Oregon Streamflow Duration Assessment Method

Interim Version – March 2009

U.S. Environmental Protection Agency, Oregon Operations Office Region 10, and Office of Wetlands, Oceans and Watersheds

U.S. Army Corps of Engineers, Portland District

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PURPOSE

The purpose of this manual and accompanying field assessment form is to guide natural resource professionals in the identification of the geomorphic, hydrological and biological indicators of stream flow to help distinguish between ephemeral, intermittent and perennial streams. Section 1 contains an introduction to the method, including definitions of key terms, method development, scoring, sources of variability, and suggested field equipment. Section 2 describes the indicators assessed by the method and provides guidance for scoring. Section 3 discusses drawing conclusions based on the assessed indicators of flow.

This method and assessment form can be used to distinguish between perennial, intermittent, and ephemeral streams, but is primarily designed to distinguish ephemeral streams from intermittent and perennial streams in a single site visit. This method is an assessment tool for natural resource professionals and should support, but not replace, best professional judgment.

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Photographs were provided by the following contributors: Rob Coulombe, Lindsey Webb, Blake Hatteberg, and Shawn Majors (Dynamac Corporation), Jim Wigington and Ken Fritz (EPA ORD), Jess Jordan and Peter Ryan (ODSL), and Dana Eckard (Bureau of Land Management). Figures are credited in the document following the title with full citation information in Appendix A.

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Section 1: Introduction

A stream* can be described as a channel containing flowing surface water including:

- *Stormflow* – increased stream flow resulting from the relatively rapid runoff of precipitation from the land as interflow (rapid, unsaturated, subsurface flow), overland flow, or saturated flow from surface water tables close to the stream, or;
- *Baseflow* – flow resulting from ground water entering the stream or sustained melt water from glaciers and snowmelt (observed during long gaps between rainfall events), or;
- A combination of both stormflow and baseflow, and;
- Contributions of discharge from upstream tributaries as stormflow or baseflow, if present. ***Note:** For the purposes of this method the descriptor 'stream' is attached to the channel, and applies regardless of whether flow dries up seasonally or otherwise.

As a stream flows from its origin, water may be derived primarily from stormflow, baseflow, or some combination of the two. Streams typically continue to accumulate water from stormflow, baseflow and other tributaries as they flow downstream. As streams accumulate flow they commonly transition along a gradient from ephemeral to intermittent and perennial; but sometimes quickly transition from ephemeral to perennial in high gradient systems, or transition from perennial to ephemeral to total cessation of flow on the surface. Often these changes are gradual and may not be obvious to the casual observer. There are, however, several indicators of stream flow that collectively can be used to characterize the flow duration of a stream along a particular reach as ephemeral, intermittent or perennial. In this manual duration is used to encompass the concept of the cumulative time period of flow in a year, which may vary interannually with climate, groundwater withdrawal or streamflow diversion, and other patterns. This manual describes these indicators and presents a method for assessing and drawing conclusions from these indicators in the state of Oregon.

Stream systems can be characterized by interactions among hydrologic, geomorphic (physical) and biological processes. Variations in these attributes along the length of a stream are used as indicators of the dominant processes related to flow duration (Figure 1). To identify the indicators and distinguish ephemeral streams from intermittent streams or intermittent streams from perennial streams using the information presented in this manual, the field evaluator should have experience making geomorphic, hydrologic and biologic observations in streams.

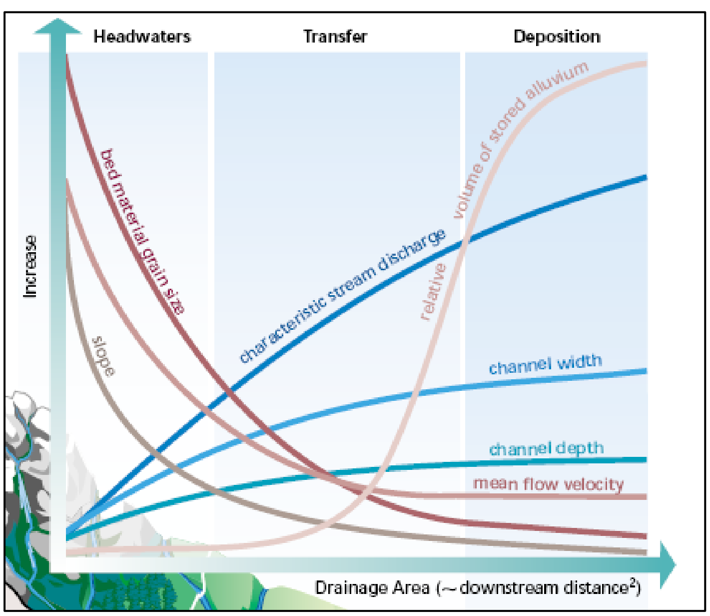

Figure 1. Hydrologic and geomorphic characteristics in relation to drainage area (FISRWG 1998).

