data collection and recording, which will improve consistency between the types and format of data recorded throughout the survey period.

6.2 Steps Taken in the Field

The USFS Stream Inventory Protocol procedures laid out in Appendix A include within the protocol itself several quality assurance and quality control (QA/QC) methods. These QA/QC measures will be employed by field crews, and generally include the following:

- Follow the standard partner system with a consistent recorder and consistent observer throughout each reach. We plan to keep a consistent observer throughout the entire study area (all reaches) to keep biases consistent and comparable within the assessment. The recorder may occasionally change.

- Calibrate the observer's observations by first estimating a given metric and then employing different quantitative methods to measure that metric. This provides an understanding of the observer's level of accuracy and precision during estimation. Repeat the calibration measurements regularly throughout the survey (e.g., every nth unit).
- Timely and consistent data entry, such as completion of the Final Reach Form that must be filled out in the field as soon as the reach endpoint is determined" (USFS, 2020)

As digital data will be collected during the field efforts, such as photographs, GPS data points, and data recorded on tablet-based data forms, several additional technological QA/QC measures will be employed:

- Cloud-based data syncing, automatically designed to upload a backup of field data off of the tablet once connected to the internet.
- Juniper Systems Geode GPS equipment, which has sub-meter accuracy.
- Office-based senior staff review of field data within 2 days of each survey campaign. An office-based review will aim to identify any potential data collection gaps, issues, or errors in a timely manner. Should field data not meet QA/QC standards, the office-based senior staff will alert field crews and identify the data collection needs to resolve the issue. If, after discussing with the survey crew, there are still concerns about there being potentially erroneous data (e.g. due to measurement or recorder error) the data in question will be discarded. Within timing and logistical constraints, missing data will be re-measured/confirmed with a follow-up field visit. If this cannot be reasonably achieved, a note will be made in the report explaining there is missing data and explaining potential effects the missing data may have on the analysis results.

7.0 Data Management Procedures

Field observation and measurement data collected during the Icicle Reach Assessment will be directly entered into digital versions of the forms described in Section 5 on tablets by the designated recorder for the habitat survey. These data will then automatically upload to the cloud as soon as teams return to network service and stored in a shared server for ready access. Once the surveys for the Icicle Creek study area are completed and the final reach forms are completed in the field, the data will be reviewed and compiled in preparation for the development of the Icicle Creek restoration strategy, the determination of REI ratings for reaches along the study area, and the composition of an overall Icicle Creek Reach Assessment report. The data will be reviewed by the same individual(s) for consistency. The final report draft and data will be submitted for review to the Yakima Nation Fisheries, Washington State Department of Ecology, UCSRB, and UCRTT. Relevant data will be entered into the Environmental Information Management System (EIM), including the discharge and stream temperature data, under the Icicle Creek Reach Assessment 2024 study (Study ID WROCR-2325-ChCo-50T8).

8.0 Reporting and Field Activity Assessments

Data collected in the Icicle Creek surveys, results of preliminary hydraulic analyses, and developed restoration strategies will be synthesized into a final report to communicate findings of the Icicle Creek Reach Assessment. The report will include a basin summary for Icicle Creek, reach summaries for the 21 miles surveyed, as well as summary tables of the data collected. It will recommend a restoration strategy based on the various analyses performed throughout the reach assessment, describing what restoration actions may be most effective or worth prioritizing for Icicle Creek. It will also include maps of Icicle Creek with labeled reaches, tributaries, and significant features identified while teams were at the site. This report will go through a review process with Yakama Nation and UCRTT; and will also be made available for Department of Ecology review if desired.

9.0 References

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10.0 Appendix A

USFS Level II Stream Inventory Handbook

USDA

United States Department of Agriculture

STREAM INVENTORY HANDBOOK

LEVEL I & II

APPENDIX REFERENCE IN TEXT

PACIFIC NORTHWEST REGION - 2020

Forest Service | Version 2.20 | June 2020

In memory of Mike Sheehan
Always in our hearts!

Love ya, Man!

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CHAPTER 1
Introduction/Overview

BACKGROUND

Periodic, recurring inventories are an integral part of the fish habitat and watershed management programs and form the foundation for effective program management. Inventories should produce comparable information, both between administrative units, as well as across time. They will generate the baseline information that will be used to support a variety of management activities, including, but not limited to; watershed analysis, timber sales, range allotments, special use permitting, and fish habitat and watershed restoration programs. They will also serve as the basis for stream monitoring and evaluation programs. Specifically, inventories will identify existing aquatic and riparian conditions, identify factors limiting the productive capabilities of habitats, measure attainment of meeting stream habitat objectives, and help to assess cumulative watershed effects. The inventories can be used to monitor and refine Land Management Plan Standards and Guidelines.

The Pacific Northwest Region (Region 6) stream inventory is designed on a hierarchical scale to provide the user the opportunity to choose an inventory protocol which meets the data needs for the questions asked. Level I is the basic in-office procedure which identifies standard attributes of the watershed/stream to be analyzed. Its primary objective is to document and consolidate sources of general knowledge of the stream system. Level II is an extensive stream channel, riparian vegetation, aquatic habitat condition and biotic inventory on a watershed-wide scale. This level is to be used to determine the "pulse" or condition of a system during low flow conditions. Level III is an intensive field inventory designed specifically to answer a particular question (i.e., monitoring, project level planning and project design, etc.).

This handbook provides standards for both the level I (office inventory) and level II (field inventory). A level II inventory requires the completion of a level I as a prerequisite. The protocol identifies core attributes that are necessary to evaluate the condition of the stream (mandatory for collection), and non-core, Forest optional attributes. Forests have the flexibility to add attributes to the protocol to meet their needs; however, unit costs and target allocations/accomplishments will be based on the Regional protocol.

Region 6 has produced a recommended protocol for level III inventories, but the methods are not included in this handbook. By contrast, it is recognized that a standardized approach to level IV is inappropriate due of the large variation in data needs that exist. Therefore, procedures for level IV are open to development at the District, Forest, or research unit level.

The purpose of both the level I and level II inventories is to identify existing stream channel, riparian and aquatic ecosystem conditions on a watershed scale. As inventories are completed and repeated over time, the information generated by them can be useful in measuring changes in stream channel conditions and determining attainment of habitat management objectives, provided stringent quality control administration occurs. In this context, the inventory can be applied as a basic "monitoring" tool.

INVENTORY ATTRIBUTES

Key attributes of the Region 6 level I and II stream inventories were developed considering the following concepts:

Driven by questions that are to be addressed. Identification of management questions formed the basis for the content of the inventory. The ability to address questions consistently and comparably across units has been demanded of the United States Department of Agriculture, Forest Service (FS) by both users and managers of the resources. Inventory and analysis procedures were developed to provide the information necessary to answer those questions.

Contains a consistently applied set of core attributes. The level I and II inventories contain data attributes that were identified by an interagency interdisciplinary team as the most critical for defining stream channel, riparian vegetation, and aquatic resource condition. The core data attributes are likely to be key elements in any future inventory process and can be used to drive a number of aquatic/channel classification systems.

Quantifiable through direct observation. Where practicable, the level II inventory generates quantitative measurements and estimates of channel conditions and habitat attributes.

Statistically valid approach. The level II inventory meets assumptions for standard statistical analysis and results in estimates with known boundaries of error for habitat unit dimensions. It follows a stratified random sampling design and permits extrapolation of known, measured attributes throughout the watershed.

Repeatable. This protocol provides a statistically defensible method for evaluating and minimizing the observer bias by measuring all habitat dimensions. Quantitative measures for streamflow, bankfull channel dimensions, bank instability, and substrate are intended to further reduce surveyor bias and sampling error. These considerations are intended to reduce the inherent variability surrounding many of the attributes so that replication of sampled attributes will be meaningful across time and space.

Coordinated with other resource areas and management entities. The procedures for these inventories represent an integrated approach between FS watershed and fisheries disciplines in defining stream channel, riparian vegetation, and aquatic resource conditions at the watershed scale. It has been reviewed and is compatible with similar aquatic inventories developed by state agencies, specifically the Oregon Department of Fish and Wildlife (ODFW) and Timber, Fish and Wildlife (TFW) in Washington State. It has been developed as the aquatic companion to the FS Integrated Resource Inventory (IRI), and is comparable with other FS stream inventories developed in Regions 1, 4, and 5. It contains the “Core Data Standards” developed by an interagency team for implementation of the Northwest Forest Plan.

Cost efficient. The Region-wide average cost to complete this survey is $1,500 per mile (for both aquatic inventory and aquatic biota). Local conditions such as stream size, channel complexity, location, etc. and contracting of services contribute to a range of costs around this value. These estimates include data collection, data entry, analysis, and report writing. Costs can be considerably higher as Forests add optional attributes that are not considered in the annual allocation of funds from the Region.

ESTABLISHING FOREST PRIORITIES

The stream inventory program is an institutionalized component of the fisheries and watershed programs. A rate of 10 percent of fish-bearing streams per year is prescribed and offers a program that is responsive to management needs. This infers a 10-year re-inventory recurrence interval for all fish-bearing streams.

Forests should consider the following factors in setting priorities for stream inventory:

- Tier 1 and Tier 2 Key Watersheds where Watershed Analysis is to be completed in the near future.
- Sensitivity of fish stocks present.
- Habitat/watershed vulnerability or sensitivity; watersheds that are particularly vulnerable or sensitive to management activities should be a high priority.
- Level of planned activity in the watershed.
- Management plan development (e.g., Wild and Scenic Rivers designation) or agency coordination/cooperation.
- Relative importance of a watershed in terms of fish production or use.
- "Representativeness" of a watershed to others for stratification and extrapolation of information to those systems that are lower priority.
- Size/feasibility of detecting change and managing that change (i.e., it is more difficult to detect change in larger systems and frequently more difficult to mitigate those effects).
- Wilderness or watersheds representing intact, hydrologically functioning systems; to be used in developing numeric ranges for attributes which quantify “Desired Future Conditions.”

STREAM INVENTORY PROGRAM MANAGEMENT

Data management. The data collected during Stream Inventory is entered and stored in the Natural Resource Manager (NRM) Aquatic Survey (AqS) database.

Like all electronic software, training is required to ensure the quality of data entered to the database. This handbook identifies the necessary protocols designed to ensure quality data is collected in a standardized fashion. While two companion instructional manuals, *User Guide to NRM Aquatic Surveys* and *R6 Level II Stream Inventory Data Entry Quick Guide* are available for guiding the entry of field data into the Aquatic Survey database, it is essential that all data entry personnel receive formal training in NRM before attempting to enter field data into the NRM database.

A series of standard summary tables has been developed within the NRM database. The tables provide the basic information necessary to characterize stream condition, habitat, and function. Forests and Districts are encouraged to do additional data analysis to explore specific habitat relationships and develop more effective ways of presenting the information. Additional analysis can be done most efficiently by downloading the stream inventory data into a personal computer (PC) environment.

PROGRAM ADMINISTRATION AND QUALITY CONTROL

Stream inventory data are increasingly used to make significant resource management decisions. As such, the reliability and credibility of the information is paramount. Past program reviews have identified potential problems in program management and significant changes have occurred to address these deficiencies. In order to ensure the highest quality of information is provided through the inventory, program and quality control standards have been developed. The following items should be viewed as minimum standards in the annual implementation of the program.

<u>Program Administration</u>

- Forest and District Program Managers ensure data are collected according to standard protocol, the data analyzed, and reports written in a timely fashion.
- Forest and District Program Managers will develop an operational understanding of the inventory protocols.
- Either the Forest hydrologist or fisheries biologist will attend the annual Regional training session.
- Obtain required permits for Aquatic biota sampling.
- Each Forest will establish a stream inventory quality control contact person.
- Each Forest will supplement Regional training with Forest-level training and orientation to ensure comprehension and proper application of the Regional inventory procedures.
- Each Forest will develop a “test reach” as part of Forest-level training.
- Each Forest will resurvey three sections of the streams surveyed in the current year. These sections will be no less than 1000 feet in length and must be resurveyed as close to the original survey date as possible.
- See the *R6 Stream Habitat Inventory Quality Assurance/ Quality Control Manual* for specific information on setting up a Quality Control Program.

<u>Pre-Inventory Training Phase</u>

- Each survey member will be given a handbook for review and will be accountable for techniques and terms.

- The context of the level II in the four level hierarchical inventory program will be understood.
- Training in basic map and air photo interpretation for each surveyor will be documented.
- Training in the use and maintenance of necessary equipment for each surveyor will be documented.

Field Inventory Training Phase -- Prior to beginning of the field portion of stream inventory, all crews must demonstrate a proficiency in completing these tasks:

- How to complete all field forms.
- How to take a measured streamflow.
- How to place temperature recording devices.
- How to make bankfull determinations.
- How to conduct a Wolman pebble count.
- How to sample fish populations and correctly identify both fish and amphibian species.
- How to check data sheets to catch chronic data recording errors.

Post-Inventory Training Phase

- How to error-check recorded data.
- How to correctly label photographs.
- How to develop final inventory maps.
- How to enter data to the Aquatic Survey database.
- How to analyze NRM Aquatic Survey reports.
- How to write draft reports.

A STANDARD PROTOCOL

Can the survey be repeated? To ensure an affirmative answer, a standard protocol has been adopted for surveys on fish bearing-streams. These protocols are designed to produce a valid and repeatable survey regardless of the surveyors.

Requirements of this standard protocol include:

- An office inventory is the first step.
- Each survey is divided into stream segments called reaches.
- Field surveys occur only during minimum streamflows.
- Stream discharge is measured at least once.
- All habitat lengths and average wetted widths of the mainstem channel must be measured.
- Maximum depths are measured to a depth of 4 feet. Depths greater than 4 feet may be estimated.
- All habitats are identified as one of 11 basic types (see number 2 of **Channel Unit Types** under Channel Unit Form, page 38).

- A <u>minimum</u> of 3 fast waters must be measured in EACH REACH (five to seven preferred). The key component of this measurement is the bankfull and floodprone data collection.
- Ten percent of channel units must have riparian vegetation collected.
- Two pebble counts are completed for each reach. A gradient shall be measured at each of these locations.
- A biological survey determines the range of fish species throughout the section of inventoried stream.
- NRM Aquatic Survey, a national database, is the final home for all standard stream inventory data.
- A formal report is written for each stream surveyed.

Exceptions to the Standard Protocol: There are very few exceptions to the standardized methods described throughout this handbook. Management units (forests, districts, National Scenic Areas) are free to collect habitat data in addition to the core attributes integral to this region wide process.

Appendix C of this handbook catalogs the most common “Forest Options”.

It is permitted to break the standard protocols for only one reason – SAFETY.

Some examples of safety concerns include:

1. The stream may be too large to safely walk the centerline (or thalweg).
2. A bedrock gorge may provide no safe passage.
3. A stream may be too brushy to walk through the stream safely.

Any deviations from the standard protocols must be documented in the field notes (Comments Form). These deviations must also be described in the formal stream inventory report.

PRESENTATION OF INFORMATION

The preferred format for summarizing and presenting stream inventory data is the stream inventory report. It contains two basic components, which provide information in a legible, understandable format to two distinct audiences: Line and Staff personnel within the FS and the technical specialists.

The executive summary highlights the condition and identifies the issues, concerns, and opportunities within the watershed for line and staff. The target audience for the main body of the report is the technical specialist. It contains summaries of the quantitative data collected as well as field observations and the resulting conclusions on stream condition, habitat interrelationships, and potential factors limiting fish production. The information is summarized at both the reach scale and the drainage basin scale.

The foundation for every report resides in sound interpretation of the available historic data wedded to habitat information obtained during the field inventory. Rather than merely a regurgitation of numbers and figures in the summary tables, interpretation should include investigating the interrelationships that exist between the data attributes (e.g., number of channel-width pools (slow water units) per mile, number of functional pieces of large woody material (LWM) larger than 24 in. diameter per mile, stream reaches where stream temperature exceeds state standards). Correlations of pools per mile to riparian vegetation condition and to the amount of large woody material can aid in identifying potential habitat deficiencies in aquatic systems. These same relationships offer an indication of rehabilitation potential for a stream and its riparian vegetation.

Although basic data interpretation can be completed by the individuals conducting the stream survey, all reports should have journey-level fish biologist or hydrologist review and concurrence. The section of the report addressing management implications should be written by the journey-level professionals. A good understanding of the interrelationship of the physical and biological conditions of the stream, along with an intimate knowledge of the Forest Plan, are needed in order to develop sound, realistic management interpretations and recommendations.

HANDBOOK CONTENT

The Stream Inventory Handbook provides instructions for conducting the level I and level II stream inventories. It contains three sections: Office Procedures (level I), Field Procedures (level II), and Appendices.

User Guides for the NRM Aquatic Surveys database are issued as separate documents.

Office Procedures: This section contains the specific instructions for completing the office phase, or level I inventory. Information collected from the office phase is placed on Survey Form and Preliminary Reach Form. The purpose of completing Survey Form is to familiarize the surveyors with the historical use and natural history of the landscape drained by the inventoried stream. The purpose of completing Preliminary Reach Form is to delineate preliminary stream reaches and create a field map which includes access points for the field inventory. The field phase (level II) will validate or amend the reaches first delineated on Preliminary Reach Form. Preliminary Reach Form will be retained with the stream folder as documentation of the level I inventory. The level I will also identify potential access points and danger areas.

Field Procedures: The field phase (level II) is the nuts and bolts of the stream inventory process. The level II utilizes the following forms: Final Reach Form, Channel Unit Form, Special Cases Form, Comments Form, Aquatic Biota Form, Discharge Form, Wolman Form and Aquatic Invasives Form. They are used to gather information on the physical attributes of the stream and its riparian condition. The Final Reach Form also has attributes that are derived from field data, but are more easily completed in the office. The Aquatic Biota Form documents fish and amphibians observed during the survey. The Discharge Form records stream discharge; the Wolman Form is used to characterize the streambed substrate in riffles. The Aquatic Invasives (AIS) Form records the observation of invasive species including the time looked but not found. Data gathered during the field phase is used to assign a letter designating the dominant Rosgen

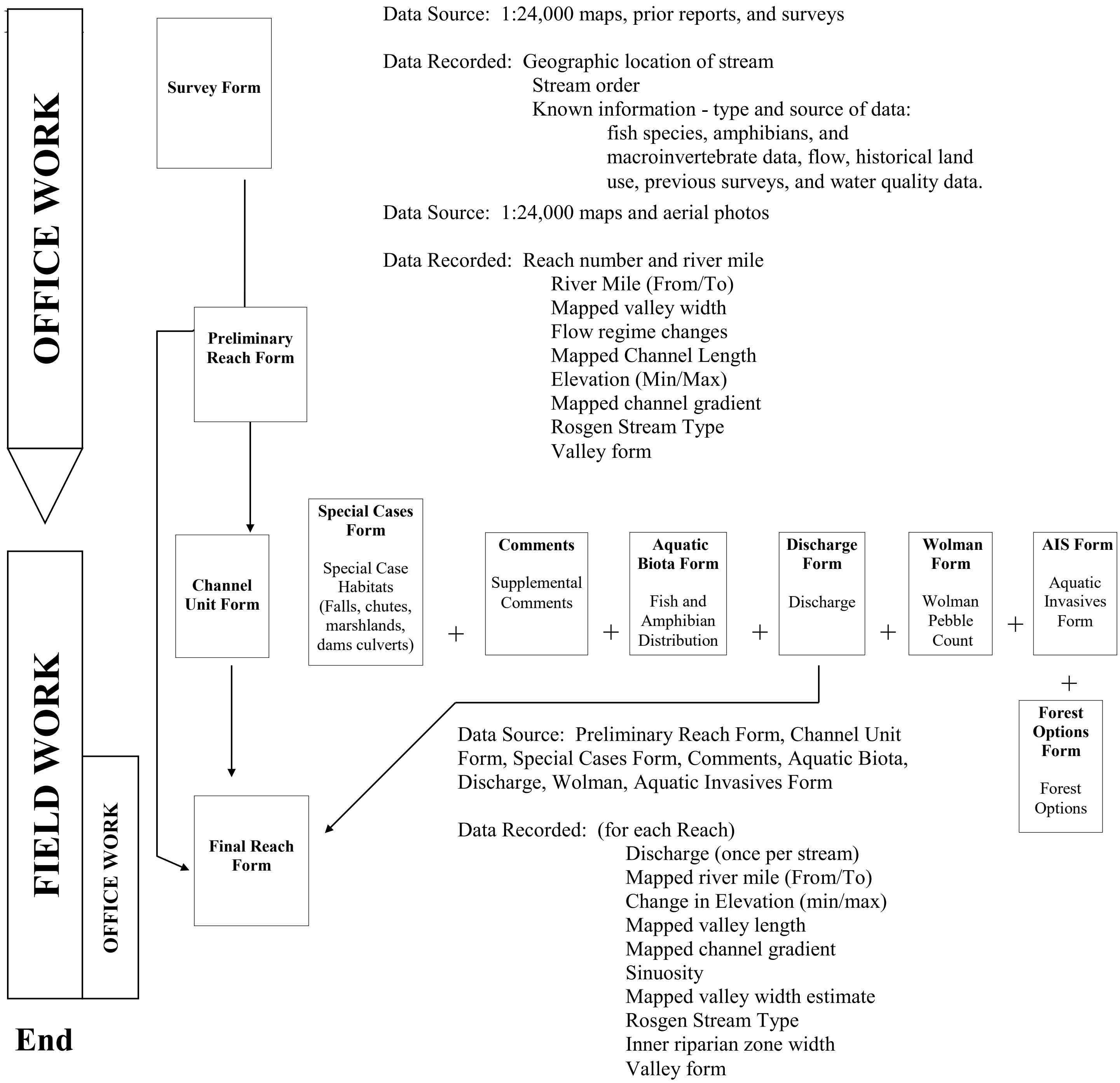
Stream Type of each reach. The Forest Options Form is also available to record data outside the core attributes.

Appendices: The appendices contain specific information that support a number of the data attributes collected in both the office and field phases.

Forms: A total of 10 forms are completed as part of the inventory (11 if the Forest Options Form is used). Copies presented in this handbook are provided as masters from which your working copies can be made. **Please note**: Waterproof forms can be made using waterproof copy paper.

The following figure presents a view of the inventory process that includes a timeline and flow chart outlining the relationship between the suite of forms used in the course of completing a stream inventory.

Figure 1: Flowchart showing the order that Data Forms are used



CHAPTER 2

Office Procedures Level I Inventory - Identification Level

OBJECTIVES

The objective of the office phase is to provide the field crews with a general introduction to the stream targeted for inventory. This is accomplished through assembly and summarization of any data that has been previously collected for the basin. This information is used to tentatively stratify the stream into stream order and stream reaches. A reach is a relatively homogeneous section of stream containing attributes of common character. Review of the information compiled by the office phase will be extremely valuable in selecting sampling intervals for measured habitats, planning stream access logistics, summarizing initial hydrologic information, and initially identifying perennial and fish-bearing streams. The statistical validity of this inventory process was first described in "Estimating total fish abundance and total habitat area in small streams based on visual estimation methods" (Hankin and Reeves 1988).

Aerial photo analysis and the use of maps of suitable scale (i.e., 1:24,000) will enable the survey team to identify, at an acceptable level of resolution, such attributes as mapped channel gradient, sinuosity, vegetative types in riparian and upslope areas, watershed acres, floodplain widths, tributary confluences, and watershed characteristics. **This analysis of maps and aerial photos should also be used to identify potential danger spots such as steep terrain, waterfalls and to identify safe parking areas.** The maps assembled during this process will be of great value to the crews in the field. An effective field map(s) will show tributary streams, road crossings, access points, and general location of notable geologic features and unique characteristics. These characteristics will be used by the field crew to accurately locate reach breaks and features in the basin.

STANDARDS

The office phase level I inventory provides information only as accurate as the scale and accuracy of the maps, photos, and any previously collected data. Accuracy is also affected by the human error introduced when measuring the attributes required. Use only 1:24,000 scale USGS topographic maps to determine the measurements for the mapped attributes of both the Preliminary Reach Form and the Final Reach Form. Mapping software, such as, ArcMap, Terrain Navigator or ArcGis Explorer (FREE) are readily available.

EQUIPMENT/INFORMATION NEEDED

- → Aerial Photos /Topographic Maps -Scale of 1:24,000.
- → Mapping software
- → Calculator.
- → Watershed Codes from USGS/NRCS.

- → Hydrological Data-flow, temperature, turbidity, macroinvertebrate, etc.
- → Geological Information-Geological province, landform type, etc.
- → Historical Land Use Information (i.e. - road density, range allotments, timber management, private lands, recreation, wilderness).
- → Past Stream Surveys-US Bureau of Fisheries, FS, USDI Bureau of Land Management (BLM), State, etc.
- → Level I Inventory Forms - Office Phase.
  - Survey Form
  - Preliminary Reach Form.

PROCEDURE

The office phase requires the completion of the Survey Form and the Preliminary Reach Form. Much of the information for Preliminary Reach Form can be collected from aerial photos, orthophotographs, and 1:24,000 scale USGS topographic maps or using a mapping software. Each attribute is identified in **BOLD** text and is followed by instructions on how to measure or collect information on the attribute.

At the end of many attribute descriptions is an example intended to illustrate a valid entry.

PLEASE NOTE THAT THE INSTRUCTIONS FOR COMPLETING THE HEADER FOR EVERY FORM USED IN THE LEVEL I AND LEVEL II INVENTORIES ARE LISTED ONLY IN THE SECTION OF CHAPTER 2 LABELED "SURVEY FORM INSTRUCTIONS." ATTRIBUTES A THROUGH G ARE THE SAME FOR EVERY FORM. Where additional header information is required, specific instructions are given for that form.

Should questions arise concerning any phase of the inventory process, consult with the local hydrologist and/or fisheries biologist. It is their role to supply answers and clear direction during the inventory process.

PRODUCTS

A level I inventory (office phase) is completed for every stream designated for a level II inventory. The level I process will produce:

- A list of existing information previously collected on the stream and drainage basin.
- A completed Survey Form.
- A completed Preliminary Reach Form.
- A draft copy of a 1:24,000 scale USGS topographic map of the target stream that shows preliminary reach breaks, access points, road crossings (culverts, bridges, etc.), private land, known dams and diversions, and other points of interest that will help orient the field crews to the stream to be inventoried. Forests are encouraged to develop and adopt a consistent set of map symbols, which encode stream channel and riparian conditions of concern to the management of each Forest.

- A safety map identifying potential hazardous areas such as steep terrain, waterfalls, private land, and identifying safe access points into the stream.

SURVEY FORM

R6-2500/2600-10.

SURVEY FORM INSTRUCTIONS

A. STATE: Enter the appropriate 2-letter code:
Oregon...........OR
Washington....WA

B. COUNTY: Enter appropriate County Name.

C. FOREST: Enter appropriate two-digit code for the Forest or Forest name.

D. DISTRICT: Enter appropriate two-digit code for the District or the District name. (e.g., 03)

E. STREAM NAME: Enter the name of the stream inventory. (e.g., Salmon Creek)

F. 8-digit HUC (4th field): Enter only the first four 2-digit fields (Hydrologic Region, Hydrologic Subregion, Accounting Unit, and Cataloging Unit). Refer to Appendix A for a more detailed explanation. (e.g., 17,09,03,01)

10-digit and 12-digit HUC (5th and 6th field): The 10 and 12 level HUC's are the identifiers for the watershed (10-digit HUC) and subwatershed (12-digit HUC). Contact your hydrologist or GIS specialist for assistance in correctly identifying the correct hydrologic unit code. (e.g., 10, 03)

G. USGS QUAD: Enter the name of the registered USGS Quadrangle containing the stream mouth or point where it leaves the Forest. This is the 1:24,000 (2.64-inch) scale USGS topographic map. (e.g., Stinker Mountain)

H. SURVEY DATE: Enter the date the field survey began. Be sure it is the actual date level II is initiated using the following format: MM/DD/YYYY. (e.g., 07/10/2000). **NOTE:** The date on the Channel Unit Form should correspond with the actual date of data collection.

I. NAME: Persons filling out the Survey Form will record the initial of their first name as well as their complete surname (e.g., J. Smith). NOTE: This attribute **WILL NOT** be entered into the NRM Aquatic Surveys database version of the Survey Form.

The following attributes are not individually entered into NRM Aquatic Surveys. Rather the information is designed to provide direction for the office phase of inventory. The most significant information gathered should be entered as “Comments” to the Survey Form.

1. **WATERSHED AREA**: Find the area of the basin above the mouth of the target stream and record it to the nearest 10 acres. This area can be found from the previous, latest stream survey, or by querying a GIS watershed layer. If you use an acreage figure from a previous survey, check it for accuracy against a GIS query. Boundaries and accuracies have improved over the years.

   The USGS web site https://streamstatsags.cr.usgs.gov/streamstats/ is particularly useful and accurate in calculating drainage areas above points located upstream from the mouth of the target stream. Bring up the StreamStats web site and type in the name of your stream and the state in the search bar on the left. Select the stream from the query list. Select the State Study Area. Then zoom in on the stream and pan over to the section of stream where your survey starts, until you see the Delineate bar and click on that. The program will prompt you to select a blue box on the stream, above which it will delineate a drainage area. Click on the Continue bar at the bottom. Scroll down to Basin Characteristics and in the pull down menu select DRNAREA to get the drainage area. Scroll to bottom and click on the Continue bar at the bottom. Click Continue again and it will calculate basin characteristics and show area in square miles for the drainage it delineated in a report. Convert square miles to acres (1 Sq. mile = 640 acres). Record the result for Watershed Area in acres.

2. **FISH AND AMPHIBIAN SPECIES AND DATA SOURCE**: Starting from the left, record dominant or management-emphasis fish species as well as any threatened, endangered, or sensitive amphibian species known to be in the basin. The species codes consist of the first two letters of the genus and the first two letters of the species names. See Chapter 3 for a list of the standard species codes for freshwater fishes and amphibians of Washington and Oregon. If no data exist, write "Nothing on record.” (e.g., ONTS, ONKI, ONMY, ONCL)

3. **FLOW DATA**: Enter in narrative form, the historical flow data available for the stream. List all sources, such as USGS gauging stations, Forest monitoring sites, IFIM studies, etc., and the dates that data were collected. See your local hydrologist for peak flow data and predictable effects of recent high flows on bankfull indicators you can expect to observe. Record the return interval of recent peak discharge(s) from the nearest downstream USGS gaging station, if available and applicable. If no data exist, write "Nothing on record." ((e.g., USGS Gaging Stn. #14146500 is located 0.2 RM from mouth; ave. flow for JUL = 260 cfs).

4. **WATER QUALITY DATA**: Review files for any quantitative physical or chemical data. Reference the type and source of information and year data were collected. If no data exist, write "Nothing on record.” (e.g., ODFW max/min stream temp. during JUN-SEP: 1970-88)

5. **MACROINVERTEBRATE DATA**: Enter, in narrative form, the type and source of previous information on the presence, distribution, and abundance of macroinvertebrates in the stream to be inventoried. Examples include analysis conducted by the Aquatic Ecosystem Analysis Lab, local forest studies, etc. If no data exist, write "Nothing on record." (e.g., 1990 survey by Taxon, Inc. reported that chironomids comprised 65% of the biomass in pools and riffles, and the remaining 35% were split relatively evenly among six other insect taxa.)

6. **PREVIOUS SURVEYS**: Reference the source of the information, level of survey, and year accomplished. If no data exist, write "Nothing on record." (e.g., 1965 Blue River RD survey of culverts included the three culverts on this stream.)

7. **HISTORICAL LAND USE DATA**: Record here any useful historical information you have accumulated regarding activities in the drainage basin and stream network (e.g., old photos, interviews on file, splash dams, mining, literature, etc.). Also review the Forest's Historical Land Use Atlas - see an Archeologist for this document. If no data exist, write "Nothing on record." (e.g., Railroad built in 1930-33 for logging. Rails removed and railbed rebuilt as sealed road in 1965, active logging in upland since 1965, and map of units by age of cut is available.)

8. **COORDINATION**: Verify participation or coordination with other agencies or interest groups for the present inventory. Explain the groups participating and their work to be accomplished. (e.g., WDFW will inventory the private land sections of the stream, has agreement with owners, will use R06 protocol.)

9. **COMMENTS**: Use this space to elaborate on the above attributes. Note apparent watershed problems, special features or habitats, fish stocking information, management problems, studies, critical habitats, special land allocations, etc. (e.g., 45% of drainage basin is in private hands, permission has been denied for inventory of stream through Clark Timber Co. lands.)

PRODUCTS OF THE SURVEY FORM PROCESS

1. Completed Survey Form.
2. Review of available historical records and information on the drainage basin in which the stream to be inventoried is found.

SURVEY FORM
R6-2500/2600-10

Page: ____ of ____

A. State ___________ B. County ___________ C. Forest ___________ D. District _____________

E. Stream Name ______________________________

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit ____ 12-digit _____

G. USGS Quad ______________________________

H. Survey Date ____/___/_______ I. Name ______________________________
MM/DD/YYYY

---

1. Watershed Area ___________________________ Acres
2. Fish and Amphibian Species ______________________________
   Data Source ______________________________
   ____
3. Flow Data ______________________________
   ____
   ____
4. Water Quality Data ______________________________
   ____
5. Macroinvertebrate Data
   ____
   ____
6. Previous Surveys
   ____
   ____
7. Historical Land Use Data
   ____
   ____
8. Coordination ______________________________
   ____
   ____
9. Comments ______________________________
   ____

PRELIMINARY REACH FORM

R6-2500/2600-20

The Preliminary Reach Form is used to stratify the stream into preliminary reaches. This is done with information gleaned from GIS layers, topographic maps, lidar, and aerial photographs. If the stream to be inventoried has been surveyed before, review the reaches identified in the historic stream inventory reports to identify preliminary reaches.

The repository for the data you collect during a stream inventory is entered into NRM Aquatic Surveys. The inventory data is attached to a GIS layer displaying the network of perennial streams using the National Hydrography Dataset (NHD). This layer is a feature-based dataset that interconnects and uniquely identifies the stream segments or "reaches" that make up the Nation's surface water drainage system.

Characteristics along a specific GIS stream route that should be used to initially select stream reach breaks are changes in: mapped valley width estimates, mapped channel gradient, sinuosity, and streamflow due to large tributaries (see figure 2). Development of a mapped longitudinal profile (i.e., mapped gradient) from the 1:24,000 scale USGS topographic map will identify major gradient changes useful in establishing the starting and ending points for each reach. These preliminary reaches should closely correspond to the level I Rosgen Stream Types (i.e., A, B, C, D, DA, E, F, and G).

The recommended minimum length for all reaches is 0.5 miles. Reaches shorter than 0.5 miles require a greater commitment of time and effort to ensure the reach is adequately characterized by the data. A minimum of 3 bankfull/floodprone measurements must be conducted regardless of reach length. In addition, two Wolman pebble counts must be completed in these short reaches.

These reach endpoints will be verified, refined, or modified by the field crew during the level II (field phase) inventory, and these field-verified reaches will be accurately translated onto the field maps and/or aerial photographs. When the field portion of the reach inventory is complete, the information from the Preliminary Reach Form will be used to complete the Final Reach Form; once the Final Reach Form has been completed, the Preliminary Reach Form will be retained in the stream folder as originally completed.

NOTE: Preliminary Reach Form data will not be entered into the NRM Aquatic Surveys database.

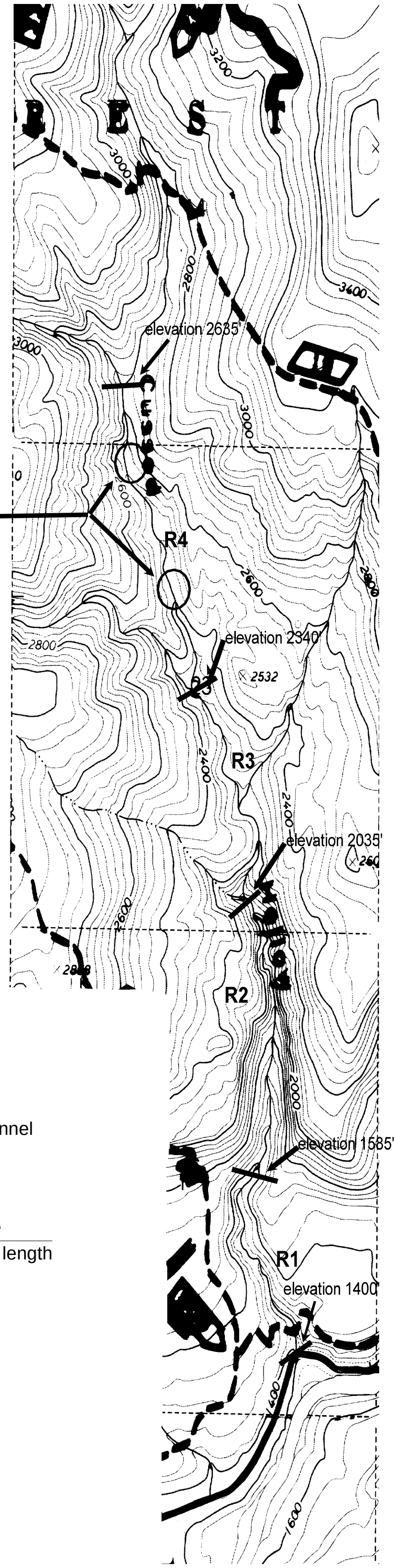
PRELIMINARY REACH FORM INSTRUCTIONS

Fill out a Preliminary Reach Form for each stream reach:

NOTE: INSTRUCTIONS FOR COMPLETING PRELIMINARY REACH FORM HEADER (ATTRIBUTES A - H) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS on Page 16.

