Aquatic Inventories Project
Methods for Stream Habitat Surveys

Conservation and Recovery Program
Oregon Department of Fish and Wildlife
2014
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INTRODUCTION

The Aquatic Inventories Project’s stream habitat survey protocol is designed to provide quantitative information on habitat conditions for wadeable streams throughout Oregon. This information is used to provide basic information for biologists and land managers, to establish monitoring programs, and to direct or focus habitat restoration efforts.

Development of an Aquatic Inventories Project began within the Oregon Department of Fish and Wildlife (ODFW) in 1989 with sponsorship by the Restoration and Enhancement Program. Drafting of stream survey methods and implementation of field work began in 1990. The conceptual background for this work came from the experience of project staff and from interactions with Oregon State University, forest industry, and USFS PNW research scientists (Bisson et al. 1982, Grant 1986, Everest et al. 1987, Hankin and Reeves 1988, Moore and Gregory 1989, and Gregory et al. 1991). Significant contributions and review of these methods were provided by ODFW research staff and from consultation with ODFW and United States Forest Service (USFS) biologists working on similar programs. Members of the Umpqua Basin Fisheries Restoration Initiative and the Oregon Forest Industry Council have provided additional review and consultation. Although a basin type census survey was the primary driving force developing these methods, additional objectives can be addressed using this stream habitat protocol. In 1998, monitoring programs under the Oregon Plan for Salmon and Watersheds were designed to assess the status and trend in fish populations and aquatic habitat in Oregon’s coastal basins and later for Lower Columbia River tributaries. Additionally, the effectiveness of stream restoration efforts can be evaluated with these methods.

This methodology was designed to be compatible with other non–ODFW stream habitat inventories and classification systems (i.e., Rosgen 1985, Frissell et al. 1986, Cupp 1989, Ralph 1989, USFS Region 6 Level II Inventory 1992, and Hawkins et al. 1993). This compatibility is achieved by systematically identifying and quantifying valley and stream geomorphic features. The resulting matrix of measurements and spatial relationships can then be generalized into frequently occurring valley and channel types or translated into the nomenclature of a particular system. For example, information summarized at the reach level (valley width, channel type, slope, terrace height and width, sinuosity, width, depth, substrate, eroding banks, etc.) can be used to characterize the stream into one of the types described by Rosgen (1985) or to match the parameters collected in other quantitative (USFS) or historic (U.S. Bureau of Fisheries) surveys.

The process of conducting a stream habitat survey involves collection of general information from maps and other sources and the direct observation of stream characteristics in the field. Habitat assessment objectives may vary depending on
the questions to be answered. Whether using a Generalized Random Tessellation Stratification (GRTS) survey design (Stevens and Olsen, 2004) or at a basin (census) type survey design to conduct stream habitat surveys, this manual describes how to identify and collect pertinent stream habitat data using a standardized protocol. This information is both collected and analyzed based on a hierarchical system of regions, basins, streams, reaches, and habitat units. Region and basin data will primarily come from ODFW-EPA region and sub region classifications and from map analysis. Supervisors will be responsible for collecting the general information on regions and basins and for directing the activities of the survey crews. Survey teams will collect field data based on stream, reach and channel unit characteristics.

The following instructions and definitions provide the outline for these activities and a description of the tasks involved in conducting ODFW’s stream habitat inventory.

Each field crew is comprised of two people with each member responsible for specific tasks. The "Estimator" will focus on the identification of channel unit characteristics. The "Numerator" will focus on the counts and relative distribution of several unit attributes and will verify the length and width estimates for a subset of units. The "Estimator" and "Numerator" share the responsibility for describing reach characteristics, riparian conditions, identifying habitat unit types, and for quantifying the amount of large woody debris. Crew members may switch responsibility for estimator or numerator when they start a new stream. They cannot, however, switch estimator and numerator jobs on the same stream.

**WATERSHED INFORMATION**

Watershed information is gathered prior to and during the course of the survey. Some of this information (primarily map work and regional classification) must be collected in the office. Most of this information is not the responsibility of the field crews. However, relevant comments by the survey crews should be included in their Field Books and on the Data Sheets. These summaries are used to group and classify streams and to provide general information for the final analysis and reports.

1. **Basin name.** Use the name of the large river commonly used to describe a region. For example, use McKenzie R for Lookout CR, not Willamette or Columbia.

2. **Stream name.** Use a standardized system of the name followed by descriptors of forks etc. Examples: Alsea R, Drift CR, Lobster CR, E FK. Spell out descriptive or non-standard types such as Branch, Slough, or Swale. Spell out compass direction only for larger streams and when the usage is common, such as North Umpqua. If the site’s identification is pre-determined with a name and/or number due to survey design, make sure to include this data when filling in the header information on data sheets. Use the same name format on all data sheets.

3. **Stream order, drainage area, and drainage density of the study stream.** Determined from blue line tributaries (perennial and intermittent) shown on U.S.G.S. 7.5 minute topographic maps.

4. **Elevation (m) at the beginning and end of the survey and at reach changes (if applicable).** If adequate satellite coverage is available these can be obtained from the GPS unit, otherwise they will have to be interpreted off of the USGS topographic map.
5. ODFW-EPA Eco-Regions and Sub regions, geology, and soils of the basin.

6. Stream Flow. Identify the location of USGS or other gauging stations. The location and stage height at any gauging station, marked bridge, or staff gauge will also be recorded during the survey.

7. Description of fish species present, management concerns, and linkage to other databases or research projects.

8. Flow Regulation: Description of existing or proposed dams, fish ladders, and diversions influencing the basin or site segment.

9. General description of land use and ownership in the basin (e.g. managed timber, rural residential, agricultural, livestock grazing).

10. Contacts. Names, addresses, and phone numbers of key people to contact with respect to survey. Include ODFW district biologists, interested private individuals, landowners contacted for access, etc. Do not trespass.

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**EQUIPMENT**

1. Maps - 7.5 minute quad (1:24,000 scale) USGS topographic maps of the stream and basin. Road map coverage by county or fire district. Oregon Atlas and Gazetteer (Delorme Mapping).


3. Clothes - Chest waders, wading shoes, and/or hip boots (non-slip soles are advised), rainwear, and clothing appropriate for the weather conditions.

4. Survey equipment - Two-meter-long staff (marked in meters and tenths), compass, 50 meter fiberglass measuring tape, day pack, polarized glasses, thermometers, clinometer, clipboard, vest, flagging, permanent markers, digital camera, PDA or electronic data recording device, GPS unit, and range finder.

5. Safety gear – first aid kit, poison oak pretreatment, head lamp, cb radio, cellular phone, whistle, safety or polarized glasses.

See Equipment Checklist (page 41) in for a more complete equipment description.
MAP WORK

Do not go into the field without a topographic map! Data that cannot be linked to the maps are essentially useless. Use the maps to orient to the stream and to identify the location of reach changes, named tributaries, roads, and bridge crossings. Clearly mark where you start and end the survey and areas where you are denied access. Mark all reach changes (if they exist) and important features on the map. Write the channel unit number on the map at the place that corresponds to the location of named tributary junctions, bridges, and other landmarks.

A good correspondence between landmarks on the map and the data collected is an essential part of our survey effort. Information from the surveys will be utilized and integrated with Geographic Information System (GIS) analysis. Well documented and accurate maps are required for this process. In addition to a well-marked map, it is essential that the habitat survey follow the USGS named stream on the topo map, regardless of the amount of flow.

See Appendix 2 for an example of field entries on a topographic map when conducting a basin (census) type survey.

Record the Easting and Northing UTM coordinates at the beginning of the survey, at all reach changes (if applicable), at channel metrics and riparian transects, and at the end of the survey.

FIELD BOOK

Maintain a succinct log of your activities in the field book. Each day, record the date, name of the stream or site you surveyed, and the unit numbers surveyed. Record relevant details about access to the stream, name(s) of corporate contacts of cooperating industry or agency groups and private landowners you contact to gain permission to survey. Pay particular attention to descriptions of the riparian zone, additional details concerning land use, or factors that influence the fish populations. This is the appropriate place to express your opinions. Other comments, sketches of complex features, suggestions, complaints, etc. are often useful.

PHOTOGRAPHS

A good photograph and photographic record of the stream survey provides additional information and documentation. Take pictures that typify the reach at a site, any reach changes, riparian zones, interesting or unusual plants, animals, and other stream characteristics as described in this manual. For each picture, record the habitat unit number, date, time, and a description of the subject on the Photo Record and Unit sheets. Remember, more photos are better than too few. Take some time and effort with your photos. Make sure the photo is taken from the best angle possible, in focus, and the content represents a clear and concise image of what you want to portray.
DATA SHEETS: REACH, UNIT-1, UNIT-2, WOOD, and RIPARIAN

REACH FORM

A reach is a length of stream defined by some functional characteristic or identified in advance via survey design. A reach may be simply the distance surveyed but more frequently is defined as a segment of the stream with consistent valley and channel formation (geomorphology). However, depending on survey design (random or census surveys), major changes in vegetation type, changes in land use or ownership, and stream segments between named tributaries can be attributed to identifying a stream reach within a watershed. See Appendix 1 or 2 for survey-specific details.

The following sequence corresponds to the listing of variables on the data sheet:

1. **Date.** Date the survey was conducted.

2. **Reach.** The numbered sequence of reaches as they are encountered. Each reach is comprised of variable number of channel units.

3. **Unit Number.** Sequence number(s) of the first unit recorded for the particular reach.

4. **Channel Form.** Determined by the morphology of the active channel, hill slopes, terraces, and flood plains. Identify the channel form and enter the appropriate two-letter code in this column.

   *Refer to Valley and Channel Classification definitions, allowable combinations, and example on pages 34-37.*

   First look at the ratio of the active channel width to the valley floor width to determine the **Valley Width Index** (VWI) (see page 7, # 6).

   The definition of active channel (also referred to as bankfull stage) is the stage associated with the flow that just fills the channel to the top of its banks and at a point where the water begins to overflow onto a floodplain (Leopold et al. 1964). This flow is associated with a momentary maximum flow that has an average recurrence interval of 1.5 years as determined using a flood frequency analysis. This stage corresponds to the discharge at which channel maintenance is the most effective - sediment moves and forms or removes bars, bends and meanders change - resulting in the average morphologic characteristics of channels.

   The valley floor width is simply the width of the valley from toe of the hillslope on one side to the toe of the hillslope on the other. This ratio determines if you are in a **broad** (VWI > 2.5) or **narrow** (VWI ≤ 2.5) valley floor type.

   Next, look at the types of land forms adjacent to the stream channel to characterize and complete your classification.

   The channel is constrained when adjacent landforms restrict the lateral movement of the channel. In constrained channels, stream flows associated with all but the largest flood events are confined to the existing channel configuration.
• **Narrow Valley Floor Types (VWI ≤ 2.5)** Always constrained, defined by the characteristics of the constraining feature.

  **CB**  Constrained by **Bedrock** (bedrock-dominated gorge)
  **CH**  Constrained by **Hill slope**

• **Broad Valley Floor Types (VWI > 2.5)** The valley is several times wider than the active channel. The channel, however, may be either unconstrained or constrained depending on the height and configuration of the adjacent landforms.

  1. **Unconstrained Channel** (terrace height < flood prone height* and the floodprone width* > 2.5X active channel width). Low terraces, overflow channels, and flood plains are adjacent to the active channel.

    **US**  Unconstrained-predominantly **Single channel.**
    **UA**  Unconstrained-**Anastomosing** (several complex, interconnecting channels usually separated by higher terraces with established vegetation).
    **UB**  Unconstrained- **Braided channel** (numerous, small channels often flowing over alluvial deposits).

  2. **Constrained Channel** (terrace height is greater than the flood prone height*). Adjacent landforms (terraces, hillslopes) are not part of the active flood plain.

    **CT**  Constraining **Terraces.** (terrace height > floodprone height and floodprone width < 2.5 X active channel width).
    **CA**  Constrained by **Alternating terraces and hill slopes.** Same rule for terrace height but the channel may meander across the valley floor. The stream channel is confined by contact with hill slopes and high terraces.
    **CL**  Constrained by **Land use**(road, dike, landfill)

* See page 18 for floodprone height and width definitions.

5. **Valley Form.** General description of the valley cross section with emphasis on the configuration of the valley floor. Divided into types with a narrow valley floor (valley floor width (VWI) ≤ 2.5 X stream active channel width (ACW) and types with a broad valley floor (VWI > 2.5 X ACW).

**Narrow Valley Floor (VWI < or = 2.5)** – see page 35 for examples:

  **SV**  **Steep V-Shaped valley or bedrock gorge** (side slopes ≥60°).
  **MV**  **Moderate V-Shaped valley** (side slopes >30°, <60°).
  **OV**  **Open V-Shaped valley** (side slopes ≤30°).

On rare occasions where you might encounter a different classification on each side of the stream, record only one on the reach sheet and make a note of the other in the note column.
Broad Valley Floor (VWI > 2.5) – see page 35 for examples:

CT  Constraining Terraces. Terraces typically high and close to the active channel. Terrace surface is unlikely to receive flood flows and lacks water dependent (hydrophilic) vegetation.

MT  Multiple Terraces. Terraces with varying heights and distances from the channel that are within the constraining terrace(s). Lower terraces annually inundated with high flows.

WF  Wide-Active Flood plain. Significant portion of valley floor influenced by annual floods, and has water dependent vegetation (mesic meadow). Any terraces present do not impinge on the lateral movement and expansion of the channel.

Valley Form and Channel Form are related and can only occur in certain combinations, which are shown in Table 1, page 34.

6. Valley Width Index. Ratio of the width of the active stream channel to the width of the valley floor. The Valley Width Index (VWI) is estimated for the reach by dividing the average active channel width into the average valley floor width. The VWI is also entered on UNIT 1 sheet when the channel metric measurements are conducted (see pages 18 and 19).

\[
\text{VWI} = \frac{\text{ACW}}{\text{VFW}}
\]

Do not start a new reach for minor changes in VWI. However, always start a new reach when the channel changes from VWI < 2.5 to VWI > 2.5; or VWI > 5.

When the valley width changes repeatedly within a short distance, select an average value for the VWI. For example, when the valley floor gradually widens from a hillslope constrained reach to a broad valley reach, make one reach change, not new reach designations every few channel units.

It is possible to have an unconstrained channel but a VWI of 1. This may occur in some meadow reaches and other situations where the multiple channels and the floodplain spread across the entire valley floor.

Getting out of the stream channel will help you to accurately estimate VWI, identify floodplain and terrace surfaces, and to classify reach types.

7. Streamside Vegetation (Veg Class). We consider the description of streamside vegetation to be within 10 meters or one active channel width, whichever is greater, of either side of the stream channel to represent this vegetation classification. Separate entries are made for the dominant and subdominant plant communities as estimated from crown density. (Note: In some instances grass can be the dominant plant taxa). The first letter of the two letter code identifies the plant community. The second part of the code refers to the size of trees within identified dbh classes.
Example: C30 (dominant) and G (subdominant) in ponderosa pine/grass communities.

Do not enter a size or age class for shrubs, brush, or grasses.

**Vegetation Type:**

- **N**: No Vegetation (bare soil, rock)
- **B**: Sagebrush (sagebrush, greasewood, rabbit brush, etc.)
- **G**: Annual Grasses, herbs, and forbs.
- **P**: Perennial grasses, sedges, rushes, and ferns
- **S**: Shrubs (willow, salmonberry, some alder)
- **D**: Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.)
- **M**: Mixed conifer/deciduous (~ 50:50 distribution)
- **C**: Coniferous Dominated (canopy more than 70% conifer)

**Size Class.** Use groupings for the estimated diameter at breast height (dbh) expressed in centimeters of the dominant trees. Estimate diameter of young conifers below the first whorl of branches. Enter the first number (in bold, below) of your choice, ex. C30.