This method and assessment form are designed to help the USACE Portland District Regulatory Program and EPA Region 10, and Oregon Department of State Lands distinguish between ephemeral, intermittent and perennial streams. This method is designed to be used throughout Oregon; however, the climatic and hydro-geomorphic variation across Oregon requires that local conditions and the potential strength of an indicator be considered when assessing indicator strength. For example, the arid regions of eastern Oregon will not produce thick wrack lines as will the deciduous forests of western Oregon in fall, but both systems can produce "strong" wrack lines. In addition, one indicator - presence of a clear riparian vegetated corridor - is used only in arid regions of Oregon (defined for this method as those areas that occur within the Arid West Region described in the Regional Supplement to the 1987 USACE Wetland Delineation Manual). Another indicator, presence of a lichen line on stream bed rocks or on the bank, is used only in arid regions and alpine areas.

Background

This method has been developed, in part, based on the experiences and progress of the North Carolina Division of Water Quality on their *Identification Methods for the Origins of Intermittent and Perennial Streams.*[1] The North Carolina Stream Identification Method (NC Method) was developed and tested based on documented scientific principles in hydrology, geomorphology and biology. Version 1 of the method was implemented in 1998 after extensive review from the academic and regulatory community. Since 1998, several major revisions have been made as experience and science advanced. The NC Method is viewed as an evolving document, and will continue to change over time. Since the NC Method is a regulatory tool used to guide rapid assessment of intermittent and perennial streams, it is used as a guide *only* and does not replace best professional judgment. As a regulatory tool, the NC Method facilitates consistent stream identification across many scientific disciplines, and evaluators must be certified by passing a state-legislated four-day training course.

Starting from that base, experts in relevant academic and professional fields have been consulted in the development of the Oregon Streamflow Duration Assessment Method (Oregon Method). A team of experts from the USACE Portland District, USEPA Region 10 Oregon Operations Office and Office of Research and Development, USGS Idaho and Arizona Water Science Centers, Oregon Department of State Lands, and North Carolina Division of Water Quality conducted a one week field assessment of the method in the five major physiographic and climatic regions of Oregon. The field assessment compared the Oregon Method to known flow durations for headwater streams in the Coast Range, Willamette Valley Lowlands, Cascades Range, Great Basin, and the High Desert Plateau. In addition, several other efforts have informed selection of appropriate indicators, identification of potential problems in the field, and development of meaningful indicator descriptions and scoring, including: review of the scientific literature; beta-testing by the USACE Portland District, USEPA Oregon Operations Office, and Oregon Department of State Lands; development of a Xerces Society report "Using Aquatic Macroinvertebrates as Indicators of Streamflow Duration;" external peer-review; and results of the first phase of a USEPA field verification study of the OR Method including more than 170 streams from both sides of the Cascade Range. This interim version of the streamflow duration assessment method will be used, evaluated, and refined as experience and scientific understanding advances.

Application of this method requires that users receive training in the identification and rating of these indicators to ensure accuracy and consistency in results.

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[1] http://h2o.enr.state.nc.us/ncwetlands/documents/NC_Stream_ID_Manual.pdf

Definitions

As used by this method:

Channel forming flow is the discharge that maintains the channel form and transports the greatest quantity of sediment over time (commonly referred to as bankfull flow). For streams with active floodplains, the channel forming flow can be defined as the point at which the flow just begins to enter the floodplain. Thus there are a variety of indicators that can be used to identify this point. For example, on some streams without active floodplains the distance between the lower limit of rooted terrestrial vegetation on each bank can be used (Dunne & Leopold, 1978).

Channel is an area that contains flowing water (continuously or not) that is confined by banks and a bed.

> Dry Channel is an area confined by banks and a bed that at times contains flowing water, but at the time of assessment does not contain flowing water (it may contain disconnected pools with no sign of connecting flow).
>
> Wet Channel is an area confined by banks and a bed that contains flowing water at the time of assessment (flow may be interstitial).

Ephemeral Stream flows only in direct response to precipitation. Water typically flows only during and shortly after large precipitation events.,. An ephemeral stream may or may not have a well-defined channel, the stream bed is always above the water table, and stormwater runoff is the primary source of water. An ephemeral stream typically lacks biological, hydrological, and physical characteristics commonly associated with the continuous or intermittent conveyance of water.

Groundwater occurs at the subsurface under saturated conditions and contains water that is free to move under the influence of gravity, often horizontally to stream channels when a confining layer blocks downward percolation.