Figure 2: River basin characteristics derived from a 1:24,000 scale USGS topographic map

General area where you will do the pebble counts in Reach 4 (i.e. ,1/3 and 2/3 of reach length)



Reach 4

Stream channel length = 3872 ft.

Mapped channel = gradient $\frac{(2635-2340)}{3872} \times 100 = 8\%$

Reach 3

Stream channel length = 2816 ft.

Mapped channel = gradient $\frac{(2340-2035)}{2816} \times 100 = 12\%$

Reach 2

Stream channel length = 3520 ft.

Mapped channel = gradient $\frac{(2035-1585)}{3520} \times 100 = 13\%$

Reach 1

Stream channel length = 2288 ft.

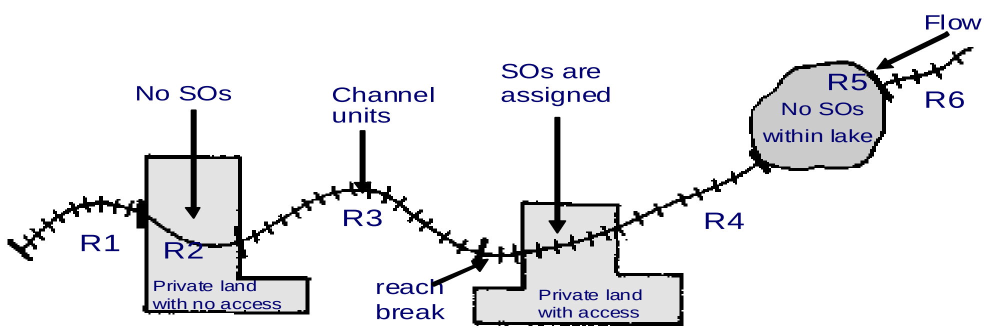
Mapped channel = gradient $\frac{(1585-1400)}{2288} \times 100 = 10\%$

mapped channel length = mapwheel channel length

$$\text{mapped channel gradient} = \frac{\text{elevation change}}{\text{mapped channel length}}$$

1. REACH NUMBER: Enter the reach number beginning at the lowest point of the proposed inventory. Number the segments (reaches) sequentially in an upstream direction. If access is denied to portions of the stream, which are privately owned, treat the private land section as a separate reach (see figure 3). If permission to inventory the private land is secured, do not break out that portion of the stream as a separate reach. Whenever a lake occupies a valley section between two portions of the stream to be inventoried, treat the lake as a separate reach in a fashion identical to private land/no access. The pool upstream of a beaver dam is not a lake, and this type of pool is not considered as a separate reach. The pool upstream of a beaver dam is simply a slow water (pool) habitat. Use standard geomorphic characteristics as described above to delineate the reach breaks in all other cases. Reaches less than 0.5 miles long are acceptable provided the minimum of 3 bankfull/floodprone measurements are collected. A Wolman pebble count is still required in reaches that are shorter than 0.5 miles long.

Figure 3: Example of how SOs are assigned (or not assigned) within private land inholdings and within lakes



2. MAPPED RIVER MILE: Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river miles if available. If the EPA river mile for the start of the survey is unknown, begin the mileage measurement at the mouth of the stream, starting with RM = 0.0. Whenever the starting point of a stream inventory is not at the mouth of the inventoried stream, the river mile location of the startpoint will reflect the mapped distance of the startpoint upstream from the mouth of the surveyed stream. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (e.g., Reach 1: RM 0.0 to 1.1; Reach 2: RM 1.1 to 4.0; Reach 3: RM 4.0 to 5.2). Use an available mapping software to calculate river miles (see Appendix J for recommendations). The technique is to follow the stream line channel course as drawn on the 1:24,000 scale USGS topographic map. Record to the nearest 0.1 RM.

3. MAPPED VALLEY WIDTH ESTIMATE: Enter the estimated average width of the floodplain or valley bottom as determined from the 1:24,000 scale USGS topographic maps and from aerial photographs. The estimate is derived from interpreting 1:24,000 scale USGS topographic maps and aerial photographs of the valley. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley.

The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Elevation contour lines cross the line defining the stream. Use the midpoint along the stream between contour intersections to make your estimate of the valley width. An estimate is made for each reach.

4. FLOW REGIME CHANGE: Note any large tributaries to the inventoried stream. These may offer excellent reach breaks if the tributary drains a basin similar in area to the drainage basin of the inventoried stream upstream of the confluence with the tributary. If a tributary contributes 20% or more to the main stem of the survey a reach break is warranted. Reaches can be stratified by significant changes in flow, while other variables remain the same. Enter yes Y or no N if this is used for reach delineation purposes.

5. MAPPED CHANNEL LENGTH: Using mapping software, determine the stream channel length between the preliminary reach breaks for each reach.

6. CHANGE IN ELEVATION (MIN/MAX) : Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contour lines on the map. Unless the contour lines cross the stream at the end point of a reach, interpolation will be necessary. Enter the downstream elevation as the minimum and enter the upstream elevation as the maximum elevation for the reach.

7. MAPPED CHANNEL GRADIENT: Use GROSS changes in gradient to develop preliminary channel reach breaks. Long homogeneous lengths of similar gradient may delineate a reach. However, other attributes can temper the stratification. Channel gradient for Preliminary Reach Form will be calculated by dividing the elevation gain (high elevation contour minus low elevation contour) by the mapped channel length for each reach. Make sure that the elevation change and the mapped channel length are both expressed in feet.

8. ROSGEN STREAM TYPE: Use the values derived from the investigation of the 1:24,000 scale USGS topographic maps and aerial photographs to assign a level I Rosgen Stream Type to each preliminary reach. Previous inventories on the same stream channel may provide additional insight concerning potential reach breaks.

9. REASON FOR REACH BREAK / COMMENTS: A description of the reasons for ending the reach should be provided. These reasons will be validated during the level II survey.

10. STREAM ORDER [Forest Option]: Utilizing the Strahler method, identify stream order (see Appendix B) of the lowest most reach. A first order stream is the smallest fingertip mapped tributary. A first order channel can appear as either a dotted or solid stream channel on a 1:24,000 scale USGS topographic map. (e.g., 3)

11. VALLEY TYPE [Forest Option]: Enter appropriate code (1 through10) that best describes the valley form. Examples are: wide, glaciated U-shaped valley; steep, narrow V-shaped valley; broad, flat plain; alluvial outwash; etc. (See Appendix C-page 94).

PRODUCTS OF PRELIMINARY REACH FORM PROCESS

1. Completed Preliminary Reach Form, which includes a preliminary Rosgen Stream Type[1] for each reach.
2. Field-ready 1:24,000 scale USGS topographic map identifying preliminary reach breaks, private land holdings, and potential access points

[1] Reference: Rosgen, D.L. *Applied River Morphology***.** Wildland Hydrology, 1996.

PRELIMINARY REACH FORM Page: ____ of ____
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A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit_____12-digit ______

G. USGS Quad ______________________________

H. Survey Date ____/___/______
MM/DD/YYYY

1. Reach # _________ 2. Mapped River Mile From _______ To _________ 3. Mapped Valley Width Estimate (ft) __________ 4. Flow Regime Change ____________________ 5. Mapped Channel Length ____________________ 6. Change in Elevation (ft) Min _____ Max ______ 7. Mapped Channel Gradient (%) ______________ 8. Rosgen Stream Type ____________________ 9. Reason for Reach Break / Comments:________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ 10. Stream Order (Forest Option) _______________ 11. Valley Type (Forest Option) _________________	1. Reach # _________ 2. Mapped River Mile From _______ To _________ 3. Mapped Valley Width Estimate ______________ 4. Flow Regime Change ____________________ 5. Mapped Channel Length ______________ 6. Change in Elevation Min ________ Max_______ 7. Mapped Channel Gradient ______________ 8. Rosgen Stream Type ____________________ 9. Reason for Reach break / Comments:________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ ________________________________ 10. Stream Order (Forest Option) _______________ 11. Valley Type (Forest Option) _________________

CHAPTER 3

Field Procedures: Level II Inventory-Aquatic Ecosystem Inventory

OBJECTIVES

The level II inventory is the basic tool for determining the quality and quantity of aquatic habitat and to obtain estimates of basic riparian and hydrologic conditions. The objective of the level II inventory is to provide a generally quantitative characterization of aquatic (fish/water) and riparian conditions at a watershed scale **in a safe manner.**

SAFETY

Stream inventory, as with any outdoor work can have its hazards. Safety is always the first concern when performing any job. Safety hazards and precautions are to be addressed in a Job Hazard Analysis (JHA). An example JHA can be found in Appendix H. Inventory crews are required to complete the following safety measures prior to going in the field:

- Receive proper training in first aid and CPR, and possess valid certifications for both techniques,
- Receive specific training on radio or satellite phone communications that apply to the field site,
- Prepare a map during the Level I, the office phase of the inventory, that identifies safe access points and potential danger spots,
- Review the appropriate JHA with their supervisor,
- Obtain the proper safety equipment such as a personal first aid kit, waders, stream boots with vibram soles and studs,
- Complete the check-out procedures, and provide an estimate for the crews return,
- Complete the daily vehicle safety inspection,
- Possess and carry a valid driver’s license.

A tailgate safety session should occur each day before any field work begins to identify potential hazards for that day.

Hazards that may be encountered and need to be addressed in the JHA may include but are not limited to:

- Steep terrain, bedrock canyons, waterfalls,
- Loose rocks in the stream, slipping or falling,
- Debris jams,
- High flows,
- High wind producing falling trees or branches,
- Bees, ticks, poison plants, water-borne pathogens,
- Separation from your partner,
- Thunderstorms,

- Hypothermia,
- Heat Exhaustion,
- Hazardous roads,
- Vehicle breakdown,
- Sunburn,
- Getting lost,
- Illegal activities (Marijuana plantations, methamphetamine labs),
- Drowning.

STANDARDS

Standards for the field phase are intended to obtain consistent quantitative data. Specific standards for the procedure to accomplish the level II inventory are listed below. Data collected shall be at least as accurate as specified in the Region 6 protocol presented in this handbook. All the attributes described in this protocol are mandatory, unless clearly stated as a "Forest option."

1. It is best to keep the same observer throughout the stream inventory. **DO NOT CHANGE THE OBSERVER MIDWAY THROUGH A REACH! IF A CHANGE IN OBSERVER IS NECESSARY, CHANGE AT THE START OF A NEW REACH BREAK!**

2. A minimum of three bankfulls will be collected in **EACH REACH,** 5 to 7 bankfulls are preferable**.** Bankfull and floodprone data will be collected on the first 3 fast waters in each **REACH** with good bankfull indicators. If no good bankfull indicators are present on any of the first 3 fast water units, collect the measurements on the next available fast water with good indicators. Additional bankfulls can be collected at any fast water unit with good bankfull indicators. It would be desirable to collect at least one at the midpoint of the reach and another toward the end of the reach.

3. The average wetted width shall be measured, not estimated.

4. **Bank Orientation**: The sides of a stream are named (**right** or **left**) relative to the view looking downstream.

5. The thalweg length of every channel unit shall be measured, not estimated. The thalweg is simply the path most water takes as it flows through each channel unit; it is the deepest trough from upstream to downstream. The only acceptable deviations from this protocol are for reasons of safety.

6. Measured gradients are **required** at the sites chosen for Wolman pebble counts (two per reach). Locations chosen by the survey team for Wolman pebble counts must be "representative" of the reach and completed in fast water channel units. Deciding what conditions are representative of the reach reflects the sum of the fast water channel units already observed downstream of the first site chosen for Wolman pebble counts. This location is ideal for measuring water level gradient for the reach, because it is the average fast water condition already observed in the reach.

Acceptable measuring tools include hand levels and Abney levels; a clinometer is not an acceptable tool for measuring water level gradient. See Appendix C: Forest Options for more detailed instructions.

7. A biological survey must be completed across the same section of stream that will be surveyed for channel units. That is, the segment of stream that receives a physical survey (i.e. channel unit dimension, etc) must also be biologically surveyed. The only acceptable biological sampling methods include: electroshocking, snorkeling, seining, and hook and line. Biological sampling will occur in ten percent of fast and slow waters unit. No random start is needed. Starting with the fifth fast water and the fifth slow water, sample every tenth slow water and every other tenth fast water. (i.e. S5,S15, S25,S35, etc, and F5, F25, F45, etc.).

8. A long-term recording thermograph must be placed in a slow water unit near the starting point (downstream most point of the survey in Reach 1), and the thermograph must operate correctly between mid-June and late-September. The thermograph must be calibrated before installation. The device is then placed in the deepest part of the channel to ensure submersion as flows drop. The chosen site should not occur near the inflow from a cold spring where thermal mixing is questionable. A hand-held thermometer reading shall be taken at the time the thermograph is installed.

9. A system of photographs shall be established for the stream reach. The beginning, ending, and representative channel unit types for each reach shall be photographed and documented, with a reference to SO and channel unit type photographed entered in the Comments Form. Other photographs may include, camping areas, road crossings, culverts, fish passage barriers, and issues affecting the stream.

10. A working map will be developed during the office procedure that will facilitate and expedite the field procedures' portion of the survey. This working map has been described in CHAPTER 2, OFFICE PROCEDURES: LEVEL I INVENTORY – IDENTIFICATION LEVEL (page 14 of this manual). Field notes and observations shall be noted on this map, since this map will serve as the foundation for a final survey map to be included in the stream inventory report.

EQUIPMENT/INFORMATION NEEDED

- Level II Survey Forms (Final Reach Delineation, Channel Unit Form, Special Cases, Comments, Aquatic Biota, Discharge, Wolman Pebble Count) as appropriate.
- 30 cm ruler for Wolman pebble counts or gravelometer.
- Pencils.
- Clipboard.
- 1:24,000 scale USGS topographic maps.
- USGS quadrangle maps, GIS stream layer maps, and aerial photographs.
- 150-foot tape measure (an additional 150-foot tape measure may be necessary if the surveyed stream's floodprone zone is wider than 200 ft).
- Good quality, heavy duty scale stick or stadia rod.
- Camera.
- GPS Unit
- Extra batteries for any electronic equipment

- Laser rangefinder (if available)
- Water velocity meter.
- Long-term recording thermographs for each inventoried stream.
- Thermometer.
- Abney level, hand level, or peep site.
- Plastic strip flagging and grease pencil/marker for use as needed.
- Waders/Wading boots with tread and studs.
- First Aid kit...a bee sting kit is a recommended element.
- Polarized sunglasses.
- Hardhat
- Radio.
- Snorkel, mask, wetsuit or dry suit.
- Backpack electroshocker.
- Bankfull pins and tension clamps (for measuring bankfull dimensions).

PROCEDURES

There are three phases needed to complete a level II survey: (1) preplanning before starting field work (see level I); (2) field measurements (field phase) which include reach location data and channel unit data for every reach sampled (Final Reach Form, Channel Unit Form, Special Cases Form, Comments Form, Aquatic Biota Form, Discharge Form, and Wolman Pebble Count Form); and (3) data entry, analysis, and summarization or reporting.

PRODUCTS

The level II inventory will produce:

- Completed Final Reach Forms for each reach delineated during the field phase which will include a determination/validation of the level I Rosgen Stream Type for each reach.
- Completed entries to the appropriate field forms for each channel unit assigned an SO.
- At least one streamflow (Discharge) determination near the downstream end of the inventoried stream.
- An accurate field map (1:24,000 scale USGS topographic series) which labels reaches, tributaries, and other significant features discovered during the field phase.
- A completed stream data file in Aquatic Survey database which includes all entries made to the Final Reach Form, Channel Unit Form, Special Cases Form, Comments Form, Aquatic Biota Form, and Aquatic Invasives Form).
- A coherent stream inventory report that includes an executive summary, a basin summary, reach summaries, summary data tables; all of which should lead to sound data analysis and recommendations; these recommendations are an essential element of any level II inventory.

FINAL REACH FORM

R6-2500/2600-21

The purpose of the Final Reach Form is to document the final reach boundaries for the inventoried stream. Surveyors are required to determine the validity of preliminary reach breaks originally chosen in the office. The upstream endpoint of each preliminary reach must be evaluated in the field. The survey team is free to change the reach breaks to reflect the conditions the team observed during the field survey of channel units (i.e., habitats). Valley and channel conditions are used to evaluate the preliminary reach endpoints. It is the surveyors' task to answer the question, "Are the valley and/or channel conditions upstream of the preliminary reach break substantially different from the conditions already observed downstream?" If the team expects the upstream character to differ substantially from the conditions they observed downstream, the preliminary reach endpoint is accepted, and a new reach is begun.

The majority of the attributes on the Final Reach Form are calculated using maps. If the preliminary reach breaks determined in the office are validated in the field, the mapped values assigned to the preliminary reaches will be used to complete the corresponding mapped values on the Final Reach Form.

Whenever surveyors do not accept the preliminary reach endpoints, the survey team must calculate new mapped values for the changed reaches. These mapped values include river mile, reach length, change in elevation, valley length, channel gradient, sinuosity, valley width estimate, and stream order; and these attributes are best calculated in an office setting. The Rosgen Stream Type requires the analysis of bankfull and floodprone dimensions collected on individual fast water channel units (i.e., riffles, rapids, cascades, and runs) before a category can be chosen. However, certain attributes of the Final Reach Form should be completed in the field at the same time that the decision to begin a new reach is made. These field attributes include observer, recorder, the date the reach was completed, reach number, the beginning and ending sequence order (SOs) of the reach, and inner riparian zone width (valley form is a Forest option). It is also required that the survey team describes the reasons for ending the present reach in the Reason for Reach Break section of this form.

It is mandatory that the field data for the Final Reach Form shall be entered IN THE FIELD as soon as the reach endpoint is determined.

Reaches shall begin and stop on specific channel units (i.e., slow water units and fast water units) that are part of the mainstem stream and have accompanying sequence order numbers (SO's). After those terminal units have been identified, final reach stratification can occur.

It is imperative to end and start all reaches at channel units that can be specifically identified on the ground. Future surveys of the same stream will likely use the same reach end points provided they can be found. Photographs of each reach break will assist future surveyors locate the reach end points (e.g., stream tributary confluence, waterfall, road crossing, cliff, etc.). GPS points are also very helpful in identifying endpoints of reaches especially when reaches end at locations where no specific landmark exists.

Fill out a Final Reach Form for each stream reach.

NOTE: INSTRUCTIONS FOR COMPLETING THE FINAL REACH FORM HEADER (ATTRIBUTES A – G) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS page 16.

FINAL REACH FORM INSTRUCTIONS

1. REACH NUMBER: Enter the segment identification number for each reach beginning at the downstream end (or startpoint) of the inventoried stream. Stream reaches are incremented sequentially in an upstream direction.

2, 3. SEQUENCE ORDER (SO): Enter the starting (SO From) and ending SO's (SO To) for each reach **(e.g., Reach 1 = SO 1-55, then Reach 2 = SO 56-126, etc.).** This information is extracted from the Channel Unit Form, following final reach delineation. In the case of private land where no access has been granted, DO NOT assign any SO's for the reach (enter 0), resume sequential SO numbers at the next reach. The following is an example of a stream crossing private land in which access has been denied: Reach 1, SO = 1-203; Reach 2 (Private), SO = (enter 0); Reach 3 (Public), SO = 204-365, etc.).

4. START DATE: Enter the date that the level II inventory on the reach was started. Use the format MM/DD/YYYY (e.g., 07/23/2001).

5. END DATE: Enter the date that the level II inventory on the reach was completed. Use the format MM/DD/YYYY (e.g., 07/23/2001).

6. **PROTOCOL**: Enter the protocol used for the survey:

- **R6E Count** – Used eastside wood size classes, counted fish during AB survey
- **R6E Presence** – Used eastside wood size classes, conducted presence AB surveys only
- **R6W Count** – Used westside wood size classes, counted fish during AB survey
- **R6W Presence** – Used westside wood size classes, conducted presence AB surveys only

7, 8. CONTACTS (OBSERVER/RECORDER): Using a first initial and surname format (e.g., S.SWEET**)**, enter the name of the observer. Enter the name of the person recording for the reach using the same format.

9, 10. CHANGE IN ELEVATION (MIN/MAX): Estimate the elevations at the downstream (min.) and upstream (max.) endpoints of the reach by reading the contour lines on the map. Unless the contour lines cross the stream at the end point of a reach, interpolation will be necessary.

11. STREAM ORDER [Forest Option]: Utilizing the Strahler method, identify stream order (see Appendix B) for each reach. A first order stream is the smallest fingertip mapped tributary. A first order channel can appear as either a dotted or solid stream channel on a 1:24,000 scale USGS topographic map. (e.g., 3)

12. VALLEY TYPE [Forest Option]: Enter valley form code which best describes the average condition for the reach. The designations are based on valley floor width and the gradients of the valley side slopes. See Appendix C—Page 95, for figure.

13. FLOW REGIME [Forest Option]: Enter Ephemeral, Intermittent, or Perennial. See definitions in the glossary. See Appendix C, page 95.

14. SURVEY REACH LENGTH: Enter the sum of the stream-measured lengths (from field forms) of the main channel habitat units. Do **NOT** include side channel lengths in this measurement.

15. MAPPED REACH LENGTH: Enter the digital measuring tool value for the field-verified reach length. Trace the line defining the stream channel within the chosen mapping software (mapping software should be loaded with 1:24,000 scale USGS topographic map).

16. MAPPED VALLEY WIDTH ESTIMATE: Enter an estimate of the average valley floor width for the reach. The estimate is derived from interpreting 1:24,000 scale USGS topographic maps and aerial photographs of the valley. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley. The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Elevation contour lines cross the line defining the stream. Use the midpoint along the stream between contour intersections to make your estimate of the valley width. Record the estimate to the nearest 10 ft.

17. DISCHARGE TYPE [FOREST OPTION]: Enter Bankfull, Baseflow, Flood, or Medium. This is the relative amount of flow within the reach at the time the discharge was taken. See Appendix C, page 94.

18. DISCHARGE: Enter actual measured discharge recorded in cubic feet per second. At a minimum, take one measured discharge in the first reach near the starting point of the survey. If a tributary is estimated to contribute greater than 20 percent of the main channel flow and the reach length is at least 0.5 miles long downstream of the tributary, note approximate amount of flow in "Comments" and consider beginning a new reach. If additional measured flows are desired, they should be measured near the downstream end of each reach. See Chapter 4 of this handbook for instructions on determining streamflow. Record streamflow to the nearest 0.01 cfs.

19, 20. START DISTANCE (RM From) and END DISTANCE (RM to): Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river miles if available. If the EPA river mile for the start of the survey is unknown, begin the mileage measurement at the mouth of the stream, starting with RM = 0.0. Whenever the starting point of a stream inventory is not at the mouth of the inventoried stream, the river mile location of the start point will reflect the actual distance of the start point upstream from the mouth of the surveyed stream. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (e.g., Reach 1: RM 0.0 to 1.1; Reach 2: RM 1.1 to 4.0; Reach 3: RM 4.0 to 5.2). Use mapping software to calculate river miles. The technique is to follow the stream channel course as drawn on the 1:24,000 scale USGS topographic map. If a reach is less than 0.5 mile in length, you must still collect a minimum of 3 bankfull measurements (multiple bankfull measurements can be taken in longer fast water units); and at least one Wolman pebble count must be completed for the reach. Record to the nearest 0.1 RM.

21. MAPPED VALLEY LENGTH: The mapped valley length will be determined after the reach delineation has been verified or changed in the field. This is a valley line distance between the two endpoints of the reach, utilizing the 1:24,000 scale USGS topographical map and mapping software. The distance is determined by using the mapping software length tool to trace an imaginary midline of the valley floor from the start point of the reach to the endpoint of the reach. Mapped valley length is not a straight line, but a curved line formed by connecting the topographic contours. These contours normally form a "V" or a "U" as they cross the valley floor. Record the value to the nearest 0.01 miles.

22. MAPPED CHANNEL GRADIENT (%): Calculate the mapped channel gradient for the reach from a 1:24,000 scale USGS topographic map once the final reach boundaries have been delineated. Subtract the river mile estimate for the upstream end of the reach from the river mile estimate for the downstream end of the reach to determine the mapped channel length. Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contour lines on the map. Calculate the gradient by subtracting the lowest elevation from the highest, and dividing that change in elevation by the mapped channel length. Mapped stream channel length is a distance measured by tracing the map stream channel on a 1:24,000 scale USGS topographic map. Mapped channel length is the river mile length of the reach expressed in feet.

23. SINUOSITY VALUE: Sinuosity is calculated for each reach using the sum of stream-measured lengths of the main channel habitat units. Divide the sum of channel lengths entered in **#14** above by the mapped valley length entered in the above **#21**. Since a stream channel is at least as sinuous as its valley floor, the value derived must be equal to or greater than 1.0. Record the value to the nearest 0.01.

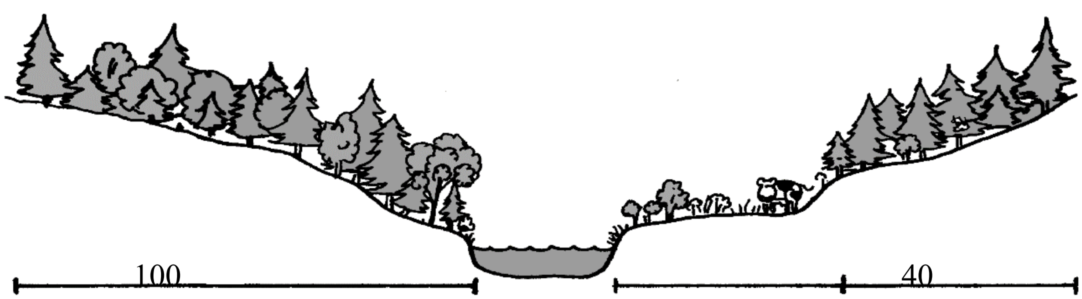
24. ROSGEN CLASS: Enter the Rosgen level I letter designator which best fits the conditions observed for the stream reach (e.g. A). The methodology is defined in *Applied River Morphology*, Rosgen, D., 1996. Copies of this text have been distributed to every National Forest in the Pacific Northwest Region. Consult your local hydrologist and/or fisheries biologist for further clarification.

25. REASON FOR REACH BREAK: Enter as specifically as possible the reason for breaking the reach at this point (e.g. substantial change in gradient, large tributary contribution, etc.)

26. INNER RIPARIAN ZONE WIDTH [FOREST OPTION]: The riparian zone investigated in this inventory is an area on either bank, which is 100-feet wide. The inner riparian zone is the portion of that 100 feet which is characterized by a vegetative condition that is different from the remainder of the riparian zone. It is often the case that vegetation changes dramatically as the distance from the bankfull channel increases. True water-adapted plants may only occur very near the wetted channel. Alternatively, the inner riparian zone may describe an area in which ground-disturbing flows occur with sufficient frequency that mature conifers are quite rare, and a distinct hardwood zone is identifiable. The estimate of inner riparian zone width is the average width along both banks from bankfull to the distinct change in vegetation. The outer zone is calculated by subtracting the inner zone from 100 feet. For example, if the inner zone for the reach is estimated to be 60-feet wide, then the outer riparian is 40-feet wide (see figure 4). Forests have the option to designate a single riparian zone, and in such a case, enter 100 feet as the inner riparian zone width. (e.g., 100).

27. COMMENTS: Write down any comments important to the aquatic or riparian resources. This is a good place to clarify some of the entries made to Final Reach Form. In particular, a description of the reasons for ending the reach should be included, as should a description of the location (SO and Channel Unit Type Number) of any thermographs placed in the reach. Other comments may include nearby landslides associated with the reach; road fords within the reach; an estimate of juvenile fish habitat availability; a list of amphibians or other wildlife observed in the reach; problems at culverts on tributaries to the reach; the general condition of the upland slopes; and how well shaded is the reach's wetted channel (e.g., Broke reach at trib contributing 30% to flow, near-riparian grazing widespread and shade provided by trees is spotty, 3 steelhead redds discovered on flanks of point bars).

Figure 4: Examples to help you decide how to designate the inner riparian zone width



Example 1: no clear vegetation zones are apparent, so use one zone=100 feet if the condition is the same on both bank's vegetation zones.

Example 2: designate an inner vegetation zone if you expect to encounter a change in vegetation due to elevation (e.g. terraces), altered habitat (roads), or other management activities (harvest, grazing).

Remember that during the survey, both sides of the stream will have the same inner vegetation zone for the entire reach.

FINAL REACH FORM Page: ___ of ___
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A. State _____B. County ______________C. Forest _____________D. District ___________

E. Stream Name ____

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit ____ 12-digit ____

G. USGS Quad ____

1 Reach Number	2 SO From	3 SO To	4 Start Date	5 End Date	6 Protocol	7 Observer	8 Recorder	9 Elevation Min (ft)	10 Elevation Max (ft)
11 *Stream Order	**12 *Valley Type**	**13 *Flow Regime**	**14 Survey Reach Length (ft)**	**15 Mapped Reach Length (ft)**	**16 Mapped Valley Width (ft)**	**17 *Discharge Type**	**18 Discharge (cfs)**	**19 Start Distance (RM From)**	**20 End Distance (RM To)**
21 Mapped Valley Length (ft)	**22 Mapped Channel Gradient (%)**	**23 Sinuosity Value**	**24 Rosgen Class**	**25. Reason for Reach Break:** **26.*Inner Riparian Zone Width:**					
				27. Comments:					

* Indicates a Forest Option

1 Reach Number	2 SO From	3 SO To	4 Start Date	5 End Date	6 Protocol	7 Observer	8 Recorder	9 Elevation Min (ft)	10 Elevation Max (ft)
11 *Stream Order	**12 *Valley Type**	**13 *Flow Regime**	**14 Survey Reach Length (ft)**	**15 Mapped Reach Length (ft)**	**16 Mapped Valley Width (ft)**	**17 *Discharge Type**	**18 Discharge (cfs)**	**19 Start Distance (RM From)**	**20 End Distance (RM To)**
21 Mapped Valley Length (ft)	**22 Mapped Channel Gradient (%)**	**23 Sinuosity Value**	**24 Rosgen Class**	**25. Reason for Reach Break:** **26.*Inner Riparian Zone Width:**					
				27. Comments:					

CHANNEL UNIT FORM
R6-2500/2600-22

The following items (with the exception of certain Forest Options) should be recorded on the Channel Unit Form for the channel units to be surveyed. Each Forest shall use a standard for "right bank" and "left bank" orientation while looking downstream (see figure 5 to clarify the importance of distinguishing the banks of the stream).

Only one attribute can be estimated. The maximum channel unit depth can be estimated in cases where water depths are greater than four feet.

FOREST OPTIONS FORM

Some of the Forest Options listed below will be recorded on the Forest Options Form which can be found on page 105 in Appendix C.

NOTE: INSTRUCTIONS FOR COMPLETING THE CHANNEL UNIT FORM HEADER (ATTRIBUTES A - G) ARE LISTED ON THE SURVEY FORM INSTRUCTIONS ON PAGE 16. SEE BELOW FOR INSTRUCTIONS ON D2.

CHANNEL UNIT FORM INSTRUCTIONS

D2. PROTOCOL East__ West __: Check the appropriate space next to the corresponding protocol used during the survey. E = Eastside wood categories, W = Westside wood categories.

H. REACH NUMBER: Reaches shall be numbered sequentially, with the first reach beginning at the downstream startpoint of the survey, usually at the mouth of the stream, with each succeeding reach's startpoint coinciding exactly with the previous reach's endpoint (e.g., 1, 2, 3, etc.).

THE FINAL REACH BOUNDARIES MAY CHANGE FOLLOWING VERIFICATION DURING THE FIELD PHASE. PRIOR TO COMPUTER DATA ENTRY, FINAL DELINEATION MUST OCCUR, AND THE TRUE REACH NUMBER MUST BE ASSIGNED TO THE RESPECTIVE CHANNEL UNITS. (SEE FINAL REACH FORM)

When starting a new reach, record the data on a new Channel Unit Form, page 55. This will facilitate data entry and minimize data entry errors.

MAKE SURE SOs LISTED ON THE FINAL REACH FORM COINCIDE WITH THE SOs ON ALL THE CHANNEL UNIT FORMS COMPLETED FOR EACH REACH BEFORE YOU BEGIN DATA ENTRY TO THE NRM AQUATIC SURVEYS.

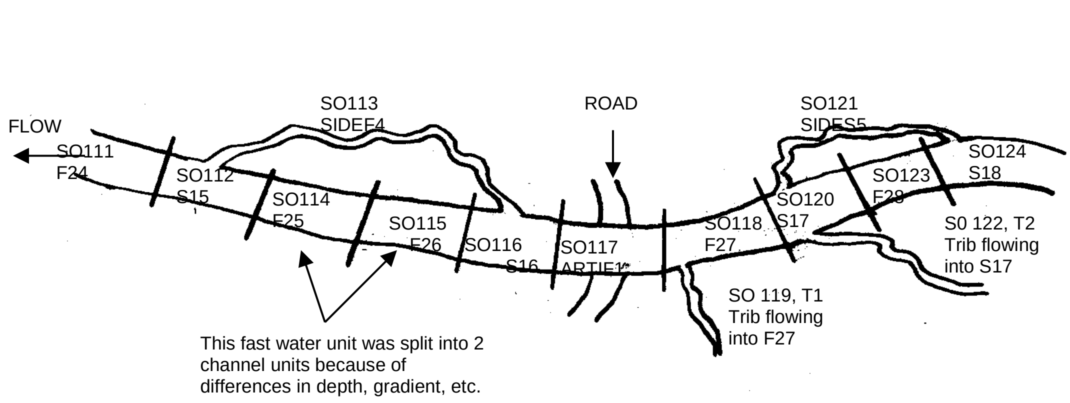
I. SAMPLING FREQUENCY: This will only be used to determine the sights where riparian vegetation, certain forest options, and aquatic biota will be collected**.** Ten percent of the total main channel habitats will have riparian vegetation and forest options collected. No random start is needed. Starting with the fifth sequence order, measure every tenth SO after. If a measured unit falls on an SO other than a fast or slow water habitat type, wait and measure in next available slow or fast habitat type. Enter 5, 15, 25, 35, etcetera in SO sampling frequencies. Aquatic biota will be sampled starting with the fifth fast water and the fifth slow water, sample every tenth slow water and every other tenth fast water. (i.e. S5, S15, S25, S35, etc, and F5, F25, F45, etc.).

1. SEQUENCE ORDER (SO): Enter a unique sequence order number for each channel unit. SOs should be entered in the same order as channel units are encountered in the field survey, beginning with the first channel unit and incrementing sequentially as new channel units are encountered moving upstream, (e.g., 1, 2, 3, etc.).

The numbering sequence shall remain consistent throughout all reaches, (if Reach 1 ends at SO #203, then Reach 2 shall begin at SO #204). There are only two exceptions: a reach of private land to which access has not been granted, and a lake which occupies a middle segment of the surveyed stream channel (see figure 3). In either case, a reach number is assigned to the private land and to the lake; but no SOs are assigned to either of those two reaches. Sequential assignment of SOs resume in the next upstream reach (e.g., if Reach 2 is private land, no access, then SOs are as follows: Reach 1 = SO 1 to 203; Reach 2 has no SOs assigned (and does **NOT** get entered into NRM Aquatic Surveys); Reach 3 = SO 204 to 251...).

All side channels (SIDEF or SIDES) with streamflow at the time of the survey should be treated as an individual channel unit and assigned an individual SO number. They should be assigned the next incrementally higher SO than the main channel unit into which they flow. When multiple channel units (side channels) converge upon the mainstem channel unit at exactly the same place, number them in a clockwise order while facing upstream (see figure 5).

Figure 5: How to designate channel unit SO's for a stream with side channels and tributaries.



2. CHANNEL UNIT TYPE AND NUMBER: **All of the following channel units receive an SO.** Enter the channel unit type and number for each unit. An expanded set of acceptable slow water and fast water channel units are listed in Appendix C: Forest Options (page 95). Valid channel unit codes include:

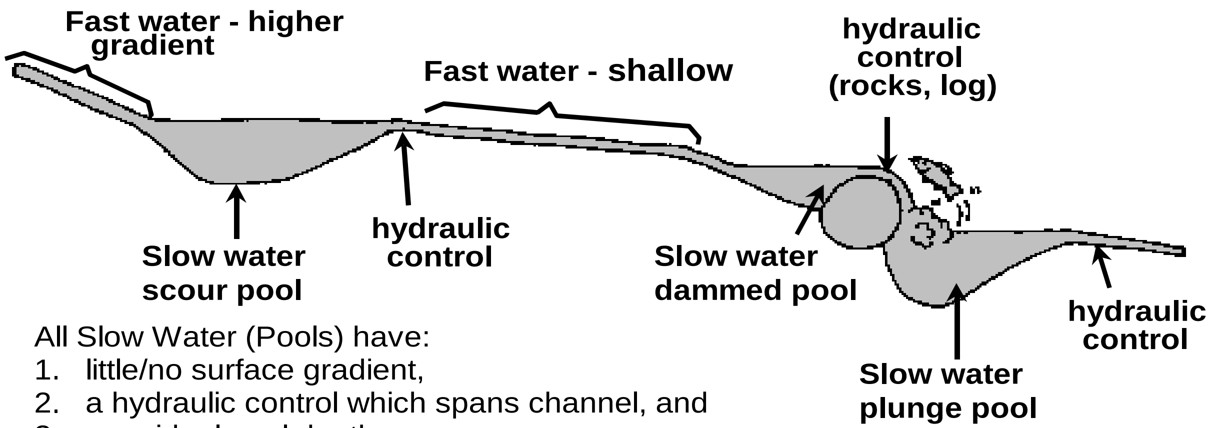
- **S** = Slow Water (Pool) (Length, Wetted Width, Max. depth, max depth at pool tail crest)
  - **SD** = Dam Pool
  - **SS** = Scour Pool
  - **SSPL** = Plunge Pool
  - **SDBV** = Beaver Dam Pool
- **F** = Fast Water (Riffle) (Length, Wetted Width, and max depth)
  - **FT** = Turbulent
  - **FN** = Nonturbulent
- **T** = Tributary
- **SIDES** = Slow Water Side Channel (Side channel dominated by pool habitat)
- **SIDEF** = Fast Water Side Channel (Side channel dominated by riffle habitat)
- **CHUNITB (can be coded with B only)** = Braid
- **CHUNITD (can be coded with D only)** = Dry Main Channel
- **ARTIF** = culverts, dam, (Special Cases Form)
- **WF** = Waterfall (Special Cases Form)
- **CH** = Chute (Special Cases Form)
- **ML** = Marshlands (Special Cases Form)
- **BVD** = Beaver Dam (Special Cases Form)

NOTE: The codes above are for field data only. Entry into the Aquatic Survey database will utilize the full name of the channel unit.