- **1-3**: Seedlings and new plantings.
- **3-15**: Young established trees or saplings.
- **15-30**: Typical sizes for second growth stands. West side communities may have fully closed canopy at this stage.
- **30-50**: Large trees in established stands.
- **50-90**: Mature timber. Developing understory of trees and shrubs.
- **90+**: Old growth. Very large trees, nearly always conifers. Plant community likely to include a combination of big trees, snags, down woody debris, and a multi-layered canopy.

*These size classes correspond to dbh estimated in inches of: <1, 1-5, 6-11, 12-20, 21-35, and 36+, respectively.*

8. **Land Use.** Determined from observations of terraces and hillslopes beyond the riparian zone. Code subdominant land use where appropriate. Separate entries for the dominant and subdominant land uses (i.e. PT (dominant) and HG (subdominant) = Partial cut Timber and Heavy Grazing). If a code listed below does not adequately describe a land use, use the most appropriate and make a note. DO NOT create new codes.

- **AG**: Agricultural crop or dairy land.
- **TH**: Timber Harvest. Active timber management including tree felling, logging, etc. Not yet replanted.
- **YT**: Young Forest Trees. Can range from recently planted harvest units to stands with trees up to 15cm dbh.
- **ST**: Second growth Timber. Trees 15-30cm dbh in generally dense, rapidly growing, uniform stands.
- **LT**: Large Timber (30-50cm dbh)
- **MT**: Mature Timber (50-90cm dbh)
- **OG**: Old Growth Forest. Many trees with 90+ cm dbh and plant community with old growth characteristics.
- **PT**: Partial cut Timber. Selection cut or shelterwood cut with partial removal of large trees. Combination of stumps and standing timber. If only a few live trees or snags in the unit, describe in note column.
- **FF**: Forest Fire. Evidence of recent charring and tree mortality.
Land Uses continued

BK Bug Kill. Eastside forests with > 60% mortality from pests and diseases. Enter bug kill as a comment on the unit sheet when it is observed in small patches.

LG Light Grazing Pressure. Grasses, forbs and shrubs present, banks not broken down, animal presence obvious only at limited points such as water crossings. Cow pies evident.

HG Heavy Grazing Pressure. Broken banks, well established cow paths. Primarily bare earth or early successional stages of grasses and forbs present.

EX EXclosure. Fenced area that excludes cattle from a portion of rangeland

GN GreeN way. Designated Green Way areas, Parks (city, county, state).

UR URban

RR Rural Residential

IN INdustrial

DW Domestic W Water supply watershed.

CR Conservation area or wildlife R efuge.

GF GoLF course.

MI Miining

WA Designated W ilderness A rea or Wilderness Study Area

WL WetLand.

NU No U se identified.

WS Wild and S cenic Area

9. Water Temperature. Stream temperature recorded at each reach change or a minimum of once per page of data. Record the time as well. Note if the temperature is measured in °C or °F.

At named tributaries, record the stream temperature of the tributary and in the mainstem stream upstream from the tributary confluence. Identify and record each temperature in the appropriate line of the Note column.

10. Stream Flow. Description of observed discharge condition. Best observed in riffles. If a gauging station is present, be sure to record the stage height.

DR DRy

PD PuDDled. Series of isolated pools connected by surface trickle or subsurface flow.

LF Low Flow. Surface water flowing across 50 to 75 percent of the active channel surface. Consider general indications of low flow conditions.

MF Moderate Flow. Surface water flowing across 75 to 90 percent of the active channel surface.

HF High Flow. Stream flowing completely across active channel surface but not at bankfull.

BF Bankfull Flow. Stream flowing at the upper level of the active channel bank.

FF Flood Flow. Stream flowing over banks onto low terraces or flood plain.

11. Location. Township, range, section and quarter at the start of the reach. Use the following example as the format: T10S-R05W-S22SE.
12. **Photo Number and Time.** Take photographs that show the stream and riparian zone at each reach change. Record the exposure number and the time shown on the camera on the Reach and Photo Record sheets.

13. **Reach Note.** Additional space for comments, names of tributaries, land ownership, and reach start location. Abbreviate by ownership code or use names of forest, timber companies, ranches, etc. when known.

<table>
<thead>
<tr>
<th>Code</th>
<th>Ownership</th>
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<tr>
<td>P</td>
<td>Private</td>
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<tr>
<td>M</td>
<td>Municipal</td>
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<tr>
<td>C</td>
<td>County</td>
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<td>Tribal</td>
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<td>GN</td>
<td>GreeNway</td>
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<td>FW</td>
<td>Oregon Department of Fish and Wildlife</td>
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<td>BL</td>
<td>Bureau of Land Management</td>
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<tr>
<td>SF</td>
<td>State Forest</td>
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<tr>
<td>NF</td>
<td>National Forest</td>
</tr>
<tr>
<td>US</td>
<td>US Fish and Wildlife Service</td>
</tr>
<tr>
<td>WA</td>
<td>Wilderness Area</td>
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</tbody>
</table>

14. **Sketch.** Make a sketch of the channel and valley cross section for each reach in one of the boxes provided on the reach form. Identify the reach number and GPS reading in the box. Label and give approximate measurements and dimensions for important landform features.

15. **Record** GPS UTM coordinates. If there is not a designated space for UTM coordinates, simply write them on the sketch box.
UNIT-1 FORM

The “Estimator” member of the field crew completes this data sheet.

- Crews work upstream, identifying and characterizing the sequence of habitat units.

- **At tributary junctions:**
  
  Tributary channel junctions (confluence with a tributary) are identified and surveyed, regardless of flow. Note with Comment Code on the Unit 2 sheet; record the active channel width and temperature of the tributary in the Note column. Refer to the topo map and indicate the tributary referencing the unit number into which the tributary flows. At each channel junction, estimate the percent of total flow in each channel.

  Proceed up the named stream on the USGS topographic map regardless of flow. If neither channel is named, proceed up that with the greatest flow.

  Survey and record a minimum of one unit for each tributary and additional units (if applicable) that would become part of the main channel at bankfull flow. Tributary channel units will be numbered and sequenced from the point where the tributary enters the main channel. Be sure to use the proper channel type code.

  A tributary differs from a spring seep because it will have a defined channel. Spring seeps are not surveyed, yet are noted with a Comment Code.

- **In braided channels:**
  
  Continue upstream, always taking the channel with the greatest flow, until reaching the unit where the stream again forms a single channel. Backtrack, and then survey the sequence of units in the side channel, then the sequence of units in the side channel with the next most flow, etc.

  For particularly complex areas, make a simple sketch in the field book showing the sequence and locations of channel units (type and number).

1. **Reach.** The number of the reach; links unit data to reach data.

2. **Unit.** The sequential number describing the order of channel habitat units. A reach is comprised of many channel units.

3. **Unit Type.**

   The concept of a channel habitat unit is the basic level of notation for our survey methodology. We subdivide the stream into two general classes of unit types: channel geomorphic units and special case units.

   Channel geomorphic units are relatively homogeneous lengths of the stream that are classified by channel bed form, flow characteristics, and water surface slope. With some exceptions, channel geomorphic units are defined to be at least as long as the active channel is wide. Individual units are formed by the interaction of discharge and sediment load with the channel resistance (roughness characteristics such as bedrock, boulders, and large woody debris).
Channel units are defined (in priority order) based on characteristics of (1) bedform, (2) gradient, and (3) substrate. Special case units describe situations where, because of stream flow level or a road crossing, the usual channel geomorphic unit types do not occur. Special case units include dry or partly dry channels and culverts.

GEOMORPHIC CHANNEL UNITS

Characteristic water surface slopes are given for each group of habitat unit types. However, channel bed form and flow characteristics are the primary determinant of unit classification. Use the unit slope to help make determinations when the other characteristics are ambiguous.

POOLS  (The water surface slope is always zero)

**PP** Plunge Pool: Formed by scour below a complete or nearly complete channel obstruction (logs, boulders, or bedrock). Substrate is highly variable. Frequently, but not always, shorter than the active channel width.

**SP** Straight scour Pool: Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross section.

**LP** Lateral scour Pool: Formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Asymmetrical cross section. Includes corner pools in meandering lowland or valley bottom streams.

**TP** Trench Pool: Slow flow with U or V-shaped cross section typically flanked by bedrock walls. Often very long and narrow with at least half of the substrate comprised of bedrock.

**DP** Dammed Pool: Water impounded upstream of channel blockage (debris jams, rock landslides). The length may be less than the active channel width.

**BP** Beaver dam Pool: Dammed pool formed by beaver activity and always preceded by a SD (step-over-beaver dam). The length may be less than the active channel width.

SUBUNIT POOLS  (The water surface slope is always zero)

Alcoves, backwaters, and isolated pools are types of habitat subunits; generally not as long as the full channel width. They are, however, generally easy to identify and are important habitat types. Subunit pools are formed by eddy scour flow near lateral obstructions.

**AL** ALcove: Most protected type of subunit pool. Alcoves are laterally displaced from the general bounds of the active channel. Substrate is typically sand and organic matter. Formed during extreme flow events or by beaver activity; not scoured during typical high flows.
**BW**  Backwater Pool: Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble.

**IP**  Isolated Pool: Pools formed outside the primary wetted channel, but within the active channel. Isolated pools are usually associated with gravel bars and may dry up or be dependent on inter-gravel flow during late summer. Substrate is highly variable. Isolated pool subunits do not include pools of ponded or perched water found in bedrock depressions. Additionally, this unit type is not to be used to characterize isolated pool units encountered within the main channel of puddled or dry channels.

**GLIDES**

**GL**  Glide: An area with generally uniform depth and flow without surface turbulence. Very low gradient; 0-1 % slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity. There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993).

**RIFFLES**

**RI**  Riffle: Fast, turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross section. Low gradient; usually 0.5-2.0% slope, rarely up to 6%. Low gradient bedrock is considered a rapid (see Rapids below).

**RAPIDS**

**RB**  Rapid with protruding Boulders: Swift, turbulent flow including chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Moderate gradient; usually 2.0-4.0% slope, occasionally as high as 7.0-8.0%.

**RR**  Rapid over BedRock: Swift, turbulent, "sheeting" flow over smooth bedrock. Sometimes called chutes. Little or no exposed substrate. Moderate to steep gradient; 2.0-30.0% slope. Low gradient bedrock, similar to a riffle, is considered “RR”.

**CASCADES**

**CB**  Cascade over Boulders: Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. Fast, turbulent, flow; many hydraulic jumps, strong chutes, and eddies; 30-80% white water. Slope usually 3.5-10.0%, or greater.

**CR**  Cascade over BedRock: Same flow characteristics as Cascade over Boulders but structure is derived from sequence of bedrock steps. Slope 3.5% or greater.
STEPS

Steps are abrupt, discrete breaks in channel gradient. Steps are usually much shorter than the channel width. However, they are important and therefore need to be recorded. In some cases, steps can separate sequential units of the same type. For example, small steps (<0.3m high) that separate pools may be important features in very low gradient reaches and should be recorded as individual habitat units. Low steps (<0.3m high) in moderate to high gradient reaches formed by gravel and small cobbles on the face of transverse bars can usually be included in the next fast water unit upstream.

Steps are classified by the type of structure forming the step.

- **SR**: Step over Bedrock (include hardpan and clay steps)
- **SB**: Step over Boulders
- **SC**: Step over face of Cobble bar
- **SL**: Step over Log(s) (natural pieces, including branches and rootwads)
- **SS**: Step created by Structure (man-made structures, including culverts, weirs, artificial dams, habitat structures). This unit must be broken out regardless of height.
- **SD**: Step created by Beaver Dam

Measure the height from water surface of the preceding unit to the water surface flowing over the step. Record the step height in the Note column. Take a picture of any step that is a potential barrier to fish passage. (Note: always record a step height in the Note column for the SS and SD unit type regardless if a passage problem cannot be determined).

Fish ladders should be surveyed as 1 unit and recorded as SS. Use the NOTE field to describe the ladder, its dimensions, name of facility, etc. Take a photograph as well.

SPECIAL CASE UNIT TYPES

- **DU**: Dry Unit: Dry section of stream separating wetted channel units. Typical examples are riffles with subsurface flow or portions of side channels separated by large isolated scour pools. Record the length, active channel width, and unit data. Count boulders within ACW.

- **PD**: Puddled: Nearly dry channel but with sequence of small isolated scour pools less than one channel width in length or width. Record average the wetted width, modal depth, and all unit data. Note the ACW and any deep pockets in the NOTE field.

- **DC**: Dry Channel. Section of the main channel or side channel that is completely dry at time of survey. Record all unit data, use active channel width for width. Count boulders w/in ACW. Depth = zero.

Note: In dry or puddled units, break out Step unit types (see STEP section above) that are potential barriers to upstream migration as individual units. Record the Step unit type and height as it would appear if wetted. Enter ‘0’ for water depth.
**CC**  Culvert Crossing. Stream flowing through a culvert. Record all data as for any other habitat unit. When surveying a non-arch culvert, the fill material around the culvert is the *substrate* composition. The shade on a CC unit is recorded as 90° left and 90° right.

- The majority of Culvert Crossing unit types encountered will have a SS unit type immediately preceding it unless there is absolutely no drop to the water below. The height from the culvert lip to the stream surface (drop) is the SS. Write the SS height in the Notes.

- In the Notes column, record the diameter, material, shape of culvert, road name, and a UTM recording. Photograph any culvert that is a potential fish barrier. If possible, have a depth staff or person in the photo to reference the step height. Write “no drop” if there isn’t one.

A. Perched culvert, as evident by the water drop. The sequence of habitat units as one proceeds upstream would be pool, SS, CC.

B. Non-perched culvert. Note that there is not a step-over-structure prior to culvert crossing.

C. Open-bottom arch culvert. The bottom of the culvert is the natural streambed and the source of the substrate data. There is not a SS prior to culvert.
4. **Channel Type.** Channel ordering code based on channel by size and location. Orders the sequence of single, multiple, and side channels.

- **00** No Multiple Channels (all flow in one channel)
- **01** Primary Channel (of multiple channel reach or in the unit where a tributary enters the channel)
- **02** Side channel - secondary, tertiary, etc. channel* (of multiple channel reach)
- **10** Isolated Pools, Alcoves, or Backwater Pools.
- **11** Primary channel of valley floor tributary. If the tributary has a name, write it in the note column.
- **12** Secondary channel of valley floor tributary.

<table>
<thead>
<tr>
<th>UNIT NUMBER</th>
<th>UNIT TYPE</th>
<th>CHANNEL TYPE</th>
<th>% FLOW</th>
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<tbody>
<tr>
<td>1</td>
<td>RI</td>
<td>00</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>LP</td>
<td>00</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>RB</td>
<td>01</td>
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<tr>
<td>4</td>
<td>RI</td>
<td>11</td>
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<tr>
<td>5</td>
<td>PP</td>
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</tr>
<tr>
<td>6</td>
<td>RI</td>
<td>01</td>
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<tr>
<td>7</td>
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<td>IP</td>
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</tr>
<tr>
<td>18</td>
<td>CB</td>
<td>00</td>
<td>100</td>
</tr>
</tbody>
</table>
*In most cases these channels are separated from the primary channel by an island type feature (terrace, gravel bar) which is higher than the active channel.