Hyporheic Zone is the zone under and adjacent to the channel where stream water infiltrates, mixes with local and/or regional groundwater, and returns to the stream. The dimensions of the hyporheic zone are controlled by the distribution and characteristics of alluvial deposits and by hydraulic gradients between streams and local groundwater. It may be up to two to three feet deep in small streams, and is the site of both biological and chemical activity associated with stream function.

Intermittent Stream is a channel that contains water for only part of the year, typically during winter and spring when the stream bed may be below the water table and/or when snowmelt from surrounding uplands provides sustained flow. The channel may or may not be well-defined. The flow may vary greatly with stormwater runoff. An intermittent stream may lack the biological and hydrological characteristics commonly associated with the continuous conveyance of water.

Normal Precipitation is defined as the 30-year average, provided by NOAA National Climatic Data Center, computed at the end of each decade. These data are available as annual and monthly means.

Perennial Stream contains water continuously during a year of normal rainfall, often with the stream bed located below the water table for most of the year. Groundwater supplies the baseflow for perennial streams, but flow is also supplemented by stormwater runoff and snowmelt. A perennial stream exhibits the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water.

Stream Origin is the point where flow first appears on the land surface with enough force to disturb the substrate creating a lasting sign of flow. Stream origins are often wetlands, springs, seeps or headcuts.

Swales can be wetlands or uplands (when assessed under the USACE 1987 Wetlands Delineation Manual or appropriate regional supplements) and primarily serve as a vegetated flow path occurring in a slight depression in the landscape but lacking differentiation between bed and bank. Swales often connect uplands to wetlands or streams, connect wetlands together, or connect upstream and downstream reaches of small streams that flow through a colluvial fan or an abrupt change in grade.

Thalweg is the deepest part of a stream channel and the last part of the stream to contain flowing water as a stream dries up. As used in this method, the thalweg comprises the "lowest flow" pathway and typically spans approximately 5 to 20% of the channel width.

Water Table is the surface elevation of the saturated zone below which all interconnected voids are filled with water and at which the pressure is atmospheric, commonly identified as the top of the local (i.e., floodplain) or regional groundwater aquifer.

Considerations When Using the Method

Spatial Variability

Spatial variations in stream indicators occur within and among stream systems. Sources of variation between stream systems in Oregon are due primarily to physiographic province (geology and soils) and climate (seasonal patterns of precipitation and evapotranspiration). For example, riffles and pools result from in-channel structures and these structures can vary between rocks and boulders in the mountains and roots and wood debris in the alluvial valleys. The method was designed to apply to all stream systems within the diverse physiographic and climatic regions of Oregon.

A substantial amount of variability can also occur along the length of a given stream system. Common sources of variation within a stream system include:

- Longitudinal changes in stream indicators related to increasing duration and volume of flow. As streams gain or lose streamflow, the strength of indicators changes.
- Longitudinal changes due to variables such as channel gradient and valley width, which affect physical processes and thus directly or indirectly affect many indicators.
- Temporal variation of flow related to precipitation and evapotranspiration seasonality. For instance, in western Oregon the strong seasonal rainfall pattern - several months of wet weather followed by several months of dry weather - supports the establishment of intermittent streams. Due to these long periods of rain many of the intermittent streams in Oregon carry 80 - 90 percent of the yearly discharge associated with a perennial stream of the same size. This large yearly discharge results in very strong geomorphological development of the stream channel relative to the flow duration when compared with intermittent streams in other parts of the country.

The Concept of Scale

For the purposes of applying this method perhaps the most important type of variation between streams, however, is simply the size of the stream. Streams develop different channel dimensions due to differences in flow magnitude, landscape position, land use history, and other factors. **When assessing a stream, it is of paramount importance to consider scale when determining the strength of indicators.** For instance, depositional features or channel structures of a given size may be insignificant (i.e., “weak”) in a large stream, while features of the same size in a small stream may be a clear expression of physical processes and thus merit a score of “strong.” Section 2 provides specific guidance for considering the scale of features when assessing individual indicators; some indicators are scale-independent, in which case no additional commentary on scale is provided.

Reach Selection

This manual lays out a method for assessing geomorphic, hydrologic, and biologic indicators of stream flow duration. However, flow characteristics often vary along the length of a stream, resulting in gradual transitions in flow duration. Recognizing that in many streams flow duration exists on a continuum, choosing the reach on which to conduct an assessment can influence the resulting conclusion about flow duration.

Assessments should be made for a representative reach, rather than at one point of a stream. **A representative reach for stream assessments is equivalent to 35 - 40 channel widths of the stream.** For narrow streams, the length of the assessment reach should be a minimum of 30 meters.