Channel unit type numbers will be assigned sequentially as the inventory progresses upstream. Both SOs and channel unit numbers are lowest near the downstream end (= startpoint) of the inventory, regardless of channel unit type. The reach number has no bearing on how numbers are assigned to channel units (e.g., if Reach 1 ends at S25, the next slow water unit encountered would be in Reach 2, and it would be designated S26.)

In order to consider a channel unit type as a separate unit, the channel unit length must be equal to or greater than the wetted width. The **ONLY** exceptions to this rule are special case channel units, beaver dam pools, and channel-spanning plunge pools (see figure 6).

Figure 6: Basic distinctions between slow water and fast water units



All Slow Water (Pools) have:
1. little/no surface gradient,
2. a hydraulic control which spans channel, and
3. a residual pool depth.

All Fast Water (Riffles) have:
1. Gradient > 0%
2. Usually has emergent substrate
3. Surface Turbulence

Slow water plunge pools of this type typically are located downstream of a debris jam or log which spans the wetted channel. Such a condition causes a slow water unit to be scoured during high flow events. These slow water units must span the width of the wetted channel, but they need not be longer than their average width. These pools should be given the specific code for plunge pools (SSPL).

Pools forming behind beaver dams are generally very wide and also need not be longer than their average width. These pools should be given the specific code for beaver dam pools (SDBV).

For all channel units other than channel-spanning plunge pools, beaver dam pools, and Special Case channel units, if the wetted length of a channel unit (measured along the thalweg) is not greater than the average wetted width, do not consider it as a separate unit. For extremely long channel units, (e.g., fast water units approaching 900 feet in length) consider dividing them into smaller more manageable lengths. Use the endpoints of side channels attached to the fast water unit, changes in streambed composition, or stream gradient in the fast water unit to divide a long fast water unit into shorter fast water units. Assign each of the sections of fast water unit a **different** SO and channel unit number (e.g., a survey team decides to split a 1245 ft. section of a stream into three consecutive fast water units: a 455 ft. fast water unit (SO 20, F10), a 530 ft. fast water unit (SO 21, F11), and a 260 ft. fast water unit (SO 22, F12).

BRAIDS (CHUNITB or B): A series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands. Vegetation on these unstable islands is typically non-woody annual plants, very young seedlings, or willow. Bankfull flow will frequently cut new braids across these unstable islands. These secondary channels offer very poor winter refuge for juvenile salmonids, yet may offer high quality spawning opportunities for large adults. It is conceivable that during low flow, a single channel may be wet while the additional braids are dry. These should be designated as CHUNITS and the width is the sum of the average wetted channel widths for each of the multiple channels with flowing water. A remark will be made in the comments section that this was a braided section.

SIDE CHANNELS (SIDES/SIDEF): Assign all side channels an SO unless it is totally dry. Enter only wetted length, average wetted width, and maximum depth. Determine whether the side channel is dominated by fast water (SIDEF) or slow water (SIDES) and code appropriately. A side channel is separated from the mainstem channel by a stable island. A stable island in a forested stream is usually colonized by woody plants. Woody plants other than willows are excellent indicators of the stability of an island. In reaches characterized by meadows, a well-developed layer of soil atop the island indicates a stable secondary (side) channel. But the best indicator of stability is the presence of bankfull indicators at an elevation below the surface of the island. If the island is not inundated during bankfull flows consider the island stable even if the island has no vegetation at the time of survey. These stable secondary channels offer very important rearing habitat for juvenile salmonids. **Do not assign an SO to dry side channels.** Do not break out individual channel units (slow water units, fast water units) within side channels. Woody material and unstable banks can be collected in side channels but it is not required it is a Forest Option. If a flowing side channel has a dry section, record only the length of the channel that is wet, and in "Comments" record the estimated length of dry side channel section. Also record in "Comments" both the bank of the mainstem channel into which the side channel flows, and the upstream mainstem channel unit where the origin of the side channel is located.

TRIBUTARIES are assigned an SO and are coded "T". The tributary will be recorded with the next subsequent SO after the SO where the tributary enters. For tributaries record temperature (degrees Celsius) and the time it was taken. Estimate a percent of flow contributed by the tributary to the mainstem streamflow below the tributary. Record the estimated flow contribution, the gradient of the tributary, whether there is fish access, and which bank the tributary intercepts. If a dry tributary is encountered **do not** assign it an SO but record a note in the comments. If possible, identify the tributary on the field map and label with the appropriate SO.

DRY MAIN CHANNEL (CHUNITD OR D): Enter only the length of the inventoried mainstem stream channel that is dry at the time of the survey. Enter 0 for wetted width and maximum depth. Any LWM within the bankfull of a dry main channel will be tallied according to its dimensions and recorded. Large woody material within the bankfull channel of a dry channel segment is potentially mobile during high flow events. Unstable banks must be collected according to protocol in dry channels as well.

SPECIAL CASES (culverts, dams, beaver dams, marshlands, waterfalls, and chutes) will be designated in several ways. Artificial structures (culverts and manmade dams) are assigned an SO and designated by the code "ARTIF". Falls (WF), chutes (CH), beaver dams (BVD), and marshlands (ML) will be assigned an SO and coded appropriately. Information will be entered on both the Channel Unit Form and the Special Cases Form for all the above channel units. Enter the appropriate SO, channel unit sequence type and number, length, and wetted width of the channel unit to the Channel Unit Form. The remaining information is entered on the Special Case Form. Instructions for completing the Special Case Form is found in this chapter under the heading **"Special Cases Form (Culverts, Dams, Beaver Dams, Falls, Chutes, and Marshlands."**

3. CHANNEL UNIT LENGTH: Measure the length of mainstem channel unit; the dimensions of side channels may be estimated. Channel unit length is a measured dimension for slow water units, fast water units, dry channels, chutes, marshlands, beaver dams, culverts, and dams. These channel units may not be estimated for length (some exceptions apply, see below)). Wetted channel unit length is a measurement of thalweg length. The thalweg is the line of greatest depth from downstream to upstream through the channel unit; it is rarely a straight-line dimension (see Appendix I, pg 131 for a definition of thalweg). The length of certain special case units (culvert, dam, and beaver dam) is the length of the structure from the downstream end to the upstream end.

The observer is required to drag a measuring tape behind them as they walk upstream. As the observer searches for the maximum depth in the channel unit, the dragged tape will trail behind them in the thalweg. The recorder simply waits at the downstream end of the channel unit until one of two things occurs. Either the observer has determined the upstream end of the channel unit, or the observer has dragged all of the tape upstream.

Measuring the length of **side channels** is a forest option.

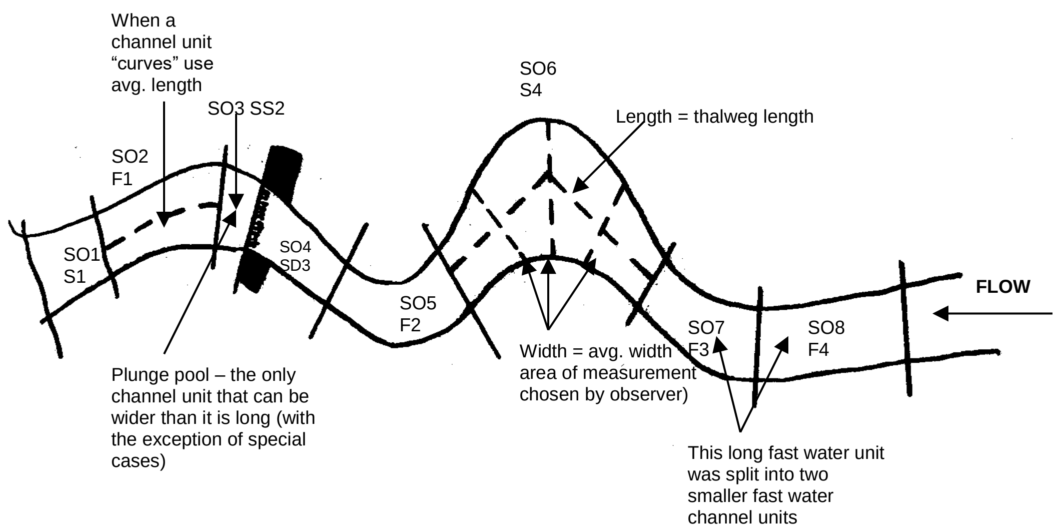
Estimates of length and width may replace measurements only when safety is in question. Such safety concerns may occur in streams too large or deep to wade the thalweg. An impassable bedrock falls or stream too brushy to see where you are walking are also examples of conditions in which channel unit lengths and widths may be estimated.

How a forest chooses to measure channel unit length is a Forest Option. See Appendix C, Page 99 for a method of measuring channel unit length that has received extensive field testing. These methods are not required but measuring channel unit length and widths for all channel units except side channels is mandatory.

Measuring tapes of 100 ft. or greater length, unattached to a reel, or a surveyor's rope are preferred because the tape tends to stay in the thalweg as the observer moves upstream. Measure and record channel unit length to the nearest foot.

4. CHANNEL UNIT WETTED WIDTH or STRUCTURE WIDTH: Measure the average wetted width of mainstem channel unit; the observer decides where to measure channel unit wetted width. Channel unit average width is a measured dimension for slow water units, fast water units, chutes, marshlands, culverts and dams. Width of Dry channels will always have a wetted width of zero feet. The width of certain special case units (culvert, dam, and beaver dam) is the width of the structure from one end to the other. Estimates of average wetted width may replace measurements only when safety is in question. Such safety concerns may occur in streams too large or deep to cross. An impassable bedrock falls or stream too brushy to see where you are walking are also examples of conditions in which channel unit wetted widths may be estimated.

Figure 7: Channel unit width and length measurements



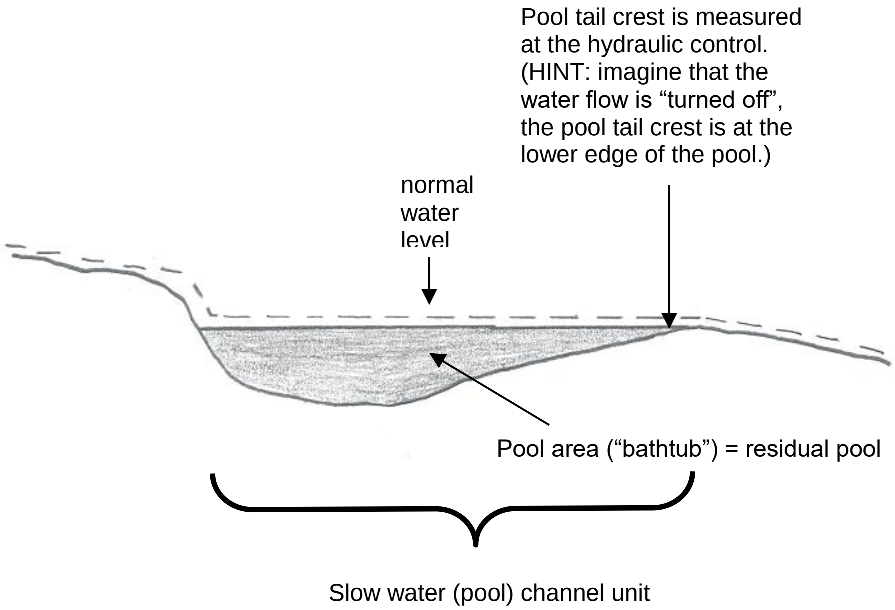
5. MAXIMUM DEPTH: Enter the measured maximum depth for each channel unit to the nearest 0.1 ft. The maximum depth will be measured wherever that depth is less than 4 ft. In those channel units in which maximum depth exceeds 4 ft., an estimate of maximum depth will be made. Maximum depth can be easily measured in most channel units with a depth rod if the depth is less than 4 ft.

6. **AVERAGE DEPTH [Forest Option]**: Estimate the average depth in fast water units only. This is an ocular estimate, and implementation is a Forest-level decision.

7. POOL CREST DEPTH: Enter the maximum measured depth to the nearest 0.1 ft. at the pool tail crest for every slow water unit channel unit. This location is at the point where the water surface slope breaks into the downstream fast water unit or plunges to a slow water unit below the upstream slow water unit. Measure the maximum depth at this location along the width of the hydraulic control feature that forms the slow water unit. The hydraulic control can be viewed as a dam holding back the slow water unit's water. This "dam" is rarely a straight line across the downstream end of the slow water unit; rather it usually forms an irregular curve.

To identify the location of the maximum depth along the hydraulic control (pool tail crest), visualize a condition in which streamflow has almost stopped, but a trickle of water is still exiting the slow water unit (see figure 8). That point is the maximum depth at the pool tail crest. This measurement is for calculating residual pool depth (e.g., maximum depth minus pool tail crest depth = maximum residual pool depth). The depth will be measured at each slow water unit and estimated wherever the maximum depth at pool tail crest exceeds 4 ft.

Figure 8: How to visualize where the pool tail crest occurs.



8. FORMED BY (Forest Option): Record what type of material or obstruction is creating the pool. See Appendix C, pg 94 for more detail.

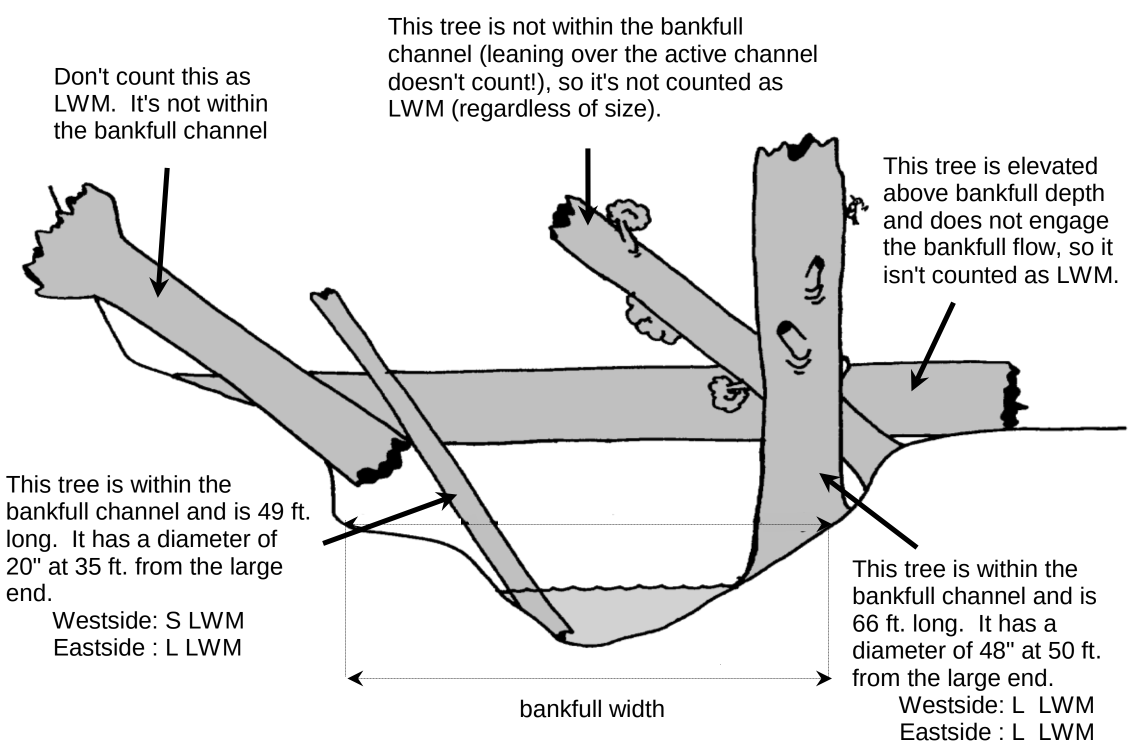
9, 10, 11. PIECES OF LWM: In order to calibrate the surveyors' eye, measure the dimensions (length and diameter at appropriate length based on eastside or westside criteria) of the first 5 pieces of wood encountered each day after first estimating the dimensions. This data does not need to be recorded unless the piece of wood meets criteria.

Enter the number of pieces of large woody material (LWM) within the bankfull channel for each mainstem channel unit. The presence of LWM in the bankfull channel decreases the force of high flow events, tends to capture substrate, offers cover for fish and refuge from the force of storm events. Large woody material also slows the movement of organic matter (leaves, twigs, and drifting macroinvertebrates) allowing aquatic organisms to more efficiently process and retain the nutrients available in organic debris.

To be included, the tree bole or root swell of live or dead trees must interact with the streamflow at bankfull conditions. The bole of a tree is the trunk of a tree, and is known by its gentle taper from the bottom to the top of the tree. The root swell is the portion of the tree between the roots and the bole; root swell is the fusion of individual roots, creating a sharply tapered portion of the tree. The stump of a tree is largely root swell. The roots are the subterranean branched network of a tree.

If a log or tree leans over the bankfull channel or spans the wetted channel, but does not interact with the streamflow during bankfull conditions, do **NOT** count it as LWM (see figure 9). The approximate numbers of potential LWM (i.e., leaning trees or channel-spanning logs above bankfull flow) are appropriately recorded on the Comments Form.

Figure 9: Classifying a tree as large woody material (LWM) is dependent on whether or not the tree is at least partly within the bankfull channel



If only the roots of a tree intercept bankfull flow, the tree is not counted as LWM. Enter the number of pieces of large woody material in each of the three size classes; Small, Medium, and Large. Use the following minimum diameter and length criteria:

Eastside Forests (east of the High Cascades):

(9) S = Diameter > 6 in, at a length of 20 ft. from the large end (Mandatory)
(10) M = Diameter > 12 in, at a length of 35 ft. from the large end (Mandatory)
(11) L = Diameter > 20 in, at a length of 35 ft. from the large end (Mandatory)

Westside Forests (west of the High Cascades):

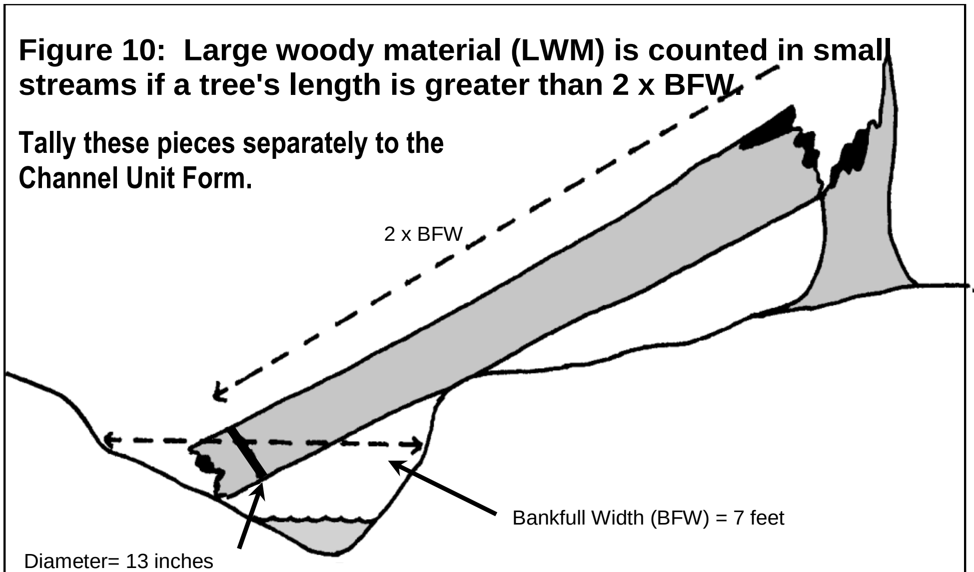
(9) S = Diameter > 12 in, at a length of 25 ft. from the large end (Mandatory)
(10) M = Diameter > 24 in, at a length of 50 ft. from the large end (Mandatory)
(11) L = Diameter > 36 in, at a length of 50 ft. from the large end (Mandatory)

If a piece of large wood does not meet the length criteria listed on the previous page, but is longer than twice the average bankfull width for the reach, count the piece in the appropriate size class. Measure the minimum diameter at a distance from the large end equal to twice the average bankfull width for that channel unit. The diameter size criteria do not change regardless of the length of the piece of large wood (see figure 10).

Tally the LWM counts separately on the Channel Unit Form for LWM meeting the standard length criteria from LWM that is shorter than the standard lengths but longer than twice the average bankfull width. Separating these tallies will facilitate sharing data with other agencies and groups using different methods for assessing large wood.

Figure 10: Large woody material (LWM) is counted in small streams if a tree's length is greater than 2 x BFW.

Tally these pieces separately to the Channel Unit Form.



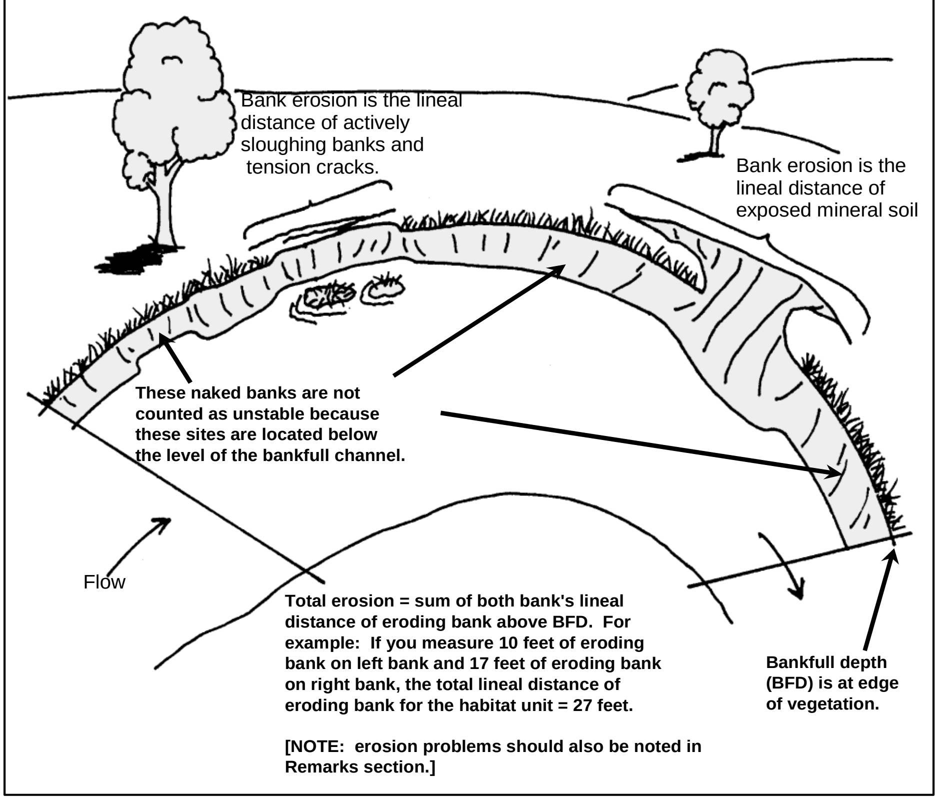
This tree is 15 ft. long, which does not meet the normal minimum length criteria for LWM. But, because it is at least twice as long as the BFW, it is counted as LWM. The size class of LWM is based on the diameter of 13 inches at a distance from the large end equal to twice the BFW of the habitat unit.

For this example:
Eastside: medium LWM
Westside: small LWM

Make note of logjams and rootwads in the bankfull channel on the Comments Form. It is important to remember that LWM encountered in a channel unit type treated as a Special Case channel unit will be recorded in the Aquatic Survey database. Therefore, those pieces must be recorded with the Special Case channel unit on the data sheet.

12, 13, 14. UNSTABLE BANKS: Measure the lineal distance of actively eroding banks along both sides of every mainstem channel unit (fast waters, slow waters, and dry channels) and tally separately (left bank, right bank or total for both banks). Lengths can be estimated only when safety concerns are present. Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin. That is, naked substrate within the bankfull channel is the normal condition due to the dynamic nature of the bankfull channel, and is not necessarily an indication of eroding banks. An eroding bank is characterized by any one, or a combination of the following factors provided they occur at an elevation above the bankfull flow: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing (see figure 14). A bank that is composed of only cobbles and gravels may, nonetheless, be stable; the sand, silt and clay components no longer present in a naked bank may be quite resistant to erosion. If there is no sloughed material perched atop the lower banks, do not consider a naked bank unstable. Record to the nearest foot.

Figure 14: Bank stability is the sum of the lineal distance actively eroding banks on both sides of each measured channel unit



15. WETTED WIDTH AT BF SITE: Enter the measured wetted width at the location of the bankfull measurements.

16. BANKFULL WIDTH (BFW): Enter the MEASURED bankfull width at selected fast water unit. Bankfull is defined as the high streamflow event occurring on average every 1.5 years. This streamflow forms and maintains the channel over time. Select sections of fast water units that have a straight and relatively narrow channel since such sites offer the clearest bankfull indicators. The banks along the site selected for measuring BFW must be free of obstructions which cause high flow backwater across the entire channel. An area with an undercut bank is also a very poor choice for bankfull determination since bank slumping will give a false reading of bankfull conditions. An actively eroding bank is another unreliable site for measuring bankfull flow.

Bankfull is identified by interpreting the evidence of bankfull flow atop the banks of the stream. The most consistent indicators of bankfull flow are the areas of deposition; the top of these deposits define the active floodplain. Active floodplains are formed and maintained by bankfull discharges. These deposits are often known by the change in particle size. Other indications of bankfull flow are less reliable. But by using all of the evidence, accurate bankfull measurements can be obtained. The other bankfull indicators include: a change in vegetation (i.e., from none to some, or from herbaceous to woody); a change in bank topography (a change in slope of the bank above the water's edge); a line defining the lower limit of lichen colonization; a stain line visible on bare substrate; a defined scour line (exposed roots, etc.); a line of organic debris on the ground (but NOT debris hanging in vegetation!).

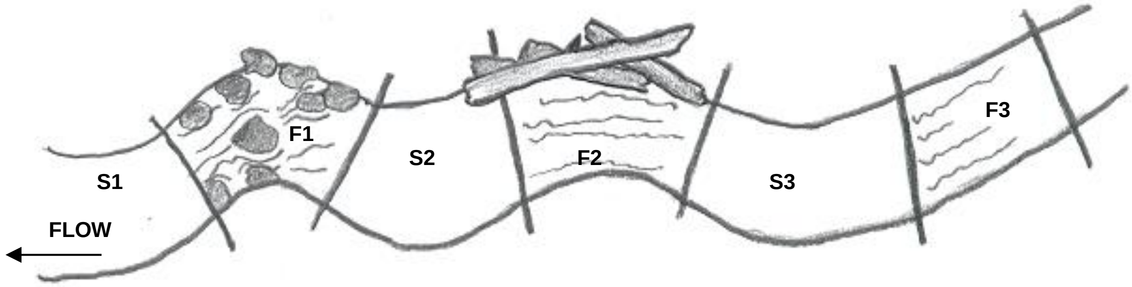
Know the predictable effects of recent peak discharge(s) within the watershed. The best indicator of bankfull flow is the deposits of streambed material which remain after a recent bankfull event. For entrenched streams, these may be small pockets or tiny inclusions of fine substrate scattered along a bank of the stream. All indicators of bankfull may be impacted by flood flows that exceed an average bankfull event. For example, a recent large flood can produce new depositional flats, changes in substrate size and slope and debris and stain lines all perched above the bankfull level for the stream. Take counsel from a local hydrologist and look for remnant deposits and woody vegetation that indicate the enduring features of true bankfull dimensions.

Stretch a measuring tape taut, level, and perpendicular to the thalweg across the channel at the elevation of the clear bankfull indicators. Enter the measurement of BFW to the nearest 0.1 ft.

If clear indicators of bankfull flow are absent in the first three encountered fast water units, no bankfull or floodprone measurements should be taken. The surveyors must then investigate each succeeding fast water unit for clear indicators of bankfull flow. Once bankfull indicators are discovered, the surveyors will make the bankfull and floodprone determinations at that fast water unit and enter the data with that channel unit.

NOTE: Be aware in streams with shorter reaches dominated by fast water units three bankfulls/floodprone measurements still need to be collected. Be sure to break the fast water units into manageable lengths in order to meet the minimum three measurements. Multiple bankfull/floodprone measurements can be taken in the same unit if needed to meet the requirement.

Fig. 11: An example showing what to do when the first fast water channel units don't have any clear indicators of bankfull width.



Oh, Oh, F1 is the fast water channel unit where you're supposed to determine bankfull. But you discover there are no clearly visible bankfull indicators. When that happens you must search for clear bankfull indicators in the next fast water channel unit.

In this example, F2 also lacks clear bankfull indicators because of a debris jam on the right bank. So you continue to the next fast water channel unit, where you find clearly visible bankfull indicators. Therefore, bankfull and floodprone measurements are recorded with channel unit F3. Proceed to collect bankfull and floodprone measurements on the next two fast water channel units with clearly visible bankfull indicators.

17 through 26. BANKFULL DEPTH (BFD1, BFD2, BFD3, BFD4, BFD5, BFD6, BFD7, BFD8, BFD9, BFD10): At each measured fast water unit, 10 bankfull depths will be measured. These measurements will be made at the same location as the site for bankfull width (BFW). To calculate the interval across your channel cross section, first divide your bankfull width by 10 resulting in a value of A. Then divide A by 2 to determine how far to measure out from the edge of the bankfull width to the first measurement location along the measuring tape. To get subsequent measurement locations, add A to the consecutive measurement location.

For example, the bankfull width is 10 feet across, 10÷10 = an interval of 1.0 feet, divide the interval 1÷2 = first measurement location is at 0.5 feet. Measure the bankfull depth at 1.0 foot intervals across bankfull channel. Measure at 0.5, 1.5, 2.5, 3.5, etc.

Bankfull depth is the measured height from the streambed to the measuring tape stretched taut and level across the channel at a height equal to bankfull flow. Record each bankfull depth (BFD) measurement to the nearest 0.1 ft.

It is expected that some of these measurements will be made outside of the wetted channel atop dry streambed since the surveys are performed under low streamflow conditions. See figure 12 for a visual depiction of the process.

27. MAXIMUM BANKFULL DEPTH (max BFD): At the same time average bankfull depth is determined, measure and record the maximum bankfull depth along the stretched tape. This will inevitably be found along the thalweg in the wetted channel. It is simply the maximum elevation measured between the tape measure and the streambed. Record the measured value to the nearest 0.1 ft (see figure 12).

28. FLOODPRONE WIDTH (FPW): Floodprone width is measured at the horizontal level found at two times the maximum bankfull depth. At either end of the measuring tape where pinned, place the bottom of the survey rod on the level of the tape set at the bankfull depth elevation. On the survey rod, find the numerical value of max BFD that was just measured in the bankfull transect. A measuring tape could then be stretched level, at the same elevation as the max BFD, across the valley floor until the tape touches the ground on either side of the stream. For longer horizontal measurements, use a level from that height on the rod to sight over to where the sideslope intersects the floodprone depth level.

The floodprone width is determined by extending the floodprone elevation across the valley floor (see figure 13). The floodprone width is the width of the valley floor inundated during a flood, which occurs approximately every 50 years.

If the floodprone width is less than 2.5 times the bankfull width at that location, measure to the nearest foot. If the floodprone width is greater than 2.5 times the bankfull width at that location, simply estimate the floodprone width. The ratio of floodprone width to bankfull width is referred to as the entrenchment ratio, and this ratio is useful in refining the level I Rosgen Stream Type for each reach.

Figure 12: Where to measure bankfull depths (BFD) in order to determine the average BFD and maximum BFD

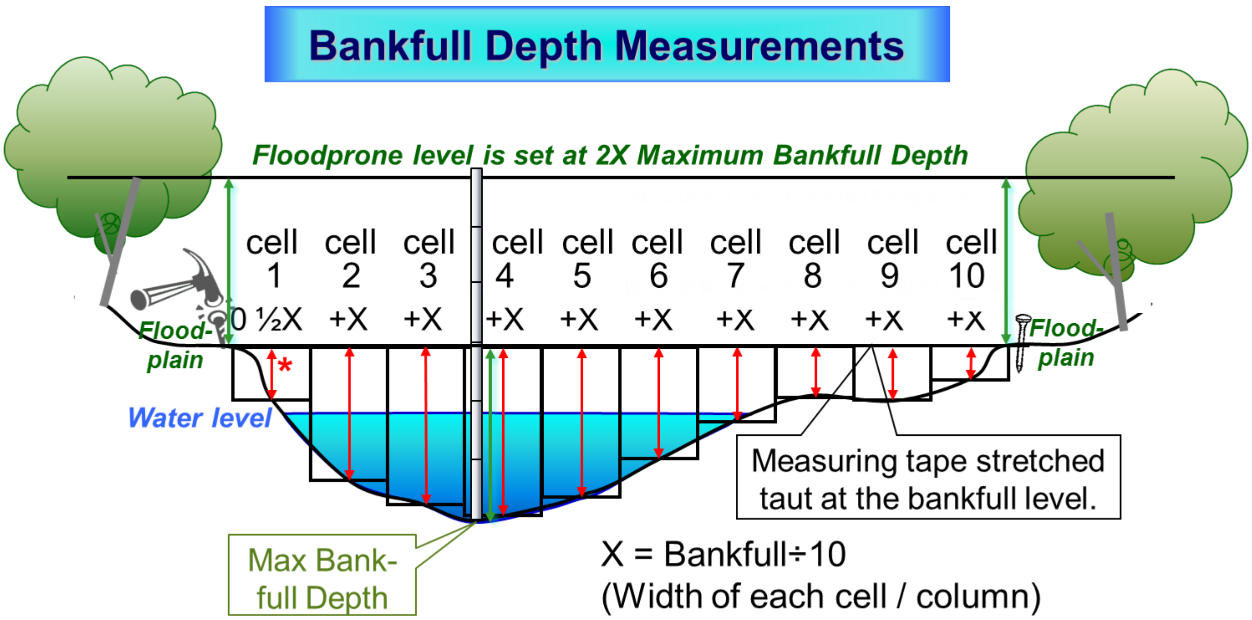
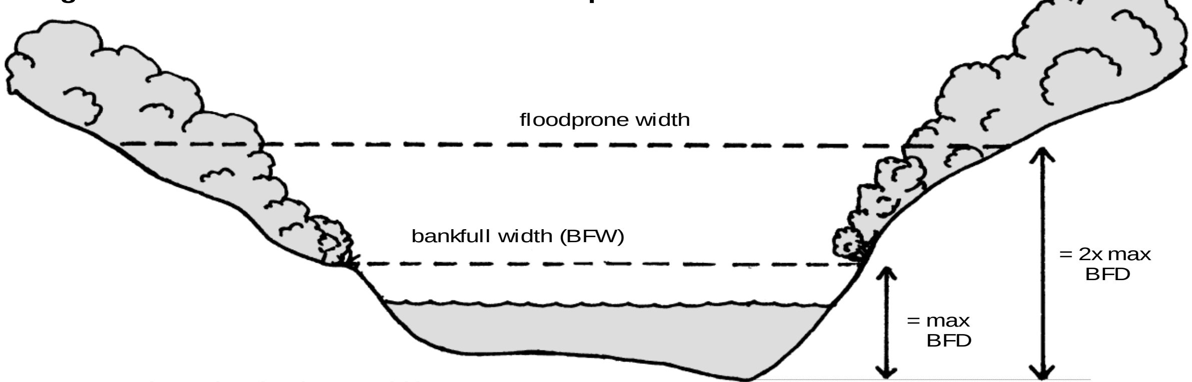


Figure 13: How to determine the floodprone width



Steps to determine floodprone width:

1) Measure max bankfull depth (BFD) (on the bankfull transect).
2) Determine floodprone depth = 2 x max BFD.
3) Stretch tape across stream at height of floodprone depth, (Keep that tape level!) and measure distance between floodprone banks = floodprone width.

[Note: entrenchment ratio = (floodprone width)/(bankfull width)]

29, 30, 31. RIPARIAN VEGETATION (INNER ZONE): Ten percent of main channel units (fast, slow, and dry) will have riparian vegetation collected. No random start is needed. Starting with the fifth SO measure every tenth unit after (i.e. SO5, SO15, SO25, SO35, etc.). If the designated SO falls on a special case, tributary, or side channel, collect the data on the next main channel habitat. The width of the inner riparian zone is variable by reach and specified on the Final Reach Form. Once a width for the zones has been established, that distance must be maintained throughout the reach. Aerial photographs are usually sufficient to establish the average inner riparian zone width for each reach identified during the level I (office phase) inventory. A level II inventory seeks to characterize the average condition of the riparian vegetation for each reach. It is from the description of each measured channel unit's vegetative condition that the average for the reach is determined.