It is very important that the primary channel be identified with the proper code. This information is used in a critical step of the data analysis to calculate both primary and secondary channel length and sinuosity.

The inventory considers the stream as the system of all channels that transport water down the drainage. The intention is to survey and quantify all aquatic habitats located within the valley floor. All active channels and unit types will be classified with a channel code and an estimate of the percent of total flow carried in each channel.

5. **Percent Flow.** Visual estimate of the relative amount of flow in the channel, in each channel where multiple channels occur, or the contribution to total flow from a tributary. Record 0% for alcove, backwater, and isolated pool unit types. For dry unit types don’t try to estimate what the percentages would be if water were present – record 100% in the 00 or 01 channel unit(s) and 0% for the 02 channel unit(s).

   *This is difficult to measure accurately. Don’t be concerned about balancing your totals for flow to 100 percent. The information is used only to identify the relative contribution or distribution of flow. Record the active channel width (ACW) of the tributary in the Note column.*

6. **Unit Length.** Length of each unit in meters as measured along the thalweg of the unit. Measure every unit with a tape or range finder. Pools are always measured as a continuous, single unit. Restrictions to the measured length of non-pool units may vary according to survey design. See Appendix 1 or 2 for survey-specific details.

7. **Unit Width.** Width of the wetted channel. Measure the width at 3 locations and record the average width. On multiple wetted channel units, such as step-over-bedrock where there are several wetted slots carved into the rock, record the sum of the wetted widths.

8. **Slope.** Gradient of water surface in the unit. Expressed as the percent change in elevation over the length of the unit. Estimated with a clinometer using the scale on the right side in the viewfinder.
9. **Channel Shade.** (Shade Left and Shade Right on data sheet). Measured with the clinometer as the degrees (left side in the viewfinder) above horizontal to the top of highest riparian vegetation ($\leq 90^\circ$). Measured perpendicular to the channel unit on the left and right banks from the beginning of the habitat unit. If the value derived is from topographic shading, indicate this in the Note column.

The following 10 through 16 are referred collectively as the Channel Metrics. The active channel (see definition on page 5) is the foundation that these measurements are built upon. Be as accurate as possible when identifying 10 & 11 below. Channel Metrics are measured at prescribed intervals (see Appendix 1 or 2 for survey-specific detail) and near the start of new reaches.

Refer to the Illustrated Channel Metric Measuring Guide on pages 38-40 for detailed instructions for measuring these values in the field.

10. **Active Channel Height.** Vertical distance from the average level streambed to the top of the active channel. Determined by averaging 3 equally-spaced measurements across the active channel at either the pool tail crest (PTC) or fast water unit transition.

11. **Active Channel Width.** Distance across channel at "bankfull" flow. The boundary of the active channel can be difficult to determine; use changes in vegetation, slope breaks, a change in particle size on the stream bank, top of deposited bedload (gravel bars), or high water marks as clues. Sum the width of all active channels in multichannel situations.

12. **Floodprone Height.** The floodprone height is determined by simply doubling the active channel height. The floodprone height is the average depth in the channel during a flood event occurring approximately every 50 years.

13. **Floodprone Width.** Distance across the stream channel and/or unconstraining terraces at floodprone height until at which time the flood inundation meets a constraining feature such as a high terrace, hillslope, or anthropomorphic feature. The floodprone width is the portion of the valley floor which is submerged during a flood event occurring approximately every 50 years.

The ratio of floodprone width to active channel width is necessary to determine the reach type and entrenchment ratio.
14. **Terrace Height.** The height from the average streambed to the top of the high terrace. A high terrace is defined as the first terrace encountered above the floodprone height. If there isn’t a terrace, the terrace fields should remain empty.

15. **Terrace Width.** This is the inter-terrace distance measured from the first high terrace lip, across the stream channel, to the corresponding feature (terrace or hillslope) on the opposite side of the stream. In multichannel situations, sum the inter-terrace width of all channels. Measure a terrace width and height if the following two conditions exist:

   1) The terrace height is greater than the floodprone height  
   AND  
   2) The terrace width is less than 4 times the ACW.

16. **VWI** Valley Width Index. Same method as described under the Reach section of this manual (page 7). Additional estimates improve accuracy of average value. Draw a cross section of the transect on the appropriate data sheet (see example data sheets pages 44 and 46). Indicate the valley width and VWI estimate on the drawing.

   Refer to diagrams below and in the appendix for illustrations of active channel, floodprone, terrace, and valley width measurements.

17. **Note.** Any pertinent additional information or items of interest. Please be descriptive. If needing additional space for detail or drawings, use the yellow field book. Observations to include in the Note column are fish or wildlife observations (be specific if possible), evidence of pollution or illegal dumping, description of channel structure, names of roads or tributaries, step heights, non-native vegetation, etc. If a debris jam, habitat structure, or mass movement span more than one habitat unit, indicate the units impacted.
UNIT-2 FORM

Information recorded by the "Numerator" member of each field crew.

1. **Unit Number.** Corresponds to number on "Estimator" sheet.

2. **Unit Type:** Corresponds to same type on "Estimator" sheet.

3. **Depth.** Maximum depth in pools, modal or typical depth in glides and fast water units. Measure to the nearest 0.05 meter as accurately as possible in pools. Probe the bottom with the depth staff to find the deepest point. Small differences in pool depth are significant.

4. **Depth at Pool Tail Crest:** The pool tail crest (PTC) location is where the water surface slope breaks into the downstream habitat unit. Measure the maximum depth to the nearest 0.01 meter along the hydraulic control feature that forms the pool. For beaver ponds unit type (BP) that do not have water flowing over the top of the dam yet there is subsurface flow through the sticks and logs of the dam, record the PTC depth as 0.01 meter. For subunit pools (BW, AL, IP), a PTC is not measured or recorded.

5. **Verified Length and Width.** Verified measurements only apply to Basin surveys. Refer to Appendix 2 for description and survey detail.

6. **Substrate.** Percent distribution by streambed area of substrate material in six size classes: silt and fine organic matter, sand, gravel (pea to baseball; 2-64mm), cobble (baseball to bowling ball; 64-256mm), boulders, and bedrock. Estimate distribution relative to the total area of the habitat unit (wetted area only). Round off each class to nearest 5 percent

   - Do not worry about totaling your estimates exactly to 100 percent; your values will be weighted accordingly during analysis.
   - Estimate the distribution of the surrounding and/or supporting substrate to the best of your ability at SS (step over structure), SL (step over log), and CC (culvert crossing) units. For open-bottom culverts, estimate the substrate as for a normal habitat unit.
   - Be sensitive to the difference between surface flocculants and other fine sediment. Fine sediment that covers and embeds gravel and cobble should be part of your estimate. A thin layer of low density fine material over bedrock or boulders should not.
   - Hardpan clay or conglomerate substrate has bedrock characteristics; therefore, it is classified as bedrock when estimating percent composition. Indicate this in the Note field.

7. **Boulder Count.** Count of boulders greater than 0.5 m in average diameter. Within this size class, include only the boulders that have any portion protruding above the water surface and those at the margin of the wetted channel. In dry units and dry channels, estimate the boulder count within the active channel.
8. **Bank Erosion.** Actively eroding, recently eroding, or collapsing banks that have the following characteristics: (1) exposed mineral soils and inorganic material, evidence of tension cracks, or active sloughing, and (2) lack of woody vegetation, roots, rocks (gravel, cobble, boulder), or logs. Eroding banks may contribute material slowly to the stream or collapse in large chunks. Determine if bank erosion is present from the top of the active channel and above, yet not to exceed the height of the floodprone. Record presence / absence if cumulatively over 25 percent of all bank length exhibits signs of erosion. If so, select the appropriate box on the PDA or write ‘Y’ (yes) or ‘N’ (no) on the paper data form.

9. **Undercut Bank.** The undercut must be at least 1 meter in length and have an average of 15 horizontal centimeters of immediate overhanging ceiling. If present, select the appropriate box on the PDA or write ‘Y’ (yes) or ‘N’ (no) on the paper data form.

   Look for areas that provide good hiding cover for fish. Include areas undercut beneath root wads.

10. **Comment Codes.** Comments identifying important features. Enter as many codes as appropriate. For codes which apply to a specific bank, use a slash (/) to indicate the stream, and (when looking upstream) record those features originating on the left side of the stream on the left side of the slash, and like-wise for those features on the right.

   **AM** AMphibian. Record species (if known) in Note field.
   **BC** Bridge Crossing. Record road name or number in Note field.
   **BD** Beaver Dam. Include height of step/dam created by beavers.
   **BK** Bug Kill. Patches of insect or disease tree mortality.
   **BV** BeaVer Activity (beaver den, cut trees, chewings, pond, etc.) Indicate age of activity – very old, old, new, recent, fresh.
   **CC** Culvert Crossing. Stream passes through a culvert. Record road name or number, as well as culvert material and dimensions. There must be a matching CC unit type.
   **CE** Culvert Entry. Applies to those tributaries a distance from the stream, usually for road drainage.
   **CS** Channelized Streambanks. Rip-rap or other artificial bank stabilization and stream control.
   **DJ** Debris Jam. Accumulation of large woody debris that fills the majority of the stream channel and traps additional sediment and debris. These have potential to alter channel morphology.
   **FC** Fence Crossing.
   **GS** Gauging Station.
   **HS** Artificial Habitat Structure. Describe type: gabion, log weir, cabled wood, interlocking log jams, etc. If the habitat structure spans several habitat units, record it in the unit most affected by the structure. Identify the habitat units it spans in the NOTE field.
   **MI** Mining. Dredging, sluicing, tailings (old or new), equipment, etc.
   **PA** Potential Artificial Barrier. Potential artificial or human-created barrier to upstream or downstream migration of fish.
   **PN** Potential Natural Barrier. Potential natural barrier to upstream or downstream fish migration.

   Natural and Artificial Barriers are relative to the stream size, fish species, and fish age class encountering them. Consider these variables when using this Comment Code. Document the height, take photographs, and record in Notes.
Comment Codes continued

RF  Road Ford.  Road that crosses within the active channel of the stream (no bridge).

SD  Screened Diversion.  Pump or canal diverting water.  Give some indication of size or capacity.

SS  Spring or Seep.  Usually small amounts of flow (<5% of total flow) directly entering from hillslope.  For large springs, estimate the contribution to flow.  Springs do not have defined channels.

TJ  Tributary Junction (both named and unnamed).  Use the TJ class only for tributaries with clearly developed channels.  Survey even if the trib is dry.  Place this code on the primary (01) channel unit, and indicate the side of the stream where the trib is located.  Place the tributary name on the tributary (11) channel unit.  Record the unit number of primary channel unit on the topo map.

UD  Unscreened Diversion.  Unscreened pump or canal diverting water.  Give some indication of size or capacity.

WL  WildLife use of stream or riparian zone.  Identify species if possible.  This code refers to everything except fish, amphibian, and shellfish species.  Use the AM code for amphibian observations and record fish or shellfish observations only in the Note column.

If a code does not exist for an observation, do not invent a code.  Add detail/describe in the Note column.

Mass Movement.  A two-part Comment Code to identify the type and condition of mass movements.  The first letter of the code identifies the type of mass movement failure.  The second letter evaluates the apparent activity of the failure.  (Example: Al = inactive debris avalanche.)  Do not confuse mass movements with bank erosion.  Mass movements are not immediate stream bank-associated scouring or degradation.  If a mass movement spans across several habitat units record it once.  Put the Comment Code in the unit most affected and record the other impacted units in the Notes column.

Type:

E  Earthflow: general movement and encroachment of hillslope upon the channel.  These can be identified by groups of unusually leaning trees on a hillslope

L  Landslide: failure of locally adjacent hill slope.  Usually steep, broad, often shaped like a half oval, with exposed soils.

A  Avalanche: failure of small, high-gradient trib.  Often appear “spoon shaped” looking upslope.  Water may flow in these intermittent or ephemeral channels that contribute alluvial soils debris.

Condition:

A  Active: contributing material now.

I  Inactive: evidence of contribution of material during previous winter or high flows.

S  Stabilized: vegetated scars, no evidence of recent activity.

Note.  Additional information to describe or identify the habitat unit, Comment Code, riparian vegetation, fish species, measurements of steps, culverts, barriers, etc.
WOOD FORM

Objective of this effort is to apply a standardized and consistent methodology to obtain quantitative estimates of wood volume and distribution within stream reaches. Information will be used to evaluate effects on fish habitat and channel structure and to make quantitative comparisons between streams.

- Minimum size requirement is 15 cm (0.15m) diameter AND 3 meter length. Length exception: rootwads less than 3m long are included and counted on the Wood Form in a specific column (RW<3).

- Count all dead pieces that are within, partially within, or suspended over the active channel, regardless of height above channel. Do not count any live or partially-alive woody material. Nurse logs are dead; the material growing on them is live.

- Collect data for all wood that meets the minimum size criteria and location requirements.

- Measure the entire length and diameter of all pieces; include the portion outside the active channel (do not estimate). If a log is partially buried, record the length for only that portion which is exposed.

- A LWD jam consists of 5 or more pieces which meet the size requirements and are in contact with each other. Indicate grouping of pieces in individual jams by drawing brackets outside of the appropriate rows. Put an “X” in the JAM field to indicate the piece is part of a LWD jam. If using a PDA, check the box. A jam on the Wood Form does not necessarily mean a DJ Comment Code is required.

- Put an “X” in the HS field to indicate the artificially-placed piece of wood. If using a PDA, check the box. Make sure an HS Comment Code is recorded in the Comment field on the unit sheet for each purposefully-placed habitat structure.

- Make no entry for units where woody debris is absent.

1. Unit Number. Matches the habitat data unit number.

2. Unit Type. Matches the habitat data unit type.

3. Diameter. Estimate diameter of each piece at 2 meters above the base of the stem. Record pieces to the nearest 0.05 meter (ex. 0.15, 0.20, 0.30, 0.45). For pieces greater than 0.60 meter diameter, be as accurate as possible when determining diameter and length.

4. Length. Measure, count and tally the number of pieces within each length class. Wood >3m but <6m goes in the 3-6m column; wood >6m but <9m goes in the 6-9m column, etc. Root wad <3m long (frequently with a cut end) is a special case and has its own column (RW<3).

5. Wood Note. Note the tree species if known and any other information or assessments of the source (i.e. part of a habitat improvement structure), influence, or character of the woody debris.

Record and tally all countable pieces. A photograph CANNOT be used as a substitute for the wood count. However, take a photograph of huge jams so they can be included in the final report.
RIPARIAN ASSESSMENT FORM

Purpose: The Riparian Assessment is designed to provide additional general qualitative information on the species composition, abundance, and size distribution within the riparian management area of a stream.

The Riparian Assessment will consist of a type of belt corridor extending across the riparian zone perpendicular to the stream channel on each side.

Frequency: Assessments will be conducted at prescribed intervals (refer to Appendix 1 or 2 for survey-specific details). The assessment should be conducted at the bottom or top of the identified habitat unit. Do not select an area elsewhere in the unit because of ease of access or to get a "better" sample. Record UTM’s. If not an Oregon Plan survey, mark the location on the 7.5 minute topo map.