Assessments should begin by first walking up and down the channel, from the stream origin to the downstream confluence with a larger stream (to the extent feasible). This initial review of the site allows the evaluator to examine the overall form of the channel, landscape, and parent material, and variation within these attributes as the channel develops or disappears upstream and downstream. Walking the channel also allows the assessor to observe characteristics of the watershed such as land use and sources of flow (e.g. stormwater pipes, springs, seeps, and upstream tributaries). Once these observations are made, the assessor can identify the areas along the stream channel where these various sources (stormflow, tributaries or groundwater) or sinks (alluvial fans, abrupt change in bed slope, etc.) of water may cause abrupt changes in flow duration. Similarly, the assessor can identify if the stream segment in question is generally uniform or should be assessed as two or more distinct reaches.

For regulatory purposes the reach in question will often be predetermined by property ownership or proposed activities; the above process for assessing the stream should be followed to the extent possible, and if the reach in question is generally uniform one assessment is appropriate. If the reach in question is not uniform, two or more assessments are recommended to fully describe the changes along the reach. Regardless of the number of reaches assessed, decisions should be made in conjunction with “best professional judgment” to reach a conclusion on flow duration as ephemeral, intermittent, or perennial.

Recent Precipitation

The rate and duration of flow in stream channels is influenced by climate and by recent weather. **Recent (within 48 hours) rainfall can influence scoring; therefore it is *strongly* recommended that field evaluations be conducted at least 48 hours after the last significant rainfall.**

However, note that this assessment method has been designed with redundancy to allow for reasonably accurate ratings even after a recent rainfall. Evaluators should note recent rainfall events on the assessment form and take them into consideration when drawing conclusions and assessing the applicability of individual indicators.

Ditches and Modified Natural Streams

This method can be used, in combination with best professional judgment, to assess the flow duration of natural streams, modified natural streams, and ditches dug in wetlands or uplands.

When assessing a reach that is a ditch or modified natural stream, it is important to walk the entire reach and locate the inflow point or origin as well as the downstream terminus of flow (most often a confluence with another channel). Similarly, any disturbance or modifications to the stream channel should be noted on the assessment form – especially if it means one or more indicators are not applicable (Figure 2). For highly modified streams, and many ditches, it may be necessary to use an alternative method to identify flow duration based on the presence of one or two key indicators that were not affected by the modifications; it may also be appropriate to visit the site multiple times or conduct hydrologic monitoring. **For all assessments, disturbances or modifications to the stream or its catchment that may affect the presence and/or strength of the stream indicators should be noted.**

Figure 2. Example of a modified stream. Several indicators are apparent in this reach, but assessor should note the strength of indicators in upstream or downstream segments that are not directly affected by the road. Such field notes will more fully describe the site and may be useful in determining flow duration.

Disturbed or Altered Streams

Assessors should be alert for natural or human-induced disturbances that affect streamflow duration and/or the strength of indicators. Streamflow duration can be directly affected by flow diversions, urbanization and stormwater management, septic inflows, agricultural and irrigation practices, vegetation management, or other activities. The strength of indicators can be affected by changes in streamflow, and can also be affected by disturbances that may not substantially affect streamflow (for instance, a channel could be graded, thus removing many indicators even without changing the flow duration; other examples include grazing, logging, recent fire, beaver activity, riparian management, culvert installation, bank stabilization). **Such disturbances should be described in the "Notes" section of the field assessment form.** Similarly, natural sources of variation should also be noted such as fractured bedrock, volcanic parent material, recent or large relic colluvial activity (landslides or debris flows), and drought or unusually high precipitation.

Conducting Field Assessments and Completing the Assessment Form

Suggested Field Equipment

- This guidebook.
- Amphibian and macroinvertebrate field guides: (e.g. *Amphibians of Oregon, Washington and British Columbia*, Corkran and Thomas, 1996, Lone Pine Publishing, Redmond, WA; *Macroinvertebrates of the Pacific Northwest*, Adams and Vaughan, 2003, The Xerces Society, Portland, OR)
- Plant identification guide and current wetland indicator status list [2]
- Global Positioning System (GPS) – used to identify the boundaries of the reach assessed.
- Camera – used to photograph and document site features.
- Clinometer – used to measure channel slope.[3]
- Tape measure
- Calculator
- Kicknet or small net and tray – used to sample aquatic insects and amphibians.
- Hand lens
- Munsell Soil Color Chart – used to classify the color of various soils and distinguish redoximorphic features.
- Polarized sun glasses – for eliminating surface glare when looking for fish, amphibians, and macroinvertebrates.
- Soil auger and/or soil probe – used to examine soils in the toe of the bank and determine if the hyporheic zone is saturated.
- Rock hammer or equivalent – useful for digging into the hyporheic zone.