It is a "Forest Option" to designate either a single 100-ft. wide riparian zone or two adjacent riparian zones (inner and outer zones) totaling 100 ft. in width. If a Forest chooses to characterize a single riparian zone, the data is entered to the columns labeled "Riparian Vegetation (Inner Zone)," and the remaining columns for vegetation labeled "Riparian Vegetation (Outer Zone)" are left blank. If two zones are designated data will be entered on the Forest Options Form in Appendix C.

29. CLASS: Enter the existing riparian vegetation successional class within the inner zone of each measured channel unit. Use the following diameter codes to describe the riparian successional class (see Appendix D for illustration and definitions of successional stages). It is rare for riparian forests to consist of a single successional (i.e., seral) class. The task is to define from an overhead (i.e., bird's-eye) view which successional class occupies the most overstory area within the inner zone width along both banks of the measured channel unit. It is the average of both banks' condition.

DIAMETER CLASS

NV = No Vegetation (bare rock/soil, dbh not applicable)
GF = Grassland/Forb Condition (dbh not applicable)
SS = Shrub/Seedling Condition (1.0 - 4.9 in. dbh)
SP = Sapling/Pole Condition (5.0 - 8.9 in. dbh)
ST = Small Trees Condition (9.0 - 20.9 in. dbh)
LT = Large Trees Condition (21 - 31.9 in. dbh)
MT = Mature Trees Condition (> 32 in. dbh)

If no overstory layer is present and the dominant vegetation in the inner zone is in seral class GF, enter GF for (seral) Class. If the dominant vegetation in the inner zone is in seral class SS, enter SS for (seral) Class.

30. OVERSTORY: Enter the dominant overstory species of vegetation growing in the inner zone for each measured channel unit, using the species codes listed below. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the inner zone along both banks of the measured channel unit. It is the average of both banks' condition.

If the seral class in the inner riparian is SP, ST, LT, or MT, use the following codes to identify the dominant overstory species. Forests may add to this list to include additional vegetation species. At a minimum, HX and CX can be used to denote hardwoods and conifers respectively.

Hardwood:
HA = Alder
HB = Bigleaf maple
HC = Cottonwood, ash, poplar
HD = Dogwood
HE = Elderberry
HL = Liveoak, canyon
HM = Madrone
HO = Oak, Oregon white, California black
HQ = Quaking aspen
HT = Tanoak
HV = Vine Maple
HW = Willow
HX = Other/unknown

Conifer:
CA = Subalpine fir, mountain hemlock, whitebark pine
CC = Cedar, western red
CD = Douglas-fir
CE = Subalpine fir _ Engelmann spruce
CF = Fir, silver and noble
CH = Hemlock, western
CJ = Juniper
CL = Lodgepole pine, shore pine
CM = Mountain Hemlock
CP = Ponderosa pine, Jeffrey Pine
CQ = Western white pine
CR = Red fir
CS = Spruce, Sitka
CT = Port-Orford-cedar
CW = White fir, grand fir
CY = Yew
CX = Other/Unknown

If there is no clear dominant species of tree in the overstory layer, then enter one of these three conditions as dominant: shrub/seedling, grass/forb, or no vegetation**.**

SHRUB SEEDLING HEIGHT [Forest Option]: Forests have the option of designating the height class of the shrub seedling class wherever no dominant overstory species is present. For example, if shrubs between 5 and 10 feet tall are the dominant successional class in the inner zone, the entry for dominant overstory species would be SS3 (see Eastside example below). Shrub height classification is an optional field and applies only to seral class SS. Use the following categories:

1 = 0 ft. - 2 ft.
2 = 2 ft. - 5 ft.
3 = 5 ft. - 10 ft.
4 = > 10 ft.

31. UNDERSTORY: Enter the dominant understory species growing in the inner riparian zone for each measured channel unit, using the species codes listed below. Each Forest can decide what defines the understory, and how to estimate conditions in this riparian vegetative layer. Contrasting views of understory include what species are likely to replace the canopy dominants with time and presently are sapling/pole versus what is the vegetative site potential where the understory is likely to be small shrubs.
Examples:

The examples depend on how Forests interpret the understory component of riparian vegetation and in no way restrict Eastside and Westside forests to the methods described in the examples.

Eastside _ If seral stage in the inner zone is Grassland/Forb, with grasses dominant with a few shrubs 3 ft. tall: the entries for Class/Overstory/ Understory might be GF/SS2/GF. If seral stage is shrub/seedling dominant, with shrub/seedlings 30 ft. tall and alder subdominant the riparian vegetation might be categorized as SS/SS4/HA.

Westside _ Seral stage is large trees with Douglas-fir dominant in the overstory and western hemlock dominant in the understory, the designation for riparian condition might be LT/CD/CC.

RIPARIAN VEGETATION (Outer Zone) FOREST OPTION

This data is entered on the Forest Options Form in Appendix C.

CLASS: Enter the existing riparian vegetation successional (i.e., seral) class within the outer zone of each measured channel unit. Use the diameter codes described in #28 (see Appendix D, pg 106 for an illustration and definitions of successional stages). The task remains the same as described for the inner riparian zone. Define from an overhead (i.e., bird's-eye) view which seral class occupies the most overstory area within the outer zone width along both banks of the measured channel unit. It is the average of both banks' condition. Whenever a Forest chooses to characterize a single riparian zone, it is considered an inner zone of 100 ft. In such a case, there is nothing recorded for the "Riparian Vegetation (Outer Zone)".

OVERSTORY: Enter the dominant overstory species of vegetation growing in the outer riparian zone for each measured channel unit, using the species codes listed for #29 and #30. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the outer riparian zone along both banks of the measured channel unit. It is the average of both banks' condition. Forests again have the option to designate the height class of shrub/seedling wherever that seral class is the dominant overstory component (see #22 for an explanation).

UNDERSTORY: Enter the dominant understory species growing in the outer riparian zone for each measured channel unit. Use the species codes listed for #29 and #30. It is the task of individual Forests to define the characteristics of the understory of interest to them.

32, 33. WATER TEMPERATURE:

32. DEGREE: Take stream temperatures within the mainstem channel at the same time Riparian Vegetation is being collected. It is also recommended to take a water temperature at the start and end of each survey day. Enter to the nearest Celsius degree. Submerge the thermometer for at least 1 minute to allow a handheld thermometer to adjust to the water temperature.

NOTE: Temperatures should be recorded in degrees Celsius.

Stream temperatures should also be recorded for each tributary encountered and entered to the Temperature field for the tributary.

33. TIME: Enter the military time when temperatures are taken, and record the time to the nearest hour (e.g., 1400).

It bears repeating for emphasis that every stream to be surveyed shall have a long-term temperature recording device installed in a slow water unit near the start point of the inventoried stream that will record water temperatures from mid-June through late-September.

STREAMBED SUBSTRATE [Forest Option]: This data is entered on the Forest Options Form in Appendix C. Enter the visually estimated percent that each size class of substrate comprises of the wetted streambed area. This estimate is made only after the observer has walked the length of the entire channel unit. If any of the size classes of substrate listed below constitute at least 10 percent of the area of the streambed, record the percent in the appropriate column, in increments of 10 percent, each size class supplies to the surface of the streambed. Each Forest has the option to collect estimates of streambed substrate or to disregard these qualitative attributes.

Caution: There is a tendency for observers to over-estimate the percent of streambed which is cobble or greater in size. Surveyors under-estimate the contribution to area made by the edgewater streambed. The margins of most channel units tend to have a streambed comprised of smaller substrate than commonly found in deeper portions of the channel unit.

Use the following size classes:

SA = Sand, Silt, and Clay	(<0.08 in....<2 mm.)	(smaller than "BB")
GR = Gravel	(0.08 _ 2.5 in....2 - 64 mm.)	("BB" to tennis ball size)
CO = Cobble	(2.5 _ 10 in....64 - 256 mm.)	(tennis ball size to basketball size)
BO = Boulder	(10.0 - 160 in....256 - 4096 mm.)	(basketball to small car)
BR = Bedrock	(>160 in. >4096 mm.)	(larger than a small car)

CHANNEL UNIT FORM

pg :____________ of __________

Protocol Used: E___ W___

R6-2500/2600-22

A. State________ B. County ___________________________ C. Forest___________________________ D. District___________________________

E. Stream Name___________________________ F. 8-digit HUC Code ____,____,____,____10-digit_____12-digit_____ G. USGS Quad ________________________________

H. Reach #_______ I. Sampling Frequency (Rip. Veg. & AB): F_____________________ S_________________________ J. Survey Start Date ________________________

K. Contacts: REC:__________________________________ OBS:_____________________________________ mm/dd/yyyy

Channel Units								Woody Material			Unstable Banks			Bankfull Measurements														Riparian Vegetation			Water Temp	
Seq.	Channel Unit Type & No.	Length	Wet Width	Max Depth	Avg Depth	Pool Crest Depth	Formed By	S	M	L	Total Length	Length Left	Length Right	Wetted Width at BF Site	BF Width	BFD 1	BFD 2	BFD 3	BFD 4	BFD 5	BFD 6	BFD 7	BFD 8	BFD 9	BFD 10	Max BF Depth	FPW	Class	Over story	Under story	°C	Time
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

Channel Unit Codes: S - Slow water (pool), **SD** - Dam Pool, **SS** - Scour Pool, **SSPL** - Plunge Pool, **SDBV** - Beaver Dam Pool, **F** - Fast Water (riffle), **FT** - Fast Turbulent, **FN** - Fast Nonturbulent, **SIDES** - Side channel (slow), **SIDEF** - Side channel (fast), **CHUNIT D or D** - Dry Main Channel, **ARTIF** - culverts, dams (Special Cases Form), **WF** - Waterfall (Special Cases Form), **CH** - Chute (Special Cases Form), **CHUNIT(M)** - Marshlands (Special Cases Form), **BVD** - Beaver Dam (Special Case Form), **T** - Tributary

Formed By: **BV** - Beaver, **WD** - Wood, **BR** - Bedrock, **BO** - Boulder, **SB** - Stream Bend, **TR** - Tributary, **CU** - Culvert, **DA** - Dam, **RS** - Restoration, **OT** - Other

SPECIAL CASES FORM (CULVERTS, DAMS, BEAVER DAMS, FALLS, CHUTES, AND MARSHLANDS)

R6-2500/2600-23

This form is intended to encompass both manmade and natural special case units. It will be used to document specific information on manmade units such as culverts (road crossings encountered during the survey) and dams. Culverts and dams are to be noted on the general Channel Unit Form as an “ARTIF" channel unit type. Natural features include information on falls, chutes, beaver dams, and marshlands. These are aquatic channel units that do not fit the standard channel unit types entered to the Channel Unit Form.

Definitions:

CULVERTS: A pipe or arch buried by road fill material through which a stream flows beneath a road.
NOTE: In the event where multiple culverts are present under a road choose the pipe with the best access to fish. Record required data on the Special Case Form. Data regarding the other culverts should be recorded on the Special Case Form and the comments but no SO would be assigned to these culverts. In the event where multiple pipes have similar attributes record the culvert type of one, the length of one, the sum of wetted widths of all, the depth inside one of the culverts (enter data on Channel Unit Form), the gradient of one, the jump height of one, and the spill pool depth immediately downstream of the measured pipe.

FALLS: An essentially vertical drop in the channel bed that results in a waterfall. This is considered a fast water unit. It is a Forest-level decision as to what height of the drop constitutes a Special Cases channel unit.

CHUTES: A section of the channel, usually constrained by bedrock, resulting in a funneling of stream flow through a narrow constriction. This is considered a fast water unit.

BEAVER DAMS: A dam built by a beaver made of wood/twigs/mud and is channel spanning and impounding water. This is the structure **ONLY** – it does **NOT** include the pool above which will be identified as a separate unit (SDBV).

DAMS: Specific **human-made** structures to impound water.

MARSHES: A water-saturated, poorly drained wetland area either permanently or periodically inundated with water. It has no discernable bankfull channel.

Large wood that engages bankfull flow within a special case channel unit is viable LWM. Tally and record with the appropriate channel unit.

NOTE: INSTRUCTIONS FOR COMPLETING THE SPECIAL CASES FORM HEADER (ATTRIBUTES A - H) ARE LISTED IN THE SURVEY FORM INSTRUCTIONS, Page 16.

1. REACH NUMBER: Enter the reach in which the culvert is located.

2. SO NUMBER: Enter the SO number assigned to the special case and entered on the Channel Unit Form.

3. CHANNEL UNIT TYPE AND NUMBER: Like other channel units of an inventoried stream, culverts and other special case channel units are sequentially numbered from downstream to upstream. For example, every culvert is assigned an "ARTIF" as the prefix to the ARTIF unit number. The same process applies to each of the Special Case channel units: falls (WF), chutes (CH), beaver dams (BVD), marshlands (ML), and dams (ARTIF).

4. TYPE OF STRUCTURE (applies only to culverts): Indicate the type of culvert by writing in the appropriate type from the diagram at the bottom of the data sheet. (e.g., open arch)

5. LENGTH OF STRUCTURE or CHANNEL UNIT: Lengths will be entered on the Channel Unit Form as well as the Special Cases Form.

> **Culverts**: Enter the length of the culvert measured along the bottom of the culvert from the outlet to the inlet. Record to the nearest 1 ft. If multiple culverts exist at the site record only the length of the culvert with the best fish passage. (**NOTE:** Only **ONE** length should be recorded at each culvert site even when multiple culverts are present).
> **Dams**: Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow. Record to the nearest 0.1 ft.

6. DIAMETER OR WIDTH: Enter the measured diameter or width of the structure (culverts and dams). If an arch, open arch, box, or open box, measure maximum width. If multiple culverts are present at the site and all have similar passage for fish sum the widths of all culverts. Enter average wetted width for a falls, chute, or marshlands.

7. GRADIENT: Enter the measured gradient as a percent slope using a hand level, abney level, or peep site. Measurement of slope using a clinometer is not acceptable. Gradient is required for culverts, falls, and chutes. In addition a gradient will be taken at each Wolman pebble count site. Gradient is optional for marshes and dams. Enter the gradient of the Special Case channel unit in percent slope, to the nearest percent. This can be determined most easily by dividing the height of the Special Cases channel unit by the channel unit's length (rise/run).

8. JUMPING DISTANCE (Culverts and falls): Enter the measured height from the surface of the stream to the culvert's lip (downstream end) or the top of the falls.

9. SPILL POOL DEPTH (Culverts and falls): Enter the depth of the pool (slow water unit) downstream of the channel unit. A spill pool is a pool immediately downstream of a falls or culvert.

10. HEIGHT (Falls, chute, dam or culvert,): Enter the height of the special case channel unit. Height is the vertical difference between the water level at the downstream end of the falls, chute, or dam from the water level to the upstream end of the special case unit. Height for a culvert is the vertical diameter of the culvert (top to bottom).

11. BAFFLES PRESENT: Baffles are flow detectors that create velocity breaks inside the culvert; these velocity breaks provide resting areas for fish migrating upstream. Record Y for Yes, N for No to indicate the presence or absence of baffles in the culvert.

12. MIGRATION BARRIER: Record Y for Yes, N for No to indicate if the channel unit is a barrier to fish passage.

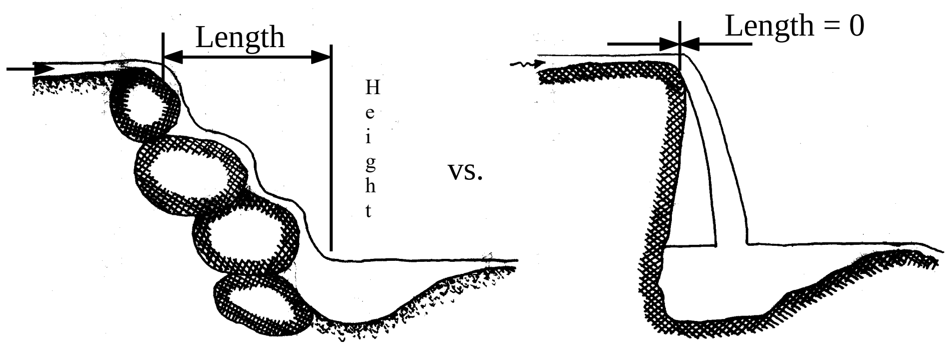
13. COMMENTS: Enter any pertinent comments for the feature. Such as:

- Culverts: If there are multiple culverts list the number of culverts, dimensions of the culverts outside of the best fish passage culvert.
- Falls is actually a series of three steps with no intervening slow water units.
- Large beaver dam creating 3 foot deep pool behind.

Required attributes for Special Cases

Falls:	Height, wetted width, jump height, migration barrier, and gradient are required.
Chutes:	Length, width, height, and gradient are required. Height is defined as the elevational change between the bottom and the top of the chute. To calculate chute height using an Abney level, measure the slope angle of the chute in degrees. The height equals the product of the length of the chute multiplied by the sine of the angle.
Dams:	Length, width, height, and migration barrier are all required. Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow.
Beaver Dam:	Length, width, and height are all required. Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow.
Marshes:	Both length and width of the valley floor in a marshland condition are required.
Culverts:	Type of structure, Length of structure, width of structure, height of structure, gradient of structure, jumping distance, spill pool depth, baffles present, migration barrier

Figure 15. A contrast between a waterfall with length and a waterfall with no length.



The waterfall on the left is formed of boulders; provides no resting habitat between the plunge pool downstream and the habitat upstream of the falls. The boulder falls has channel length, while the bedrock waterfall on the right plunges over a vertical lip. The bedrock falls has no length.

SPECIAL CASES FORM

(Culverts, Dams, Falls, Chutes, and Marshlands)
R6-2500/2600-23

A. State ___________ B. County ___________ C. Forest __________ D. District __________
E. Stream Name ____
F. 8-digit HUC Code ____, ____, ____, ____ 10-digit ____12-digit_____
G. USGS Quad ____
H. Survey Date _____/___/_______ I. Contacts: Observer:___________________________Recorder:___________________________
MM / DD / YYY

Reach #	Sequence Order #	Channel Unit Type and No.*	Type of Structure (culverts)**	Length of Structure or Channel Unit (ft)	Diameter or Width (ft)	% Gradient	Jumping Distance (ft)	Spill Pool Depth (ft)	Height (ft)	Baffles Present (Y or N)	Migration Barrier (Y or N)	Comments
1	2	3	4	5	6	7	8	9	10	11	12	13

*Channel Unit Type = **ARTIF** (Culvert, Dam), **WF** (waterfall), **CH** (Chute), **ML** (Marshlands), **BVD** (Beaver Dam)

**Type of Structure (for culverts only). This data entered into Comments area in Aquatic Survey database only

Round Pipe (RP) Box (BX) Arch (AR) Open Arch (OA) Open Box (OB) Elliptical (EL)

COMMENTS FORM
R6-2500/2600-25

The function of the Comments form is to provide additional space, if needed, for any comments concerning channel unit condition, observed biota, riparian condition, upland condition, etc. that won't fit in the "Comments" space provided on some of the field forms (Final Reach Form, Special Cases Form, and Aquatic Biota Form. Consider developing codes for recurring comments (such as RW for a root wad); this will assist in querying data at a later time.

NOTE: INSTRUCTIONS FOR COMPLETING THE COMMENTS FORM HEADER (ATTRIBUTES A - H) ARE LISTED ON THE SURVEY FORM INSTRUCTIONS, pg 16).

1. REACH NUMBER: Enter the number of the reach where the observation is made.

2. SEQUENCE ORDER (SO): Enter the SO for the channel unit that is the focus of the remark as listed on the Channel Unit Form.

3. CHANNEL UNIT TYPE AND NUMBER: Enter the channel unit type and number of the channel unit that is the focus of the comment as listed on the Channel Unit Form.

4. COMMENTS: Enter your comments regarding any of the above evaluations and photos; or geomorphological, hydrologic, or biological observations here. For culverts, dams, falls, chutes, and marshes use the Special Cases Form to document specific information regarding these features. Other suggested features to note are:

Fish passage: jams, barriers, fish habitat improvement opportunities, etc.

Watershed concerns: landslides, erosion areas, streambank damage, watershed rehabilitation potential, etc.

Braided Channel: When a fast water unit has a series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands the area is considered a braid. These secondary channels offer very poor winter refuge for juvenile salmonids, yet may offer high quality spawning opportunities for large adults. A remark shall be made in the comments section that this fast water channel unit was a braided section.

LWM: Debris jams, large amounts of wood too short or too small in diameter to be tallied in the small category, wood accumulations above bankfull.

Bankfull dimensions: not measured in one of the first 3 fast water units in the reach. A comment stating the reasons for not measuring bankfull/floodprone should be recorded.

Other: diversions, mining, dredging, filling, riprap, undocumented campsites, etc. Also identify reaches that are within Wild and Scenic rivers and wilderness areas.

Tributaries: Note the channel unit at the confluence, bank orientation, estimated tributary discharge, the channel gradient of the tributary immediately upstream of mouth, and the percent contribution to the flow of the mainstem stream. Also make note of dry tributaries.

End of Survey: Note the reasons for ending the inventory at a given point. The upstream endpoint for the inventory must be geographically defined so that the point can be reestablished in the future. If possible, mark beginning and end of each reach with a metal tag attached to a tree and describe the location of the tag in “Comments” section. This information will give the reviewer insight as to the reasoning for ending the survey, and will minimize the need to re-examine that point in the watershed. (e.g., riparian buffers intact, 10-yr old revegetation on upland R.BANK slope)

COMMENTS FORM
R6-2500/2600-25

Page: ____ of ____

A. State __________ B. County ___________ C. Forest ___________ D. District ____________

E. Stream Name ____

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit ____12-digit_____

G. USGS Quad ____

H. Survey Date ____/______/______
MM/DD/YYYY

Reach No.	SO	Channel Unit Type and No.	Comments

AQUATIC BIOTA FORM

R6-2500/2600-30

This form is to be used to document the range and distribution of aquatic-dependent species identified during the inventory. Although the focus is on those species that are dependent on water for all life stages (fish), amphibians are to be noted. Sampling methods will focus on those specific to collecting/observing fish species. The sampling intensity may vary between Forests, but the minimum biological survey effort when combining the aquatic biota survey with the aquatic inventory is to sample one of every ten slow water units and one of every twenty fast water units. No random start is needed. Starting with the fifth fast water and the fifth slow water, sample every tenth slow water and every other tenth fast water. (i.e. S5,S15, S25,S35, etc, and F5, F25, F45, etc.). Snorkeling, electroshocking, hook and line, minnow trapping, or seining are the only acceptable methods of biological survey.

If the biological survey does not take place at the same time as the stream inventory it is acceptable to sample at known locations within the surveyed stream such as road or trail crossings. Samples may also be performed between known locations at which time a GPS location should be obtained. Please see the Appendix E for the R6 Aquatic Biota Only Protocol for more detailed information on this procedure. The Aquatic Biota Form in this manual can be used for either method.

Identification of aquatic species is carried to the taxonomic level of which the observer is sure. Ideally, genus and species is sought, since the objective is to determine the species distribution across the stream section surveyed. Stealth during your approach to a target channel unit may increase the chances for identification of the species present.

Identify species only when directly observed. If individual organisms are measured or their lengths estimated, the units of measure must be millimeters.

SAFETY

All safety issues addressed in the Field procedures section on pg 26 also pertain for daytime snorkeling, night snorkeling, snorkeling in swift water, and electroshocking. In addition, all snorkelers must be able to swim and be certified by the Forest Dive Safety Officer (this person will ensure that each snorkeler has the proper training and skills to perform the assigned tasks). A JHA specific to the activity must be prepared prior to that activity taking place. A tailgate safety session must be held as part of each day’s biotic inventory efforts. Additional hazards specific to snorkeling and electroshocking such as the following need to be addressed:

- Hypothermia,
- Entanglement, especially in debris jams,
- Electrocution,
- Drowning,
- Disorientation during night snorkeling,
- Fatigue while driving at night.

NOTE: INSTRUCTIONS FOR COMPLETING THE AQUATIC BIOTA FORM HEADER (ATTRIBUTES A -G ARE LISTED IN THE SURVEY FORM INSTRUCTIONS (page 16)).

NOTE #2: If aquatic biota (fish, amphibians, macroinvertebrates, etc. are observed outside of the formal AB survey the data should be entered on this form with as much accuracy as possible.

H. REACH NUMBER: Enter the number of the reach where sampling occurred.

I. WATER and AIR TEMPERATURE (^{o}C)/TIME: Enter water and ambient air temperature (in degrees Celsius) at time of biological survey.

NOTE: All fields with an * are optional.

1. SEQUENCE ORDER (SO): Enter the Sequence Order number as listed on the Channel Unit Form of the channel unit in which the fish and/or amphibian identification occurred.

2. CHANNEL UNIT TYPE AND NUMBER: Enter the channel unit type and number assigned to the SO described in #1 (above) as listed in the Channel Unit Form.

3. DETECTION METHOD: Enter method used for collection /identification on the AB Form. (See AB Form for Detection Methods).

4. DETECTION TYPE: Enter the appropriate type on AB Form. (See AB Form for Detection Types).

5. DATE: Date survey was performed

6. START TIME: Time (HH:MM (24 hour clock)) sampling began.

7. END TIME: Time (HH:MM (24 hour clock)) sampling ended.

8. # OF OBSERVERS*: Enter number of actual observers (Ex. If one person is snorkeling and one person is recording enter 1).

9. VISIBILITY*: Enter one of the following:

- **Good:** Excellent ability to detect organisms being observed.
- **Moderate**: Fair ability to detect organisms being observed.
- **Poor**: Difficult to detect organisms being observed.

10. SPECIES (CODE): If only identified to genus, enter the first 2 alpha characters of the genera, and denote species by XX. If identified to species, enter the first two letters of the genus, followed by the first two letters of the species. These codes are shorthand for the Aquatic Biota

Form. Data entry into NRM Aquatic Surveys (Biota) will require the user to choose the correct scientific name.

Example: Two snorkelers see several juvenile trout but neither can identify if they are rainbow (*Oncorhynchus mykiss*) or cutthroat trout (*Oncorhynchus clarkii*). The observations are entered to NRM Aquatic Surveys (Biota) as *Oncorhynchus.*
Amphibian species can be treated in an identical manner using a four-letter code designating genus and species for all amphibians encountered. There are two field guides that can provide surveyors with excellent color photos, a species description, a brief discussion of habit and habitat, and distribution maps for each amphibian species: *Amphibians of Oregon, Washington and British Columbia: A Field Identification Guide*, by Charlotte C. Corkran and Chris Thoms and *Amphibians of Washington and Oregon: The Trailside Series,* by William P. Leonard et al. (e.g., SACO)

11. COUNT ESTIMATE*: Enter the estimated number of individuals observed by class and species. Enter the actual count if you are using an AB_Count protocol.

12. LIFE STAGE*: Enter the life stage of the species observed. See Appendix F for values.

13. LIFE HISTORY*: Enter the life history of the species observed. See Appendix G for values.

14. MIN SIZE*: Enter the minimum size (length) of the species observed.

15. MAX SIZE*: Enter the maximum size (length) of the species observed.

16. SIZE UOM*: Enter the unit of measure used to measure the length of the organisms (inches, mm, cm, etc.)

17. COMMENTS: Enter comments regarding any of the evaluations and document photos. Additional comments might include geomorphic, hydrologic, or biological observations. (e.g., several stream restoration structures in this reach offering excellent cover for juvenile trout)

While the FS is responsible for the stewardship of habitat for fish and amphibians, it is the state agencies that remain empowered to protect the species. Both Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife require personnel engaged in sampling fish populations obtain a permit. A federal permit is required to snorkel, seine, or electroshock in any stream that has fish or wildlife with federal status as “threatened” or “endangered.” The U.S. Fish and Wildlife Service has jurisdiction over resident fish and wildlife; NOAA Fisheries is the permitting agency for salmon and other anadromous fish.

PARTIAL LIST OF FISH AND AMPHIBIAN SPECIES

CODE	GENUS AND SPECIES	COMMON NAME
CAXX	*Catostomus* sp.	Unknown sucker
COXX	*Cottus* sp.	Unknown sculpin
GAAC	*Gasterosteus aculeatus*	Threespine stickleback
GIBI	*Gila bicolor*	Tui chub
JUVL	....	Unknown juvenile salmonid
ENTR	*Entosphenus tridentatus*	Pacific lamprey
LARI	*Lampetra richardsoni*	Western brook lamprey
LAXX	………..	Unknown lamprey
ONCL	*Oncorhynchus clarkii*	Cutthroat trout
ONGO	*Oncorhynchus gorbushcha*	Pink salmon
ONKE	*Oncorhynchus keta*	Chum salmon
ONKI	*Oncorhynchus kisutch*	Coho salmon
ONMY	*Oncorhynchus mykiss*	Steelhead, Rainbow, Redband trout
ONNE	*Oncorhynchus nerka*	Sockeye salmon
ONTS	*Oncorhynchus tshawytscha*	Chinook salmon
ONXX	*Oncorhynchus* sp.	Unknown salmon/trout
PRWI	*Prosopium williamsoni*	Mountain whitefish
PTOR	*Ptychocheilus oregonensis*	Northern pikeminnow
RHCA	*Rhinichthys cataractae*	Longnose dace
RHXX	*Rhinichthys* sp.	Unknown dace
SACO	*Salvelinus confluentus*	Bull trout
SAFO	*Salvelinus fontinalis*	Brook Trout
SATR	*Salmo trutta*	Brown Trout

AMPHIBIANS

CODE	GENUS AND SPECIES	COMMON NAME
AMGR	*Ambystoma gracile*	Northwestern salamander
AMTI	*Ambystoma tigrinum*	Tiger salamander
ASTR	*Ascaphus truei*	Tailed frog
BAWR	*Batrachoseps wrighti*	Oregon slender salamander
BUBO	*Bufo boreas*	Western toad
BUWO	*Bufo woodhousii*	Woodhouse’s toad
DICO	*Dicamptodon copei*	Cope’s giant salamander
DITE	*Dicamptodon tenebrosus*	Pacific giant salamander
ENES	*Ensatina eschoscholtzii*	Ensatina
PLEL	*Plethodon elongatus*	Del Norte salamander
PLDU	*Plethodon dunni*	Dunn’s salamander
PSRE	*Pseudacris regilla*	Pacific chorus frog
RAAU	*Rana aurora*	Red-legged frog

AMPHIBIANS (cont.)

CODE	GENUS AND SPECIES	COMMON NAME
RABO	*Rana boylii*	Foothill yellow-legged frog
RACA	*Rana cascadae*	Cascades frog
RAPI	*Rana pipiens*	Northern leopard frog
RAPR	*Rana pretiosa*	Spotted frog
RHCAS	*Rhyacotriton cascadae*	Cascade torrent salamander
SPIN	*Spea intermontana*	Great Basin spadefoot
TAGR	*Taricha granulosa*	Roughskin newt

FRESHWATER MOLLUSKS

CODE	GENUS AND SPECIES	COMMON NAME
ANCA	*Anodonata californiensis*	California floater
ANNA	*Anodonata nuttalliana*	Winged floater
ANOR	*Anodonata oregonensis*	Oregon floater
ANKE	*Anodonata kennerlyi*	Western floater
ANBE	*Anodonata beringiana*	Yukon floater
MAFA	*Margaritafera falcata*	Western pearlshell
GOAN	*Gonidea angulate*	Western ridged
MULA	*Musculium lacustre*	Western lake fingernail
COFL	*Corbicula fluminea*	Asian clam

MACROINVERTEBRATE TAXA

Ephemeroptera	Mayflies
Odonata	Dragonflies and Damselflies
Plecoptera	Stoneflies
Trichoptera	Caddis flies
Gastropoda	Gastropods, slugs, snails
Diptera	Midges
Heteroptera	Water striders
Coleoptera	Beetles
Megaloptera	Dobsonflies, fishflies, hellgrammites alderflies
Astacidae	Crayfish

AQUATIC BIOTA FORM
R6-2500/2600-30

Page: ____ of ____

A. State __________ B. County __________ C. Forest _________ D. District _________
E. Stream Name ____
F. 8-digit HUC Code ____, ____, ____, ____10-digit ____12-digit_____
G. USGS Quad ____
H. Reach Number ____________
MM / DD / YYYY
I. Water Temperature (ºC)/Time ____________________ Air Temperature (ºC)/Time ______________________

Detection Methods (enter method used for collection/identification in table below): Net (N), Visual (V), Efish (E), Angling (A), eDNA (D)

Detection Types (enter appropriate type in table below): Seine (S), Snorkel (SN), Wading (W), Backpack (BP), Hook and Line (H), Minnow Trap (M)

*Optional Fields

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SO	Channel Unit Type/No.	Detection Method	Detection Type	Date	Start Time	End Time	# of Observers*	Visibility*	Species (Code)	Count Estimate*	Life Stage*	Life History*	Min Size*	Max Size*	Size UOM*	Comments

CHAPTER - 4

Specialized Field Procedures Discharge and Wolman

STREAM HABITAT DATA DISCHARGE FORM

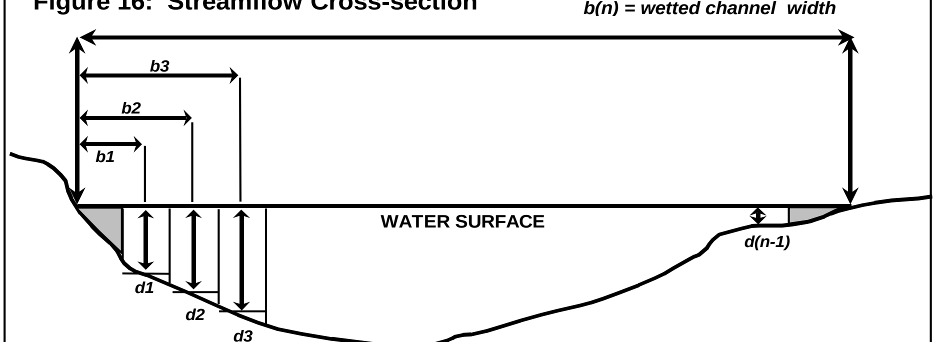
R6-2500/2600-31

The level II stream inventory is designed to identify habitats during low streamflow conditions. On most streams in the Pacific Northwest, low flow occurs in the summer. Habitats with only slight turbulence during low flow conditions are often quite turbulent as streamflow (discharge) increases. Stream discharge must be completed within 10 calendar days of beginning the physical habitat inventory. Only one discharge measurement is needed. By measuring discharge at the beginning of the field inventory, managers are able to compare inventories completed during different years on the same stream.

Stream discharge (Q) is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second (cfs). Discharge is simply the velocity multiplied by the cross-sectional area of the stream (Q=VA). Cross-sectional area is the vertical plane of water filling the channel, and this plane is always perpendicular to the thalweg. Area is approximated by dividing the wetted cross-section into subsections. The depth and width of each subsection are determined. Velocity is measured in each subsection using a current meter. The discharge for each subsection is calculated and the subsectional discharges are summed to derive a total stream discharge.

The figure below displays the mid-section method for dividing the stream cross-sectional area into subsections. The distance "b_n" is the width of the wetted channel. The distance, "b_1," represents the distance from the initial point ("O") to the location of the first depth and velocity measurements. The dotted lines indicate the vertical boundaries of each subsection, with the measured depth and velocity of each subsection occurring along the midline of the subsection.

Figure 16: Streamflow Cross-section



Three rectangular subsections are displayed by depth and distance from the water's edge to the midline of each subsection. The shaded triangles represent the stream margin, with a depth too shallow to measure velocity. The stream margins make a negligible addition to streamflow.

The best place to measure discharge is where laminar flow dominates and the flow is perpendicular to the cross-section. These conditions exist in gravel dominated fast water units or the shallow portions of pools near their pool tail crests. Seek a cross-section where smaller substrates dominate (cobble or finer) and turbulence is minimized.

Water in a channel flows at different rates depending on its location, so the area of the cross-section is divided into subsections, with one or more measurements taken for each. At least 25 to 30 subsections are needed for most channels, and no more than 10 percent of the total discharge (Q) should pass through any subsections. Add additional subsections for broad or structurally complex cross-sections.

For computing the area, the mid-section method (see figure above) uses the vertical line of each measurement as the centerline of a rectangular subsection; boundaries fall halfway between the centerlines. Discharge in the triangular subsections at the waters edge, where the water is too shallow to allow a meter reading, are negligible in terms of total discharge. Record a zero for the value of these two subsections' discharges.

Multiply the mean velocity for each subsection by the area of the subsection to compute the discharge (Q_n) for the subsection. Sum all subsection discharges to get the total discharge (Q) for the cross-section.

The field procedure is much like measuring elevations along the cross-section, except a current meter is used instead of a stadia rod. A two-person crew works best, one to operate the current meter and one to take notes. In high gradient or deep streams, use appropriate safety precautions.

CURRENT METERS

Meters commonly used to measure current velocity include: Marsh-McBirney, Swoffer, Price AA, and Pygmy. Some brands have rotating cups, while others have a pair of electronic contacts on a small head. Older models read out revolutions of the cups by clicking or buzzing into a headset. Newer models have a digital read-out.

Most current meters mount on a top-setting rod, which allows the current meter to be easily set to the correct depth. Top-setting rods are recommended for discharge measurement because they make the process simpler and quicker.