Begin the assessment at the active channel margin. In a case where the assessment occurs within a braided or multiple channel area, start the assessment at the outer-most channel margins (see example in the diagram below). The assessed area will be perpendicular to the main axis of the channel and extend a total of 30 meters on each side of the stream as measured on the ground. The transects will be 20 meters wide. Zone 1 (closest to the stream channel) will extend 10 meters; Zone 2 will extend 20 meters.
Select the left or right side of the stream and using a rangefinder or measuring tape determine the extent of Zone 1 (10m long x 20m wide). Position yourself parallel to the active channel margin at the midpoint of the 20 meter wide zone. Looking at the uppermost canopy or overstory, determine the predominant hardwood AND conifer species dbh size class. Record just the first number of the diameter class. For example: if dbh is predominantly 15-30 cm diameter deciduous and 30-50 cm conifer, then record D15 and C30. Remember to record the size class that is represented at the diameter at breast height. If recordable hardwood or conifer overstory is absent from the plot then indicate with a dash (ex: D- or C-). Refer to page 8 for descriptions and size categories. Next, indicate the primary canopy by circling (or check-box on the PDA) either the deciduous or coniferous tree type. If there is a 50/50 presence, circle both.

Indicate the dominant understory or ground cover type: S=shrub, G=grass/forb, B=sagebrush, and N=no vegetation cover (rock, duff, road bed, or other). If there is a 50/50 presence, circle both.

Another objective of the assessment is to determine potential recruitment of very large conifers or deciduous trees into the stream channel. If you observe any deciduous or conifer trees that have a dbh size 50-90cm or greater than 90cm where the trunk of the tree is located within the prescribed boundary of the zone, circle or select on the PDA the appropriate size. This is regardless of whether the large size class was indicated earlier when determining dominant canopy.

After finishing the assessment of Zone 1, walk in a straight line perpendicular to the channel 10 meters out to the beginning of Zone 2. Use the above protocol to perform an assessment for Zone 2. Complete both left and right sides of the stream.

Complete the following entries on the Riparian Assessment Form:

1. **All header information on every page.**
2. **Unit Number.** The unit at which the transect is established.
3. **Photos.** Photograph number and view of photo (left, right, zone, etc.)
4. **UTMs.** Record the easting and northing coordinates. Record the datum used throughout the survey in the NOTE field.
5. **Notes.** Optional comments that describe or clarify tree species or the plant community, large woody debris, or characteristics of snags or old stumps. Note presence or absence of large down wood in riparian zone. Note any riparian restoration efforts conducted in the area. Record the riparian photo number and time here as well.

**NOTE:** This Riparian Assessment survey is designed to provide a general qualitative assessment of the riparian community at a relatively fast pace. However, if a quantitative assessment is desired, then the following Riparian Inventory protocol should be used. Talk to your supervisor about how frequently transects should be conducted.
RIPARIAN INVENTORY FORM

Purpose: The Riparian Inventory is designed to provide additional quantitative information on the species composition, abundance, and size distribution of riparian zone vegetation.

The Riparian Inventory will consist of a type of belt transect extending across the riparian zone perpendicular to the stream channel on each side.

Frequency: Transects will be conducted at prescribed intervals (refer to Appendix 1 or 2 for survey-specific details) and near the beginning of each reach. Every identified reach has to have at least one riparian transect. The transect should be located at the bottom or top of the identified habitat unit. Do not select a starting point elsewhere in the unit because of ease of access or to get a "better" sample. Record a gps reading. Mark the location of each transect with 3D coverage on the 7.5 minute topo map. Discuss transect spacing/frequency with your field supervisor.

Transects will begin at the margin of the active channel or where the initial band of riparian trees starts, whichever comes first. The transects will be perpendicular to the main axis of the stream and extend 30m as measured on the ground. The transects will be 5m wide and will be subdivided into three 10m long sections or zones with Zone 1 being closest to the water.
One member of the survey crew will extend the tape measure out from the stream channel the entire 30 meters (if feasible - do not risk injury or death to perform this task). The other crew member will follow with the data sheets or PDA and record the measurements his/her survey partner calls out. Use the depth staff to determine if trees are within the area to be counted. Any tree **trunk** that can be touched with the depth staff extended 2.5 meters from the mid-line of the transect (practice the amount of reach you require to represent a 5m band) should be counted.

Visually estimate and count only in difficult situations. There is no need, for example, to try and walk through 30m of blackberry bramble to measure the diameter of one or two alder trees. Likewise, it is not necessary to climb steep slopes to measure tree diameters. Use the Note column to indicate the reason for estimation.

Complete the following entries on the Riparian form:

1. **Unit Number.** The unit at which the transect is established.
2. **Side.** Left or right side of the channel, when looking upstream.
3. **Zone.** Subdivision of the transect.
   
   1 0-10 meters
   2 10-20 meters
   3 20-30 meters
4. **Surface.** Geomorphic surfaces observed within the zone. If more than one surface is observed, record both on the data sheet in the space provided separated by a diagonal line and then circle the more dominant feature. Note length of each feature and explain any ambiguous observations in the note column.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP</td>
<td>Flood Plain</td>
</tr>
<tr>
<td>LT</td>
<td>Low Terrace (height is &lt; Flood Prone Height)</td>
</tr>
<tr>
<td>HT</td>
<td>High Terrace (height is &gt; Flood Prone Height)</td>
</tr>
<tr>
<td>HS</td>
<td>Hill Slope</td>
</tr>
<tr>
<td>SC</td>
<td>Secondary Channel</td>
</tr>
<tr>
<td>TC</td>
<td>Tributary Channel</td>
</tr>
<tr>
<td>IP</td>
<td>Isolated Pool or unconnected valley wall channel.</td>
</tr>
<tr>
<td>WL</td>
<td>Wet Land bog or marsh with no obvious channel.</td>
</tr>
<tr>
<td>RB</td>
<td>Road Bed (indicate surface type, i.e. pavement, gravel)</td>
</tr>
<tr>
<td>RG</td>
<td>Railroad Grade</td>
</tr>
<tr>
<td>RR</td>
<td>Rip Rap</td>
</tr>
</tbody>
</table>

5. **Slope.** Measure the percent slope of the dominant surface in the zone.

**NOTE:** For terraces, a typical terrace slope measurement will be similar to example #1 below. However, for transitioning terraces (examples #2 and #3) measure and record the slope of the transition but record the feature as a High Terrace (do NOT record transitioning terraces as a Hill Slope – a hillslope feature cannot precede a high terrace). Make a comment in the RIPARIAN NOTE field that it is a transitioning feature and note approximate distances. A transitioning terrace is defined as having a measurable slope that is over 5 meters in length that is measured from the active channel margin to top of a defined level terrace surface.

---

**# 1**

[Diagram of zone 1 and zone 2 with HT: 0% slope]
6. **Canopy Closure.** The percent canopy closure estimated by looking up while standing in the middle of the zone being recorded. Include the influence of both conifer and hardwood species. Tall shrub cover (above your head) should be included as well. Estimate within 10% increments.

7. **Shrub Cover.** The percentage of ground cover provided by shrubs. Include blackberry, salmonberry, devils club, willow, sage, etc. Small trees (seedlings and saplings less than 8 feet high) should be included in shrub cover. Estimate within 5% increments.
8. **Grass and Forb Cover.** The percentage of ground cover provided by grasses, ferns, moss, herbs, sedges, rushes, etc. Estimate within 5% increments.

9. **Duff and Rock Cover.** The percentage of rock and/or duff. Duff is dead plant material provided by decomposing leaves, needles, and/or grass. Also known as leaf litter. Estimate within 5% increments.

10. **Tree Group.** Conifer or hardwood.

11. **Count.** Tally of trees by diameter class. Measured at the dbh in centimeters as: 3-15, 15-30, 30-50, 50-90, or 90+.

12. **Riparian Note.** Optional comments that describe tree species or the plant community, large woody debris, invasive plants, or characteristics of snags or old stumps. Note presence or absence of large down wood in riparian zone. Record the riparian photo number and time in this column as well.

13. **GPS.** Record the UTM coordinates of the riparian transect.
LITERATURE CITED


ADDITIONAL LITERATURE


ILLUSTRATIONS OF CHANNEL METRICS AND SHADE MEASUREMENTS

WETTED, ACTIVE CHANNEL, FLOOD PRONE, TERRACE, AND VALLEY FLOOR WIDTHS

\[
FPH = 2 \times ACH
\]

\[
\text{VALLEY FLOOR WIDTH} \div ACW = VWI
\]

CHANNEL SHADE

Use of the clinometer to measure degrees of topographic and vegetative shading.
### TABLE 1: POSSIBLE REACH – CHANNEL – VALLEY COMBINATIONS

<table>
<thead>
<tr>
<th>CHANNEL FORM</th>
<th>VALLEY FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VALLEY FORM</strong></td>
<td><strong>CHANNEL FORM</strong></td>
</tr>
<tr>
<td><strong>VWI &lt; 2.5</strong></td>
<td><strong>NARROW VALLEY FLOOR</strong></td>
</tr>
<tr>
<td><strong>VWI &gt; 2.5</strong></td>
<td><strong>BROAD VALLEY FLOOR</strong></td>
</tr>
<tr>
<td><strong>BEDROCK</strong></td>
<td><strong>CB - SV</strong></td>
</tr>
<tr>
<td><strong>HILLSLOPE</strong></td>
<td><strong>CB - MV</strong></td>
</tr>
<tr>
<td><strong>ALT. HILLSLOPE TERRACE</strong></td>
<td><strong>CB - OV</strong></td>
</tr>
<tr>
<td><strong>HIGH TERRACE</strong></td>
<td><strong>CH - SV</strong></td>
</tr>
<tr>
<td><strong>LAND USE</strong></td>
<td><strong>CH - MV</strong></td>
</tr>
<tr>
<td><strong>UNCONSTRAINED:</strong></td>
<td><strong>CH - OV</strong></td>
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<tr>
<td><strong>SINGLE CHANNEL</strong></td>
<td><strong>UNCONSTRAINED:</strong></td>
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<td><strong>US - MT</strong></td>
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<td><strong>BRAIDED CHANNEL</strong></td>
<td><strong>UA - MT</strong></td>
</tr>
<tr>
<td><strong>LAND USE</strong></td>
<td><strong>UB - MT</strong></td>
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</tbody>
</table>

Check the valley form description against the Valley Width Index. If it does not match, is it because the reach was not described properly, or was the ACW determined incorrectly?

Does the terrace height work with the channel and valley form calls? Remember that a high terrace is any terrace that is above the Flood Prone Height.

Streamside terraces are frequently present within narrow valley floors. However, remember that when VWI <2.5, it is a hillslope or bedrock constraining reach call, regardless of the terraces encountered.

In rare cases, notably flooded bogs, multiple channel wetlands, or flooded valley bottoms due to beaver activity, the VVI will equal 1 (ACW spans the width of the valley floor) but technically the channel is unconstrained (drain the beaver pond and the VVI will be greater than 2.5 - usually). Make a note and explain.

Use the boxes on the reach form to make diagrams of the reach cross section. Label your drawings so that ambiguous or exceptional reach types can be understood.

An unconstrained reach must meet at least these two criteria: 1) VVI has to be greater than 2.5 and 2) the Flood Prone Width has to be greater than 2.5 times the Active Channel Width.
NARROW VALLEY FLOOR: VWI < 2.5

OPEN V-SHAPED (OV)

0 - 30 degrees

BROAD VALLEY FLOOR: VWI > 2.5

CONSTRAINING TERRACES (CT)

FPW

ACW

MULTIPLE TERRACES (MT)

PPW

ACW

STEEP V-SHAPED (SV)

30 - 60 degrees

60 - 90 degrees

WIDE - ACTIVE FLOODPLAIN (WF)

ACW
EXAMPLES OF CONSTRAINED CHANNEL MORPHOLOGY

**VWI < 2.5**

1. **MV**
2. **OV**
3. **SV**
4. **FPW**
5. **CH or CB**
6. **ACW**

**VWI > 2.5**

1. **TTW**
2. **FPW**
3. **ACW**

**CONTAINED WITHIN TERRACES WITH MULTIPLE TERRACE FEATURES:**

\[ CT / MT \]

**VALLLEY FLOOR WIDTH**

\[ \frac{VALLLEY FLOOR WIDTH}{ACW} = VWI \]

**CONTAINED WITHIN TERRACES**

\[ CT / CT \]

**ALTERNATIVELY CONTAINED BY HILLSLOPE AND TERRACES WITH MULTIPLE TERRACE FEATURES:**

\[ CA / MT \]
EXAMPLES OF UNCONSTRAINED MORPHOLOGY:
A channel is unconstrained when FPW > 2.5x ACW.
Note: It is not necessary to locate and measure a TW if the FPW > 4x ACW

**VWI > 2.5**
**GUIDE TO MEASURING CHANNEL METRICS**

**Step 1:** Clinometer (CLINO) identifies his eye height on the depth staff.

**Step 2:** CLINO and survey partner (TAPE) discuss and agree on the active channel scour or margin on either side of the stream. **NOTE:** Channel metrics are to be conducted at the pool tail crest or at the top or bottom of a fast water unit type.

**Step 3:** TAPE places depth staff at top of the active channel. CLINO stands at the water surface. TAPE slides her hand down the depth staff until CLINO sees the hand come into view while keeping the clinometer on 0% slope.

**Step 4:** Subtract the height where CLINO saw the hand on the depth staff (Step 3) from the eye height established in Step 1. This is the height above the water surface ("A" in Step 3).

**Step 5:** CLINO takes the end of the tape measure and starts across the channel while TAPE stays at the active channel margin. CLINO takes 3 depth measurements at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ distance of the active channel width while crossing the channel (the measurements are usually the water depth but occasionally can be an exposed gravel bar above the water surface - thus a negative value).
Step 6: Take the average of the three measurements. The example in Step 5 has the measurements 0.15, 0.30, and -0.15 (average = 0.10). Add this value to the measurement "A" obtained in Step 3. This sum is the Active Channel Height (ACH).

Step 7: TAPE repositions her hand at CLINO's eye height on the depth staff. On the other side of the stream, CLINO backs up the bank until his eye is level with TAPE's hand on the depth staff (using the clinometer at 0% slope). CLINO has now established the active channel margin on the other bank. The distance between CLINO and TAPE is the Active Channel Width (ACW) as x depicts above.

Step 8: TAPE subtracts the Active Channel Height value from CLINO's eye height on the depth staff. CLINO remains at the active channel margin with the clinometer at his eye on 0% slope. TAPE backs up the bank until her hand (at the new position) comes into CLINO's view. TAPE has now established the margin of the flood prone on her side of the stream.

Step 9: TAPE repositions her hand back to CLINO's eye height on the depth staff and does not move. CLINO backs up until his eye (clinometer on 0%) is looking at TAPE's hand. CLINO has now established the flood prone margin on his side of the stream. The measurement between CLINO and TAPE is the Flood Prone Width (FPW) as depicted by y in the above illustration. Flood Prone Height (FPH) is simply 2X the Active Channel Height.
**Step 10:** If a high terrace (terrace feature above FPH) exists within 4 active channel widths then measure a terrace height (TH) and terrace width (TW). TAPE backs up until she is on the edge of the high terrace lip while CLINO stays at the flood prone margin on his side of the stream. TAPE slides her hand down the depth staff until CLINO (with clinometer on 0%) sees TAPE's hand in view. Subtract this height from CLINO's eye height on the depth staff. Add this difference to the Flood Prone Height value. This sum is the Terrace Height (TH).

TAPE repositions her hand back to CLINO's eye height on the depth staff and stays at the terrace lip while CLINO moves back until his eye (on 0%) is looking at his corresponding eye height on TAPE's depth staff. The distance between them is the Terrace Width (TW) as z depicts above.