General Guidance for Completing the Field Assessment Form

The Oregon Streamflow Duration Assessment Method relies upon the assessment of up to 21 indicators of flow duration and on the assessor's understanding of the site. As described in the

[2] The 1988 plant list and 1993 Region 9 supplement are the currently applicable lists for use in Oregon.
[3] Channel slope can also be determined from topographic maps or surveys.

Ditches and Modified Natural Streams section above, modifications to the site or areas upstream of the site may affect the presence or strength of the indicators. Similarly, natural variation such as interannual variation in precipitation can affect the year to year depth to groundwater, stream discharge, and the presence of the indicators used in this method. **Therefore, it is important to accurately complete the field assessment form, including information for date, project, evaluator, waterway name and location, recent precipitation, observed hydrologic status, and channel gradient and width.** Furthermore, the evaluator should indicate whether she has participated in a classroom "orientation" to the method, a field-based training class, or both.

If the stream does not have defined a channel (i.e., bed and banks are not apparent), estimate the width of the flow path and describe in the "Notes" section. Any other relevant observations should also be recorded in the "Notes" section of the form. These may include the local geology, runoff rates, hydrologic unit codes, evidence of stream modifications or hydrologic alterations upstream of the assessment area (e.g. dams, diversions, stormwater discharge), and recent land clearing activities upstream. All pertinent observations should be recorded on the form, including a clear and repeatable way of identifying the boundaries of the reach being assessed and the reasons for choosing those boundaries.

Scoring

Identification of stream type is accomplished by evaluating up to 21 different indicators of streamflow duration and assigning a score to each. The scoring sheet is used to tally the scores for each indicator and determine the total numeric score for the stream. The total score reflects the persistence of flow, with higher scores indicating intermittent and perennial streams. Thresholds for total scores separate perennial, intermittent and ephemeral streams, but local conditions including disturbances and modifications made to the stream should be taken into account when using best professional judgment to reach a flow duration conclusion for a stream. If a quick or comprehensive assessment leads to an overall score within a point or two of the threshold for flow duration category, the assessor should carefully review the indicators and the potential disturbances and modifications made to the stream before reaching a final conclusion on flow duration category, carefully documenting rationale for the conclusion on the assessment form or supporting documents.

A four-tiered scheme is used for scoring each indicator or attribute while accounting for the variability of streams. The scores, "Absent", "Weak", "Moderate", and "Strong" are applied to sets of geomorphic, hydrologic and biological indicators.[4] Each score reflects the evaluator's judgment of the average degree of an indicator's development along the stream reach being evaluated.

The range of scores is intended to allow the evaluator flexibility in assessing indicators that exist along a continuum, instead of relying simply on presence/absence of an attribute. The small increments in scoring between gradations also will help reduce the range in scores between different evaluators.

It is important to note that "Moderate" scores are intended as an approximate qualitative midpoint between the two extremes of "Absent" and "Strong." The remaining description, "Weak", represents gradations between "Absent" and "Moderate" that will often be observed in the field.

[4] The scoring system includes both primary and secondary indicators: the secondary indicators are weighted less than the primary indicators.

Natural disturbances such as recent landslides and wildfires could mask the presence of some indicators. Similarly, human modifications to streams, such as toxic pollution or cement lined channels, could also preclude some indicators from forming. **These situations should be explained in the "Notes" section of the assessment form.**

General definitions of "strong", "moderate", "weak", and "absent" are provided in Table 1. These definitions are intended as overall guidelines. **The evaluator must select the most appropriate score for each indicator based primarily upon specific guidance (see Section 2) and secondarily upon experience and professional judgment, observations of the stream, and characteristics of the watershed and physiographic region.**[5]

Scoring of the indicators is based on observations and should not include predictions of what could or should be present. Disturbances and modifications to the stream should be described in the notes section of the assessment form and taken into consideration when drawing conclusions from the information collected. It is also important to explain the rationale behind conclusions reached, and when necessary that rationale should be supported with photos and other documentation of the reach condition and any disturbances or modifications that were taken into consideration.

Table 1. General Guide to Scoring Categories

Category	Description
Absent	The indicator is not observed
Weak	The indicator is present but not common
Moderate	The indicator is common but not ubiquitous
Strong	The indicator is present throughout the reach

[5] Physiographic region is an important consideration when assessing the presence of certain indicators. For example, assessment of the strength of indicators *10 - Leaf litter / loose debris* and *11 - Debris piles or wrack lines* in the arid eastern half of Oregon should reflect the vegetation present and the potential for accumulation.