Examine the meter before going into the field, and read the manufacturer's instructions. Some meters (i.e., Price AA and Pygmy meters) will require a spin test before each measurement; a short series of strong breaths on a Pygmy should yield a minimum spin of 30 seconds. Or perhaps even test it in running water--using a nearby stream, irrigation ditch, or a garden hose aimed at the cups. Check the batteries providing power to the digital read-out and take spares. Calibrate your meters prior to the field season. If you have more than one meter, compare results from the same cross-sectional point, and calibrate the meters as necessary. Meter calibration services are available from the USGS and universities.

PROCEDURE FOR CURRENT VELOCITY MEASUREMENT

1. Stretch a measuring tape between the endpoints of your wetted channel, perpendicular to the flow and suspended above the water. The location of the measuring tape is the cross-section, and as such, it is acceptable to rearrange the streambed to promote laminar flow. It is best to remove the larger streambed particles causing irregular flow both upstream and downstream of the tape before beginning to measure velocity with the meter.

After streambed manipulation, divide the distance between the waters edges by 25 (at least) to set the interval for metering (e.g., the water surface is 22 feet across, 22 ÷ 25 = an interval of 0.88 feet, which can be rounded down to 0.8 to ensure a minimum of 25 subsections). Use closer intervals for the deeper parts of the channel or wherever you suspect flow through the subsection to exceed the 5 percent limit.

2. Record the time of day that discharge measurement was begun. Start at the waters edge, the recorder will call out the distance from waters edge to the center of the first subsection. The observer will place the rod and meter at that distance without touching the measuring tape. The observer will stand in the stream at least 15 inches downstream of the rod to reduce the potential of turbulence affecting the velocity measured by the current meter. Hold the rod in a vertical position with the meter directly into the flow. The observer will then call out the depth, then the velocity.

3. To take a reading, the meter must be completely under water, facing into the current, and free of interference. The meter may be adjusted slightly upstream or downstream of the tape measure to avoid cobble, boulders, or other obstructions. The recorder will call out the calculated distance for each velocity reading; however, the observer is free to change that distance (e.g., take velocity and depth readings at closer intervals through the thalweg).

- Take one or two velocity measurements at each subsection. **Assure the meter is reading in Feet per Second (F/S) not Meters per Second (M/S)).**
- If depth (d) is less than 2.5 ft., measure velocity (v) once for each subsection at 0.6 times the total depth (d) measured from the water surface (e.g., if d is 2 ft., measure at 1.2 ft. from the water surface, or 0.8 ft. above the bottom).
- If depth (d) is greater than 2.5 ft., measure velocity (v) twice, at 0.2 and 0.8 times the total depth (e.g., if d is 3 ft., measure at 0.6 ft. and 2.4 ft. from the water surface). The average of these two readings (+) is the velocity for the subsection.
- Allow enough time for each reading--a minimum of 40 seconds for most meters. The observer calls out the distance, then the depth, and then the velocity. The note taker repeats it back as it is recorded; this provides a check on the team's communication. Readings from some meters are simply a count of revolutions by the meter and must be converted by the note taker, while others read out digitally in feet-per-second.

4. The recorder will calculate the partial stream discharge for each subsection, and finally sum all of the subsectional discharges to determine the total discharge of the stream. If any of the subsections has a discharge greater than 10 percent of the stream's total discharge, the "problem" subsections will be further divided into smaller subsections such that none of these smaller partitions will exceed the 10 percent limit.

5. The observer will measure new depths and velocities at the midline of each of these smaller subsections. The recorder will calculate the partial stream discharge in each of the small subsections and sum these values. This new sum will replace the sum of discharges for all original subsections carrying more than 10 percent of the total stream discharge, and a new stream discharge will then be calculated.

COMPUTING DISCHARGE

When the velocity measurement is complete, calculate the total discharge (Q). Determining total discharge accurately is a complex issue, and a variety of methods and equations exist. The mid-section method is currently recommended by the USGS.

The following formula defines the basic method for calculating discharge:

$$Q = \Sigma (a\ v)$$

Where Q is the total discharge; a is the area of a rectangular subsection, the product of width (w) and depth (d) for that subsection; and v is the mean velocity of the current in a subsection.

1. Using the mid-section method, compute the area (a_n) of each subsection:

$$a_n = d_n \frac{b(n+1) - b(n-1)}{2}$$

Where b is distance along the tape from the initial point. "Lost" discharge in the triangular cross-sectional areas at the water's edges is assumed to be negligible. Simply record these two velocities with a value of 0.

2. Next, multiply the subsectional area (a_n) by the mean velocity (v_n) for the subsection; the result is the subsectional discharge (Q_n). If only one velocity measurement was taken at 0.6 depth, that value is the mean velocity (v_n). If two measurements (v_1 and v_2) were taken at 0.2 and 0.8 depth, compute the mean value as:

$$v_n = \frac{v_1 + v_2}{2}$$

3. To compute the discharge for each subsection, use the equation:

$$Q_n = a_n\ v_n$$

Where:

Q_n= discharge for subsection n,
a_n= area of subsection n, and
v_n= mean velocity for subsection n.

The calculation is repeated for each subsection, as shown below:

$$Q_1 = a_1 v_1,\ Q_2 = a_2 v_2,\ Q_3 = a_3 v_3, \text{ and so on...}$$

4. The subsection products are then added to get total discharge (Q):

$$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 \text{ and so on...}$$

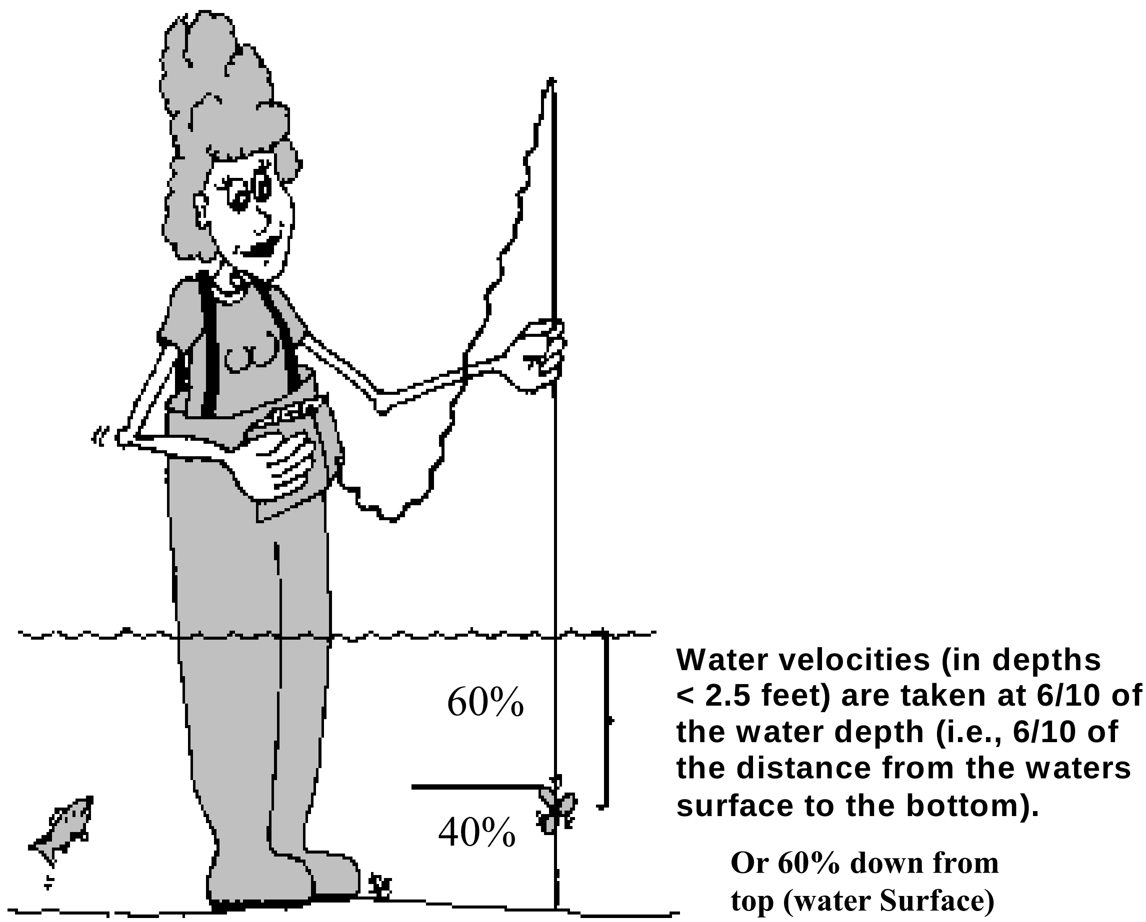
Thus, total discharge (Q) equals the sum of all subsectional discharges (Σ (a v)), as stated earlier in the basic equation:

$$Q = \Sigma (a\ v).$$

If you have any questions about this computation, draw a hypothetical cross-section, assign current velocities (from 0 to 5 ft. per second) to each subsection, assign a depth to the midline of each subsection, and work out a sample discharge before going to the field. Field crew members should understand this procedure and be able to compute sample discharges before field work begins.

Reference: Harrelson, C.C, C.L. Rawlins and J.P. Potyondy, *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, General Technical Report RM-245, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Co. 1994.

Figure 17: Water velocities are measured at 6/10 of the water column depth



DISCHARGE FORM Page: ____ of ____
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A. State __________ B. County __________ C. Forest __________ D. District ____________

E. Stream Name ____

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit _____12-digit_____

G. USGS Quad ____

H. Survey Date ____/_____/_____ I. Survey Time:__________________

MM / DD / YYYY

J. Observer/Recorder ____

K. Meter Type ________________ L. Comments ______________________________

REMINDER: Set meter to Feet per Second (F/S) not Meters per Second

Distance from initial point (ft)	Width (ft)	Depth (ft)	Observation Depth (ft)	Revolu-tions	Time in Seconds	F/S Velocity at point (ft/sec)	Velocity Mean in Vertical (ft/sec)	Area (ft²)	Discharge (cfs)

WOLMAN FORM
R6-2500/2600-32: WOLMAN PEBBLE COUNTS

PROCEDURE
The Wolman pebble count will be performed two times in each stream reach identified during the level I (office phase) inventory as delineated on the field map. One pebble count will be completed at approximately one-third and a second pebble count will occur at two-thirds of the total reach length. The fast water unit chosen for each pebble count should possess what is perceived to be normal conditions for fast water units already inventoried in that reach. The fast water unit chosen for the Wolman pebble count need not be a measured fast water unit. It is the surveyor's task to determine the normal condition of fast water units in each reach. The survey team needs to continually evaluate the following questions.

- What water level gradient is normal in the fast water units; less than 4 percent, greater than 4 but less than 10 percent, or greater than 10 percent?
- What substrate types best represent the reach; bedrock is common, cobble and gravel dominate, sand/silt/clay is common, etc.?
- Is LWM a common component of fast water units?
- Are the banks actively eroding in most fast water units?
- Are side channels commonly associated with riffles in the reach?

While the answers to these questions may change as more of the reach is observed, these channel characteristics will provide guidance in selecting a riffle that is representative or average for the reach. The first Wolman pebble count is performed in a representative riffle located at one-third of the reach's length; the second Wolman pebble count is performed in a riffle that is representative of the reach at two-thirds of the reach's length.

The pebble count technique (Wolman 1954) has long been used by geomorphologists, hydrologists, and river engineers to characterize rivers which flow on coarse material and are wadable during low flows. The procedure has recently been recognized by fishery biologists as a better alternative to characterize substrate than the visual estimation techniques commonly used in fisheries and instream flow studies. In addition, pebble counts are used on many National Forests as monitoring tools to evaluate entry of fine sediment into streams.

For monitoring purposes, a selected site is often measured for several years. Generally, individuals are interested in measuring changes to surface fines (i.e., sand, silt, or clay) due to management activities such as timber harvest, fire, or road construction. It is widely accepted that an increase in fines in stream channels is detrimental to fisheries.

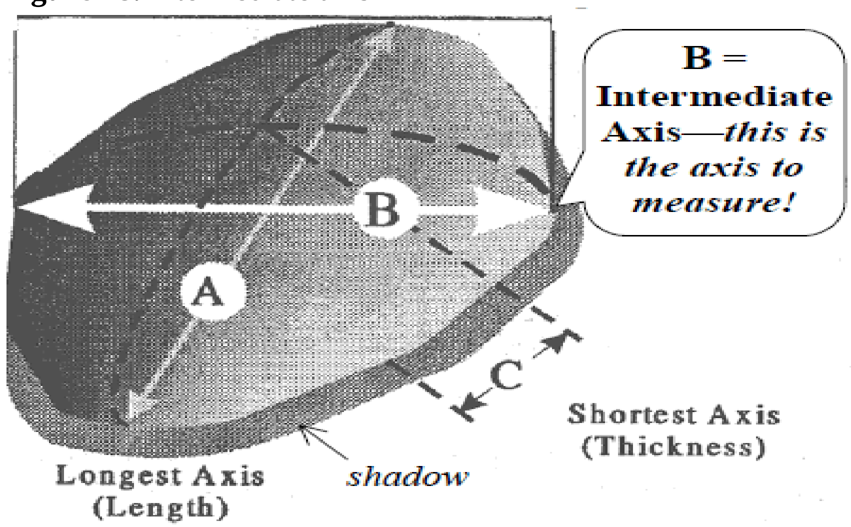
Several different schemes can be adopted to provide the minimum 100 tallies of substrate. One transect of 100 equally-spaced tallies can be selected, or two transects of 50 tallies each, or any combination that is linear and equates to at least 100 samples of the streambed. It is common to tally an excess of 100 samples, but avoid having less than 100. The transects must run from one edge of the bankfull channel to the opposite edge of the bankfull channel. These transects need not be perpendicular to the flow, but they must span the entire bankfull channel, with both the first and last substrate tally of each transect occurring at bankfull stage. Do not limit the sampling to the wetted channel! A zigzag set of transects is commonly employed through the chosen riffle.

As the channel dimensions decrease and habitats become smaller, it may be difficult to perform a complete Wolman pebble count in a single riffle. In such cases, it is quite acceptable to perform some of the tallies in slow water units, provided the transect chosen does not intentionally avoid the deeper portions of the slow water unit. Whenever slow water units are included in the Wolman pebble count, the percent of tallies in slow water units should approximate the percent that slow water unit habitat comprises of the total habitat of the reach.

THE PEBBLE COUNT TECHNIQUE

A pebble count consists of a random selection of at least 100 particles from the streambed. Individual pebbles can be selected from a grid system, but more commonly pebbles are selected from the toe of the boot along a toe-to-heel transect which traverses the stream from bankfull stage to bankfull stage. The intermediate axis of each pebble, defined as neither the longest nor the shortest of three mutually perpendicular axes of a particle, is measured. See Figure 18 below for a visual representation. The intermediate axis can be visualized as that dimension of the pebble which controls whether or not it would pass through a soil sieve.

Figure 18. Intermediate axis



The greatest source of bias in pebble counting is associated with the manner in which observers pick up particles. The natural tendency is to select larger rocks. To avoid this, observers will need to consistently use a fixed reference point, such as a mark on the tip of a boot, and a fixed point on the tip of the finger that descends into the water to select the particle for measurement. To limit the visual bias towards larger substrate, the observer should extend their finger over the boot without looking until the streambed is touched. The first particle touched by the tip of the finger will be measured. Because the technique requires physically picking up particles, it is commonly limited to wadable streams. Particles too large or too well cemented into the streambed to be removed must be estimated. Whenever possible, measure the lesser of the two exposed axes and record in the appropriate size class. In certain situations, the depth of the channel may impede sampling. Surveyors are encouraged to determine the dimensions of their boots so that the boots' width and length may be used as a surrogate for a millimeter ruler.

Pebbles down to 2 mm in size (very coarse sand) will be directly measured and tallied in the appropriate size class. Sand, silt, and clay particles will be tallied as "less than 2 mm". Wolman pebble counts also have a built-in bias against fine sediment due to the precision of selecting individual pieces of substrate. Numbing due to cool stream temperatures, low visibility in turbulent water, and our visual bias for larger substrate reduce the ability to accurately record fines (sand, silt, and clay) as streambed substrate tallies. By carefully lifting the finger from the streambed, the observer can reduce the bias against fine sediment. If a plume or cloud of fine sediment is released as the finger lifts, the tally should be in the "less than 2 mm" size class. Caution should be taken to recognize the difference between the organic material coating many streambed particles (= algal scum) and fine inorganic sediment resting atop larger particles of the streambed.

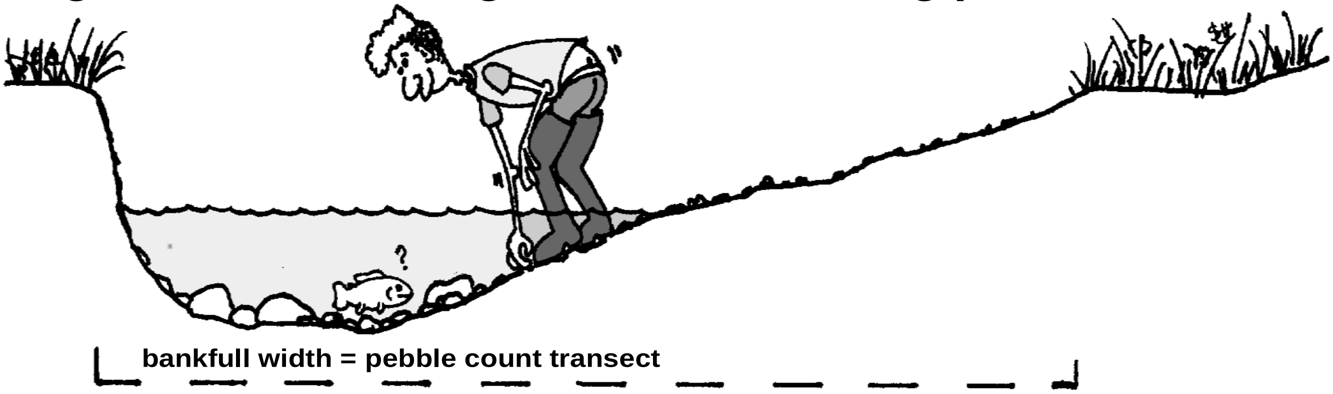
The number of pebbles in each size class will be tabulated and converted into percentages. Data will be plotted as a cumulative size distribution curve. "Cumulative percent finer" will be plotted on the y-axis, and "particle size" expressed as the upper limit of each size range will be plotted on the x-axis. "Particle size" classes and cumulative percent finer versus size are shown on The Wolman Form. While any bedrock encountered as tallies during the Wolman procedure should be recorded, the tallies are not graphed. This is due to the absurdity of graphing an "upper limit" to the size of bedrock. In such cases, the graph will form an asymptote at the cumulative percent finer than 4096 mm.

The resulting frequency distribution represents the percent of the streambed covered by particles of a certain size since each pebble represents a portion of the bed surface. Results are theoretically equivalent to size distributions obtained from bulk samples.

The entire width of the bankfull channel is investigated, and the rocky particles of the streambed are grouped by their size. A frequency distribution by size class is graphed, and the resultant curve is used to make inferences about channel dynamics. During bankfull flows, it is expected that all particles smaller than the median value (D_{50}) displayed on the curve will be mobile, and this same value further refines the Rosgen channel type for that reach. In a similar sense, particles larger than the 84th percentile (D_{84}) will comprise the immobile portion of the streambed during bankfull discharge.

NOTE: A gradient measurement is required at each Wolman pebble count site.

Figure 19: General guidelines for doing pebble counts



Pebble Count "Hints":

1) Always begin a transect at the edge of the bankfull channel and end each transect at the opposite edge of the bankfull channel.
2) Measure at least 100 "pebbles" (but, don't stop measuring until you reach the end\ of the transect atop the bankfull indicator).
3) Measure the first "substrate element" you touch at each designated sample location.
4) Substrate is measured across the intermediate axis, (neither the longest nor shortest of the three mutually perpendicular axes).
5) Pebble counts are usually done in riffles (twice per reach).
6) If you don't get 100 measurements on a transect, continue to do transects within the riffle until you meet or exceed 100 measurements.
7) Two pebble counts should be done for each reach, in riffle habitats. The riffles should be located about 1/3 and 2/3 of the total length of each reach. Use your map (developed during the completion of the Preliminary Reach Form) to locate the section of stream in which the sample riffles will be located.

*** for additional information, see Harrelson, et al. 1994.**

References:
King, R, Potyandi, J. 1993. *Statistically Testing Wolman Pebble Counts: Changes in Percent Fines!* Stream Notes, USDA Forest Service.
Rosgen, D.L. 1996. *Applied River Morphology.* Wildland Hydrology,
Wolman, M.G. 1954. *A method of sampling coarse river-bed material.* Transactions of the American Geophysical Union. 35(6): 951-9

WOLMAN FORM Page: ____ of ____

R6-2500/2600-32

A. State _________ B. County ________ C. Forest __________ D. District _________

E. Stream Name____.

F. 8-digit HUC Code ____, ____, ____, ____ 10-digit _____12-digit _____

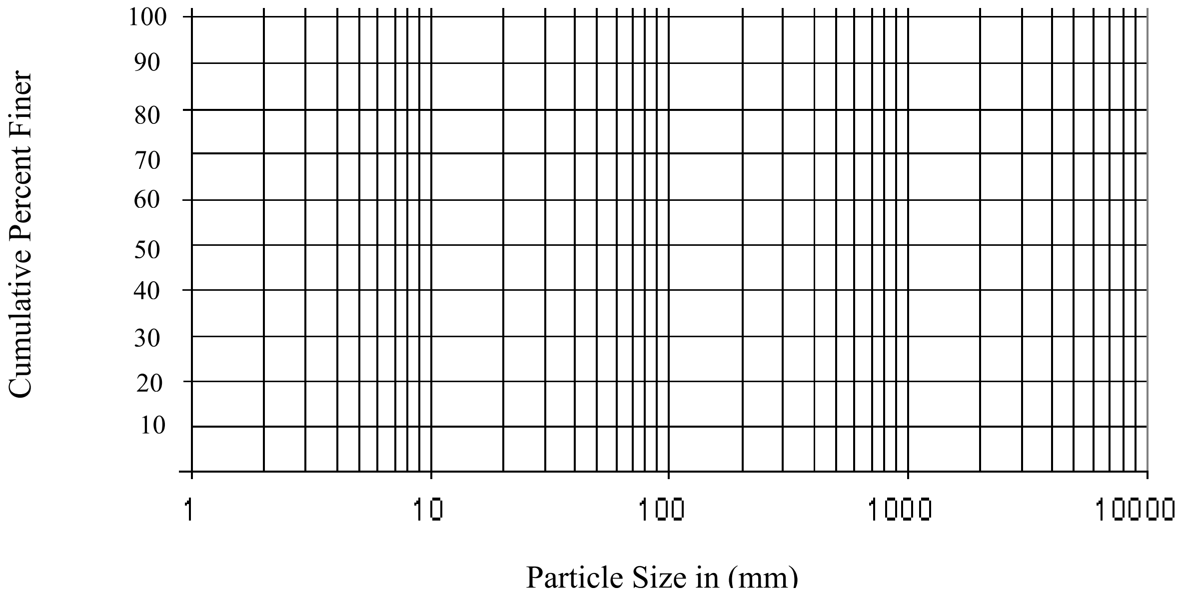
G. USGS Quad ____

H. Survey Date ____/______/______

MM / DD / YYYY

PEBBLE COUNT						
SO #:		Channel Unit #		# of Transects:		
Surveyor:				Reach:	% Gradient:	
PARTICLE	Millimeters		Particle Count	**Total #**	**Item %**	**% Cum**
Sand	< 2	S/C/S				
Very Fine	2 -4					
Fine	4 -5.7	G				
Fine	5.7 - 8	R				
Medium	8 -11.3	A				
Medium	11.3 - 16	V				
Coarse	16 -22.6	E				
Coarse	22.6 - 32	L				
Vry Coarse	32 - 45	S				
Vry Coarse	45 - 64					
Small	64 - 90	C				
Small	90 - 128	O				
Large	128 - 180	B				
Large	180 - 256	B				
Small	256 - 362	B				
Small	362 - 512	L				
Medium	512 - 1024	D				
Large	1024 -2048	R				
Vry Large	2048 -4096	S				
	Bedrock	BDRK				
			Totals:			
	Total Tally:					

Cumulative Percent Finer vs Particle Size- Logarithmic Graph:



CHAPTER - 5
Field Protocol for Aquatic Invasive Species

INTRODUCTION

Nonnative species are common in the freshwater, marine, riparian, and terrestrial ecosystems of the Pacific Northwest. New species are introduced every year, and many of these organisms can significantly alter habitat in the aquatic ecosystems they invade – They are commonly known as **Aquatic Invasive Species (AIS)**

There are 2 criteria for an organism to be considered an **invasive species:**

1) Nonnative (alien, exotic, non-indigenous) to the community or ecosystem under consideration, *and*
2) Its introduction causes or is likely to cause economic or environmental harm, or harm to human health.

An emphasis on terrestrial invasive species management nationwide has left a critical need for prevention, monitoring and control of aquatic invasive species (AIS). Level II survey crews provide a great opportunity to incorporate AIS monitoring into existing stream surveying activities.

Eradication or control of invasive species is generally more successful (and less expensive) when populations are small and relatively isolated. **Early Detection Rapid Response (EDRR)** is the activity of monitoring habitat for potential invasive species and quickly reporting any sightings. EDRR is a critical component of AIS monitoring and management; and this document provides the field protocol for R6 Level II survey crews to apply while performing stream surveys.

GOALS

The early detection and reporting tools provided in this field protocol are designed as a supplement to the standard data collection protocols used by Level II stream surveyors. Our goal is to detect and control AIS threatening Oregon's aquatic and riparian systems without substantially increasing the tasks of the already stretched-to-the-limit surveyor.

Use of this AIS field protocol should be considered the first phase of addressing AIS invasions. The second phase is the reporting protocol already discussed. We expect that surveyor feedback and suggestions will be used to inform a larger effort to holistically integrate AIS early detection into all USFS field efforts in the future.

FOCAL AQUATIC INVASIVE SPECIES

We used the following **criteria** for selecting species for this list:

1. The species is on the Oregon Department of Agriculture's *Noxious Weeds A List*, or the Oregon Invasive Species Councils *100 Most Dangerous List* (designates species for early detection and rapid response), OR
2. The species has a large management program which could benefit from additional distribution knowledge, AND
3. The species invades stream or riparian habitats.

We have classified species into several categories, based on where they are likely to be observed:

- aquatic animals
- aquatic plants
- terrestrial animals
- terrestrial plants

The following table provides the current 2018 AIS Focal List for Level II stream surveys.

Table 1. 2020 Focal Aquatic Invasive Species for Level II

Type	Common name	Genus species	Species Code	Comments
Aquatic animals	New Zealand mudsnails	*Potamopyrgus antipodarum*	POAN	
	Zebra mussels	*Dreissena polymorpha*	DRPO	
	Quagga mussels	*Dreissena rostriformis bugensis*	DRRO	
	Rusty Crayfish	*Orconectes rusticus*	ORRU	Key is to be able to correctly identify native Signal crayfish
	Red Swamp Crayfish	*Procambarus clarkii*	PRCL	
	Ringed Crayfish	*Orconectes neglectus*	ORNE	
	Northern Crayfish	*Orconectes virilis*	ORVI	
	Chinese mystery snail	*Cipangopaludina chinensis*	CICH	
	Asian Clam	*Corbicula flumina*	COFL	
	Big Eared Radix	*Radix auricularia*	RAAU	
	Bullfrog	*Lithobates catesbeiana*	RACO	
	African Clawed Frog	*Xenopus laevis*	XELA	
	Nutria	*Myocaster coypus*	MYCO	
Aquatic plants	Yellow Flag Iris	*Iris pseudacorus*	IRPS	
	Hydrilla	*Hydrilla verticillata*	*HYVE*	
	Nonnative Milfoils	*Myriophyllum species*	MYSP	
	Yellow Floating Heart	*Nymphoides peltata*	NYPE	
	Brazilian Elodea	*Egeria densa*	EGDE	
	Flowering rush	*Butomus umbellatus*	BUUM	
	Common reed	*Phragmites austalis*	PHAU	
	Curly-leaf pondweed	*Potamogeton crispus*	POCR	
	Purple Loosestrife	*Lythrum salicaria*	LYSA	
	Water-Hyssop	*Bacopa Rotundifolia*	BARO	
	Garden Loosestrife	*Lysimachia vulgaris*	LYVU	
	Water primrose	*Ludwigia spp.*	LU	
Terrestrial animals	Feral Swine	*Sus scrofa*	SUSC	
Terrestrial plants	Japanese Knotweed	*Fallopia japonica*	FAJA	Just identify to knotweed
	Giant Knotweed	*Polygonum sachalinese*	POSA	
	Hybrid Bohemian Knotweed	*Polygonumx bohemicum*	POBO	
	Giant Hogweed	*Heracleum mantegazzianum*	HEMA	
	Old Man's Beard	*Clematis vitalba*	CLVI	
	Garlic Mustard	*Alliaria petiolata*	ALPE	
	Himalayan blackberry	*Rubus discolor*	*RUDI*	
	English Ivy	*Hedera helix*	*HEHE*	
	Salt Cedar	*Tamarisk ramosissima*	*TARA*	
	Orange hawkweed	*Hieracium aurantiacum*	*HIAU*	
	Yellow archangel	*Lamiastrum galebdolon*	*LAGA*	

Certain invasive species, especially microbial disease species, are not represented in the AIS Focal List due to the difficulty of identifying their occurrence:

- Sudden Oak Death (disease)
- Chytrid fungus (disease)
- Whirling disease

Certain other AIS have not yet risen to a level of concern to be included in the Focal AIS List. But the tasks performed, and the locations assessed, offer stream surveyors a unique opportunity to encounter these species. Since early detection is key to our AIS efforts, surveyors are encouraged to familiarize themselves with the species listed below. Short introductions to these species can be found in the Aquatic Invasive Species: A Primer for Level II Surveyors.

Table 2. Additional AIS species to address during stream survey.

Type	Common name	Genus species	Species Code
Aquatic animals	Chinese Mitten Crab	*Eriocheir sinensis*	ERSI
	Grass Carp	*Ctenopharyngodon idella*	CTID
	Bighead Carp	*Aristichthys nobilis*	ARNO
	Silver Carp	*Hypophthalmichthys molitrix*	HYMO
	Mosquitofish	*Gambusia holbrooki*	GAHO
	Amur Goby	*Rhinogobius brunneus*	RHBR

METHODS FOR MONITORING AND DOCUMENTING

Detecting and documenting Aquatic Invasive Species can easily be integrated into our established monitoring protocol and means taking action before, during, and after you return from the field.

I. Before going to the field:

Familiarize yourself with the Focal AIS List and Guides. Focal species identification is challenging since many of the species share characteristics with native species and with other AIS. Crew members are encouraged to review the information frequently, before and while going to the field.

Review the Aquatic Invasive Species – A Primer for Level II Stream Surveys. This document has photos and descriptions of all the species on the focal list.

II. In the field:

-Bring various sizes of "ziplock" plastic bags in order to collect AIS specimens.

-Carry AIS field guides with you.

-Keep an eye out for all the species as you conduct your work. Certain species may be more likely encountered at certain steps in your normal protocol:

Aquatic species may be found as you:

- Visually assess the streambed and during bankfull/floodprone Determinations – Turning rocks and observe for crayfish
- Complete pebble counts – As rocks are being measured take the time to inspect for AIS with New Zealand mudsnails the most likely to be observed
- Conduct biological surveys – Scan for invasives such as mudsnails and crayfish
- Wait for your partner to join you – during this time surveyors can turn over rocks and look for other aquatic plants and animals.

Riparian species may be found by scanning the streambanks and riparian zone for distinguishing plant characteristics such as plant form or leaf shapes. You can always be scanning the riparian vegetation while conducting the search for large woody material. However, you are most likely to find riparian species as you:

- Walking in and out of your stream survey area – As you hike in and out of your survey area scan for AIS species.
- Enter or leave the water. Anytime the surveyor is in the riparian or upland area they should be scanning for possible invasive species.
- Measure bankfull and floodplain width – While collecting bankfull information take the time to scan for invasives.
- Assess riparian vegetation
- Wait for your partner to join you

-Document whether or not you find an AIS. It is important to document the non-detection as well as the detection of an AIS**.**

1. **Photograph any infestation.**
2. **Complete a Daily AIS Report Form**

-If possible, collect a specimen. Use a plastic bag that can be securely sealed to collect specimens for positive identification. Sprinkle water inside the bag and keep it as cool as possible. Put a paper label inside the bag. The label should indicate the name of the stream, the reach number, the SO of the start of infestation (and in the "Remarks" column, the SO at which the end of the infestation is determined), the encounter number, date, and species identified.

III. When you return from the field:

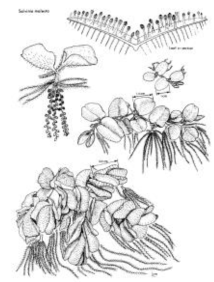
-Report any AIS found immediately: Rapid reporting is critical to containing and possibly eradicating the AIS. Contact your supervisor right away that you found an AIS and provide her/him with a copy of the Daily AIS Report Form and send your supervisor the photographs. Keep the original copy of the report with your other forms.
-Download the photographs and label them with stream name, reach ID, date, species code, and photo number.

Note to survey supervisor: If a crew member reports a found AIS, forward the report and photographs as soon as possible to:

1. Katie Serres – Regional Stream Inventory Quality Control Coordinator (Contact information on pg 89).
2. Jim Capurso – Pacific Northwest Regional Fisheries Biologist (Contact information on pg 89).

TOOLS FOR THE FIELD

The following materials are provided to make looking for, documenting, and reporting AIS you find as efficient as possible. Review these identification tools frequently before the field and to hone your AIS skills. They will make your field observations more efficient.



- **Oregon Sea Grant AIS Field Guide**
- **Aquatic Invasive Species: A primer for level II surveyors**
- **Aquatic Invasive Species Identification and Habitat Reference Guide**

DECONTAMINATION

The movement of stream surveyors from one watershed to anther could be one of the most important pathways for the spread of AIS. A few simple steps can make a big difference in preventing the spread of AIS:

- **EVERY DAY:**
  - Use a stiff-bristled brush to scrub your field gear (i.e., waders, boots, drag and reel tapes, depth rod, thermometer, etc.) near the stream as you leave a site for the day. **Visually inspect your gear for AIS.**

- **WHEN YOU MOVE TO A DIFFERENT STREAM (four options):**

  1. Green Solutions High Dilution 256® (formerly Sparquat 256®):
     i. Transport all wet gear in double 4 mil plastic bags when driving away from the field site.
     ii. Create a 2% solution.
        1. 2.5 ounces Green Solutions to 1 gallon water.
     iii. Coat all exposed (wet) gear and your scrub brush and let sit for 10 min. **at least 1000 ft away from any stream but preferably at an offsite location.**
     iv. Rinse equipment with tap water and allow wet gear to dry.
     v. Solution when used as a soak can be recaptured and used again. Solution can be reused for up to a week. Testing strips are available to determine strength of solution.

  2. Chlorine bleach bath:
     i. Transport all wet gear in double 4 mil plastic bags when driving away from the field site.

  ii. Create a 2% chlorine solution.
    1. 1 cup household bleach per 3 gallons of water.
  iii. Soak all exposed (wet) gear and your scrub brush for 2 min. in a basin large enough to submerge the gear, **at least 1000 ft away from any stream, but preferably an offsite location.**
  iv. Save bath solution for future gear baths.
  v. Rinse bathed equipment with tap water and allow wet gear to dry.
  vi. **NOTE:** Chlorine is not a good option for Gortex™ waders or boots since chlorine will cause the synthetic material to develop leaks.

3. Formula 409™ Degreaser/Disinfectant or Scrubbing Bubbles Scrub™ option:
  i. Lay a double layer of 4 mil plastic atop a flat surface, **at least 1000 ft away from any stream, but preferably an offsite location..**
  ii. Spread wet gear atop the plastic.
  iii. Scrub gear with your stiff brush and rinse with clean water.
  iv. Spray boots, waders, and other wet gear with Formula 409™ /Scrubbing Bubbles™ (the common household cleaner)**.**
  v. Allow gear to stand for 10 minutes after scrubbing.
  vi. Rinse scrubbed equipment with water, and allow wet gear to dry.

4. Drying option (will work for surveyors concerned about whirling disease):
  i. Double-bag all wet gear in 4 mil plastic bags when leaving the field site.
  ii. Place waders and boots in direct sunlight for 48 hrs. to dry completely.
  iii. **NOTE:** UV-radiation (sunlight) also degrades synthetic materials.

- **IF POSSIBLE:**
  - Keep several changes of field gear for use in different bodies of water or in different watersheds. This will allow you to completely dry out your gear (for at least 48 hrs) before using in a new watershed.