The Valley Width Index (VWI) is an estimate of how many Active Channel Widths can fit between the toe of the hillslope on one side of the valley to the toe of the slope on the other side of the valley. In the illustration above, if the Valley Width is 30 meters and the Active Channel Width is 15 meters, then the VWI is 2.0.
EQUIPMENT CHECK LIST

IN STORAGE BOX:

☐ ATLAS
☐ FIELD IDENTIFICATION GUIDES
   (Amphibian, Non-native plants, Fish)
☐ USGS TOPOGRAPHIC MAPS
☐ CAMERA
☐ CLINOMETER
☐ CLIPBOARDS
☐ COMPASS
☐ PDA and CHARGER
☐ GPS / BLUETOOTH unit
☐ DATA FORMS / FILE BOX
☐ FIBERGLASS MEASURING TAPE
☐ FIELD BOOK
☐ FLAGGING TAPE
   (blue and white stripe)
☐ SURVEY METHODS AND
   INSTRUCTIONS
☐ THERMOMETER
   (Pocket Celsius scale)
☐ VESTS
☐ STORAGE BOX
☐ CB RADIO
☐ LASER RANGE-FINDER (optional)

☐ PENCILS, SHARPIE WATERPROOF
   MARKER
☐ FIRST AID KITS
☐ CELL PHONE
☐ AXE / PULASKI
☐ SHOVEL
☐ DEPTH STAFF
☐ ODFW HATS AND UNIFORM SHIRTS
☐ HIP BOOTS
☐ BOOTIES
☐ POLARIZED SUNGLASSES
☐ WADERS
☐ WADING SHOES
☐ RAINGEAR
☐ HEADLAMP, WHISTLE
☐ WATER JUG
☐ COPPER SULFATE (optional)
☐ OREGON PLAN SIGNAGE
   (yellow signs, orange whiskers, nails)
☐ VEHICLE SAFETY EQUIPMENT
   (flares, jumper cables, fire extinguisher)

All equipment must be checked in at the end of the field season. Your supervisor will replace hip boots, wading shoes, and other equipment that may become worn out during the summer. Keep your supervisor informed of your equipment needs.
EXAMPLES OF BLANK AND COMPLETED DATA FORMS
# REACH

**STREAM:** Example Creek  
**BASIN:** North Somewhere River  
**CREW:** Jane Doe, John Doe  
**USGS 7.5 MAP NAMES:** Cedar Butte

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<tr>
<th>DATE</th>
<th>REACH NUMBER</th>
<th>UNIT</th>
<th>CHANL. FORM</th>
<th>VALLEY FORM</th>
<th>VVI</th>
<th>VEG CLASS</th>
<th>LAND USE</th>
<th>WATER TEMP</th>
<th>STRM</th>
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**UTM:** 1. UTM 435440  
2. UTM 435799  
3. UTM 435990  
4. UTM 436102  
5. UTM 436440  
6. UTM 436503

**ACW:** 12m  
**ACW:** 8m  
**ACW:** 6m  
**ACW:** 4m  
**ACW:** 10m  
**ACW:** 6m
| REACH | UNIT | UNIT | CHANL | % | UNIT | UNIT | SLOPE | SHADE (0-90) | ACTIVE CHANNEL | FLOOD PRONE | TERRACE | NOTE |
|-------|------|------|-------|---|------|------|-------|-------------|----------------|-------------|----------|--------|------|
| # | # | TYPE | TYPE | FLOW | LENGTH | WIDTH | % | LEFT | RIGHT | HT.* | WIDTH | HT. | WIDTH | HT.** | WIDTH | VWI |

* MEASURE FROM THE STREAMBED TO THE TOP OF THE ACTIVE CHANNEL. TAKE THE MEASUREMENT AT POOL TAIL CREST ON POOL UNITS.

** MEASURE FROM THE STREAMBED TO THE TOP OF THE TERRACE.
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<th>REACH #</th>
<th>UNIT #</th>
<th>UNIT TYPE</th>
<th>CHANNEL TYPE</th>
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<th>LENGTH</th>
<th>UNIT WIDTH</th>
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<th>SHADE (0-90)</th>
<th>ACTIVE CHANNEL HT.</th>
<th>CHANNEL WIDTH</th>
<th>FLOOD PRONE HT.</th>
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<th>TERRACE HT.</th>
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* MAX DEPTH POOLS - MODAL DEPTH IN FAST WATER UNITS
** ONLY MEASURED @ POOLS (EXCEPT OFF-CHANNEL POOLS)
| UNIT # | UNIT TYPE | DEPTH* | DEPTH** | VERIFIED LENGTH | WIDTH | SO | PERCENT SUBSTRATE | SND | GRVL | CIBLE | BLDR | DRED | BDRC | BLDRC | COUNT | EROSION | UNDERCUT | COMMENT CODES | NOTE |
|-------|-----------|--------|---------|-----------------|------|---|------------------|-----|-----|-------|------|------|------|-------|-------|---------|---------|----------|-----------|----------------|---------------|-----|
| 1     | R1        | .20    | -       |                 |      | 5 | 10 | 45 | 40 | 0 | 0 | O | N | N |         |         |          |            | 1T5 Elk Creek |               |     |
| 2     | RB        | .25    | -       |                 |      | 0 | 5 | 30 | 65 | 10 | 0 | 0 | Y | Y | BV |         |         |          |            |               |                |     |
| 3     | LP        | 1.2    | .15     |                 |      | 10 | 10 | 40 | 20 | 0 | 0 | Y | N | N |         |         |          |            |               |                |     |
| 4     | RB        | .20    | -       |                 |      | 0 | 5 | 35 | 65 | 10 | 0 | 0 | Y | N | BV |         |         |          |            |               |                |     |
| 5     | LP        | .90    | .15     |                 |      | 5 | 15 | 60 | 15 | 5 | 0 | 0 | N | Y |         |         |          |            |               |                |     |
| 6     | RB        | .20    | -       |                 |      | 0 | 5 | 60 | 40 | 5 | 2 | 0 | N | N |         |         |          |            |               |                |     |
| 7     | LP        | 1.1    | .20     |                 |      | 10 | 15 | 50 | 25 | 0 | 0 | Y | Y | BV |         |         |          |            |               |                |     |
| 8     | R1        | .10    | -       |                 |      | 0 | 10 | 65 | 25 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 9     | LP        | .60    | .05     |                 |      | 10 | 15 | 40 | 25 | 5 | 0 | 0 | N | N | BV |         |         |          |            |               |                |     |
| V10   | LP        | .90    | .20     |                 |      | 5 | 10 | 50 | 30 | 0 | 0 | O | N | Y |         |         |          |            |               |                |     |
| 11    | SP        | 1.2    | .10     |                 |      | 10 | 10 | 65 | 10 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 12    | R1        | .25    | -       |                 |      | 0 | 5 | 65 | 30 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 13    | BW        | .30    | -       |                 |      | 40 | 20 | 30 | 0 | 5 | 0 | 0 | O | N | Y |         |         |          |            |               |                |     |
| 14    | LP        | 1.1    | .25     |                 |      | 10 | 10 | 50 | 35 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 15    | R1        | .25    | -       |                 |      | 0 | 5 | 50 | 40 | 0 | 0 | N | N | BC | HIGHWAY 583 |         |          |            |               |                |     |
| 16    | LP        | 1.0    | .20     |                 |      | 5 | 10 | 40 | 20 | 0 | 0 | 0 | Y | N |         |         |          |            |               |                |     |
| 17    | SC        | .10    | -       |                 |      | 0 | 0 | 60 | 40 | 0 | 0 | N | N | N |         |         |          |            |               |                |     |
| 18    | LP        | .90    | .20     |                 |      | 10 | 10 | 40 | 30 | 0 | 0 | N | Y | BV | GAUGE = 1.25 FEET |         |          |            |               |                |     |
| 19    | R1        | .25    | -       |                 |      | 5 | 5 | 45 | 40 | 0 | 5 | 0 | N | N |         |         |          |            |               |                |     |
| V20   | LP        | 1.1    | .15     |                 |      | 10 | 20 | 45 | 25 | 0 | 0 | N | N | N |         |         |          |            |               |                |     |
| 21    | R1        | .30    | -       |                 |      | 0 | 10 | 50 | 40 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 22    | LP        | .30    | .25     |                 |      | 15 | 10 | 35 | 20 | 0 | 0 | Y | N | N |         |         |          |            |               |                |     |
| 23    | R1        | .25    | -       |                 |      | 0 | 5 | 60 | 35 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 24    | LP        | .85    | .20     |                 |      | 5 | 10 | 55 | 25 | 0 | 0 | N | N | N | COHO |         |         |          |            |               |                |     |
| 25    | SR        | .05    | -       |                 |      | 0 | 0 | 0 | 5 | 90 | 0 | 0 | O | N | N |         |         |          |            |               |                |     |
| 26    | R1        | .15    | -       |                 |      | 0 | 5 | 60 | 30 | 5 | 0 | 0 | Y | N | 85/100 |         |         |          |            |               |                |     |
| 27    | PP        | .90    | .20     |                 |      | 5 | 15 | 50 | 20 | 5 | 0 | 0 | N | N | N |         |         |          |            |               |                |     |
| 28    | SS        | .05    | -       |                 |      | 0 | 0 | 30 | 35 | 30 | 0 | 0 | N | N | N |         |         |          |            |               |                |     |
| 29    | CC        | .05    | -       |                 |      | 0 | 0 | 30 | 35 | 30 | 0 | 0 | N | N | CC | DIA = 5.8 FEET, METAL |         |          |            |               |                |     |
| V30   | RB        | .25    | -       |                 |      | 0 | 0 | 30 | 60 | 10 | 0 | 2 | Y | N |         |         |          |            |               |                |     |

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Date: July 12, 2019
Name: John Doe
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**Notes:**

**UTM E:**

**UTM N:**

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**Legend:**

D = Deciduous/Hardwood
C = Conifer
S = Shrub
G = Grasses/Forbs
B = Sagebrush
V = Vegetation Cover (Rock, Duff, Roadbed)
Other = Record in Notes

See classes (cm): 0 = 0-1, 1 = 1-5, 5 = 5-15, 15 = 15-30, 30 = 30-60, 60 = 60-90, 90 = >90
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<th>DOM GROUND COVER</th>
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NOTES: Left Zone = very few hardwoods, mostly salmonberry and vine maple
poison oak throughout both sides and zones!

| 67    | LEFT | 1    | D 15    | S G              | D50 D>90          | RIGHT| 1    | D 15    | S G              | D50 D>90          |         |       |       |
|       |      |      | C 50    | B N              | C50 C>90          |      |      | C --    | B N              | C50 C>90          | 126, 127, 128, 129 | 0421777 | 4778760 |
|       |      | 2    | D 15    | S G              | D50 D>90          |      |      | D --    | S G              | D50 D>90          |         |       |       |
|       |      |      | C 50    | B N              | C50 C>90          |      |      | C 15    | B N              | C50 C>90          |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |

NOTES: Right side Zone 1 - clear cut

| 90    | LEFT | 1    | D --    | S G              | D50 D>90          | RIGHT| 1    | D --    | S G              | D50 D>90          |         |       |       |
|       |      |      | C --    | B N              | C50 C>90          |      |      | C --    | B N              | C50 C>90          | 132     | 0421995 | 4775536 |
|       |      | 2    | D 50    | S G              | D50 D>90          |      |      | D --    | S G              | D50 D>90          |         |       |       |
|       |      |      | C 30    | B N              | C50 C>90          |      |      | C --    | B N              | C50 C>90          |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |

NOTES: Left Zone 2 = 1 big leaf maple; 50:50 mix of shrub and grasses
Right Zone 1 = gravel road to access farm
Right Zone 2 = clear cut continued

| 102   | LEFT | 1    | D 15    | S G              | D50 D>90          | RIGHT| 1    | D 15    | S G              | D50 D>90          |         |       |       |
|       |      |      | C --    | B N              | C50 C>90          |      |      | C --    | B N              | C50 C>90          | none    | 0422011 | 4774596 |
|       |      | 2    | D 15    | S G              | D50 D>90          |      |      | D --    | S G              | D50 D>90          |         |       |       |
|       |      |      | C 50    | B N              | C50 C>90          |      |      | C --    | B N              | C50 C>90          |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |
|       |      |      |         |                  |                   |      |      |         |                  |                   |         |       |       |

NOTES: Right Zone 1 = gravel road to access farm
Right Zone 2 = cattle feed lot

D = DECIDUOUS / HARDWOOD  C = CONIFER  S = SHRUB  G = GRASS/FORB  B = SAGEBRUSH  N = NO VEGETATION COVER (ROCK, DUFF, ROAD BED, OTHER - RECORD IN NOTES)
SIZE CLASSES (CM): 3 = 3-15,  15 = 15-30,  30 = 30-50,  50 = 50-90,  90 = >90
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<th>GRASS/FORB</th>
<th>TREE</th>
<th>COUNT (DBH in CENTIMETERS)</th>
<th>RIPARIAN NOTE</th>
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**FOR EACH RIPARIAN TRANSECT, DRAW AND LABEL THE SURFACES (HT, LT, FP, HS, ETC) OF A CROSS SECTION IN THE BOX PROVIDED ABOVE. DRAWING AND LABELING VEGETATION IS NOT NECESSARY.**
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For each riparian transect, draw and label the surfaces (HT, LT, FP, HS, etc) of a cross section in the box provided above. Drawing and labeling vegetation is not necessary.
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<td>Upstream. Looking at Orakel over stream</td>
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<td>Upstream of fence. Looking upstream</td>
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<td>Fence photo upstream of fence. Left bank</td>
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<td>Fence photo downstream of fence. Mid.</td>
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<td>Fence photo downstream of fence. Mt.</td>
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<td>Old stone house along stream</td>
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<td>Looking downstream of SS (2).EB</td>
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<td>Photo of springhead contributing (2%).Flow</td>
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<td>Upstream photo at two small springheads</td>
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<td>Downstream near photo. Upstream Mt.</td>
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<td>Upstream beach photo</td>
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<td>Downstream</td>
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RANDOM PROBABILITY HABITAT SURVEYS

INTRODUCTION

An important objective of the Oregon Plan for Salmon and Watersheds is to determine current salmon habitat conditions and track trends in habitat over time. In order to accomplish this goal a long-term monitoring program coordinating stream habitat surveys, juvenile snorkeling inventories, and spawning salmon surveys were developed. All field surveys encompass a randomly selected point. Due to the standard survey length of the monitoring sites, some measurements are taken at increased frequency while others are omitted. These survey modifications are specific to the random monitoring surveys and do not apply to the comprehensive basin survey design. See appendix 2 for basin details.

REACH INFORMATION

The goal of the random habitat survey is to describe stream conditions that are representative of the point selected in the original sampling design. Therefore, it is best for only one reach to be documented in the field survey. There are instances in which the beginning or end of a survey may be moved in order to accommodate a reach break. Always check with your field supervisor BEFORE moving a survey. Surveys should not cross a spawning survey start or end sign. Please update your Reach Sheet.

Example: On a 1km survey, if a reach break occurs 100 meters into a survey and the survey point has not been reached, move the start of the survey to the beginning of the new reach. If the same condition occurs but the point is surveyed in the first 100 meters then move the survey below your initial survey point and restart the survey so that it ends at the reach break.