Section 2: Indicators of Streamflow Duration

A. Geomorphic Indicators

1. Continuous Bed and Bank.

Throughout the length of the stream reach, is the channel clearly defined by having a discernable bank and streambed? (Figures 3, 4, 5, and 6)

The bed of a stream is the physical confine of the baseflow; it often also confines stormflow, but it will always confine the baseflow. The lateral constraints (channel margins) during all but flood stage are known as the stream banks. In fact, a flood occurs when a stream overflows its banks and partly or completely fills its flood plain.

As a general rule, the bed is that part of the channel below the "normal" water line, and the banks are that part above the water line; however, because water flow varies, this differentiation is subject to local interpretation. In perennial and intermittent streams the bed is usually kept clear of terrestrial vegetation, whereas the banks are subjected to water flow only during infrequent high water stages, and therefore can support vegetation much of the time.

This indicator will lessen and may diminish or become fragmented upstream as the stream becomes ephemeral. This feature may also be weak or absent when a stream passes over waterfalls, long stretches of exposed bedrock, or when it enters a water control or conveyance structure – in such cases those confounding factors should be noted on the assessment form, as should the presence of a bed and bank where they had the potential to form (immediately upstream or downstream). Artificially created bed and banks should still be assessed for their presence and degree of confinement along the reach. For heavily incised channels, assess the active channel's bed and banks, not the relic incision.

Note: If the aquatic feature does not have a bed and banks it may be more appropriate to consider the feature as a swale or a wetland (if it meets hydrology, soils, and vegetation criteria).

***Strong* –** There is a continuous bed and bank present throughout the length of the stream reach.

***Moderate* –** The majority of the stream has a continuous bed and bank. However, there are obvious interruptions.

***Weak* –** The majority of the stream has obvious interruptions in the continuity of bed and bank. However, there is still some representation of the bed and bank sequence.

***Absent* –** There is little or no ability to distinguish between the bed and bank.

Figure 3. “Weak” discontinuous bed and bank (western Cascades, channel width 0.7 m)

Figure 4. “Weak” poorly defined bed and bank (Blue Mountains, flow path width 0.5 m)

Figure 5. “Moderate” bed and bank (Blue Mountains, channel width 0.7 m)

Figure 6. “Strong” bed and bank (western Cascades, channel width 0.6 m)

2. In-channel Structure – Coherent, Organized Sequences

Is there a regular sequence of coherent, organized fluvial erosion/deposition structural features in the channel indicative of recurring high flows? (Figures 7, 8, 9, and 10)

A repeating sequence of riffle/pool (riffle/run in lower-gradient streams, riffle/pool in sand bed streams, or step/pool in higher gradient streams) can be readily observed in many but not all perennial streams. This morphological feature is almost always present to some degree in higher gradient mountain streams. Riffle-run (or ripple-run) sequences in low gradient streams are often created by in-channel woody structure such as roots and woody debris. When present, these characteristics can be observed even in a dry stream bed or in small streams by closely examining the local profile of the channel. Streams with particularly course beds may lack in-channel structure.

A riffle is a zone with relatively high channel gradient, shallow water, and turbulence. In smaller streams, areas of a distinct change in gradient where flowing water can be observed are often identified as riffles. The substrate material in riffles contains the largest sediment particles that are moved by bankfull flow (bedload). A pool is a zone with relatively low channel gradient, deep water, and low turbulence during low flow periods. Fine textured sediments may dominate the substrate material in pools where a fine sediment supply exists. Along the stream reach, take notice of the spacing and frequency of the riffles and pools or other types of in-stream structures. This feature may also be absent or not well defined when a stream passes over long stretches of exposed bedrock, or when it enters a water control or conveyance structure. In such cases those confounding factors should be noted, as should the presence of an in-stream structure where it had the potential to form (i.e. immediately upstream or downstream).

***Strong* –** Stream has a coherent and organized sequence of fluvial erosion/deposition structural features along the entire reach. There is an obvious transition between structural features.

***Moderate* –** Stream has a sequence of fluvial erosion/deposition structural features along the reach but distinguishing between the features is difficult or they do not occur over the entire reach.

***Weak* –** Stream has some fluvial erosion/deposition structural features but not a coherent sequence, mostly one structural form.