Field Decontamination Equipment:

- Stiff bristled dish brush
- 2 5-gallon buckets (larger basins are even better)
- Box of 4 mil plastic bags, with twist ties
- 2 10 x 10 ft, 4 mil plastic sheets
- Spray bottle of Formula 409™ or cans of Scrubbing Bubbles™
- Bottle of household bleach and measuring cup
- Several gallon milk jugs to collect used chemical bath water

Decontamination steps are especially important if you are moving from one watershed to another. ***PLEASE take the time to inspect and clean your gear to avoid spreading AIS!***

AIS EDRR Protocol Contact Information

We welcome suggestions and comments to improve the effectiveness and efficiency of AIS EDRR protocols. Your input will be used to inform a larger effort to integrate AIS early detection into USFS stream survey protocols and other FS field work in the future. Please direct your protocol inquiries and suggestions to:

- Samuel Chan, Assistant Professor, Watershed Health/Aquatic Invasive Species Specialist, Watershed Education Team Leader
    - 307 Ballard Hall, Oregon State University, Corvallis, OR 97331
    - 503-679-4828 Fax: 541-737-3039
    - samuel.chan@oregonstate.edu

- Jim Capurso, Pacific Northwest Regional Fisheries Biologist
    - USDA Forest Service, PO Box 3623, Portland, OR 97208
    - 503-808-2847 Fax: 503-808-2469
    - jcapurso@fs.fed.us

- Katie Serres, Region 6 Stream Inventory Quality Control Coordinator
    - USDA Forest Service, 595 NW Industrial Way Estacada, OR 97023
    - 503-630-8784
    - cserres@fs.fed.us

AQUATIC INVASIVE SPECIES DAILY REPORT FORM – LEVEL II STREAM SURVEYS

Please fill out and submit this form for each stream regardless of whether you find an aquatic invasive species.

Stream Name: ______________________________ Page _______ of ________

Surveyor Names: ______________________________ Forest ____________________ District ______________________

Reach:_______________ 12 digit HUC________________________

Date	SO	Hab/#	Detection Method	Estimated Search Time (Minutes)	AIS Detected (Y/N)	Species (Enter Code)	Abundance	Distribution	GPS Coordinates	Notes (photos taken, samples collected, etc.)

Detection Methods: WI - Walking In, WO - Walking out, PC - Pebble Counts, MU - Measured Units, VO – Visual Observation

Species Codes

New Zealand Mudsnail	POAN	Asian Clam	COFL	Hydrilla	HYVE	Flowering rush	BUUM	Japanese Knotweed	FAJA	English Ivy	HEHE
Zebra Mussels	DRPO	Northern Crayfish	ORVI	Yellow Floating Heart	NYPE	Common reed	PHAU	Giant Knotweed	POSA	Salt Cedar	TARA
Quagga Mussel	DRRO	Nutria	MYCO	Yellow Flag Iris	IRPS	Curly-leaf pondweed	POCR	Giant Hogweed	HEMA	Yellow archangel	LAGA
Rusty Crayfish	ORRU	Chinese Mystery snail	CICH	Water-Hyssop	BARO	Water primrose	LUsp	Old Man's Beard	CLVI		
Red Swamp Crayfish	PRCL	African Clawed frog	XELA	Brazilian Elodea	ERDE	Purple Loosestrife	LYSA	Garlic Mustard	ALPE	Hybrid Bohemian Knotweed	POBO
Ringed Crayfish	ORNE	Bullfrog	RACO			Non-native Milfoils	MYSP	Himalayan blackberry	RUDI		
Big Eared Radix	RAAU	Feral Swine	SUSC			Garden Loosestrife	LYVU	Orange hawkweed	*HIAU*		

Abundance Codes

1-10	1
11-100	2
101-1000	3
>1000	4

Distribution Codes

Spot	1
Patchy	2
Continuous	3

INSTRUCTIONS : AQUATIC INVASIVE SPECIES DAILY REPORT FORM

1) **Date**: Fill out a line each time you perform a search for invasives whether you observe them or not.
2) **SO**: Fill in the Sequence Order where the searches take place or invasives are observed. If search took place on the walk in or the walk out leave this blank.
3) **Hab/#**: Fill in the Habitat Type and number where the searches take place or invasives are observed
4) **Detection Method**: Fill in the method (see key at bottom of form) utilized where the searches take place or invasives are observed
5) **Estimated Search Time (Minutes)**: Enter the approximate time in minutes spent searching for invasives during the specified activity (Detection Method)
6) **AIS Detected**: Enter Y (yes) if invasives observed, enter N (No) if the no invasives were observed
7) **Species (Enter Code)** – Enter the four letter species code of invasive observed.
8) **Abundance:** Visually Estimate abundance in the reach and use the following categories: 1-10, 11-100, 101-1000, >1000 individuals
9) **Distribution:** Describe its distribution using the following categories: one spot, multiple patches, continuous throughout reach
10) **GPS Coordinates**: record the coordinates where you found the species. If it is a contiguous patch, record the GPS coordinates at the downstream and upstream limit of the population.

- Fill out a new line in the table above for *each new AIS population you encounter* of the same or different species. A new encounter of the same species that is more than 500 ft away from the first encounter should be counted as its own population and get its own line. If the species occurs in multiple patches that are close together (less than 500 ft), or are continuous thought your reach, count them as one population. If you need to use two lines for one encounter, indicate this by using the same SO number.

- **Photos:** Take at least two photographs. One photo should capture the habitat where the AIS was found, a second photo should capture a distinguishing characteristic. Include a familiar object in the photo for scale.

- **Map the location:** Indicate on your reach map the location(s) where you found this species using abbreviated species codes. If you don't have a reach map, use the back of this sheet to sketch the stream showing species locations relative to the nearest identifiable stream junction or road crossing.

****IMPORTANT: SUBMIT THIS REPORT AND PHOTOS TO YOUR SUPERVISOR AS SOON AS YOU RETURN FROM THE FIELD IF INVASIVES ARE OBSERVED.****

APPENDIX A
Watershed Codes

Watersheds in the United States and the Caribbean were delineated by the U.S. Geological Survey and the Natural Resources Conservation Service using a national standard hierarchical system based on surface hydrologic features and are classified into six types. This is called the Watershed Boundary Dataset (WBD).

Hydrologic Unit Code (HUC): Each hydrologic unit is identified by a unique hydrologic unit code consisting of two to twelve digits based on the six levels of classification:

2-digit HUC first-level (region)
4-digit HUC second-level (subregion)
6-digit HUC third-level (accounting unit)
8-digit HUC fourth-level (cataloging unit)
10-digit HUC fifth-level (watershed)
12-digit HUC sixth-level (subwatershed)

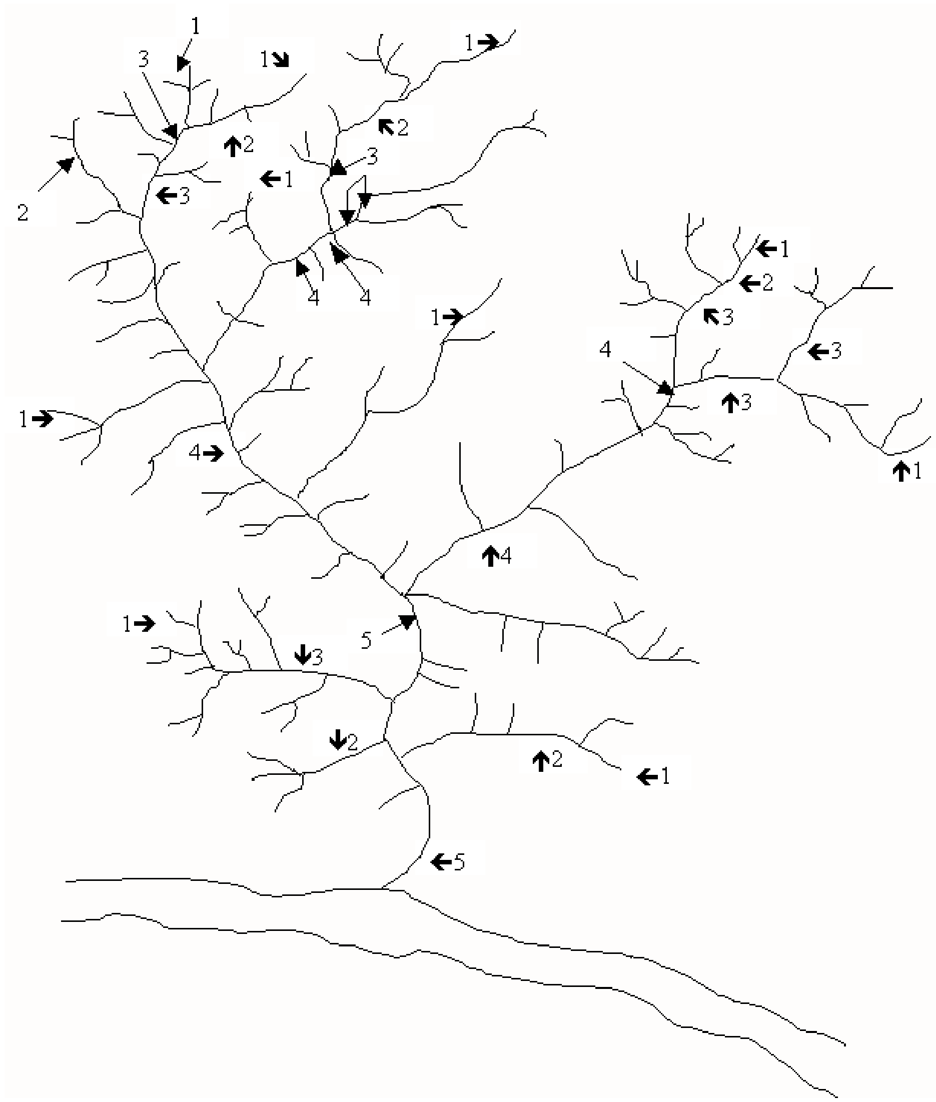
An example of this type of coding is:

Region	Pacific Northwest	17
Subregion	Middle Columbia	1707
Basin (Accounting Unit)	Deschutes River	170703
Subbasin (Cataloging Unit)	Upper Deschutes River	17070301
Watershed	Tumalo Creek	1707030105
Subwatershed	Lower Tumalo Creek	170703010502

The Forest Service maintains a GIS layer for watersheds on the corporate server at:

T:\FS\Reference\GIS\r06\LayerFile\Hydro

APPENDIX B
Stream Orders



Use 1:24,000 scale topographic map–count mapped streams only.

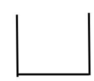
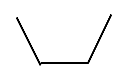
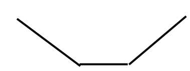
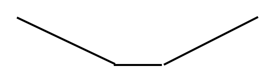
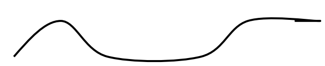
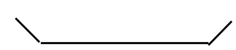
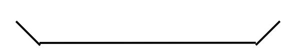
Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: the smallest, unbranched, intermittent tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams produces a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3; etc. Use of small-scale maps (<2"/mile) may cause smaller streams to be overlooked, leading to gross errors in designation. Ideally, designation should be determined on-the-ground or from large-scale air photos.

APPENDIX C
Forest Options

Each Forest is empowered to decide whether certain reach or habitat attributes will be investigated. The following is a list of those options. Forests are encouraged to gather any data they feel is relevant, but it must be recognized that the core data attributes of the Region 6 protocol discussed in Chapter 2 of this handbook are mandatory, unless expressly labeled as a “Forest Option.” It is expected that any deviations from the stated Region 6 methods will be completely described in the final stream inventory report mandated for each inventoried stream.

FINAL REACH FORM

VALLEY FORM CODES: The number codes are used to characterize the floodplain width and upland slopes of each reach and recorded on Final Reach Form (see accompanying diagram).

		VALLEY FORM CODES	**VALLEY CROSS-SECTION**
Code	Type	Side Slope	
1	Box-like canyon	Steep: > 60%	
2	Narrow V-shaped floor width < 100 ft.	Steep: > 60%	
3	Moderate V-shaped floor width < 100 ft.	Moderate: 30-60%	
4	Low V-shaped floor width < 100 ft.	Low: < 30%	
5	U-shaped floor width > 100 ft.	Moderate to steep: > 30%	
6	Trough-like open short slope lengths	> 30%, mostly 30-60%	
7	Broad, trough-like	Low: < 30%	
8	Narrow flat-floored floor width 100-300 ft.	Moderate to steep: > 30%	
9	Moderate flat-floored floor width 300-600 ft.	Moderate to steep: > 30%	

INNER RIPARIAN ZONE WIDTH: Forests can choose to designate the inner riparian zone as 0 ft. wide. This choice is appropriate for a reach or stream, but not for individual habitats. The outer riparian zone width then becomes 100 ft., and 0 ft. is recorded on Final Reach Form to describe the inner riparian zone width for that reach.

FLOW REGIME: Forests are free to characterize the nature of a reach with respect to the streamflow conditions observed at the time of the survey. Three choices are possible: perennial, intermittent, and ephemeral. Since the stream channels receiving a level II survey are usually fish-bearing, it is likely that most streams will be characterized as perennial.

DISCHARGE TYPE: Forests can enter the discharge type at the time of the survey. Generally discharge is taken when the water level is at baseflow. There may be times when a discharge was taken at flows above the normal baseflow. The 4 choices are:

Bankfull – Water level is at or near bankfull.
Baseflow – Water level at or near minimum flow.
Flood – Water level exceeding bankfull capacity.
Medium – Water level is between baseflow and bankfull.

CHANNEL UNIT FORM

FORMED BY: Forests have the option of identifying the force creating each channel unit. NRM Aquatic Surveys provides a pull down menu of potential habitat-forming forces. While the option exists to choose a force forming each channel unit, the option is most generally applied to pools.

Below is a table identifying the most common pool forming forces for the range of pools (slow water channel units) available in NRM Aquatic Surveys. Region 6 supports the use of the second level of channel unit identification (see Channel Unit Type above). The table below identifies the channel unit to the third level of channel unit identification. However, the third level can easily be collapsed to the second level by removing the last two letters of the channel unit code. For example, a beaver dam pool at the third level of channel unit identification is coded SDBV. To reduce this to the second level of channel unit identification, the code becomes SD (a slow water channel unit formed upstream of a dam).

FORMED BY (the force)	FORMED BY CODE	CHANNEL UNIT CODE	DESCRIPTION
Beaver	BV	SDBV	Slow water, the beaver pool upstream of a beaver dam
Wood	WD	SDDD	Slow water, the pool upstream of a woody debris jam
		SSPL	Slow water, the plunge pool downstream of a woody debris jam

FORMED BY (the force)	FORMED BY CODE	CHANNEL UNIT CODE	DESCRIPTION
		SSMC	Slow water, the mid-channel pool scoured beneath woody material that has not formed a sediment trapping dam
Bedrock	BR	SSTR	Slow water, trench pool…a deep slot scoured in a bedrock dominant streambed
		SSLS	Slow water, pool scoured against bedrock outcrop forming the streambank, the bedrock forces a change in the direction of streamflow causing scour
		SSPL	Slow water, pool scoured downstream of a bedrock lip forming the streambed, the bedrock lip often creates a waterfall
Boulder	BO	SDLS	Slow water, landslide dam pool upstream of coarse sediment that has dammed the stream
		SSPL	Slow water, pool scoured immediately downstream of the coarse sediment that has completely dammed the stream (the “dam” is a transverse bar of boulders and finer substrate)
		SSMC	Slow water, channel-spanning pool scoured immediately downstream of one or more boulders that have partially dammed the stream
Stream Bend	SB	SSLS	Slow water, pool scoured against a streambank, the bank forces a change in in the direction of streamflow causing scour
Tributary	TR	SSCV	Slow water, pool scoured at a channel convergence by the addition of a tributary’s streamflow
Culvert	CU	SSPL	Slow water, pool scoured downstream of a culvert’s lip, the concentration of streamflow in the culvert causes scour downstream
Dam	DA	DA	A human-built structure intended to create pooling or slack water upstream
		SD	Slow water, the pool upstream of a human-built dam
		SSPL	Slow water, the plunge pool downstream of a human-built dam

FORMED BY (the force)	FORMED BY CODE	CHANNEL UNIT CODE	DESCRIPTION
Restoration	RS	(variable)	Slow water, channel-spanning pools created through restoration efforts
Other	OT	Not applicable	Slow water, cause not one of the above

CHANNEL UNIT TYPE: Forests have the option of using the Hawkins method of habitat designation (Hawkins, et al. 1993[2]). Hawkins refers to stream habitats as channel geomorphic units that are characterized initially as either fast water or slow water habitats. These channel units are equivalent to riffles and pools. Fast water channel units are further subdivided into turbulent fast water and non-turbulent fast water channel units. In a corresponding fashion, slow water channel units are subdivided into slow water formed by scour (scour pool) and slow water formed by damming (dam pool). Hawkins offers a third level of channel unit distinction by subdividing turbulent fast water, non-turbulent fast water, scoured slow water, and dammed slow water in the following way:

FIRST LEVEL (& code)	SECOND LEVEL (& code)	THIRD LEVEL	CHANNEL UNIT CODE	CHANNEL UNIT DESCRIPTION
Fast Water (F)	Turbulent (FT)	Cascade	FTCC	A riffle with stream gradient greater than 10%
		Rapid	FTRP	A riffle with stream gradient greater than 3% but less than10%
		Riffle, Low Gradient	FTRF	A riffle with stream gradient less than 3%
	Non-Turbulent (FN)	Run	FNRN	Unit has a homogeneous streambed, no residual depth, laminar flow, nearly no stream gradient…a glide
		Sheet	FNSH	A unit that has bedrock or hardpan clay as its streambed, very shallow flow, a noticeable stream gradient
Slow Water (S)	Dam (SD)	Beaver	SDBV	A beaver pool upstream of a beaver dam
		Debris	SDDD	A pool upstream of a woody debris jam…the jam has captured sediment raising the streambed

FIRST LEVEL (& code)	SECOND LEVEL (& code)	THIRD LEVEL	CHANNEL UNIT CODE	CHANNEL UNIT DESCRIPTION
Slow Water (S)		Landslide	SDLS	A pool upstream of a landslide that has entered the stream… the added sediment has raised the streambed
	Scour (SS)	Convergence	SSCV	A pool scoured at a channel convergence by the addition of a tributary's streamflow
		Lateral Scour	SSLS	A pool scoured against a streambank, the bank forces a change in the direction of streamflow causing scour
		Mid-channel	SSMC	A mid-channel pool scoured beneath woody material or downstream of one or more boulders that have partially dammed the stream
		Plunge	SSPL	A plunge pool downstream of one of these conditions: • a woody debris jam • a waterfall • a transverse bar of substrate • a human-built dam • a culvert
		Trench	SSTR	A pool scoured in bedrock or hardpan clay in which all of the depth is parallel to the long axis of the habitat. Most of the width of the habitat is substantially shallower than the trench

NRM Aquatic Surveys permits individual Forests to select the channel unit type that matches the surveyors' level of confidence about the hydrologic and biologic forces creating the channel units. Forests are empowered to choose the level (first, second, third) of channel unit designation suited to either their management needs or their confidence in their surveyors' capabilities.

The minimum channel unit identification must distinguish fast water channel units (riffles) from slow water channel units (pools). Each of the various channel unit types listed above have been assigned unique one, two, or four-letter codes to be used on the Channel Unit Form. The letter codes are simply shorthand for the channel unit types available in NRM Aquatic Surveys.

PLUNGE POOL HABITAT: Forests are empowered to establish minimum criteria for considering a plunge pool (slow water channel unit formed by plunge) a distinct habitat. Examples of potential criteria include:

- setting a minimum residual pool depth for plunge pools
- classifying only those pools below a channel-spanning accumulation of LWM
- neglecting plunge pools occurring in reaches with valley gradients more than 10 percent

Plunge pools are extremely common in headwater streams. Such streams are often dominated by a complex of stairstep-pools, which are actually a series of plunge pools below transverse bars of cobble and boulder. Establishing minimum criteria for plunge pools may permit surveyors to more efficiently characterize these high gradient reaches.

LWM IN SIDE CHANNELS: Forests are free to count functional large woody material in side channels. The same criteria apply to woody material in these secondary channels as applies to the mainstem channel. That is, surveyors must use the three standard R06 size classes and the wood must engage the bankfull channel of the side channel. Since most side channels have a narrower bankfull width than their companion mainstem channel, the twice bankfull width rule may apply, and wood that is shorter than the standard lengths may be counted. See the discussion of LWM in Chapter 3 for greater clarification of LWM. The counts can be entered to NRM Aquatic Surveys.

HABITAT LENGTH: The **method** used to measure channel unit length is a Forest option. The following discussion is a recommended procedure for measuring habitat length of mainstem channel units. Let us assume the observer has arrived at the upstream end of the habitat, and has signaled their arrival to the recorder. The recorder reads the length of tape between the two surveyors, and then moves upstream to join the observer. The observer waits at the break between habitats so that the recorder will know the precise location of the transition to the next habitat. The surveyors will then share their habitat observations before they begin the next upstream habitat.

Some habitats, typically fast water units, will exceed the length of the measuring tape used by the surveyors. It is the recorder’s task to remain aware of the tape as it is dragged upstream. When the end of the tape reaches the position of the recorder, they must immediately signal the observer to stop moving upstream. The observer must then either wait for their partner to join them, or the observer can mark their position in the stream before renewing the survey of this long habitat. An effective marker might be a long piece of plastic flagging atop a boulder with a piece of cobble anchoring the flagging. The recorder then moves upstream, retrieves the flagging, and positions themselves in the thalweg lateral to the marker.

The recorder remains in their new location until, once again, one of two situations occurs: either the observer has determined the upstream end of the habitat, or the end of the tape is once again at the feet of the recorder. In this stepwise fashion, the thalweg length of a long habitat will be accurately measured through measuring adjacent habitat segments and summing the segments’ lengths. Very long habitats are difficult to characterize; surveyors are encouraged to break long fast water units into channel units of less than 500 ft.

A drag tape will on occasion snag in the streambed or on woody material. Usually, a gentle tug by either surveyor will free the measuring tape. To increase the team's efficiency in using the drag tape method, remember these points:

- Only the length of mainstem habitats must be measured; the dimensions of side channels and tributaries may be estimated.
- The observer should stay in the thalweg, dragging the tape measure as they walk upstream.
- Never move downstream while dragging the tape; it will surely snag.
- Anchor the upstream end of the tape at the bank before you leave the main channel or move downstream.
- Develop non-verbal cues for communicating with your partner (a whistle is useful).

Use a separate measuring tape for all other habitat dimensions (e.g., measured wetted width, bankfull width, floodprone width, and bank stability).

Measuring the length of side channels or tributaries is also a Forest option.

AVERAGE DEPTH: Forests can choose to estimate the average depth in riffles to better characterize the channel condition. The estimate is recorded on the Channel Unit Form.

STREAMBED SUBSTRATE (Forest Options Form): Forests have the choice to estimate the streambed composition by particle size class for every mainstem aquatic habitat. Forests can choose to apply this to the low flow or the bankfull channel. There are five size classes of substrate distinguished by diameter:

Sand:	< 0.08 in.	(< 2 mm)
Gravel:	0.08 to 2.5 in.	(2 - 64 mm)
Cobble:	2.5 to 10 in.	(64 - 256 mm)
Boulder:	10 to 160 in.	(256 - 4096 mm)
Bedrock:	> 160 in.	(> 4096 mm)

If a size class is estimated to comprise less than 6 percent (rounded up to 10 percent) of the total streambed area inundated at the time of the inventory, disregard that size class. If any of the five size classes makes up at least 10 percent of the area, list its contribution in 10 percent increments. The streambed substrate estimate should total 100 percent for each inventoried habitat.

SHRUB/SEEDLING HEIGHT: Forests have the option of recording the shrub/seedling height code in place of the dominant species in the overstory component of both riparian zones. The codes are:

1: 0 to 2 ft. tall
2: 2 to 5 ft. tall
3: 5 to 10 ft. tall
4: > 10 ft. tall

UNDERSTORY DOMINANT SPECIES: Forests must decide what question is of greatest concern. The two most likely questions are:

> What tree species dominates the understory component and is likely to replace the overstory dominant tree species if no disturbance removes the overstory?
> What species would likely dominate the understory if human impacts were removed?

RIGHT BANK/LEFT BANK: The sides of a stream are named (**right** or **left**) relative to the view looking downstream.

FIELD MAP SYMBOLS: Forests are strongly encouraged to develop and adopt a suite of map symbols which all survey teams would use to better characterize the inventory observations. These symbols should record the important conditions in the aquatic, riparian, and upland components of the drainage basin.

MEASURED CHANNEL GRADIENT in addition to the two required gradient measurements (Forest Options Form): Forests have the option of measuring the gradient of the stream in tandem with the identifying individual channel units. Measured channel gradient is defined as the slope of the surface of the water.

Stream gradient is a very useful tool for describing stream morphology. Hydrologists typically need accuracy within ½ of a percent or less. Measured channel gradient is also essential to more accurately determine the Rosgen stream type of a reach. Clinometers are not this accurate and thus are not acceptable for measuring stream gradient. Abney levels and hand levels are appropriate tools for measuring channel gradient as part of a level II survey. The following describes stream gradient plus two methodologies for obtaining stream gradient with either an Abney level or hand level.

Channel gradient and stream slope are used synonymously. Slope is the rise over the run. The "rise" of a stream channel is the elevational change between two points. The "run" of the stream channel segment is the distance between the same two points. Channel gradients for Level II surveys will measure the slope difference of the water surface for a distance of approximately 100 feet of stream thalweg, provided that the 100 feet chosen is typical of the reach. Certain reaches may be too sinuous or too brushy to permit two adjacent 50-foot segments to be measured. In such cases, the longest available length of channel that is typical of the reach should be chosen.

Rosgen stream types vary with gradient. Stream types C and E have channel gradients of less than two (2) percent. In those stream types, it is unlikely that you will encounter many fast water channel units (riffles) that are more than 100 feet in length. These stream types also tend to be quite sinuous, and fast riffles comprise roughly 50% of the channel's length. In Rosgen C and E stream types, it is acceptable to include a pool (slow water channel unit) in the length of stream chosen for measurement of stream gradient.

For streams with a mapped channel gradient greater than ten (10) percent, a system of step-like pools with very short connecting riffles is common. In these high gradient streams, it is acceptable to include slow pools in the length of stream used for measuring water level gradient.

For Rosgen B stream type, all measurements of channel gradient should be taken in riffles. Since the riffles chosen for Wolman pebble counts are selected as representative of the reach, they would provide excellent sites for measured channel gradient.

Remember, the ideal location for measuring the channel gradient is a site that is typical of the reach. Two measurements of channel gradient are the minimum number of samples necessary to characterize the reach.

Channel Gradient Formula:

% Gradient = [Change in Elevation / Thalweg Length] X 100

Example 1: A fast water channel unit is measured and the difference in rod readings is 1 foot for 100 feet of measured length of thalweg. Determine the percent gradient.

% Gradient = [1 foot / 100 feet] X 100 = 1%

Example 2. A step-pool system is measured and the rod reading difference is 2.5 feet within 75 feet of measured length. Determine the percent gradient.

% Gradient = [2.5 feet / 75 feet] X 100 = 3.3% slope

Note: While average slope for fish-bearing reaches is almost always less than 25%, the slope of individual channel units can be greater than 100%. For nearly vertical waterfalls, the slope may be 1000% or greater.

Hand Level Method: To use the hand level, both the total change in elevation (rod reading difference), and the total thalweg distance must be measured.

1) A rod or walking stick (now referred to as the pivot staff) is used to hold a fixed height for the hand level at a location between the upstream measurement point and the downstream measurement point. The pivot point should provide a clear line-of-sight to the two measurement points, 50 feet upstream of the pivot point and 50 feet downstream. The height of the hand level on the pivot staff cannot change, although the pivot staff must be free to turn to obtain the two sets of gradient measurements.
2) Set the base of the pivot staff at the surface of the water.
3) Measure the thalweg distance upstream, approximately 50 feet.
4) At the upstream location, hold the level rod (now referred to as the depth rod) so that the base of the depth rod at the surface of the water.
5) Looking through the peephole of the hand level, tilt the hand level until the bubble is centered. Shoot the upstream depth rod and obtain the reading. The crewperson holding the depth rod may want to move their hand up and down the rod until the person with the hand level sights their partner's hand…the partner holding the depth rod then reads the height.
6) Keeping the pivot staff in the same location, the person holding the pivot staff turns and faces downstream.
7) The person with the depth rod moves downstream approximately 50 feet.
8) Measure the thalweg distance downstream from the pivot staff to the depth rod.
9) Set the depth rod at the downstream location, and place the base of the depth rod at the surface of the water.
10) With the hand level at exactly the same elevation along the pivot staff as it was for the upstream shot, look through the peephole of the hand level, tilt the hand level until the bubble is centered, and take the downstream rod reading. Again, the crewperson holding the depth rod may want to move their hand up and down the rod until the person with the hand level sights their partner's hand…the partner holding the depth rod then reads the height.
11) The difference between the two rod readings equals the total change in elevation.
12) The total thalweg distance between the upstream point and the downstream point is summed.
13) These two measurements are applied to the formula above to obtain the stream gradient.

Abney Level Method: An Abney level is independent of distance, and thus, distance does not need to be measured. However, all measurements should be taken on thalwegs that are approximately straight, and the location of the Abney level (the pivot staff location) should be in the center of the length of channel that is measured. The Abney level is not developed for curves or meanders.

1) Locate a straight section of stream channel, both upstream and downstream of a center point.
2) Measurements will be taken from the center point location.
3) Obtain a rod that is approximately 5 feet high (now called the pivot staff).
4) Mark an elevation on a second rod, the depth rod, at a height equal to the point along the pivot staff where the Abney level will be held.
5) Set the pivot staff at the surface of the water.

6) Hold the Abney level at the chosen elevation along the pivot staff.
7) Move the depth rod upstream so that the base of the depth rod is at the surface of the water.
8) Looking through the peephole of the Abney level, turn the adjusting screw on the Abney level until the bubble in the Abney level is centered. The crewperson holding the depth rod may want to set their finger at the set elevation along the depth rod (the same elevation as the Abney level on the pivot staff).
9) Read the slope, in percent, from the Abney level.
10) Keeping the pivot staff in the same location, the person holding the pivot staff turns and faces downstream.
11) Move the depth rod downstream the same distance it was moved upstream.
12) Set the base of the depth rod at the surface of the water.
13) Looking through the peephole of the Abney level, turn the adjusting screw on the Abney level until the bubble in the Abney level is centered. The crewperson holding the depth rod may want to set their finger at the set elevation along the depth rod (the same elevation as the Abney level on the pivot staff).
14) Read the slope, in percent, from the Abney level.
15) Add the two slopes together and divide by 2 to obtain the average gradient for the reach.

KEY LWM: Downed wood that is **not** in the bankfull channel, but is nonetheless resting atop other wood that does engage bankfull flow. Key LWM influences the flow at bankfull discharge by anchoring the wood beneath the key LWM, and causing the stream flow to interact with these anchored woody pieces. Wood considered to be "Key LWM" must meet the minimum Region 6 size criteria for LWM (i.e., the piece must be at least as long as twice the bankfull width, with a diameter of 12 inches at the small end). Key LWM includes all three size categories. Surveyors shall count the number of key pieces of LWM in every slow water unit and fast water unit. Key LWM that is part of a debris jam shall be tallied and added to the key LWM count of the nearest slow water unit or fast water unit.

FOREST OPTIONS FORM

The Forest Options Form below incorporates the Forest Options not found on the Channel Unit Form.

OPTIONAL FIELDS: These fields are present on the Forest Options Form to facilitate gathering data of specific interest to individual Forests. Examples of such attributes are riparian vegetation (outer zone), streambed substrate, percent gradient (outside the two required), key LWM, and percent of stream shaded. This form is available as an excel spreadsheet and can be customized to individual forests. Contact Katie Serres (cserres@fs.fed.us) for excel file.

FOREST OPTIONS FORM

Forest___________________________ District___________________________ pg ________of __________

Stream Name__________________________ Survey Start Date _________________________ (mm/dd/yyyy)

Sampling Frequency: F_________________________ S____________________________

K. Contacts: REC:_________________________________ OBS:_____________________________

Channel Units		Riparian Vegetation (Inner Zone)			Riparian Vegetation (Outer Zone)			Streambed Substrate (Forest Option)							
Seq.	Channel Unit Type & No.	Class	Over story	Under story	Class	Over story	Under story	SA	GR	CO	BO	BR	% Grad.	% Shade	REMARKS
1	2	21	22	23	24	25	26	29	30	31	32	33			

Channel Unit Codes: S - Slow water (pool), **SD** - Dam Pool, **SS** - Scour Pool, **SSPL** - Plunge Pool, **F** - Fast Water (riffle), **FT** - Fast Turbulent, **FN** - Fast Nonturbulent, **SIDES** - Side channel (slow), **SIDEF** - Side channel (fast), **CHUNIT D or D** - Dry Main Channel, **ARTIF** - culverts, dams (Special Cases Form), **WF** - Waterfall (Special Cases Form), **CH** - Chute (Special Cases Form), **CHUNIT(M)** - Marshlands (Special Cases Form), **T** - Tributary

Diameter Class: NV = No vegetation, GF = Grass/Forb , SS = Seedling Shrub, SP = Sapling/Pole, ST = Small Tree, LT = Large Tree, MT = Mature Tree,

Hardwoods: HA = Alder, HB = Bigleaf Maple, HC = Cottonwood, ash, poplar, HD = Dogwood , HE = Elderberry, HL = Liveoak, canyon, HM = Madrone , HO - Oak
HQ = Quaking aspen HT = Tanoak HV = Vine maple HW = Willow HX = Unknown

Conifers : CA = Subalpine fir, mountain hemlock, whitebark pine; CC = Cedar, western red ; CD = Douglas fir; CE = Subalpine fir, Englemann spruce ; CF = Fir, silver and noble; CH = Hemlock, western; CJ = Juniper ; CL = Lodgepole pine, Jeffrey pine; CQ = Western white pine; CR = Red fir ; CS = Sitka spruce; CT = Port-Orford cedar ; CW = White fir, grand fir ; CY = Yew; CX = Other/Unknown

APPENDIX D
Successional Class Codes

Grass/Forb	Shrub/ Seedling	Sapling/Pole	Small Tree	Large Tree	Mature Tree
Approximate stand age (years)					

0 5 15 30 80 200 700

	Height Class 1: <2' 2: 2'–5' 3: 5'-10' 4: >10'	Diameter Size: < 8"	Diameter Size: >8"-20.9"	Diameter Size: 21"-32"	Diameter Size: >32"
GF	SS	SP	ST	LT	MT

Code:

NV = No Vegetation.
The no vegetation condition is characterized by the predominance of bare soil or naked rock.

GF = Grass/Forb condition
The grass/forb stand condition lasts 2-5 years and occasionally as long as 10 years. Shrubs and some trees that sprout are not yet dominant.

SS = Shrub/Seedling condition
The shrub stand condition often lasts 3-10 years but may remain for 20-30 years if tree generation is delayed. Tree regeneration may be common, but trees are generally less than 10-ft. tall and provide less than 30 percent of crown cover.

SP = Sapling/Pole condition
The open sapling/pole condition occurs when trees exceed 10 ft. in height and are between 5 in. and 8.9 in. dbh.

ST = Small Tree condition
The small tree condition has very little ground vegetation because of closed crown canopy. Average stand dbh is 9 in. to 20.9 in.

LT = Large Tree condition
The large tree condition is characterized by trees with an average dbh of 21 in. to 32 in. dbh. An understory of shrubs and young shade-tolerant trees is present.

MT = Mature Tree condition
The mature tree stand conditions are characterized by old live trees, snags, down woody material, and the replacement of some of the long-lived pioneer species such as Douglas-fir by shade-tolerant species such as western hemlock. Size is generally greater than 32 in. dbh

APPENDIX E AB Only Protocol

Aquatic Biota-Only Presence Protocol
Region 6

In the past few years, the Regional Office (RO) has provided funds and target miles that specifically permit an aquatic biota survey that is not done in tandem with the standard habitat assessment.

This document is intended to give some direction on acceptable methods for completing an AB-Only Presence survey. It will describe the minimum that is needed to meet the RO's standards in regards to using RO target funds to assess the biota using a stream. The minimum criteria of a valid AB-Only survey does not include assessing habitat dimensions or conditions. A valid AB-Only survey will categorize the biota that live in the streams, and locate the upper limit of distribution for each species using the stream. Biotic data that is more than 15 yrs-old may be suspect due to the expanding range of introduced (invasive) species.

This draft protocol of a valid AB-Only Presence survey is by no means the only way to accomplish the AB-Only surveys, but this will hopefully provide some guidance to those Forests seeking to complete their own biotic surveys. This draft biotic protocol may provide a foundation that the forests will use to design their own protocols that would include the **RO's minimum standards:**

- **Establishing the assemblage of species using the surveyed stream.**
- **Geographically locating the upper limit of habitat use for each species using the stream.**

The intention of the AB-Only Presence survey is to describe the presence and distribution of fish, by species, located in a given drainage. This protocol is not intended to assess population density or to generate data about the relative abundance of species. Forests have the option of performing more in-depth surveys to obtain this information, but they must be aware that the funding from the RO covers only what is necessary to complete an AB-Only Presence survey.

Surveyors should be aware that in the absence of a definite migration barrier, the absence of fish should not be interpreted as the end of fish habitat. It is common to find no hard barrier in the segment where fish presence apparently ends; and it is tempting to conclude that fish habitat has ended in your stream. This may be a case of a “false negative” assessment of the end of fish habitat. Fish may seasonally use habitat that is currently empty; their absence may reflect variations in flow (i.e., dry channel segments at the time of your survey), avoidance of high water temperatures, or some other behavioral response to unfavorable conditions. Consider extending your evaluation of fish habitat upstream to valid migration barriers to avoid the “false negative” habitat assessment.

METHODS

AB-Only Presence surveys typically would start at the mouth of each stream, unless land ownership does not allow it. An acceptable alternative startpoint may be warranted if your knowledge of the fish community in the lower reaches of a stream is very strong. In the case where your interest lies in the upper reaches that have been poorly assessed, the sampling effort may begin some distance from the mouth. But any AB-Only presence survey should begin at a geographically mapped location, such as a tributary junction or a road/trail crossing.