While some modification may allow the maintenance of only one reach, there are instances when a reach break may occur mid-survey. If a major reach change does occur during the survey, the reach will be recorded as a separate reach and the survey will continue for the full length. Only major changes in channel and valley constraint or major tributary junctions are a reason to call additional reaches.

HABITAT UNIT-1 FORM

The Metrics (Active Channel Width and Height, Flood Prone Width and Height, and Terrace Height and Width (when applicable)) will be measured 3 times per survey. Conduct these measurements at the beginning (or end) of the unit closest to these desired distances.

- For 1 km sites these will be taken at 250, 500, and 750m
- For 0.5 km sites these will be taken at 125, 250, and 375m

In order to ensure an adequate number of habitat units, maximum unit lengths are:

- The maximum length of fast-water units for 1 km sites is 50m(+5m).
- The maximum length of fast-water units for 0.5 km sites is 25m(+5m).
- There is no maximum length for slow water units (pools).
If a unit will naturally end within 5 meters of the maximum unit length the unit may be extended to the natural end.

*Example:* In a 1 km survey, if a rapid that is 55 m long is followed by a lateral scour pool, there is no need to break the rapid unit into 2 units one 50 m in length and one 5 m in length.

**RIPARIAN ASSESSMENT SURVEY**

A Riparian Assessment survey will be conducted at five transects throughout each habitat survey. As with channel metrics, it is not necessary to break a unit at exactly these measurements; however, conduct the transect at the beginning of the unit closest to the desired distance.

- For 1 km sites these will be conducted at approximately 0, 250, 500, 750, and 1000 meters.
- For 0.5 km sites these will be conducted at approximately 0, 125, 250, 375, and 500 meters.

If the first transect occurs at the confluence with another stream, conduct the riparian assessment upstream a few habitat units once you are out of the influence of the confluence.

**PHOTOS**

Reach photos will be taken throughout the survey (NOTE: The first digital photo for the site will be of the Reach Sheet - use the macro function on the camera – make sure you zoom into the site ID number and name of the stream. All the photos following this will be assumed to be of that particular site). Other photos may be taken of outstanding features of interest (such as significant barriers, debris flows, large log jams or riparian blow down). Record photo description on the Photo Sheet and on the corresponding habitat unit on the PDA as well. Complete all fields on the Photo Sheet; be sure to include the Site number and name.

**SITE SET-UP**

It is crucial that the field surveys are set-up correctly. Some sites will be shared by the spawning survey program. **The following rules are necessary for successful site set-up and are listed in order of importance.**

- Surveys must encompass the point identified for the site.
- Surveys will be 1000 meters or 500 meters (habitat-only surveys) in length.

Additional important guidelines:
- Include only one homogenous reach in survey (see reach section below)
- When possible start and end surveys at obvious recognizable points (e.g. sharp bends, tributaries, bridges, etc.).
- Clearly mark sites with flagging and yellow survey signs, take GPS readings at start and end points whenever this is possible, reference these locations on the map.
- If you have questions about the set-up of a site, contact your field supervisor.
SITE MARKING

UTM coordinates will be taken at the start and end of the survey and each will be recorded on the paper Reach sheet as well as being documented in the electronic PDA forms. If coordinates are acquired with a handheld GPS (Garmin for example) please indicate the quality of the coverage and datum used.

Yellow site tags, orange whiskers, and flagging will be placed at a noticeable location at the start and end points of the survey. Use a sharpie pen on the yellow tag to indicate stream name, site #, START or END, and the year. Location of the tags will be noted on the Reach sheet (e.g. large 30-50cm dbh conifer on right). Site tags and flagging should be replaced on repeat surveys only when missing. If the sharpie marking is faded or illegible, trace over the faded existing markings to refresh the labeling. The following instructions indicate what to do in certain scenarios:

a) You are surveying a previous year’s site. You navigate to the start coordinates but cannot find a yellow start OPlan sign anywhere. After making a significant effort you still cannot find it. You hang a new sign, mark it accordingly, hang flagging, and record UTM coordinates. After surveying several hundred meters upstream you encounter the original start sign on a tree. WHAT DO I DO? At this point, go back downstream and remove the sign you hung earlier. Walk back upstream and restart the survey at the original sign (record UTM coordinates and datum you are using). NOTE: Make sure that the encountered yellow sign refers to the site you’re supposed to be surveying. There are other surveys being conducted throughout the area (snorkeling, restoration, etc.). Restart the survey at this location. Indicate on PDA and Reach sheet the situation and the new start information.

b) You are surveying a previous year’s site. After navigating to the start sign (successfully) you notice that the UTM coordinates differ substantially from the previous survey. The sign is legible and the location/placement agrees with the reach sheet. WHAT DO I DO? It is possible that the previous crew collected the UTM coordinates in a different datum (NAD27 versus NAD83 for instance). If this is the situation you can have waypoint discrepancies up to several hundred meters. Record the UTM coordinates you obtained and the datum you are using. Begin the survey.

c) You are surveying a previous year’s site. You found the original start sign and begin the survey. After surveying approximately 950 meters you come across a yellow sign on a 30-50cm dbh alder on the left bank indicating the end of survey. You double check the reach sheet for end sign location, length of survey, and UTM coordinates of where to expect the sign. Everything agrees except that the reach sheet shows the survey to be 1050 meters long. WHAT DO I DO? First, make sure the end sign is referring to the site you’re working on. If it is, then this is probably the correct end location and record it as such (get UTM coordinates, conduct channel metrics, etc.). If time permits, leave your gear and take a scouting hike upstream for approximately 200 meters and see if you find another end sign. IF you do find another end sign referring to the site you’re surveying, then go back to your gear and continue the survey to this sign (collect UTM, channel metrics, etc.). Make a note of the discrepancy and record this in your notes.
d) If the **point** is denied by a landowner, talk to your supervisor about dropping the site.

e) If the **point** is in a tidal zone or above a barrier, talk to your supervisor before dropping the site.

f) If part of the survey (but not the **point**) is in a tidal zone or above a barrier, talk to your supervisor before modifying or conducting the survey.

g) If a survey is shortened or shifted indicate which landowners are no longer on the survey on the Reach sheet Landowner section and in the Not On Survey field in the PDA. Talk to your supervisor about any changes that may have been made.
Appendix 2: Basin (Census) Habitat Surveys

INTRODUCTION

The purpose of conducting a stream habitat survey using a basin, or census, design is to capture habitat conditions at a watershed scale. This design will produce the most accurate and reliable inventory of all habitats in a watershed. Data collected at this comprehensive scale are often needed to evaluate and prioritize habitat restoration projects, detect changes resulting from natural and anthropomorphic influences, and help guide habitat management plans.

REACH INFORMATION

When conducting surveys using a census design, enter a new line on the reach data sheet at any significant change in any one of the reach variables (valley type, channel form, adjacent landform, valley width index, vegetation, or land use) and/or at the confluence with tributaries named on 7.5 minute topographic maps. When a new reach is identified by a named tributary, write the name in the Reach Note column. Also describe a new reach if an unnamed tributary contributes significant flow (approx. 15-20% of the total). Do not invent names for unnamed tributaries, instead identify them as Trib. 1, Trib. 2, etc. and record them on the data sheet and the map.

Changes in reach characteristics are used to verify survey location and to identify reach and stream segments within our basin classification system. Circle the variable that resulted in the new reach entry.

Flagging is used to mark specific points during a survey. Hang a strip of plastic flagging at the start, at each reach change, and at the end of the survey. Mark the flagging with the unit number, unit type, date, and "ODFW-AQ.-INV.". These flags will be used to locate specific reaches and units for fish sampling and to link units and locations for repeat habitat surveys.

HABITAT UNIT-1 FORM

The Metrics (Active Channel Width and Height, Flood Prone Width and Height, Terrace Height and Width (when applicable), and Valley Width Index) will be measured every 10th habitat unit throughout the length of the survey. Conduct these measurements at the beginning of the habitat unit. Draw a cross sectional diagram of the transect above or below your measurements (see example on data sheets) when using paper forms. Contact your supervisor if you have questions regarding the frequency of these measurements if you are surveying a very large or small stream. In order to ensure an accurate measurement of habitat unit length and width follow these guidelines:

Measure every habitat length and width using a rangefinder or measuring tape
OR
Estimate every habitat unit length and width, verifying every 10th measurement. When using this protocol try to have a variety of verified lengths so that the calibration factor applied during analysis will be adequately represented for all units surveyed. For example, if by chance every 10th unit ends up being a step, verify the unit above it so that longer unit estimations can be made and incorporated into the correction factor. Most people are accurate at estimating shorter distances but then start to vary exponentially as the length increases.

Limit the length of habitat units to 150 – 180 meters (if the habitat unit is a pool keep it as one unit regardless of the length).
HABITAT UNIT-2 FORM

The verified length and width columns are to be filled in when a habitat unit’s measurements are being verified against the estimated value. This will determine a calibration or correction factor to be applied to the estimated lengths and widths during analysis. This should be conducted every 10th unit. The recorded value is not to be disclosed to the estimator in order for them to make adjustments to their estimation.

RIPARIAN FORM

Either a Riparian Assessment or Riparian Transect survey can be conducted for basin surveys depending on the desired analysis. Follow these guidelines for the frequency of conducting transects for each protocol:

- Riparian Assessment: Conduct survey every 250 to 300 meters. Make sure there is a minimum of 1 transect for each reach identified in the survey.
- Riparian Transect: Conduct survey every 30 habitat units or 500 meters, whichever comes first. Make sure there is a minimum of 1 transect for each reach identified in the survey.

PHOTOS

Reach and riparian photos will be taken throughout the survey. Record photo description on the Photo Sheet and on the corresponding habitat unit NOTE field as well. Complete all fields on the Photo Sheet; be sure to include the stream name and unit number. Other photos may be taken of outstanding features of interest (such as significant barriers, debris flows, large log jams or riparian blow down).

FIELD BOOK

Maintain a succinct log of your activities in the field book. Each day, record the date, name of the stream or site you surveyed, and the unit numbers surveyed. Write a paragraph or so of a general description for each reach. Record relevant details about access to the stream, name(s) of corporate contacts of cooperating industry or agency groups and private landowners you contact to gain permission to survey. Pay particular attention to descriptions of the riparian zone, additional details concerning land use, or factors that influence the fish populations. This is the appropriate place to express your opinions. Other comments, sketches of complex features, suggestions, complaints, etc. are useful.

MAP WORK

Do not go into the field without a topographic map! Data that cannot be linked to the maps are essentially useless. Use the maps to orient to the stream and to identify the location of reach changes, named tributaries, roads, and bridge crossings. Clearly mark where you start and end the survey and areas where you are denied access. Mark all reach changes (if they exist) and important features on the map. Write the channel unit number on the map at the place that corresponds to the location of named tributary junctions, bridges, and other landmarks.

A good correspondence between landmarks on the map and the data collected is an essential part of our survey effort. Information from the surveys will be utilized and integrated with Geographic Information System (GIS) analysis. Well documented and accurate maps are required for this process. In addition to a well-marked map, it is essential that the habitat survey follow the USGS named stream on the topo map,
regardless of the amount of flow. Record the Easting and Northing UTM coordinates at the beginning of the survey, at all reach changes (if applicable), at channel metrics and riparian transects, and at the end of all surveys.

EXAMPLE OF BASIN MAP DETAIL
Appendix 3: Oregon Plan for Salmon and Watersheds Monitoring Survey

RANDOM PROBABILITY SNORKEL SURVEY

INTRODUCTION

Monitoring salmon populations and habitat is an instrumental part of the Oregon Plan with the goal to document the current condition of Oregon’s key watershed health parameters, track changes over time, and determine if restoration efforts are effective. Snorkel surveys allow for monitoring trends in the distribution and abundance of juvenile salmonids in western Oregon’s coho Evolutionarily Significant Units (ESUs) and steelhead Distinct Population Segments (DPSs). Data are used to investigate relationships between freshwater habitat characteristics, adult spawner abundance, and juvenile recruitment.

SNORKEL SURVEY PROTOCOL

Habitat and snorkel survey lengths directly overlap within coho distribution. From the same habitat survey start point, snorkel pools upstream to the end of the habitat survey (usually a distance of 1000 meters in a reach that encompasses the GRTS point). Snorkel only pools as defined by Aquatic Inventory Project (AIP) stream survey protocol in this manual AND are a minimum of ≥20cm deep and ≥6m² in surface area. Based on the habitat and snorkel protocols, there may be smaller, shallower AIP habitat pools which do not meet snorkel protocol and will not be snorkeled. Make a single pass through each pool and count juvenile coho, Chinook, steelhead, and cutthroat trout. Only Steelhead and Cutthroat ≥90mm are enumerated. Steelhead and cutthroat <90mm in fork length are categorized as 0-aged trout. Indicate if dace, shiner, and 0-aged trout are present or absent.

All pools will be given a visibility rating from 0 to 3. Do not snorkel pools that have poor or very poor visibility (0 or 1).

HABITAT AND SNORKEL CONSIDERATIONS

Snorkeling is best conducted later in the summer after juvenile fish distribution is stabilized due to summer low flow conditions. Due to stream flow, spawning conditions, timing, and other factors these snorkel start dates may differ by Monitoring Area – contact your supervisor for more information on the allowable start date for snorkel surveys. Since the habitat survey component may occur earlier in the season, crews may need to flag pools during the habitat survey and clearly mark which need to be snorkeled once the snorkel season begins. Hang a flag with the Unit number and word ‘Start’ on the downstream end of the pool. Indicate the top of the pool with an additional flag with the Unit number and the word ‘End’. Depending on location, ownership issues, or other factors flagging may not be the desired method to identify these pools. Check with your supervisor for the appropriate method (soap stone or flagging).

Habitat surveys will be conducted regardless of the snorkel conditions (dry site, poor visibility or water quality issues). Contact your supervisor if you have any questions.
Appendix 4: PDA Protocol - Oregon Plan Monitoring Surveys

PDA PROTOCOL & REMINDERS

PDA’s (personal digital assistant) will be used as the primary method of data collection and recording. These electronic devices are expensive and can be difficult to replace therefore please treat them with care. The models that we currently use are **NOT** waterproof thus the waterproof protective cases that are used in conjunction with the device. Occasionally you may have to take the device out of the waterproof case in order to a) change a battery or b) perform a soft reset. If you have to do this, please do this away from the creek, preferably on dry ground.

Below is a list of common errors that you need to be aware of:

- After battery replacement the internal date may reset to July 1, 2005. Make sure you check and correct the date if necessary after replacing the battery. Get in the habit of checking the date at the beginning of every survey as well.
- Occasionally the device will lock up and will not allow you to exit a page. To perform a soft reset simply use the stylus to press the reset button located on the device. You will probably lose the data for the habitat unit you were working on but not any previous data. Review the data and re-survey the unit if necessary.
- If a site is not listed from the drop-down menu, select an “extra” from the list and make sure that the first record has the stream name and site number in the NOTE field in all the forms used (reach, riparian, unit, wood, and fish).
- Remember to record any dropped sites using the DROPPED form. Use the pull-down menu to indicate the reason for the drop.
- Do not forget to record the reach information in the REACH form. This is the one summarized line for the surveyed site which will also be filled in on the paper reach sheet located in the site folder.
- Some fields are not populated with the pull-down menu and require a scribed or typed numerical value. Be cognizant of entering a correct value – extra/mistyped decimals, dashes, commas, etc. in a numerical field will not allow data to be synced.
- Be aware of the name of the field you are entering data (i.e.: is the terrace width data recorded actually the terrace width and not the terrace height).
- When entering text in the NOTE field abstain from pushing the enter/return key to go on to another line. Just keep typing in one continuous entry (with punctuation of course). All text will default to upper case after you complete the entry.
- When acquiring a UTM coordinate, do not forget to select a reason from the pull-down menu in the REASON FOR UTM field.
- If a lot of wood is encountered in a survey and recording the information on the PDA impedes your progress it is ok to collect LWD information on paper. If any down time occurs you can enter this data on the PDA. Indicate on the outside of the site folder that data were collected on paper and whether the data were entered.
Appendix 5: Fish Inventory Protocols at Oregon Plan Habitat-Only Sites

INTRODUCTION

In 1998, the Oregon Plan for Salmon and Watersheds (OPSW) mandated that the Oregon Department of Fish and Wildlife (ODFW) establish annual surveys to monitor stream habitat and fish populations in Oregon coastal streams. At sites upstream of the known distribution of coho, fish are sampled with electrofishing gear to assess species composition and distribution.