***Absent* –** There are no fluvial erosion/deposition structural features in the stream.

3. Soil Texture or Stream Substrate Sorting

Has channel downcutting penetrated through the soil profile, such that the texture of the stream substrate different (i.e. much coarser) than that of the soil in the adjacent floodplain? Is there evidence of sorting of the stream substrate materials, indicative of frequent high flows? (Figures 11, 12, 13, and 14)

This feature can be examined in two ways. The first is to determine if the soil texture in the bed of the stream channel is similar to the soil texture outside the channel. If the soil texture is similar, then there is evidence that erosive forces have not been active enough to down cut through the soil profile as expected in an intermittent or perennial stream. Soils in the bed of ephemeral channels typically have the same or similar texture as the soils adjacent to the channel (Figure 11). Accelerated stormflow resulting from development, for example, may produce deep, well-developed ephemeral or intermittent channels but which have little or no coarse bottom materials indicative of upstream erosion and downstream transport (i.e., alluvium). The substrate of intermittent or perennial streams often has accumulations of coarse sediment,

Figure 7. "Weak" geomorphic sequences; channel is dominated by a single structural form (Blue Mountains, channel width 2.6 m)

Figure 8. "Weak" development of riffle/pool structure (Crooked River basin, channel width 1.7 m)

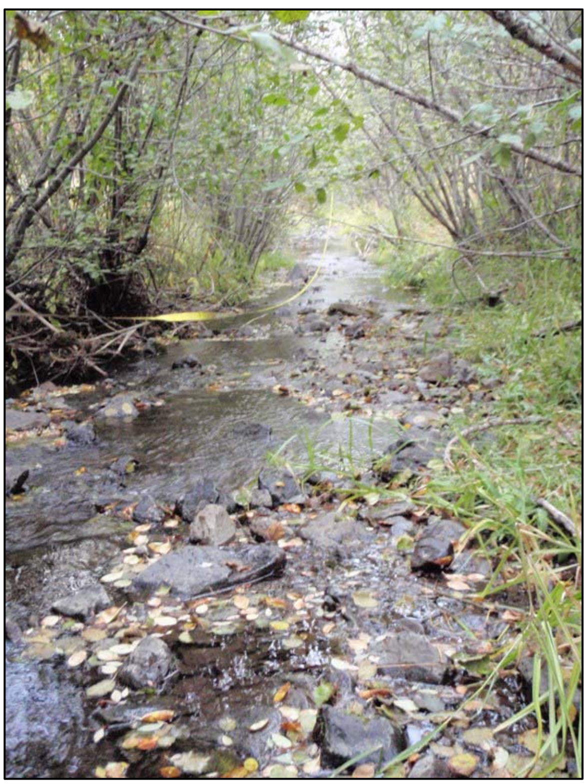

Figure 9. "Moderate" frequency of riffle/run sequences (Blue Mountains, channel width 2.2 m)

Figure 10. "Strong" set of step-pool sequences (foothills of western Cascades; channel width 2.0 m)

either from deposition or winnowing away of fines leaving behind the coarse sediments. Bedrock streams may lack any sediment on the bed for significant reaches.

The second way this feature can be examined is to look at the distribution of sediment in the substrate in the stream channel. Is there an even distribution of various sized particles throughout the reach, or is the sediment sorted into discrete patches of different grain sizes (Table 2; Figures 12 and 14)? In the arid area of eastern Oregon one may need to look for size variations among sand grains – for instance, coarse versus fine sand. The occurrence of depositional features may be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit larger depositional features, with cobble/gravel/boulders being localized in riffles and runs, and may have accumulations of fine sediments settling out in slow water areas.

Notes: The usefulness of this attribute may vary among physiographic provinces. For instance, in parts of eastern Oregon dominated by fine-textured parent materials (such as volcanic ash) the variability in the size of soil particles may be less than in the mountains and valleys. Assessors should also note if the deposits are potentially colluvial (i.e. from rock slides and other terrestrial movements outside of stream flows) and therefore not indicative of flow duration.

Table 2. Standard USDA Particle Sizes

	Diameter	
Description	**millimeters**	**inches**
fine sand	0.1-0.25	.004-.01
medium sand	0.25-0.5	.01-.02
coarse/very coarse sand	0.5-2.0	.02-.08
pebbles (gravel)	2-75	.08-3.0
cobbles	75-250	3.0-9.8
stones	250-600	9.8-23.6
boulders	> 600	> 23.6

Strong – There is a well-developed channel through the soil profile with relatively coarse-textured substrate compared to riparian zone soils; for instance, course sand, gravel, or cobbles on the coast or in the valleys; gravel, cobbles, stones, or boulders in the mountain regions. **<u>OR</u>** - There is clear evidence of sediment sorting, soil texture differs between the stream substrate and adjacent land.

Moderate – There is a well-developed channel but it has not incised through the soil profile. Soil texture differs somewhat between the stream substrate and adjacent land. Some coarse sediments are present. **<u>OR</u>** - There is relatively little sorting of fine material from coarser materials.