The crew may use a variety of sampling: snorkel, electro-shock, hook & line, minnow trap, or seine. The crew is free to change methods during a given survey that address the unique conditions within the stream, but any change must be recorded on the AB-Only field data from in “Remarks” so that data entry correctly records the methods applied in each sample site. The pattern of sampling should begin at the geographic startpoint of the survey, with the effort focused on sampling high quality habitats. The length of a sample site is variable; but noting the habitat types that are sampled and the quality of the habitats sampled, is highly recommended. Each individual sample site will be identified in the NRM database as a segment (or point), creating a mapped representation of each sample site and the survey.

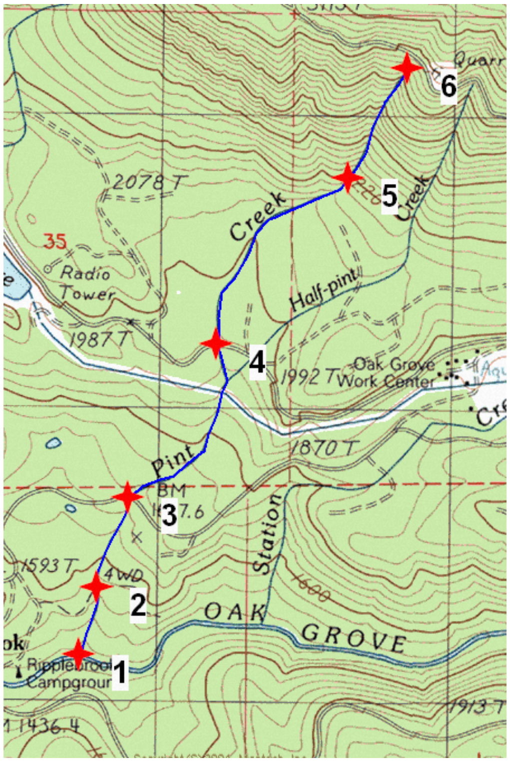
Each sample site should consist of at least two (2) high quality slow water units (i.e., pools). The crew will consider the sampled habitats as a single sample site of the survey. There is no need to hike up the stream after completing the sampling of a site; rather, the crew can leave the stream and proceed upstream to another location where they will repeat the process. Typically, this means the crew can drive to the nearest upstream road crossing or easy access point that provides the path to the next sample site upstream. If the same species are found at the upstream location, it can be assumed that those fish species are found throughout the area between the two sample sites. Repeat this process for the entire stream until the end-of-fish use is established for every species observed in the downstream sample sites.

If a species drops out from one location to the next, the crew should proceed to a downstream point, a new site that is upstream of the last sample site in which the species in question was observed. If the species that was absent in the upstream sample site appears at this new, downstream sample site, continue to sample in an upstream direction, until the species is no longer encountered. This will determine the upper limits of each species observed in the stream.

Crews should sample above and below potential barriers to clarify how species are distributed. They must establish sample sites above major barriers, such as waterfalls and culverts, in order to validate the presence (or absence) of species. A barrier would likely mark the geographic upstream endpoint, as well as the downstream endpoint, of two adjacent segments that have different conditions for species presence. Research has indicated that a survey length at least as long as 40 times the average wetted width is needed to determine the entire fish assemblage. So, if you believe you have found the last fish in the stream, another 40 wetted channel widths-long of survey should alleviate your uncertainty, especially in those situations where there is no obvious migration barrier that identifies the end of habitat use by a specific species. Without a hard barrier that identifies the end of a species using the stream, any endpoint you find may change from year to year. It is up the Forest to determine the intensity they will apply to their search for the end of presence by a species in a stream.

The sampling strategy may vary according to the frequency of easy access points to the stream. The two scenarios below differ in the strategy employed, based on access to the stream during an AB-Only Presence survey.

Example 1: an AB-Only Presence Survey in a Roaded Area



Pint Creek has 6 easily accessed sample sites via the road network.

1. At the mouth
2. 4WD road crossing (this site could be skipped as the next sample site is relatively close)
3. Road crossing
4. Road crossing
5. Waterfall barrier – crews would need to sample above and below barrier to determine fish presence
6. End of stream below upper road.

1. The crew snorkels one fast water (riffle) and two pools near the mouth of Pint Creek. They observe juvenile chinook and rainbow trout.

2. The crew leaves the stream and drives up to sample **site #3** at the road crossing. They snorkel a fast water and pool below the road and the same above the road. They again observe chinook and rainbow trout. With this observation they would not need to sample at **site #2** and can assume that chinook and rainbow trout reside in the stream from the mouth to the road crossing.

3. The crew again leaves the stream and drives up to **site #4**. They again snorkel a fast water and a slow water habitat unit below and above the road crossing. They also note that the culvert was an open bottom arch and was not a barrier to fish passage. They again see chinook and rainbow trout. They can again assume that chinook and trout reside in the stream from the mouth to the road crossing at **site #4**.

4. The crew observes what looks like a waterfall on the aerial photo, and they hike into **site #5,** where they discover a 30 foot waterfall, an obvious barrier to fish passage. The crew snorkels the plunge pool beneath the waterfall and observes chinook and rainbow trout.

5. They also snorkel two high quality pools and a riffle above the waterfall. The crew observes that rainbow trout are still present, but Chinook are absent. They now know the upper limits of chinook ends at the waterfalls. They mark their aerial photo with a pin-prick (or they take a GPS waypoint), identifying the falls.

6. The segment they snorkeled upstream of the falls has only rainbow trout; and because chinook are absent from this set of habitats, the upstream segment is now its own sample site, **site #6**, since stream segments with differences in the species assemblage must be entered to NRM as separate sample sites.

7. The crew hikes into the upper portion of the stream to **site #7**. They find no fish after snorkeling at least two high quality pools and a fastwater habitat. They then must proceed downstream until they locate the upper limit of rainbow trout.

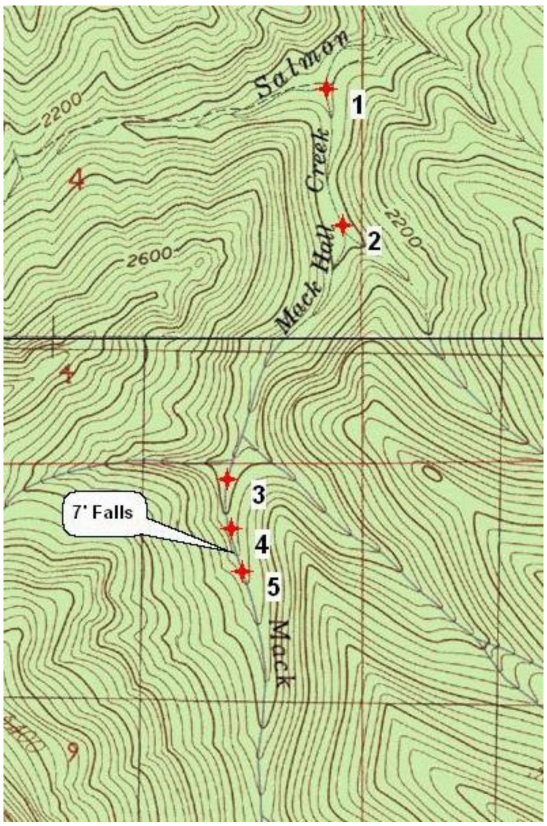
8. The crew re-inspects the map and notices that the stream gradient almost doubles at the location of what the crew expects is an unmapped tributary. The suspicion of a tributary is indicated on the map by the small valley that merges with their stream's valley approximately 0.25 miles downstream of **site #7**, even though the map has no line that represents a stream.

   The crew hikes downslope, avoiding walking in the stream, until they find the small valley that intersects with their stream. A new sample site, **site #8**, is established downstream of the valleys' intersection. The sampling site includes at least two high quality pools and a fastwater habitat. These are snorkeled; but rainbow trout are not observed.

9. Again, the crew re-inspects the map, and they estimate that they are currently less than 0.25 miles from the waterfall that marks the change from **site #5** to **site #6**, where both rainbow and chinook were observed. They decide to sample every high quality pool between their current location and the waterfall to find the end-of-distribution for the rainbow trout they already know are present upstream of the falls; and they choose to sample while moving down valley, towards the known barrier falls.

10. After already investigating four high quality pools chosen by the crew while walking streamside down the valley, a rainbow trout is seen in the fifth pool. A GPS waypoint is taken (or an aerial photo is pin-pricked) at the location of the first pool in which they encounter a rainbow trout. The confirmation of rainbow trout simply extends the length of **site #6** from the chinook barrier falls to the new upstream location of the end of habitat used by rainbow trout.

Example 2: an AB-Only Presence Survey in a Roadless Area



Mack Hall Creek has **no easily accessed sample sites** via the road network, nor does it have a trail that parallels the stream. Clues for potential changes in species presence can be observed from a map:

1. Tributary junctions may cause a reduction in flow upstream.
2. Elevation contours (1:24K scale) that are spaced less than 1/16th of an inch on the map usually indicate a barrier falls is likely.
3. A dotted line for your stream usually means the stream has dry segments during the summer.

1. The crew hikes to the mouth of Mack Hall Creek and snorkels one fast water and two high quality pools near the mouth. They observe juvenile chinook and rainbow trout, and they record the results as sample **site #1**

2. The crew leaves the stream and hikes atop the banks, watching for channel conditions to change. But, conditions remain constant for 0.25 miles, so the crew samples another two pools and riffle to validate that the species using the stream remain constant. A pin-prick of the aerial photo (or a GPS waypoint) locates sample **site #2**.

3. The crew comes to a tributary that contributes more than 20 % of flow (the trib is mapped at the 1:24K scale). As expected, the target stream has less flow upstream of the tributary, and gradient is increasing. The crew decides to establish a sample site (**site #3**) immediately upstream of the confluence with the tributary. Both species are observed in the two pools and one riffle that they snorkel.

4. Within 0.1 mile, a 7 ft-high bedrock falls is seen. Estimating that the feature may limit both species, the crew decides to snorkel the two best pools and a riffle immediately downstream of the falls. Both species are present. The take a GPS waypoint (or pin-prick their aerial photo) to geographically locate the falls.

5. Now, immediately upstream of the falls, they again snorkel the first two high quality pools and a riffle, but no fish are seen. They snorkel an additional pool to validate their suspicions, and they see no fish, and they conclude that the 7 ft-falls downstream marks the end-of-use by both species.

6. The crew then designates the sampling downstream of the falls as **site #4,** and the sampling completed upstream as **site #5**.

Expected Products of an AB-Only Presence Survey

1. A Pre-survey map to include proposed sample sites
    a. to be used in the field for identifying sample sites and barriers
    b. Location of end of use for each species is identified on your field map
2. A Post-survey map (i.e., a final survey map) that includes the actual location of segments of stream used as sample sites
3. Completed AB-Only Presence forms
    a. Each sample site will have a row on the field data form designated for each species observed in the sample site
    b. Multiple sample sites can be recorded on the same field form

Advice for AB-Only Presence Surveys

- *If conditions don't change over 0.25 miles of stream, no sample site is necessary.*
- *If the assemblage changes, then the sampling effort is split into two adjacent sample sites.*
- *The absence of one species in a single habitat or even two consecutive pools of a sample site can't be considered a change in fish assemblage*
- *3 high-quality pools in succession must lack a species to permit an assumption of absence.*
- *Intensive sampling of the length of stream equivalent to 40 times the average wetted width is necessary to confirm any change in the fish assemblage; an equivalent distance of intensive sampling is required to confirm that you have found the end of fish use in a stream*

APPENDIX F - Table of Life Stage Values

Class	Class Detail	Code	Description
	ND	ND	Not Designated
AMPHIB	ANURA	ADULT	Metamorphic changes complete, able to reproduce.
AMPHIB	ANURA	EGG	Developing ovum.
AMPHIB	ANURA	METMORPH	Undergone metamorphosis, resembles an adult, sexual maturity is not clear.
AMPHIB	ANURA	ND	Not Designated
AMPHIB	ANURA	SUBADULT	Undergone metamorphosis, resembles an adult but has not attained sexual maturity.
AMPHIB	ANURA	TADPOLE	Prometamorphic, period of growth, especially limbs, minor metamorphic changes
AMPHIB	CAUDATA	ADULT	Metamorphic changes complete, able to reproduce.
AMPHIB	CAUDATA	EGG	Developing ovum
AMPHIB	CAUDATA	LARVAE	Similar to adults but have gill structures that vary in size between habitats.
AMPHIB	CAUDATA	METMORPH	Undergone metamorphosis, resembles adults, sexual maturity is not clear.
AMPHIB	CAUDATA	ND	Not Designated
AMPHIB	CAUDATA	NEOTENIC	Incomplete metamorphic change, retains some characteristics of larvae, can reproduce.
AMPHIB	CAUDATA	SUBADULT	Undergone metamorphosis, resembles adult but has not attained sexual maturity.
FISH	GNRLFISH	ADULT	Sexually reproductive
FISH	GNRLFISH	CARCASS	Carcass
FISH	GNRLFISH	EGG	Developing ovum
FISH	GNRLFISH	JUVENILE	Not mature, not sexually reproductive
FISH	GNRLFISH	LARVAE	Developing immature
FISH	GNRLFISH	ND	Not Designated
FISH	GNRLFISH	PROLARVA	Still bearing yolk sac, also called sac fry, a subclass of larva
FISH	GNRLFISH	PSTLARVA	Postlarva, a period from yolk sac absorption to the juvenile stage, a subclass of larva
FISH	SALMONID	ADULT	Sexually reproductive
FISH	SALMONID	AELVIN	Still bearing yolk sac, also called sac fry.
FISH	SALMONID	CARCASS	Carcass
FISH	SALMONID	EGG	Developing ovum
FISH	SALMONID	FRY	Yolk sac is absorbed
FISH	SALMONID	HALFPND	Half-pounder: a small, immature steelhead that migrates upstream in the early fall. Found mainly in the Klamath, Eel and Rogue rivers, and to a lesser extent in a few other rivers of northern California and southern Oregon.
FISH	SALMONID	JACKS	Males returning to spawn at early age and small size, also called grilse
FISH	SALMONID	JUVENILE	Not mature, not sexually reproductive
FISH	SALMONID	KELTS	Spawned out fish
FISH	SALMONID	ND	Not Designated
FISH	SALMONID	PARR	Have a series of marks on their sides, parr marks
FISH	SALMONID	SMOLT	Ready to migrate to sea

APPENDIX G - Table of Life History Values

Code	Description
Adfluvial	Rear in natal stream then migrate to lakes to mature. Potadromous.
Anadromous	Rear in natal streams and migrate to marine environments to mature
Catadromous	Spawn in marine environments and migrate to freshwater to mature
Fluvial	Rear in natal streams but reside in large rivers and streams following maturation.
Resident	Found in small tributary streams, or lakes where they tend to live year round.

APPENDIX H
Stream Inventory JHA

Below you will find a JHA specific to Stream Inventory. This is just an example and a separate, more detailed JHA will be developed for other activities such as snorkeling and electroshocking that details the hazards for those specific activities.

R6-FS-6700-7 (08/12)

U.S. Department of Agriculture Forest Service	1. WORK PROJECT/ACTIVITY Fishery / Stream Surveys, Stream Walking	2. LOCATION Stream Inv. Training – Umatilla NF	3. UNIT 0614/0603/0606/0622
JOB HAZARD ANALYSIS (JHA) References-FSH 6709.11 and -12 (Instructions on Reverse)	4. NAME OF ANALYST Katie Serres	5. JOB TITLE Fish Biologist	6. DATE PREPARED 6/3/15

7. TASKS/PROCEDURES	8. HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE	10. POST ABATEMENT ACTION RISK RATING (Severity/Probability Matrix)		
			Severity	Probability	Risk Code
Driving to the survey site.	**Traffic on heavily used public roads; driving on rough roads and 4wd roads, getting vehicle stuck, being involved in a vehicle accident, driving home tired from a long day in the field.**	**Sign out and inform coworkers of EXACT destination(s) and estimated return time. Check out route before leaving station and carry pertinant local maps. Perform regular vehicle maintenance, especially gas, oil, and tire pressure checks. Follow safe and defensive driving practices; use a relief driver or take rest breaks.**	II	D	RAC3
Communication	**Lack of Radio Contact, not knowing proper radio procedures.**	**Carry a radio or have working radio in government vehicle Knowledge of proper radio procedures. Carry radio in plastic bag when in the stream, keep batteries charged and carry an extra battery pack.**	IV	C	RAC4
Back-country hiking to survey site or stream	**Hiking Injuries (trips, slips, and falls, scrapes and punctures, eye injuries)**	**Surveyors will receive training on safe walking in the woods and will be provided with personal protective equipment, including hard hats, gloves, and eye protection (sunglasses). Surveyors will be required to wear additional personal protective equipment including 8" high boots with lug soles, long-sleve shirts, long pants, and rain gear, if needed. Warm up/stretch muscles prior to walking.**	II	C	RAC2

Stream / Fishery Surveys/ Stream walking	**Slips and Falls**	**Wear proper surveying gear which includes non-felt and cork-soled waders or wading shoes, waders, and polarized glasses (all provided by the government).** **Use a walking stick.** **Move slowly, take your time. Wear a hard hat.**	II	C	RAC2
	Hypothermia	**Work in teams of two. Have warming devices available. Wear proper equipment that is in good condition. Be aware of signs of hypothermia, it's prevention, detection and treatment. Stay in tune to current weather and extended forecasts**	III	D	RAC4
	Insect bites/stings	**Carry first-aid (Benadryl) and sting relief kits. Make sure all crew members are informed about others who are allergic and what to do if they need assistance. Carry necessary emergency medication (Epipens).**	IV	B	RAC4
	Eye injuries	**Travel with care through heavy brush. Use eye protection in brushy areas.** **.**	III	D	RAC4
	Scrapes and punctures	**Wear proper clothing, long sleeved shirts and pants.**	IV	C	RAC4
	Severe injury in remote locations	**Carry a two-way radio and know how to use it.. Work in teams. Make sure someone on crew is certified in first aid. Carry a first aid kit.**	II	D	RAC3
	Blow-down / heavy debris	**Be aware of your surroundings, including hanging or leaning debris that may be dislodged and fall.**	III	C	RAC3
	High flow velocity	**Evaluate a stream before entering. If it is flowing to fast to cross or if you feel uncomfortable; find a new place to cross or do not cross the stream at all.**	III	D	RAC4

	Severe weather	**Suspend measurements during lightning storms or when a storm is approaching.**	III	C	RAC3

11. LINE OFFICER SIGNATURE	**12. TITLE**	**13. DATE**

(over)

APPENDIX I
Stream Inventory Glossary

This stream inventory glossary (and the acronym dictionary which follows the Aquatic Glossary), include terms and acronyms used in the body of the Stream Inventory Handbook. The purpose of both of these references is to foster greater understanding of the process and the specifics of stream inventory as defined by the Pacific Northwest Region.

ABNEY LEVEL: A hand held level equipped to measure changes in gradient. These changes in slope are measured in both degrees and percent.

ACCESS POINTS: Locations along the road network used by survey crews to enter or exit the valley of the inventoried stream.

ALLUVIAL: Relating to all deposits resulting directly or indirectly from the sediment transport of streams deposited in riverbeds, flood plains, lakes, fans and estuaries.

AQUATIC HABITAT: (see habitat)

BAFFLES: Deflectors that change the direction of flow or velocity of water through a culvert. Baffles are intended to reduce water velocity and provide passage for fish.

BANKFULL: A term used to describe streamflow, under the current climatic and hydrologic regime, which occurs on average once every 1.5 years. Flows of this magnitude transport the most sediment over time. Bankfull flows are the discharge responsible for maintaining the present channel shape. In channel types possessing a well-developed floodplain (e.g., Rosgen streamtype C), bankfull is the stage or streamflow that just overtops the channel's banks and begins to inundate the floodplain.

BANKFULL INDICATORS: The channel attributes created during bankfull flow and visible during low flow conditions. The best indicator of bankfull flow is the deposits of streambed material which remain after a bankfull event. The top of these depositional features closely approximates the height of bankfull flow. Other indicators of bankfull are: the lower limit of perennial vegetation (this may be a change in the species of moss), a change in the streambank's slope, a change in the particle size of the streambank, undercut banks (the top of the undercut is usually slightly lower than the bankfull stage), and the presence of stain lines or the lower extent of lichen colonization on the banks.

BANKFULL STAGE: The water level elevation during a bankfull discharge. This elevation leaves a signature on the channel in the form of depositional areas and distinct streambank slopes. The line of permanent vegetation along a stream is often a close approximation of the bankfull stage.

BEAVER DAM: A dam built by a beaver made of wood/twigs/mud and is channel spanning and impounding water.

BOLE: (see tree bole).

BRAIDED CHANNEL: A habitat characterized by the presence of at least three channels running roughly parallel to each other and appearing distinct at flows less than bankfull. At bankfull stage, the islands separating the multiple channels are overtopped, and the channel appears to be a single broad channel. This braided condition describes the Rosgen streamtype D. This is not a separate channel unit. It will be designated as a fast water unit and a remark should accompany it in regards to its braided condition.

The islands separating the braids are characteristically unstable due to their inundation and reformation during bankfull flows. The evidence of this instability is the lack of well-established perennial vegetation atop the islands. A braided channel is the result of a sediment supply that exceeds the power of the stream to transport all of the sediment through a specific channel segment.

CHANNEL: A Stream. The term may be used to describe the mapped stream, the wetted “low flow” condition, or the stream at bankfull.

CHUTE: A narrow, confined channel through which water flows rapidly. The streambed of a chute is usually composed of bedrock, but may sometimes be made of hard clay. Streamflow is usually laminar through the chute.

COLLUVIAL: Relating to loose deposits of soil and rock moved downslope by gravity alone, rather than by force of flowing water.

CONFLUENCE: The flowing together of two or more streams.

CONTOUR: A line drawn on a topographic map connecting points of equal elevation.

COVER: In the sense of cover for fish, anything that provides protection from predators or reduces adverse conditions of streamflow and/or seasonal changes in metabolic costs is an attribute providing cover. Instream cover may be provided by substrate, turbulence, undercut banks, woody material, vegetation, or depth. Cover can also be provided by overhanging vegetation or woody material elevated above the wetted channel. Aquatic organisms use cover for escape, feeding, hiding, or resting. Collecting cover data is a forest option.

Cover for fish is not to be confused with “streambed cover” (an attribute of R06 methods for stream inventory, 1990 to 1994). Streambed cover sought to answer the question, “how well armored are the lower banks to erosion?”, and had no direct relation to cover for fish.

CULVERT: A pipe made of metal, concrete, or other material that transports water and sediment beneath a road. Unlike a bridge, a culvert is constructed by burying the pipe in fill material transported to the site. Culverts can be barriers to the upstream movement of fish for several reasons: the length of the culvert or the gradient of the culvert may cause the fish to fatigue and be carried downstream; the velocity of the flow through the culvert may exceed the fish's burst speed; and the height from the surface of the water to the outlet of the culvert may exceed the ability of the fish to jump.

DAM: A human-made structure intended to impound streamflow.

DIAMETER CLASS: As applied to riparian vegetation, diameter is measured or estimated at breast height (DBH) above the ground. The diameter size class is the range of DBH expressed in inches.

In contrast, the diameter of LWM (large woody material) is measured at the appropriate distance from the large end of the log (see discussion of LWM in Chapter 2 of this handbook.

DISCHARGE: The volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per sec. (cfs) or as cubic meters per sec. (m^3/sec.). Syn: Streamflow.

DESIRED FUTURE CONDITION: An explicit description of the physical and biological characteristics of aquatic and riparian environments believed necessary to meet fish, aquatic ecosystem, and riparian ecosystem objectives.

DOT GRID: A transparent acetate sheet imprinted with regularly spaced dots forming a grid. The dotted sheet is placed atop a map, and the area of the drainage basin is estimated by counting the dots which fall inside the perimeter of the drainage basin.

DRAINAGE BASIN: A part of the surface of the earth that is occupied by a drainage system. This system consists of a surface stream or body of impounded surface water together with all tributary surface streams and impounded surface water. Additionally, a drainage basin always includes the upland slopes which deliver runoff from precipitation directly to the stream network.

DRY MAIN CHANNEL: A habitat characterized by the lack of flowing water during a low flow (level II) survey. This condition is common in intermittent streams. A dry main channel may also occur as a result of water withdrawals, and is sometimes seen in recent deposits of course sediment at the mouths of a stream. A dry side channel is not considered a habitat for the purposes of a level II survey.

ENDPOINTS: (see reach endpoints/startpoints).

ENTRENCHMENT: The ratio of the floodprone width to the bankfull width. As the ratio approaches 1.0, the degree of entrenchment increases. Rosgen streamtypes C, DA, and E have low entrenchment and broad floodplains. In contrast, Rosgen streamtypes A, B, F, and G have high values for entrenchment and poorly developed floodplains.

EPHEMERAL: The flow in an ephemeral channel does not persist beyond runoff from storms or snowmelt. A reach that transports surface water only during storm events. The channels of ephemeral reaches tend to be well vegetated with little or no evidence of scour or deposition.

FALLS: A geomorphic stream channel feature that consists of essentially a vertical drop of water over bedrock or boulders.

FAST WATER (also referred to as RIFFLE): A portion of the stream with increased water velocity. Streamflow during low flow discharge is intercepted by partially or completely submerged obstructions to produce relatively high surface turbulence, and this turbulence often is seen as pockets of whitewater. Stream channel gradient is greater in riffles than in pools. Riffles are an inclusive term for low gradient riffles, moderate gradient rapids, and high gradient cascades.

FLOOD: Any flow that exceeds the bankfull discharge of a stream or channel. In certain channel types (e.g., Rosgen stream types C, DA, and E) discharges greater than bankfull spill out onto a floodplain. In entrenched channel types, flood flows remain constrained by the channel banks.

FLOODPLAIN: The depositional zone near a stream which receives flood water and deposits during streamflows that exceed the bankfull discharge. Floodplains are constructed under the current conditions of flow and precipitation. Entrenched streams tend to lack well-developed floodplains because the water and sediment transported during streamflows which exceed the bankfull stage remain confined within the banks of the channel, rather than being dispersed across a wider valley.

FLOODPRONE WIDTH: The portion of the valley floor that is prone to relatively frequent flood events of 50 years or less.

FOREST OPTION: Optional inventory attributes. Individual forests will decide whether or how to collect these attributes.

GIS: Geographic Information System. GIS produces spatial representations of the condition of the landscape: roads, streams, vegetation, etc.

GRADIENT: The slope of a stream measured in percent ([the change in elevation (rise) / length (run)] x 100).

HABITAT: A channel-wide segment of a stream which has a distinct set of characteristics. A list of potential habitats includes: pools, riffles, side channels, dry main channels, tributaries, culverts, falls, chutes, dams, braided channels, and marshes. Pools and riffles can be thought of as slow water and fast water habitats. These two habitat types can be further classified into subtypes using channel attributes such as turbulence, gradient, position, etc. (See Hawkins, et al. 1993. A hierarchical Approach to Classifying Stream Habitat Features. Fisheries, Vol. 18, No. 6.)

HYDRAULIC CONTROL: A generally sinuous line at the downstream end of a pool where the flow is constricted and stream depth decreases. The top of any channel-spanning obstruction is a hydraulic control if streambed substrate has accumulated upstream of the obstruction forcing streamflow to crest the obstruction. Examples are bedrock outcrops, gravel or cobble bars, log weirs, or beaver dams.

INTERMITTENT: A reach that transports surface water seasonally as a result of runoff or snowmelt, but is dry during the low flow season. Evidence of seasonal flow is an unvegetated or partially vegetated channel possessing depositional and scour features. The uppermost reaches of perennial streams are often intermittent. These reaches may have persistent pools, but with sporadic flow between pools.

INTERPOLATION: To estimate a value of (a function or series) between two known values.

JOURNEY LEVEL PROFESSIONAL: A specialist functioning without a mentor. All program managers regardless of their management unit (e.g., District or Forest) are journey level professionals.

JUMP HEIGHT: The vertical distance a fish would have to jump to pass into a culvert outlet from the downstream habitat. Syn: jumping distance height.

LAMINAR FLOW: Non-turbulent flow. Flow in which the volume of water moves downstream in a fashion similar to water in a smooth pipe, with the particles of water moving parallel to each other. Such conditions are ideal for measuring streamflow. Conditions approximating laminar flow are most commonly found just upstream of a pool tail crest or through a chute.

LARGE WOODY MATERIAL: Live trees or downed wood that intercept bankfull flow in a substantial fashion and are large enough to influence the formation of habitats. For a tree or a downed piece of wood to count as large woody material, either the root swell or the tree bole must engage bankfull flow; and the wood must be at least 12 inches in diameter at 25 ft. from the larger end of the tree for Westside streams; for Eastside streams wood must be at least 6 inches in diameter at 20 ft. from the larger end of the tree.

LINE (OFFICERS): The operational hierarchy of the Forest Service which includes the District Rangers, Forest Supervisors, Regional Foresters, and the Chief of the FS. These are the individuals empowered to make the decisions about what management activities occur on the landscape.

LONGTERM TEMPERATURE RECORDING DEVICE: An electronic tool with the capacity to accurately record temperatures over an extended period of time. When these devices are used as part of a stream inventory, they must be submersible, digital probes that will record the maximum temperature of the day to at least the nearest half hour throughout the summer. The device is set to record the maximum temperature at any time within the set interval (hourly is recommended), if this feature is available. If the device has the option to record in Degrees Celsius or Fahrenheit, choose Celsius. These probes are placed in the streams in late June and then retrieved in early October.

LOW FLOW: The base flow of a stream. In the Pacific Northwest, low flow occurs on most streams in late summer. It is at low flow conditions that pools and riffles appear most distinct.

MAINSTEM CHANNEL: The main thread of a stream from its mouth to its upstream origin. The mainstem channel is composed of channel-wide habitats such as pools, riffles, dry channels, culverts, falls, chutes, etc. These mainstem channel habitats are linked in a linear fashion to adjacent mainstem habitats, and occasionally linked to secondary channel habitats. Examples of secondary channel habitats are side channels and tributaries.

MARSHLAND: Land characterized by soils that are water-saturated at least part of the year. This wetland lacks a well-defined bankfull channel.

ORACLE: A relational database used throughout the US Forest Service for information management. NRM is an application of the ORACLE database designed to manage data collected during stream inventory.

ORTHOPHOTOGRAPH: A photograph having properties of orthographic projection (i.e., the image displacements caused by camera tilt and relief of terrain are removed from a conventional perspective photograph).

OVERSTORY: The dominant tree species in the vegetation canopy layer as determined from a birds-eye (aerial) view.

PEEP SITE: A small hand level.

PERENNIAL: A reach that transports surface water year-round. Segments of dry channel may occur within an otherwise flowing reach, but such a channel is designated perennial until no aquatic habitat exists upstream.

PLANIMETER: An instrument used to measure the area of any figure by tracing the perimeter of the figure. The area of a drainage basin can be accurately calculated by tracing the perimeter of a drainage basin with a planimeter.

PLUNGE POOL: A channel-spanning pool habitat in which the scour element maintaining the depth of the pool is a channel-wide obstruction such as a bedrock falls or a debris jam over which streamflow plunges. A plunge pool must span the width of the wetted channel but need not be longer than its width.

POINT BAR: Sediment deposited on the inside bank of a bend in a stream. Most sediment is moved and deposited during storm events. Point bars are zones of low energy, that is, zones of deposition. A lateral scour pool is usually present alongside the point bar

POOL (SLOW WATER): See Slow Water.

POOL TAIL CREST (PTC): The point along the downstream end of a pool where the water surface slope breaks into the downstream habitat.

RANGE OF NATURAL CONDITIONS: The lowest and highest values a system could reach for any given ecological parameter. The effects of human intervention during the historical time frame are intentionally not included in the determination of the range of natural conditions.

REACH: A relatively homogenous section of stream having a repetitious sequence of habitat types and relatively uniform physical attributes such as channel slope, habitat width, habitat depth, streambed substrate, and degree of interaction with its floodplain.

REACH ENDPOINTS/STARTPOINTS: The beginnings and ends of all reaches. The endpoint of a reach is the start point of the reach upstream. Every endpoint occurs at the upstream end of a habitat.

RESIDUAL POOL: The pool that persists at the instant the stream stops flowing out of the pool. Residual pools are isolated from each other by dry mainstem channel.

RIFFLE (FAST WATER): See Fast Water.

RIPARIAN VEGETATION: Vegetation growing on or near banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season. This also includes near-stream vegetation which either offers shade to the stream or could supply the stream with large woody material (LWM).

RIPARIAN ZONE: The area between a stream or other body of water and the adjacent upland slopes. This zone is identified by soil characteristics and distinctive vegetation. It includes wetlands, the near-shore vegetation surrounding lakes, the portions of flood plains and valley bottoms that support riparian vegetation. The riparian zone also includes those portions of the upland which have the potential to deliver large woody material (LWM) to the stream channel.

For the purpose of a level II stream inventory, riparian zone refers to the 100 ft. strip of landscape paralleling the channel on both banks, although it is acknowledged that the true riparian zone is usually wider than these 100 ft.-wide strips.

ROSGEN STREAM TYPE: The Rosgen classification system defines stream channels based on the level of investigation. The office phase (level I) of stream inventory permits surveyors to assign a letter label (alpha class: A, B, C, D, DA, E, F, or G) to each stream reach. These labels attempt to distinguish the broad landscape differences in stream character due to valley gradient, valley width, and the apparent sinuosity of the stream observed on 1:24,000 scale USGS maps and aerial photography. Field measurements are essential to refine these landscape-level channel designations.

ROOTS: The branching network of a plant which both anchors the plant in the ground and transports nutrients and water to the stem from the ground. Exposed roots within the bankfull channel have very little impact on streamflow.

ROOT SWELL: The portion of a tree in which the root tissues are replaced by stem tissues. This region of the tree is distinctly broader than the stem, or tree bole, above it. The majority of the mass of a tree stump is root swell. Bankfull streamflow is significantly altered by the presence of just the root swell of a tree within the bankfull channel.

SAMPLING METHOD: The technique used to determine the biota using a channel unit (habitat) or the riparian area bordering the channel unit. Acceptable methods include snorkeling, seining, angling (hook and line), and electroshocking. A permit is required for electroshocking in both Washington and Oregon. Contact WDFW or ODFW respectively for specific information on the permitting process.

SCALE STICK: Synonymous with depth rod, a pole possessing tenth-of-foot increments and used to determine habitat depth.

SENSITIVITY: As applied to watersheds and fish stocks, is the degree of resiliency each possesses to changes in their conditions. That is, sensitivity is a reflection of how persistent certain physical or biological conditions are to different impacts on the system.

SERAL STAGE: The dominant vegetative condition of a particular location. For stream inventory, seral stage refers to the diameter size class of the vegetation that best describes the riparian zone. Seral is synonymous with succession, the process of plant communities to replace one another. For example, following a forest fire, longer-lived and taller woody plants gradually replace the grass/forb pioneer species that colonize a landscape after a fire until the forest is disturbed again.

SIDE CHANNELS: A lateral (i.e., secondary) channel with an axis of flow roughly parallel to the mainstem channel. This secondary channel transports water from an upstream confluence with the mainstem channel to a downstream confluence with the mainstem channel.

The island formed by the side channel and the mainstem channel is stable and not likely to be inundated during bankfull discharge. Persistent woody vegetation other than willow is evidence that the island is stable and that the secondary channel is a side channel. In certain circumstances, woody plants may be absent from a stable island. But in those cases, a well-developed soil and vegetation will be present, and the vegetation will endure bankfull discharges.

For purposes of the level II field inventory, side channels that have no flow during low flow conditions, that is, they are dry at the time of the survey, are not designated as channel units nor are they analyzed in the NRM database.

SINUOSITY: The ratio of stream channel length to valley floor length determined at the reach scale. Using mapping software length tool, the stream channel length is traced on a map between the two endpoints of a reach. The length tool is then used to trace the distance between the same two points along an imaginary line occupying the middle of the valley floor. Channels with sinuosities of 1.5 or more are called meandering.

SLOW WATER (also referred to as Pool): A portion of the stream that usually has reduced surface turbulence and has an average depth greater than riffles when viewed during low flow conditions. The bowl or tub appearance of pools is the result of high flow scouring the streambed. A pool may at times contain substantial surface turbulence at the upstream end, but always has a hydraulic control present across the full width of the channel at the downstream end.

This hydraulic control functions as a dam, which retains water in the pool even after streamflow ceases. This retained water is referred to as the residual pool. Residual pool depth is the difference between the maximum pool depth and the maximum depth along the downstream hydraulic control.

STADIA ROD: A rod divided into 0.01 ft. increments which is used to accurately determine differences in elevation.

STAFF (OFFICERS): The lead personnel from each section (e.g., Budget and Finance, Engineering, Natural Resources, Recreation, Contracting, etc.) of any management unit within the USDA Forest Service. Management units include Districts, Forests, Regions, and the Washington Office. Staff officers report directly to the line officers of their management unit. The responsibilities of staff officers include recommendations to their line officers as well as guiding the operations of programs and technical activities within their section.

STREAMFLOW: The volume of water passing through the cross-sectional area of a channel per unit time. Syn: discharge.

STREAM ORDER: A numbering convention for stream channels that reflects the degree of stream network-branching upstream of a given point along the stream. See accompanying Appendix B for an illustration.