FISH SAMPLING

The Effect of Pulsed Direct Current on Fish

Electroshocking surveys are conducted with Smith-Root backpack electrofishers that discharge direct pulsed current. When the button on the probe (anode) is pushed, an electrical circuit is completed through the water when the current flows from the negative cathode (rattail) through the water and then to the positively charged anode (probe). Fish that are on the periphery of a weak electrical current experience mild nerve excitation but still retain control of swimming ability and will escape from the field. Those under a strong electrical field experience a progressive series of reactions that culminate in immobilization. The polarized nature of body musculature often causes fish to curve toward and face the anode, but the initial orientation of fish in the electrical field results in varied directional responses. Spasmodic undulations of the musculature induced by the electrical field may also result in involuntarily swimming (electrotaxis) towards the anode probe. As fish move closer to the anode probe, they experience increased intensity of electrical current. Beyond a certain intensity, body muscles become cramped and fish are immobilized.

Fish close to the anode probe are quickly immobilized and may not exhibit electrotaxis. Larger fish are more easily immobilized than smaller fish because they present a greater amount of nerve tissue to the electrical field at a given distance from the anode probe. In addition to voltage the frequency and wavelength of pulsed direct current has different effects on muscles depending on fish size, species, water temperature and conductivity. Smaller fish generally require higher pulse frequencies to become immobilized. A minimum frequency exists below which fish will not be immobilized.

Fish recover the ability to swim quickly after electroshocking if the applied current is not too strong and the amount of time they are exposed to the electrical field is short. However, the fish may experience physiological stress for several days following shocking. Injury (damage to swim bladders, muscles, and skin; fractured vertebrae; and bleeding have been reported) or death can result if excessive current is applied.

The zone of potential fish injury is 0.5 m from the anode. Care should be taken in shallow waters, undercut banks, or where fish can be concentrated because in such areas the fish are more likely to come into close contact with the anode (NMFS, 2000).

Crew members should carefully observe the condition of sampled fish. Dark bands on the body and longer recovery times are signs of injury or handling stress. When such signs are noted, the settings for the electrofishing unit should be adjusted. Sampling should be terminated if injuries or abnormally long recovery times persist even after shocker settings have been reduced.
SAFETY

The use of electrofishers can be dangerous. Some fatalities have occurred with older electrofishers that lacked tilt switches. Common sense will eliminate most of the potential for injury. Prevent exposure to the electrical field. Use nets with insulated metal handles. Wear standard weight waders or boots without leaks.

Rubber gloves are required to be worn while electrofishing. Replace ripped or overly worn gloves. Never place bare hands in the water unless it is completely understood that the electrical current is off and the probe is removed from the water.

Stunned fish frequently need to be extracted from crevices in the streambed. Before attempting to pick up a fish, have a well understood convention with the electrofisher operator, such as the netter saying "off" and having "off" repeated by the operator after the current is stopped and the probe lifted from the water. Resume electrofishing only after both parties give an "on" command. When reaching into crevices, use only one hand and keep the other arm well out of the water. This prevents passing an arc of current through your chest. Also, there is a chance of shock if you touch the probe in the “on” position at the same time you are touching the box on the backpack.

TECHNIQUE

Electrofishing has the potential to harm or to cause direct mortality of fish. Electrofishing can also be hazardous to the survey crew if not performed correctly. Use the least amount of voltage and lowest frequency pulse that effectively immobilizes fish (see section below on Electrofishing Methods). This decreases stress and chance of injury to the fish. It also extends the amount of time on the battery charge. Increase voltage when target fish are small or when the conductivity of the water is low. Decrease the voltage and frequency if large fish are observed in the habitat unit. Do not sample if adult salmon are observed in the unit.

Sample at least 3 pools and 3 fastwater units totaling a minimum of 60 meters stream length. Record the fish collected in the first pool by species and size. Sample at least 15 meters of the fastwater unit immediately above the pool and record the fish captured. Walk upstream to the next pool and sample it and the fastwater unit above. Consecutive sampling is preferred. Continue sampling until 3 pool – fastwater sequences have been sampled. If a fish species or life history stage not observed in the first 4 units is captured in the 5th or 6th unit, sample another pool and fastwater unit. In small streams with low flow, you may have to walk a considerable distance to locate pools. In larger streams with long habitat units, you may need to subsample within unit types as well as sample a variety of unit types. If you detect a potential fish barrier in the habitat survey, electrofish above and below the barrier to determine if it impedes fish passage.

Release netted fish far enough downstream to be outside the electrical field. Carefully release fish back into the water; fish should not be exposed to air for more than a few seconds or latent mortality will likely occur.

If you are unable to identify the fish: write a description, take a close-up photo, or preserve a few individuals in ethanol for later identification. Write the date, stream name, sample site code, and name of the sampling crew members on the label in the jar or Ziploc bag. Note on the data form that a collection was made at that site.
If fish were observed but not captured, indicate as much on the data sheet and approximate the length. If movement was seen but not body length nor size, do not guess these data. Write a note on the fish sheet to describe what was observed. It is easy to confuse movement of a salamander with that of a fish.

**SURVEY GUIDELINES**

(Information in this section taken from Rodgers 2001 unless otherwise cited)

Do not shock when water temperatures are above 18°C (65°F) or expected to be above this temperature prior to completing the electrofishing. If water temperatures are appropriate in the morning, but you anticipate that they will increase later in the day, electrofish before you complete the habitat survey.

Measure the water conductivity and record it on the Fish Survey data form. High conductivity (over 2,000 microSiemens/cc) allows the electric current to spread throughout the water, decreasing the risk to fish health because most of the current flows through the water and not the fish. With higher conductivity readings use low voltages. Water conductivity may be higher in agricultural areas due to chemicals applied to fields and associated runoff. Conductivity of water also increases with increasing water temperature (Smith-Root 1998).

Smith Root electrofishers allow for adjustment of voltage, waveform, and frequency. Start with a setting of H-4 and 200 volts if in shallow pools; H-4 and 300 volts if sampling in deeper pools (>0.8m). Note that a pool for shocking may be smaller than pools identified in a standard habitat survey. If damage to fish (visible burn marks, extended spasms or long recovery periods) is occurring, decrease voltage to 100V. If fish continue to be injured, change settings to G-3 and 100V. If damage continues, try F-3 and 100V.

Increase voltage to 300V at H-4 if only small fish are being netted and larger fish are observed swimming away from the probe or fish are not stunned long enough to net. If either of these conditions continue, increase settings to I-4 and 200V. If this isn’t catching fish, increase voltage to 300V and I-4. **Do NOT increase voltage beyond 300V.** Make sure to record shocker settings on the Fish Survey form.

The preferred method to prevent accidental mortality is to “attract” fish to the ring rather than actually “rolling” them. Keep the trigger on while “attracting” or “pulling” fish and netting them. Release trigger if you are rolling fish before you are able to net them.

*The best way to get fish within an effective radius of the anode probe is to "surprise" them. Position the probe in a new area while it is turned off, turn it on only after it is in place. Sweeping a live probe about the stream merely introduces the weak border of the electrical field to new areas and fish will easily detect and escape the field. The stream should be covered systematically, moving the anode in a herringbone pattern through the water. Do not electrofish one area for an extended period. Continue shocking the habitat unit until the first pass is completed OR until at least one juvenile coho has been captured. Electrofishing of a stream must be terminated once a coho has been captured and positively identified.*
Tips about the anode:
- Do not use a net on the end of the ring.
- Wrapping the ring with cording may reduce damage to fish. Be sure to check the wrapped ring periodically for corrosion.
- Larger rings are better than smaller rings, they reduce the power gradient near the ring.
- Keep ring clean using a Scotch-brite pad suitable for Teflon. Do not use steel wool. Ring are fragile so be careful not to break them when cleaning.

Tips about the cathode:
- Add more area affected by electrical current by keeping the tail behind you in the same unit you are shocking. Be careful the cathode is not close to the anode and do not allow them to touch.

ELECTROSHOCKER TROUBLESHOOTING

Malfunction of the electrofishing system may occur in the field and can be very frustrating. The following tips can help to resolve problems with the equipment.

Problem: Unit won't shock fish.

Possible Solutions:
1. Dirty anode ring. Clean ring with wire wheel or abrasive pad. DO NOT USE SANDPAPER!
2. Broken wire in anode pole. Try a different pole. See section on ANODE TESTING for testing anode poles.
3. Broken cathode (tail). Try a different cathode. See section on CATHODE TESTING for testing tails.
4. Battery weak or dead. Check voltmeter on front of unit with output activated. Replace battery if necessary.
5. Loose connection at battery terminals. Tighten connection if possible. If connection is broken or burned return for repair.
7. Unit is tilted at too steep an angle. Tip over switch is turning off unit. Make sure to stand upright when shocking.
8. Rattail is not in water. Both the probe and rattail must be in the water for a circuit to be completed.

Problem: Unit overloads.

Possible Solutions:
1. Output voltage set too high. Reduce output voltage setting.
2. Pulse width or frequency control set too high. Reduce setting.
3. Anode and cathode too close together. Increase distance between electrodes.
4. Metallic object in the water or stream bed near the shocker.
Problem: Relay clicks on and off when output activated.

Possible Solutions:

1. Broken wire in anode pole curl cord. Try a different pole.
2. Weak battery. Replace.
3. Bad connection at battery terminals. Tighten connection is possible. If connection is broken or burned return for repair.

Problem: On/Off circuit breaker trips when unit is turned on.

Possible Solution:


Anode Testing

1. Disconnect pole from shocker.
2. Connect red lead of ohmmeter to pin A in plug on end of curl cord.
3. Connect black lead of ohmmeter to anode ring or bottom of pole.
4. Set ohmmeter to read 200 ohms full scale.
5. The ohmmeter should read near zero ohms regardless of pole switch position if not the pole is bad. Shake the curl cord during this test. If the reading changes the pole is bad.
6. Connect the red lead of the ohmmeter to pin B in the pole connector.
7. Connect the black lead of the ohmmeter to pin C in the pole connector.
8. The ohmmeter should read infinite resistance until the pole switch is pressed. If not the pole is bad. Shake the curl cord during this test, if the reading changes the pole is bad.
9. Press the pole switch. The ohmmeter should read near zero ohms. If not the pole is bad. Shake the curl cord during this test, if the reading changes the pole is bad.
10. Test between each pin in the plug and the metal shell of the plug. The ohmmeter should read infinite resistance, if not the pole is bad.

Cathode Testing

1. Disconnect cathode from shocker.
2. Connect red lead of ohmmeter to pin A in plug on end of cathode.
3. Connect black lead of ohmmeter to bare cathode cable.
4. Set ohmmeter to read 200 ohms full scale.
5. The ohmmeter should read near zero ohms. If not the cathode is bad. Pull on the cable, if the reading changes the cathode is bad.
6. Connect the red lead of the ohmmeter to pin B in the cathode plug.
7. Connect the black lead of the ohmmeter to pin C in the cathode plug.
8. The ohmmeter should read near zero ohms, if not the cathode is bad.
9. Test between each pin in the plug and the metal shell of the plug. Ohmmeter should read infinite resistance, if not the cathode is bad.
Batteries

Our Smith-Root backpack electroshockers are powered by a 24 volt gel cell battery. Following some simple procedures can prolong a battery’s service life. For instance:

1. Recharge batteries after every use.
2. Protect batteries both in use and in storage by periodically charging them during cold weather. Cold temperatures reduce the amount of cranking capacity a battery can offer so it is best if batteries are not left in the cold.

Always place batteries on a wood surface when in use or in storage. If left set directly on the ground, the battery will discharge.

FISH SURVEY FORM

See pages 57 and 58 for examples of fish survey forms.

Crew: Names of surveyors.
Stream name: Spell out the complete name of the stream being surveyed. Include the site identification number and gene conservation group (GCG) code.
USGS Map: Name of the USGS. 7.5 minute topographic quad.
Basin: Use the name of the large river commonly used to describe a region. For example, use McKenzie R as the basin name when sampling Lookout Cr, not Willamette or Columbia.
Date: MM/DD/YY.
Notes: Additional information concerning sample site location (particularly relative to culverts or other potential barriers), type of ownership, and access roads or trails. Comments on the weather, cloud cover or precipitation, visibility and habitat condition can also be made.
UTM Start: Record the UTM coordinates at the beginning point of the fish survey.
UTM End: Record the UTM coordinates at the end point of the fish survey.
Map Code: Record the site’s code including monitoring area and site id number (such as UMP-1556 – for Umpqua site #1556). Be sure to mark all sites on topo maps and be as accurate as possible in marking sample sites on maps.
Active Channel Width: Distance across channel at "bank full" annual high flow estimated from change in vegetation, slope break, or high water mark. Sum the width of all active channels in multichannel situations.
Active Channel Height: Vertical distance from the stream bottom to the top of the active channel.
Stream Flow (see page 9 for complete definitions):
DR  DRy
PD  PuDdled
LF  Low Flow
MF  Moderate Flow
HF  High Flow
BF  Bankfull Flow
FF  Flood Flow
Water Temp: Degrees Centigrade or Fahrenheit; indicate scale used.

Gear/Method: Indicate method of sampling (i.e. snorkel, seining, or electrofishing). When electrofishing, indicate voltage setting of electroshocking unit.

Photo number and time: Take a photograph that shows the stream and riparian zone typical of the reach sampled. Record the exposure number and the time shown on the camera back. This can be the same photo used for the habitat survey.

Location: Township, range, and 1/4 section at the start of the fish survey site. Use following format: T10S R05W S22 SE. Draw a rough sketch of the stream as it appears in the topo map section in the upper right corner of the data form (see example).

Site Detail and Fish Species Information

Survey Number: The number of the unit sampled during habitat survey (if known). This is important and used to cross reference to the habitat database.

Sequence Number: The sequential number describing the order that channel units were sampled. Sample a minimum of 6 units (3 fast water and 3 slow water) and at least 60 meters.

Unit Type: Use the habitat types listed in the physical habitat survey methods.

Unit Length: Estimated length of each habitat unit or channel type sampled.

Depth: Maximum depth in pools, modal or typical depth in glides and other fast water habitat unit types.

Fish Code: Use the standard codes for the following species.