STREAM ROUTE: The term used in GIS (Geographic Information system) to refer to a digitally mapped stream. The mapped stream is a series of line segments, called arcs, that all share a common identifier.

TENSION CRACKS: Visible cracks or fractures in the surface of the soil. These fractures are the result of gravitational stresses pulling the soil apart, and these cracks are visible clues of soil instability.

TERRACE: A terrace is an abandoned floodplain. Terraces are the result of a stream cutting vertically down, forming a new, active floodplain within the new cut. Terraces are then left elevated above the active floodplain.

TIER 1 KEY WATERSHED: A watershed containing habitat for potentially threatened stocks of anadromous salmonids or other potentially threatened fish such as bull trout.

TIER 2 KEY WATERSHED: A watershed with an area greater than 6 square miles possessing high quality water; such water is often the source for municipal water supplies.

THALWEG: The longitudinal (upstream to downstream) line of maximum depth within a stream channel. The deepest point in any channel cross section will occur in the thalweg.

TOPOGRAPHIC: Graphic representation of the surface features of an area on a map, displaying their relative positions and elevations by using contour lines.

TRANSVERSE BAR: An accumulation of coarse sediment oriented more or less perpendicular to the direction of streamflow. Transverse bars persist at low flow conditions, but are the result of scour just downstream as stormflow decreases. The long axis of a transverse bar often mimics some channel obstruction, such as a bedrock outcrop or a large downed tree.

TREE BOLE: The stem of the tree above its broadened base (= root swell). The tree bole is the portion of the tree harvested for lumber. Like the root swell, the tree bole of a large enough tree can substantially alter streamflow during bankfull events.

TRIBUTARY: A secondary channel system that occupies a distinct drainage basin and has a unique headwater origin. The drainage basin of a tributary is a portion of the larger drainage basin of the mainstem channel.

TURBULENCE: The motion of water where local water velocities fluctuate. The direction of flow changes abruptly and frequently at any particular location, resulting in the disruption of laminar flow. Turbulent water has an uneven surface. Subsurface water is often obscured in highly turbulent water by air bubbles entrained in the water (i.e., whitewater).

UNDERSTORY: The trees, shrubs or herbaceous species that compose the layer of vegetation below the overstory.

WOLMAN PEBBLE COUNT: An unbiased sampling of the streambed's surface layer.

WATERSHED ANALYSIS: A systematic procedure for characterizing ecological processes to meet specific management and social objectives. The process integrates prehistoric and historic land use patterns with the natural processes that have shaped the landscape. Watershed analysis is appropriately applied to drainage basins of approximately 20-200 square miles.

WETLANDS: Lands where saturation with water is the dominant factor determining the nature of soil development. Water saturation influences the types of plant and animal communities living in the soil and on its surface. Wetlands possess soils or substrates that are at least periodically saturated with or covered by water. The vegetation of wetlands is distinct from the vegetation of adjoining areas that are elevated above the zone of inundation.

GLOSSARY OF STREAM INVENTORY ACRONYMS AND ABBREVIATIONS

AB: Aquatic Biota (it is the repository of the biotic data collected in tandem with the physical channel unit inventory)

AI: Aquatic Inventory (it is the repository of the physical channel unit data)

AIS: Aquatic Invasives Species

AqS: Aquatic Survey – reference to the NRM Aquatic Survey database

BFD: Bankfull depth

BFW: Bankfull width

BLM: Bureau of Land Management (an agency within the US Department of the Interior)

BO: Boulder (a field code for boulder in the “Formed By” and the “Ocular Substrate” attributes.

BR: Bedrock (a field code for bedrock in the “Formed By” and the “Ocular Substrate” attributes of the Channel Unit Form).

BV: Beaver (a field code for beaver in the “Formed By” attribute of the Channel Unit Form).

CFS: Cubic feet per second

CH: Chute (a field code for chute in the “Channel Unit Type” attribute of the Channel Unit Form).

CHUNIT: Dry mainstem channel, a marsh, or a braid (a field code for dry mainstem channel, a marsh, or a braid in the “Channel Unit Type” attribute of the Channel Unit Form).

CO: Cobble Bedrock (a field code for cobble in the “Ocular Substrate” attributes of the Channel Unit Form).

CU: Culvert (a field code for a culvert in the “Formed By” and the “Channel Unit Type” attribute of the Channel Unit Form).

DA: Dam (a field code for a human-built dam in the “Formed By” and the “Channel Unit Type” attribute of the Channel Unit Form).

DBH: Diameter at breast height (a rough measure of the age of a tree)

EDRR: Early Detection Rapid Response

EPA: US Environmental Protection Agency

F: Fast water (a field code for a fast water channel unit (riffle) in the "Channel Unit Type" attribute of the Channel Unit Form).

FN: Fast water, non-turbulent (a field code for a fast water, non-turbulent channel unit in the "Channel Unit Type" attribute of the Channel Unit Form).

FNRN: Fast water, non-turbulent, a run (a field code for a fast water, non-turbulent channel unit (i.e., a run) in the "Channel Unit Type" attribute of the Channel Unit Form).

FNSH: Fast water, non-turbulent, a sheet (a field code for a fast water, non-turbulent channel unit (i.e., a sheet) in the "Channel Unit Type" attribute of the Channel Unit Form).

FS: USDA Forest Service

FSH: Forest Service Handbook (an exhaustive information resource used by all FS units)

FT: Fast water, turbulent (a field code for a fast water, turbulent channel unit (riffle) in the "Channel Unit Type" attribute of the Channel Unit Form).

FTCC: Fast water, turbulent, cascade (a field code for a fast water, turbulent, cascade channel unit (riffle cascade) in the "Channel Unit Type" attribute of the Channel Unit Form).

FTRF: Fast water, turbulent, riffle (a field code for a fast water, turbulent, low gradient riffle channel unit in the "Channel Unit Type" attribute of the Channel Unit Form).

FTRP: Fast water, turbulent, rapids (a field code for a fast water, turbulent, rapids channel unit (riffle rapids) in the "Channel Unit Type" attribute of the Channel Unit Form).

GIS: Geographical Information System (a digital mapping system)

GR: Gravel (a field code for gravel in the "Ocular Substrate" attributes of the Channel Unit Form).

HUC: Hydrologic Unit Code (eight digits that identify a subbasin as unique)

IFIM: Instream Flow Incremental Methodology (a process for determining the minimum streamflow needed to sustain fish populations)

IRI: Integrated Resource Inventory

LWM: Large woody material (downed woody material intercepting bankfull streamflow and large enough to remain in the system during normal flow conditions)

NHD: National Hydrography Dataset. This layer is a feature-based dataset that interconnects and uniquely identifies the stream segments or "reaches" that make up the Nation's surface water drainage system.

NMFS: (see NOAA)

NOAA: National Oceanic and Atmospheric Administration. (Parent agency of NOAA Fisheries. NOAA Fisheries is also known as National Marine Fisheries Service (NMFS)).

NRCS: Natural Resources Conservation Service.

NRM: Natural Resource Manager (a nationwide database developed by the Forest Service). Includes the Aquatic Survey (AqS) data entry program.

ODFW: Oregon Department of Fish and Wildlife

OT: Undesignated (Other) (a field code for an unknown force causing a habitat to be formed; used in the “Formed By” attribute of the Channel Unit Form).

PTC: Pool Tail Crest

R06: Region 6 (Pacific Northwest Region of the USDA Forest Service)

RD: Ranger District (each National Forest is composed of several Ranger Districts)

RM: River mile (stream channel distance measured from the stream’s mouth, typically expressed in units of tenths of a mile)

RS: Restoration (a field code for an stream restoration efforts causing a habitat to be formed; used in the “Formed By” attribute of the Channel Unit Form).

S: Slow water (a field code for a slow water in the “Channel Unit Type” attribute of the Channel Unit Form).

SA: Sand (Gravel (a field code for sand in the “Ocular Substrate” attributes of the Channel Unit Form).

SB: Stream bend (a field code for stream bend used in the "Formed By" attribute of the Channel Unit Form).

SD: Slow water, dammed (a field code for a slow water, dammed in the "Channel Unit Type" attribute of the Channel Unit Form).

SDBV: Slow water, dammed by beaver (a field code for a slow water, beaver pool in the "Channel Unit Type" attribute of the Channel Unit Form).

SDDD: Slow water, dammed by woody material (a field code for a slow water, debris jam pool in the "Channel Unit Type" attribute of the Channel Unit Form).

SDLS: Slow water, lateral scour (a field code for a slow water, lateral scour pool scoured by a change in the direction of streamflow as water velocity changes at a streambank; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SIDEF: Fast water, side channel (a field code for a side channel that is more or less riffle-like used as a "Channel Unit Type" attribute of the Channel Unit Form).

SIDES: Slow water, side channel (a field code for a side channel that is more or less pool-like used as a "Channel Unit Type" attribute of the Channel Unit Form).

SO: Sequence order (the numerical label for all stream channel units; it is assigned in order as the channel units are encountered)

SSCV: Slow water, scoured by convergence (a field code for a slow water, convergence pool scoured by a tributary's added flow in the "Channel Unit Type" attribute of the Channel Unit Form).

SSMC: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SSPL: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

SSTR: Slow water, scoured at mid-channel (a field code for a slow water, mid-channel pool scoured by a partial channel blockage; the code is used in the "Channel Unit Type" attribute of the Channel Unit Form).

TFW: Timber, Fish and Wildlife (a cooperative venture in Washington state which includes private and public partners whose goal is to smooth the path to ecosystem management)

TR: Slow water, scoured trench (a field code for a slow water, trench pool scoured into bedrock; the code is used in the “Channel Unit Type” attribute of the Channel Unit Form).

USDA: US Department of Agriculture (the Forest Service is an agency within this federal Department)

USDI: US Department of the Interior (the Bureau of Land Management, the National Park Service, and the Geological Survey are agencies within this federal Department)

USGS: US Geological Survey (an agency within the US Department of the Interior)

WBD: Watershed Boundary Dataset. The WBD contains the most current 8-digit, 10-digit and 12-digit hucs.

WD: Wood (a field code for woody material used in the “Formed By” attribute of the Channel Unit Form).

WDFW: Washington Department of Fish and Wildlife

WF: Waterfalls (a field code for waterfalls used in the “Channel Unit Type” attribute of the Channel Unit Form).

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(Bold numbers indicate location of actual Forms)

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for the greatest good

11.0 Appendix B

UCRTT Reach Assessment Guidance for the Upper Columbia

See attachment A for REI Metrics

REACH ASSESSMENT GUIDANCE FOR THE UPPER COLUMBIA

UCRTT

UPPER COLUMBIA REGIONAL TECHNICAL TEAM

April 2022

Table of Contents

Definitions

Assessment Unit – A watershed used as the spatial currency in the Upper Columbia Biological Strategy's prioritization framework. The size of an assessment unit is commonly a USGS 12-digit hydrologic unit.

Limiting Factors – Specific features of freshwater habitat that influence the productivity, abundance, diversity, and spatial structure of salmonids and which restoration and protection projects are meant to address.

Fluvial Geomorphic Processes – The physical processes that are responsible for the creation and arrangement of fluvial landforms. Geomorphic processes are governed by the flux of both water and sediment and their interactions with vegetation and geology.

Rapid Assessment – A cursory evaluation of the current geomorphic condition of one or more valley segments within an individual stream or river. The results may provide insight into potential strategies for improving or protecting salmonid habitat.

Reach – One of the nested hierarchical subdivisions of a drainage network. It is smaller than a valley segment and larger than a channel unit. A reach is often classified by the geomorphic attributes of valley confinement, bed material, channel geometry, slope, and assemblages of geomorphic units (e.g., pool, riffle, etc.). Reaches in the Upper Columbia are set to be 1-4 km long.

Reach Assessment – A rigorous evaluation of both the current *and* historical geomorphic condition of one or more valley segments (one or more reaches) within an individual stream. The assessment quantifies rates of geomorphic and hydrologic change and identifies the processes that are responsible for both historical and current habitat condition. Reach assessment results provide a quantitative foundation for identifying appropriate strategies to improve or protect salmonid habitat.

Restoration – Restoration is the full recovery of the physical processes that were responsible for the geomorphology and distribution fish habitat before Euro-American settlement of the study area. It is the return to a pristine or unimpaired geomorphic condition and ecosystem and may require the most amount of human intervention.[1] This is one of four pathways of river management action.

Rehabilitation – One of four pathways of river management action where some of the attributes of the unimpaired, pristine condition of the river are established. Because restoration is often not feasible, rehabilitation (also referred to as enhancement) is often the pathway of intervention that will lead to the largest ecosystem improvement, ecologic function, and geomorphic condition.

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[1] Unfortunately, restoration has been used interchangeably with enhancement, rehabilitation, mitigation, creation, and improvement. Strictly speaking, these terms do not mean the same thing.

Mitigation – Mitigation is the prevention of future undesired consequences, for example, the prevention of future water and resource degradation or the prevention of a spread of an invasive species. This is one of four pathways of river management action.

Protection – Preservation of the current condition of the river ecosystem for the benefit of fish populations. This is one of four pathways of river management action.

Introduction

Collecting and evaluating information about freshwater and riparian habitat is an essential first step to developing a successful salmon, steelhead, or bull trout recovery project. Without assessing the current availability and restoration potential of salmonid habitat, it would be difficult to know where to focus conservation and restoration efforts. In addition, it would be difficult to identify the types of projects that would provide the most benefit to ESA-listed Upper Columbia fish populations given the finite resources that are available to complete the work. An assessment of not only the habitat but also the geomorphic processes, ecological interactions, and human history in each study area provides invaluable information to decision makers and project sponsors.

This document describes the necessary components of a reach assessment and defines its role in the implementation of the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*. Information from reach assessments is requisite for prioritizing enhancement and protection projects, as data and results from them are needed to help populate the Upper Columbia prioritization tool. Examples of finalized reach assessments can be found on the Upper Columbia Salmon Recovery Board (UCSRB) website (Assessments).

Importantly, reach assessments need to be completed in areas where no reach assessment data are currently available or where previous reach assessment data are outdated (>10 years old). Where data have been collected for Ecosystem Diagnosis and Treatment (EDT) modeling, most of the information in a reach assessment are collected as part of EDT or are outputs from EDT modeling. Thus, where EDT modeling has occurred (e.g., Okanogan and Methow River basins), reach assessments are likely not needed. Exceptions may be identification of geomorphic and hydrologic processes and locations upstream from anadromy. The EDT information can be found at:

Okanogan Habitat Status and Trends (ecosystems.azurewebsites.net)

Methow Habitat Status and Trends (ecosystems.azurewebsites.net)

Description of Reach Assessments

Fundamentally, reach assessments should provide valuable and insightful information about salmonid habitat to guide decision making about how to recover these imperiled populations. Specifically, reach assessments should identify areas where fish habitat can be protected or enhanced, as well as identify specific projects that will address the habitat factors limiting the abundance and productivity of target fish populations. Reach assessments should identify the geomorphic processes—historical, current, and future trends—that are responsible for the creation of fish habitat. Funders and project sponsors rely on reach assessments to support the identification and development of specific habitat rehabilitation or conservation actions.

Reach Assessment Spatial Framework

A spatial hierarchy of processes is responsible for stream channel and floodplain morphologies. At the broadest scale, the lithology and tectonic history of a physiographic province influences the quantity and caliber of sediment supplied to a drainage network. At the scale of a region such as the Upper Columbia, climate and topography influence sediment and water supply. The flux of water and sediment in turn creates assemblages of geomorphic units such as pools, bars, and floodplain features that are organized into patterns at the spatial scale of a geomorphic reach. Reaches are a subdivision of valley segments, which are defined by valley slope and valley confinement. From broad-scale geology to fine-scale geomorphic units, a nested spatial hierarchy of processes influence the quality and quantity of fish habitat within a watershed.

In terms of recovery, the broadest scales of the Upper Columbia River region are the Evolutionarily Significant Unit (ESU) and Distinct Population Segment (DPS) scales. Finer spatial scales include the population (or subbasin), and watershed (or assessment unit, e.g., HUC 12).

An assessment of physical habitat should incorporate an evaluation of processes operating across a range of spatial scales from a geologic province to watershed, valley segment, reach, and finally a geomorphic unit. Evaluation of processes across the spectrum of scales will provide information to support the identification of restoration or protection activities at discrete locations, while considering broader scale physical, ecological, and anthropogenic influences.

To the extent possible, the analysis framework for Upper Columbia reach assessments should incorporate the spatial units used in the Upper Columbia River prioritization strategy (Prioritization Strategy). The finest scales are the assessment unit and the geomorphic reach. Reach assessment boundaries and spatial units should be consistent with this common framework whenever possible.

GIS spatial layers for the region's spatial framework can be found on the UCSRB's web portal. Specifically, a flowline network containing geomorphic reaches can be found here, Reaches, under the name "Reaches and Reach Breaks." A map showing the spatial framework can also be found by clicking the link under the "Webmaps and Applications" tab.

Tools and Data Sources

Many different tools are available to assist with the development and implementation of a reach assessment. Tool and method selection should be based on the following:

- Data availability
- Tool accuracy and precision
- Level of effort required to execute the tool
- Ability of the tool to achieve the objectives

- Trust and confidence in the tool based on its application in previous studies
- Experience and analytical skill of the researcher
- Amount of time and funding allocated to complete the assessment

A reach assessment will likely use both qualitative and quantitative tools. Examples of qualitative tools include literature reviews, interviews with local experts and residents, repeat ground photography, and interpretation of existing data such as geologic maps, land survey maps, and reports. Examples of quantitative tools include hydraulic models, habitat suitability models, stream habitat surveys, statistical analyses, remote sensing analyses (e.g., aerial photograph, photogrammetry, etc.), topographic surveys, geomorphic surface mapping, and geochronologic dating tools. Kondolf and Piegay (2016) provide a comprehensive review of several tools that are available to researchers.

Reach Assessment Components

In general, a reach assessment should evaluate the historical, current, and potential future condition of stream and riparian habitat, and the spatial hierarchy of processes that influence the geomorphology of the study area. At the broadest scale, a reach assessment should describe, and, if possible, quantify the processes that influence the supply of water and sediment in the assessment unit. This can be accomplished by summarizing the geology, climate, topography, and vegetation of the valley segments in the study area as well as the contributing watershed.

At a finer scale, a reach assessment should describe the processes that are responsible for the morphology of the valley segment(s) and the geomorphic reaches contained within them. At the finest scale, the reach assessment should describe and quantify to the degree possible the various characteristics of the stream channel and floodplain that may adjust to changes in sediment supply and water discharge. These modes of adjustment, or degrees of freedom, include channel geometry, bed configuration, planform, and slope. In addition to an evaluation of geomorphic attributes, the reach assessment should include an evaluation of the hydraulics and the specific ecologic features and processes that influence salmonid habitat.

In order to properly evaluate freshwater salmonid habitat conditions, it is critical to document the impairments in the study area. For example, since the beginning of Euro-American settlement in the late 1880s, numerous anthropogenic actions have negatively affected salmonid habitat in the Upper Columbia. Humans have built roads for logging across large swaths of the landscape, built highways and railroads in floodplains and across rivers, harvested timber nearly everywhere including the valley bottoms, used rivers to transport logs, removed large woody debris in rivers for flood control, developed floodplains for agriculture, built levees to protect infrastructure, and installed riprap along banks to reduce erosion. These actions severely impaired the quality and quantity of salmonid habitat. Therefore, it is essential to describe and map these impairments and discuss their effects on geomorphic processes and salmonid habitat condition.

Another key component of a reach assessment is the reconstruction of the history of each river reach or valley segment. There are many qualitative and quantitative data sets and tools available that can be used to do this. For an explanation of why an historical reconstruction is important to fish habitat restoration, please refer to Kondolf and Larson (1995).

Importantly, reach assessments need to evaluate fish periodicity and habitat use within the reach. The timing and preferences of different species directly relate to the identification of potential actions. At a minimum, the assessment should document species and life stages present, timing of reach use, relative abundance/importance, as well as any other biological aspects of note.

In some cases, a reach assessment may be conducted to update past assessment data and findings because they no longer represent current conditions. In this instance, completing all components of a full reach assessment may not be needed and a "rapid assessment" approach can be used. Furthermore, reach assessments in smaller streams may warrant a more refined data collection effort and a more concise write-up, partially because of the lack of funding and data available in these areas. That said, a "rapid" assessment should not be used in place of a full reach assessment except in certain cases. Project sponsors and funders are encouraged to work with the UCRTT to determine when and how to use a rapid assessment in lieu of a full reach assessment.

Because the desired outcome is a robust and cost-effective reach assessment, researchers proposing or conducting one should closely coordinate their efforts with those of other entities and individuals working in the region and with the UCRTT. This will help prevent the duplication of effort and data and ensure that appropriate reach assessment methods and protocols are being used. Furthermore, researchers should coordinate closely with federal, state, regional, tribal, and local organizations as well as private landowners. To improve coordination, researchers are encouraged to collaborate with the Watershed Action Teams, Methow Restoration Council, and Implementation Team as appropriate.

A reach assessment report should follow the standard structure of a scientific publication. Following an introduction, the report should state the purpose of the study, describe the methods, present the results, and discuss and interpret finding. Finally, the report should use the sound scientific evidence that is acquired during the assessment to propose a practical and useful restoration strategy. What follows is a description of the components that should be included a reach assessment.

Introduction and Background

The Introduction and Background provide justification for the reach assessment and describe how it is related to the recovery of ESA-listed fish species in the region. It also describes the goals, objectives, and location of the assessment.

Methods

This section describes the analytical methods and any other methods used. It is important to present methods to provide transparency, repeatability, and confidence in the reach assessment results.

Study Area Characteristics

Pertinent valley segment and watershed characteristics, especially those that influence the geomorphic and habitat conditions in the study area, are described in this section. A list of recommended data that are used to evaluate and summarize the study area and the surrounding watershed is provided below:

1. Hydrography
2. Geography
3. Physiography (i.e., Ecoregion)
4. Geology
5. Hydrology
6. Climate including predicted future changes
7. Vegetation
8. Natural disturbances (e.g., wildfire, mass wasting, etc.)
9. Land use including human history and disturbance
10. Fish use

Assessment Results

Stream Habitat

It is necessary to conduct a field-based evaluation of existing stream and riparian habitat in the study area. The field evaluation should include the measurement of select habitat attributes important to fish including large wood, riparian structure, bed material, and locations and dimensions of channel units such as riffles, pools, glides, bars, and floodplains. To ensure alignment with the existing regional habitat datasets, existing habitat condition measurements should be performed using protocols found in the USFS Level II Stream Inventory Handbook (USFS 2016). Researchers should consider conducting spatially explicit fish habitat modeling (e.g., habitat suitability index modeling) to quantify fish habitat suitability in the study area.

Sediment Transport

Because bed material is influenced by the flux of both water and sediment, and constitutes the physical template of fish habitat, it is important to evaluate bed material size distribution in the study area. This analysis is an important component of an evaluation of the quantity and quality of fish habitat. Furthermore, an evaluation of bed material can be used to determine the sensitivity of the study area to geomorphic changes, which will lead to a better understanding of geomorphic recovery potential. Bed material analyses should focus on areas of the channel and floodplain that are composed of different sediment facies (i.e., areas of similar grain size distributions). Interpretation of bed material data may also provide insight into sediment transport dynamics including supply, storage, and evacuation. An example of bed material analysis includes incipient motion. Additionally, an evaluation of suspended load should be made, if relevant to the study area.

Hydraulics

It is necessary to complete an analysis of the hydraulics of the study area. If available funding and data allow, development a 1-dimensional or 2-dimensional hydraulic model for each reach is suggested. The hydraulic model should represent current conditions and, if possible, potential conditions at multiple stream flows (e.g., base flow, 2-yr, 10-yr, and 100-yr recurrence interval flows). Hydraulic modeling should be conducted at the reach scale. The hydraulic model results that should be included are maps of inundation extent, water depth, and water velocity.

Geomorphology

Geomorphic Organization of the Study Area

It is important to describe the geomorphic organization of the alluvial valley with a focus on the channel(s) and floodplain. This section should include geomorphic mapping of the alluvial surfaces within the valley, construction of a longitudinal profile, and the delineation and classification of geomorphic reaches and valley segments.

Alluvial Valley Geomorphic Surface Mapping

Describe each type of geomorphic surface that occurs in the study area by its sedimentology, height above water surface, position in the valley, topographic expression, and vegetation community. Examples of geomorphic surfaces include active channel, floodplains, terraces, and alluvial fans. Additionally, the perimeter of the valley bottom, which is that portion of the valley that is comprised of the active channel(s) and the floodplain should be mapped.

Longitudinal Profile

Create a longitudinal profile of the study area. If the study area is small, consider extending the longitudinal profile in both the upstream and downstream directions of the study area. A longitudinal profile is useful for evaluating sediment transport capacity. Features to highlight include changes in slope, the shape of the profile, knickpoints, and tributary influences.

Valley Segment and Reach Delineation

Delineate and classify both the valley segments and geomorphic reaches in the study area. Classify valley segments using valley confinement and slope or stream power. Classify and describe each geomorphic reach using the following geomorphic characteristics: valley confinement, bed material size, channel geometry, organization of geomorphic units (including both channel and floodplain), and slope or stream power.

Historical Geomorphic Evaluation

It is also important to evaluate the geomorphic characteristics of the study area during the historical time period. At a minimum, describe the historical geomorphic characteristics using available information such as interviews with residents, repeat ground photography, and other historical information such as General Land Office survey maps and notes. Preferably, the study will quantify geomorphic changes and calculate rates of changes. Together with an evaluation of stream flow changes, an understanding of geomorphic changes can be used to determine the mechanisms that are responsible for the present character and condition of fish habitat.

Numerous methods are available for quantifying geomorphic changes. For example, one of the most powerful methods for quantifying geomorphic changes, specifically planform changes, is to interpret a time series of aerial imagery and measure channel migration rates. Additional methods may be used to quantify geomorphic changes (e.g., quantifying floodplain development using geochronology tools). The types of change analyses that are chosen should be dictated, in part, by the character of the study area, data availability, resources that are available to complete the study, and the questions that need to be answered.

Existing Geomorphic Evaluation

It is necessary to summarize the information that was generated in the previous sections, specifically fish habitat, sediment transport, hydraulics, and geomorphology sections to describe the current geomorphic condition of each reach. The summary should include a description of the anthropogenic impacts to the reach and how these impacts have affected the geomorphic condition. Delineated reaches and valley segments should be presented as maps in the final report. Locations of anthropogenic impacts should also be included in these maps.

Ecology

Researchers should discuss which fish species and life stages reside in the study area and when they reside there (periodicity), and describe the habitat features that support them. If data are available, this section should describe the ecological characteristics of the study area that influence the distribution, abundance, and productivity of the various life stages of each fish species. Important ecological characteristics to address include stream temperature, other water quality parameters (e.g., dissolved oxygen, contaminants, etc.), food web dynamics, and invasive species interactions. Data sets that may be useful to analyze and summarize include redd survey data, outmigrant trap data, juvenile survey data (e.g., PIT tag or snorkel data), and water quality data.

Discussion

This section should interpret results and shows how salmonid habitat has changed over time, which fluvial processes are responsible for the current habitat condition, which fluvial processes were responsible for the historical habitat condition, and what factors are responsible for changes that may have occurred to habitat forming processes. In addition, this section should speculate on the future trends in habitat quantity and quality based on the insights that have been acquired regarding the habitat-forming fluvial processes occurring in the study area. The discussion should include a description of the factors that are currently limiting the production and survival of fish populations in the study area.

Restoration Strategy

The Restoration Strategy is a critical component of each reach assessment. Importantly, this section outlines how to enhance or conserve salmonid habitat in the study area. A "restoration strategy" should do the following:

1. Develop a reach-based ecosystem indicators matrix (REI; see Attachment A). This is a comparison of current habitat conditions to established functional thresholds. Habitat data should be qualitatively classified (reported as Acceptable, At Risk, or Unacceptable) through the use of Reach Ecosystem Indicators.
2. Identify the target habitat conditions. In addition to the insights gained from the assessment, the REI scores and the *Upper Columbia Biological Strategy* may be useful in identifying appropriate target conditions.
3. Identify projects that will either improve or protect fish habitat. Include the specific action type as well as the specific location of the project (i.e., reach and river mile). Estimate the biological benefit of each action type; for example, identify the life stages that will benefit from the project and/or the limiting factors that will be addressed by the project.

Review, Distribution, and Use of Reach Assessment

Once data collection and a draft report of the reach assessment are completed, the UCRTT will review it for completeness and accuracy. This review will focus primarily on whether the reach assessment comports with the Biological Strategy and the Prioritization Tool, whether it is complete, and what changes may be warranted. Prior to the UCRTT review, it is recommended that the authors of the assessment (i.e., the assessment sponsor and, if applicable, the consultant) present on it to the UCRTT. The UCRTT will provide the sponsor with a list of comments, some of which may require a response and a revision of the report. In rare instances, the review may warrant additional analyses and interpretation as well as a significant revision of the report. Upon completion of the comment-response process, the sponsor will receive a letter from the UCRTT acknowledging the sufficiency of the reach assessment.

Once finalized, reach assessments will be made available to regional sponsors and stakeholders for use in project prioritization and development. The UCSRB compiles reach assessments and makes them available on their website through this link: Assessments. Implementors are strongly encouraged to post their completed reach assessment in this public library, so that it can be used by project sponsors, partners, and the UCRTT. Data and GIS layers are also important to make available and should be submitted to UCSRB and the UCRTT for use and distribution (as appropriate).

Use in Prioritization

The Upper Columbia prioritization strategy relies heavily on the data that are collected for and compiled in reach assessments. These data are used to 1) prioritize assessment units; 2) evaluate habitat quality; 3) identify potential limiting factors; and 4) identify important fish passage barriers. The UCSRB and UCRTT are responsible for inputting relevant raw data and REI indicator values into the UCRTT's Prioritization Tool. Projects, including their assigned priority, that are identified in reach assessments are also compiled and tracked by the UCSRB for use by the UCRTT, sponsors, and partners. Implementers are encouraged to work with UCSRB staff to ensure all available data are input into these important prioritization products.

References

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Attachment A: Reach-Based Ecosystem Indicators

Reach-based Ecosystem Indicators (REI) definitions for Adequate, At Risk, and Unacceptable ratings. These ratings are based on National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife (USFWS) matrix of pathways and indicators (NMFS 1996; USFWS 1998), and from more recent adaption of those pathways and indicators by the United States Bureau of Reclamation (USBR 2012). These definitions may vary based on application; however, most reach assessments use similar definitions to those in this table. The pathway, general indicators, and specific indicators are given for each metric. REI metrics include watershed-scale (Table A1) and reach-scale (Table A2) metrics.

Table A1. Watershed-scale metrics.

Pathway	General Indicators	Specific Indicators	Adequate Conditions	At Risk Conditions	Unacceptable Conditions
Watershed Scale					
Watershed Condition	Drainage Network and Hydrologically Impaired Surfaces	Increase in Drainage Network/ Hydrologically Impaired Surfaces	Zero or minimal increases in the drainage network that is correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total < 8%. Road density <1 mile/miles^2.	Low to moderate increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total between 8 and 14.9%. Road density 1-2.4 miles/miles^2.	Substantial increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total > 15%. Road density >2.4 miles/miles^2.
	Disturbance Regime	Natural/Human Caused	Environmental disturbance is short-lived; predictable hydrograph, high-quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Localized events of hillslope contributions, avulsion, lateral migrations, minor bed incision, scour events, debris torrents, or wildfires. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, hillslope contributions, avulsion, lateral migrations, minor to major bed incision (head cuts), scour events, debris torrents, or wildfires throughout a majority of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.
Flow/Hydrology	Streamflow	Alterations to Peak/Base Flows	Magnitude, timing, duration, and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.

Pathway	General Indicators	Specific Indicators	Adequate Conditions	At Risk Conditions	Unacceptable Conditions
Water Quality	Temperature	7-day average maximum temperatures	**Spring Chinook, Steelhead:** spawning: <13°C rearing: <15°C holding & migration: <15°C **Bull Trout:** incubation: 2 - 5°C rearing: 4 - 12°C spawning: 4 - 9°C And temperatures do not exceed 15°C in areas used by adults during migration (no thermal barriers)	**Spring Chinook and Steelhead:** spawning: 13 - 15.5°C rearing: 15 - 17.5°C holding & migration: 15 - 17.5°C **Bull Trout:** incubation: <2°C or >6°C rearing: <4°C or 13 - 15°C spawning: <4°C or >10°C And temperatures in areas used by adults during migration sometimes exceed 15°C	**Spring Chinook and Steelhead:** spawning: >15.5°C rearing: >17.5°C holding & migration: >17.5°C **Bull Trout:** incubation: <1°C or >6°C rearing: >15°C spawning: <4°C or >10°C And temperatures in areas used by adults during migration regularly exceed 15°C (thermal barriers present)

Table A2. Reach-scale metrics.

Pathway	General Indicators	Specific Indicators	Adequate Conditions	At Risk Conditions	Unacceptable Conditions
Reach Scale					
Habitat Access	Physical Barriers	Main Channel Barriers	No man-made barriers present in the mainstem that limit upstream or downstream fish passage at any flow.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.
Habitat Quality	Substrate	Substrate / Fine Sediment	Gravels or small cobbles make up >50% of the bed materials in spawning areas, embeddedness < 20%, ≤12%fines/sand (<2 mm) in spawning gravel.	Gravels or small cobbles make up 30-50% of the bed materials in spawning areas, embeddedness is 20-30%, 12-17% fines (<2 mm) in spawning gravel.	Gravels or small cobbles make up <30% of the bed materials in spawning areas, embeddedness > 30%, >17% fines (<2 mm) in spawning gravel.
	Large Woody Material	Pieces per Mile at Bankfull	Large wood (diameter > 12 in, length > 35 ft) at a minimum: **Wetted width:** < 16.4 ft, 20 pieces/mile ≥ 16.4 ft, 70 pieces/mile Adequate rating also indicates there are sources of woody debris available for both long- and short-term recruitment within the reach.	Large wood (diameter > 12 in, length > 35 ft) ranges from: **Wetted width:** < 16.4 ft, >0 - 20 pieces/mile ≥ 16.4 ft, 17-70 pieces/mile Current levels are able to maintain the minimum requirements for an "adequate" rating, but potential sources for long-term woody debris recruitment, as determined by the Riparian Structure reach metrics, are lacking in order to maintain these current levels.	Large wood (diameter > 12 in, length > 35 ft): **Wetted width:** < 16.4 ft, =0 pieces/mile ≥ 16.4 ft, 0-17 pieces/mile Current levels are not meeting the minimum requirements for an "adequate" rating, and potential source of woody debris for short- and/or long-term recruitment are lacking as well.
	Pools	Pool Spacing (unconfined reaches only, where unconfined reach is >4 times the bankfull width)	Pool spacing: Channel widths (bankfull widths) per pool. **Gradient <1%:** ≤ 2 CW/P **Gradient >1%:** ≤ 3 CW/P *Criteria are from Figure 8 in Montgomery et al. (1995)*	No criteria for At Risk Condition.	Pool spacing: Channel widths (bankfull widths) per pool. **Gradient <1%:** > 2 CW/P **Gradient >1%:** > 3 CW/P
	Off-Chanel Habitat and Refugia	Connectivity with Main Channel	Reach has many ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are low energy areas. No manmade barriers present along the mainstem that prevent access to off-channel areas.	Reach has some ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are generally high energy areas. Manmade barriers present that prevent access to off-channel habitat at some flows that are biologically significant.	Reach has few or no ponds, oxbows, backwaters, and other off-channel areas. Manmade barriers present that prevent access to off-channel habitat at multiple or all flows.

Pathway	General Indicators	Specific Indicators	Adequate Conditions	At Risk Conditions	Unacceptable Conditions
Riparian Vegetation	Condition	Structure	>80% species composition, seral stage, and structural complexity are consistent with potential native community.	50-80% species composition, seral stage, and structural complexity are consistent with potential native community.	<50% species composition, seral stage, and structural complexity are consistent with potential native community.
		Disturbance (Human)	>80% mature trees (medium-large) in the riparian buffer zone that are available for recruitment by the river via channel migration; <20% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); <2 mi/mi^2 road density in the floodplain.	50-80% mature trees (medium-large) in the riparian buffer zone that are available for recruitment by the river via channel migration; 20-50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); 2- 3 mi/mi^2 road density in the floodplain.	<50% mature trees (medium-large) in the riparian buffer zone that are available for recruitment by the river via channel migration; >50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); >3 mi/mi^2 road density in the floodplain.
		Canopy Cover	Trees and shrubs within one site potential tree height distance have >80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have 50- 80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have <50% canopy cover that provides thermal shading to the river.
Channel	Dynamics	Floodplain Connectivity	Floodplain areas are frequently hydraulically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation, and succession	Reduced linkage of wetland, floodplains, and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain, and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly.
		Channel Migration	Channel is migrating at or near natural rates within the geomorphic construct of the reach.	Channel migration is occurring at a faster or slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.
		Vertical Channel Stability	No measurable trend of aggradation or incision and no visible change in channel planform beyond the natural geomorphic processes of the reach.	Measurable trend of aggradation or incision that has the potential to, but has not yet caused, disconnection of the floodplain or a visible change in channel planform (e.g., single thread to braided).	Enough incision or human infrastructure has occurred that the floodplain and off-channel habitat areas have been disconnected from the main channel; or enough aggradation has occurred to create a visible change in channel planform (e.g., single thread to braided).