**standard abbreviations:**

- **BG** bluegill
- **BLB** black bullhead
- **BR** brown trout
- **BRB** brown bullhead
- **BSU** bridgelip sucker
- **BT** brook trout
- **BUT** bull trout
- **CC** channel catfish
- **CH** chinook salmon
- **CLM** chiselmouth
- **CO** coho salmon
- **CS** chum salmon
- **CSU** largescale sucker
- **CT** cutthroat trout
- **D** dace
- **LAM** lamprey
- **LCT** Lahontan cutthroat trout
- **MSU** mountain sucker
- **OC** Oregon chub
- **PK** pumpkinseed
- **PM** peamouth
- **PS** pink salmon
- **RB** rainbow trout
- **RSS** redside shiner
- **RT** redband trout
- **SB** smallmouth bass
- **SS** sockeye salmon
- **SU** sucker
- **WF** mountain whitefish

**non-standard abbreviations:**

- **AM** ammocoetes
- **AS** Atlantic salmon
- **ATF** adult tailed frog
- **BD** black dace
- **BTH** brook/bull hybrid
- **C** crappie
- **CF** crayfish
- **COT** sculpin
- **CP** carp
- **PGS** Pacific giant salamander
- **RTS** reticulate sculpin
- **RO** roach
- **RSN** rough skin newt
- **SH** shiner spp.
- **SKB** stickleback
- **SR** sandroller
- **SPD** speckled dace
- **NPM** northern pike minnow/squawfish
**non-standard abbreviations continued:**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTH</td>
<td>cutthroat hybrid</td>
</tr>
<tr>
<td>FRG</td>
<td>frog (species unknown)</td>
</tr>
<tr>
<td>JSU</td>
<td>Jenny lake sucker</td>
</tr>
<tr>
<td>LB</td>
<td>largemouth bass</td>
</tr>
<tr>
<td>LND</td>
<td>longnose dace</td>
</tr>
<tr>
<td>MF</td>
<td>western mosquitofish</td>
</tr>
<tr>
<td>MMS</td>
<td>Malheur mottled sculpin</td>
</tr>
<tr>
<td>MS</td>
<td>mottled sculpin</td>
</tr>
<tr>
<td>X</td>
<td>no fish found</td>
</tr>
<tr>
<td>SNF</td>
<td>sunfish</td>
</tr>
<tr>
<td>SF</td>
<td>salmonid fry (age 0+)</td>
</tr>
<tr>
<td>SAL</td>
<td>salamander</td>
</tr>
<tr>
<td>TC</td>
<td>tui chub</td>
</tr>
<tr>
<td>TF</td>
<td>trout fry (age 0+)</td>
</tr>
<tr>
<td>TFT</td>
<td>tailed frog tadpole</td>
</tr>
<tr>
<td>UT</td>
<td>unknown trout</td>
</tr>
<tr>
<td>US</td>
<td>unknown salmonid</td>
</tr>
<tr>
<td>YP</td>
<td>yellow perch</td>
</tr>
</tbody>
</table>

If a species is not on the list and a code needs to be invented, an explanation of the code must be given in the note column and on every data form the invented code is used on.

Do not use Fish codes in the Comment Code field (Unit 2 data sheet). Fish codes can be used in the Notes section but should be defined at least once within the survey.

**Count:** Tally of the number of fish grouped by species and size class.

**Note:** Indicate whether length was estimated (E) or measured (M) in comments column. Write measured lengths in all columns as needed. Also indicate pass number when separate passes are made within a single habitat unit (i.e.: E-1 for estimated 1st pass).

**References**


Appendix 6: Amphibian, Mussel, and Crayfish Inventory Protocols

INTRODUCTION

The Aquatic Inventories Project began collecting amphibian information in 2006 and mussel and crayfish information in 2011. The purpose of the amphibian, mussel, and crayfish surveys are to collect occurrence information that is useful in determining the current distribution of these species encountered in western Oregon and lower Columbia River basins.

PRECAUTIONS

MUSSELS: Avoid stepping on or crushing mussel beds when possible. Do not dig or pry live mussels out of the gravel.

CRAYFISH: Use care if handling crayfish. Place them back in same vicinity where they were collected.

AMPHIBIANS: Crews should recognize that amphibians are fragile creatures, and over-handling an individual can harm or kill it. Amphibian skin absorbs lotion, bug spray, perfume and cologne, and other chemicals. Care should be taken to not disturb habitat that is used by amphibians. Poisonous toxins released from some species’ skin can make you sick and in some cases be fatal. Wash your hands thoroughly after handling amphibians.

SURVEY GUIDELINES

MUSSELS: Record observations of mussels within the following bins: 0=No mussels observed, 1=Few mussels observed (1-50), 2=Many mussels observed (51-200) and 3=Dense mussel beds. Record on the REACH form and within the NOTE field of the data form. Collect samples of shells if possible. Place the shells in a plastic Ziploc bag and label with the monitoring area, site ID number, streamname and basin, date, and crew initials. Collect only shells of dead mussels. Although both crew members should be cognizant of the presence of mussels, the person snorkeling will have better opportunities to see mussels embedded within gravel substrate.

CRAYFISH: Record observations of crayfish in the NOTE field of the data form. Do not use the WL (wildlife) code in the COMMENT field. If possible indicate the species observed. Refer to the crayfish handout in your file box to help identify invasive species you may encounter (Ringed, Rusty, and Red Swamp). Take a picture of unknown species.

AMPHIBIANS: The following guide is meant to be a quick look at some of the Western Oregon species that may be encountered during stream habitat surveys. This is not a complete list of Oregon amphibians, and species that aren’t described on the list below may be encountered while on a stream survey. A professional amphibian identification guide should be used in conjunction to this guide. Observations are to be recorded in the NOTE field of either the Estimator or Numerator data sheet (The reach sheet of the Oregon Plan sites has a yes/no box to complete at the end of the survey. Additionally, PDA users should record observations in the Note field and check the box on the Reach form if applicable). Please, if possible, take a picture of the unknown species for later identification.
Amphibian information to be gathered includes

- Species (use these abbreviations for the more common species):
  
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Species Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGS</td>
<td>Pacific giant salamander</td>
</tr>
<tr>
<td>ATF</td>
<td>adult tailed frog</td>
</tr>
<tr>
<td>RSN</td>
<td>rough skin newt</td>
</tr>
<tr>
<td>FRG</td>
<td>frog (species unknown)</td>
</tr>
<tr>
<td>TFT</td>
<td>tailed frog tadpole</td>
</tr>
<tr>
<td>NWS</td>
<td>Northwest salamander</td>
</tr>
<tr>
<td>LTS</td>
<td>long-toed salamander</td>
</tr>
<tr>
<td>RLF</td>
<td>red-legged frog</td>
</tr>
<tr>
<td>YLF</td>
<td>yellow-legged frog</td>
</tr>
<tr>
<td>BF</td>
<td>bull frog</td>
</tr>
</tbody>
</table>

- Substrate under the observed amphibian (log, moss, rock, mud, etc.)

- Activity (breeding, calling, feeding, etc. – if it can be determined)

- Photograph (especially if ID is questionable)

- Time of day (am or pm)

**Salamanders**

**Pacific Giant Salamander** (*Dicamptodon tenebrosus*)

This is a very large, bulky salamander that is common throughout Western Oregon from the Cascades to the coast. It is the largest salamander in the region, and has a broad, thick head, a muscular body and limbs. Juveniles and Non-metamorphosed adults have very bushy gills, usually without visible stalks, and are dark brown in color. The head is usually wider than the body, and they have a laterally compressed tail which starts near the hind limbs. Juveniles and Non-metamorphosed adults can reach 14 inches in length. Metamorphosed adults of this species can also be found near streams, and are often black or gray with striking mottled brassy or coppery patterns that interconnect over the body. Metamorphosed adults can reach 7 ½ inches in length.

Pacific Giant Salamanders are quick and can deliver a very painful bite – handle with care.

**Rough-Skinned Newt** (*Taricha granulosa*)

Adults of this species are extremely common in Western Oregon ponds, streams, and forests from the Cascades through the coast range. Juveniles and adults have a pale yellow eye crossed with a dark bar. Adults are easily identified, as they are dark brown on the backs and sides, and orange to yellow on the underside. Their skin can often appear dry and rough, although the skin of individuals found in water will often appear smooth. This species does not have grooves on the sides of the body. Adults can reach nearly 8 inches in length. Surveyors should take care when handling this species, as they are the most toxic of all Oregon’s amphibians. It is highly recommended to wash your hands after handling this species.

**Western Red-Backed Salamander** (*Plethodon vehiculum*)

This is a small salamander that can be found on the edges of streams through most of the Western Oregon from Coos and Douglas Counties North. They have a long, thin body with short legs. They are dark brown in color with a yellow, green, or red stripe down the back. This stripe is very distinct with sharp edges and extends all the way to the end of the tail. Length up to just over 4 inches.

**Northwestern Salamander** (*Ambystoma gracile*)
Juvenile and Non-metamorphosed adults are abundant in Western Oregon ponds and streams from the cascades through the coast range. Juveniles have gills which protrude from the head on long stalks, and have the appearance of ostrich feathers. Typically black to olive green in color. Metamorphosed adults are typically brown to black and have a fat, robust appearance. Key features include deep grooves along the body, and large glands at the back of the head. Adults can reach 7 ¼ inches in length.

Long-Toed Salamander (*Ambystoma macrodactylum*)

This species is typically found throughout the Willamette Valley, in the coast range North of the Rogue River, throughout the Cascades, and much of Eastern Oregon. They are widespread throughout the state, existing in many different types of habitats. During the course of aquatic habitat surveys, they will be most frequently encountered in shallow to deep ponds and marshy environments. Juveniles of this species develop rapidly, and should metamorphose early in the summer. Adults are black to dark gray, and often have a mottled dark mustard colored stripe down the back. The defining characteristic is the presence of a long fourth toe on each hind foot. Adults can reach 6 ¼ inches in length.

Dunn’s Salamander (*Plethodon dunni*)

A small salamander often identified because it actively runs to escape human contact and can be found throughout Western Oregon, often right along the sides of streams but rarely in the water. They have a long, thin body with short legs. They are dark brown in color with a yellow to green stripe down the back. This stripe does not extend all the way to the end of the tail, and is ragged on the sides. The speckles of the color of the stripe can typically be seen on the sides of these individuals. Length up to 6 inches.

Frogs and Toads

Tailed Frogs (*Ascaphus truei*)

This frog lives in cool, fast moving streams in the Cascades and Coast Range of Oregon. Tadpoles of this species have a mouth that allows it to cling to rocks in fast moving water. Tadpoles can be observed clinging to rocks in riffles and rapids. Adults are small with long legs, flat hind toes and a large head. Individuals are typically mottled tan or brown, with a tan triangle on the head between the eyes and the end of the snout. The eye has a vertical pupil. Their skin can often be grainy. Males have a short, wide tail. Adults can be up to 2 inches in length.

Western Toad (*Bufo boreas*)

This species can be found in ponds, marshes, and along the edges of streams throughout Oregon except within the Willamette Valley and the coast range, although they can be found along the coast. This toad is large and robust. Color can vary and ranges from cream to brown, and typically covered in darker blotches. There is almost always a light colored, thin stripe down the back. The skin is bumpy and often dry. Adults can be up to 5 inches in length.

Pacific Treefrog (*Pseudacris regilla*)
This frog is very common and abundant throughout Oregon. Adults are small. The key characteristic for this species is toe pads on the ends of the toes. This species is wildly variable in color, but will often be observed as green, gray, or tan with darker mottling on the sides and back. They have a dark stripe or mask which extends from the tip of the snout through the eye and to the shoulder. Adults are typically under 2 inches in length.

**Cascades Frog (Rana cascadae)**

This frog is limited to the Cascade range, and is typically found in and around streams, marshes and ponds above 2000 feet in elevation. They are typically honey to olive green colored, and have sharp edged black spots on their backs. They have two folds that extend from the eyes towards the tail, which are usually raised and lighter in color. The groin area is usually a solid color without mottling. Adults are typically around 3 inches in length.

**Red-Legged Frog (Rana aurora)**

This frog is common in streams, ponds, and marshes west of the Cascades. They are green to brown or reddish-brown and sometimes have black spots or mottling over their back. The undersides of the legs of these frogs are red, and this color can often continue over the belly. The groin at the hind leg is mottled with cream and black blotches. Adults range from 2 ¾ inches up to 4 inches in length.

**Foothill Yellow-Legged Frog (Rana boylii)**

This frog is found in and along streams and rivers along the west slope of the Cascades from the Santiam basin south, and throughout the south coast. These frogs prefer low gradient streams with bedrock or gravel substrates. They are typically olive, gray or brown in color and their skin appears rough. The undersides of the hind legs are often yellow, but sometimes cream colored. The throat usually has darker mottling. Adults can reach up to 3 inches in length.

**American Bullfrog (Rana catesbeiana)**

This is an introduced species that has found its way all over western Oregon. They are large light to dark olive green frogs with darker spots and blotches. They have large, golden colored eyes, and a ridge that extends behind the eye, over the eardrum, and down to the throat. Their eardrums are distinct and at least as large as their eyes, but can be larger in males. The undersides are cream colored with dark mottling.
NOTES:
IDENTIFICATION CHART

Juvenile trout and Dolly Varden

Note: You may encounter juvenile mountain whitefish in some mainland rivers, especially those that penetrate the coastal mountains to interior regions. Juvenile mountain whitefish have an adipose fin and parr marks; however, their bodies are more slender and pencil-shaped than trout or char. The mouth of a juvenile whitefish is positioned lower down on the jaw and is smaller than that of trout or char. Juvenile mountain whitefish have fewer and thus larger scales than trout or char. Whitefish have 70–90 oblique rows of scales across the lateral line, compared to 100 or more rows on trout or char.

Atlantic

1. Red dots on lateral line on larger fish.
2. Adipose fin not orange.

Dolly Varden or Bull Trout

1. No black spots on back or sides.
2. Width of parr marks on lateral line greater than light areas.

Brown Trout

1. Adipose fin orange.
2. Small black spots above and below lateral line.
3. 9–12 parr marks, greater than diameter of eye.
4. Orange spots, if present, one close to lateral line.

Cutthroat

1. Caudal fin melanophores tend to form in lines along fin rays in fish < 50 mm.
2. Mid-dorsal parr-like marks usually absent.
3. White tip of dorsal covers 3 or fewer ray interspaces.
4. Maxillary reaches past posterior margin of eye (does not separate in trout less than 8 cm).
5. Hymn teeth present.

Steelhead/Rainbow

1. Caudal fin melanophores are evenly distributed in fish < 50 mm.
2. Fish > 50 mm, median dorsal parr marks usually present.
4. Hymn teeth absent.
IDENTIFICATION CHART

Five species of juvenile Pacific salmon

1. Bright silvery colour.
2. Going to sea usually at < 40 mm.

PINK

CHUM

SOCKEYE

COHO

CHINOOK

1. Size in fresh water usually < 50 mm.
2. Fish < 50 mm have mottled green back and silvery sides.
3. Parr marks faint or absent below lateral line.
4. Light crescents between parr marks on lateral line, < 2x parr mark width on average.
5. 19–26 gill rakers on first arch. Gill rakers stubby, about half the length of gill filaments.

1. Size in fresh water to 100 mm.
2. Some parr marks, about half above and half below lateral line.
3. Light crescent between parr marks on lateral line, about 2x average width of parr marks.
4. 30–39 gill rakers on first arch, gill rakers long and slender, = to or > length of gill filaments.

1. Leading edge of anal fin longer than base.
2. Orange hue, particularly on adipose, anal and caudal fins.
3. 13–14 branchiostegals.

1. Leading edge of anal fin < the length of base.
2. 16–18 branchiostegals.