Weak – The channel is poorly developed through the soil profile. Soil texture differs little between the stream substrate and adjacent land. **<u>OR</u>** - Some coarse sediments are present, but substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (large rocks, etc.).

Absent – The channel is poorly developed, very little to no coarse sediments are present, and substrate sorting is absent. No difference between soil texture in the stream substrate and adjacent land is observed.

Figure 11. Both substrate sorting and soil texture differentiation are “weak” (Willamette Valley, channel width 0.7 m)

Figure 12. “Strong” sorting of particle sizes amongst stream substrate (Willamette Valley, channel width 1.2 m)

Figure 13. “Weak” substrate sorting (Blue Mountains, channel width 0.9 m)

Figure 14. Example of different patches of sorted particles (pine needles are approx. 10 cm long).

4. Erosional Features

Is there evidence of fluvial erosion? Does the channel show evidence of fluvial erosion in the form of undercut banks, scour marks, channel downcutting, or other features of channel incision? (Secondary Indicator) (Figures 15 and 16)

Undercut banks and scour marks are the most common signs of fluvial erosion for streams in a floodplain system. In steeper landscapes, channel downcutting and incision may occur. Other weaker signs of erosion include the scour marks on the downstream side of boulders and other obstructions.

Assess the erosional features within the active channel; relic channel incision that is not part of the active channel should not be assessed. Human modifications to armor or stabilize the bed or banks of the stream (e.g. root wads and riprap) should be considered an indicator of fluvial erosion. Note that bank sloughing is not directly caused by fluvial processes and should not be considered an erosional feature.

Note: Erosion and deposition processes differ between bedrock and alluvial channels. The field assessment form includes a check box to denote if the streambed consists of more than 50% exposed bedrock. This information is used to interpret indicator scores and document best professional judgment.

Strong – Fluvial erosion is obvious throughout the reach, or there are some substantial erosional features present.

Moderate – Fluvial erosion is present throughout most of the reach, or there are some moderate erosional features present.

Weak – Fluvial erosion is infrequent along sampling reach and the features are weak.

Absent – Fluvial erosion is completely lacking.

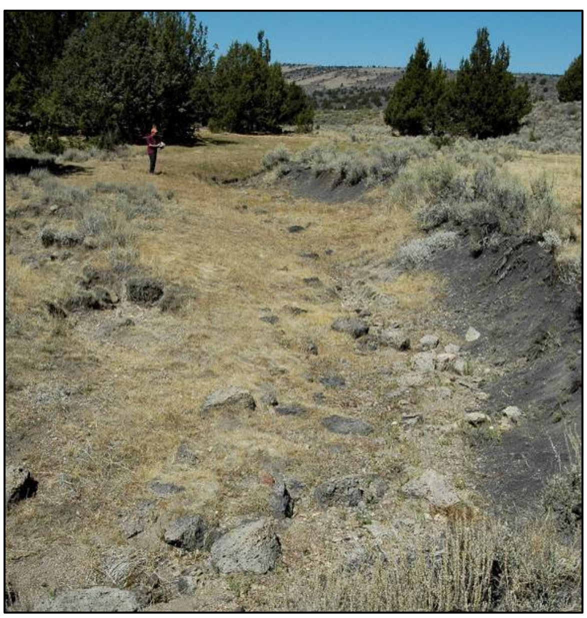

Figure 15. "Weak" lateral erosion is not continuous along length of reach, and banks are relatively stable (Northern Basin and Range, approximate channel width 1.8 m)

Figure 16. "Strong" erosional feature is continuous along length of reach, and bank is actively undercutting (Blue Mountains, channel width 2.4 m)

5. Depositional Features

Are there depositional features such as bars or fresh deposits of alluvial materials in the stream channel or on the floodplain? Is there an active floodplain at the bankfull elevation? (Figures 17, 18, and 19)

When a stream channel conveys perennial flow, the forces of channel scouring and deposition create distinct erosional and depositional features. Alluvium may be deposited as sand, silt, gravel and cobble. There are several different types of depositional features, all of which are assessed with this one indicator and should be scored based on the presence of depositional features along the reach of stream being assessed. Observing depositional feature(s) along only a third of the reach would be weak, but depositional feature(s) along the entire length of the reach would be strong.

Bars are accumulations of sand or silt in a stream channel which may or may not be covered with vegetation. These include point bars, lateral bars and mid-channel bars. The presence of depositional bars suggests that the channel transports sediment and is in or near dynamic equilibrium with the shaping forces of its water/sediment load. Depositional bars also indicate a relatively continuous hydrologic regime.

Floodplains are relatively flat areas that accumulate organic matter and inorganic alluvium deposited during flooding, and are usually located outside of and adjacent to the stream channel. An active floodplain (at current bankfull elevation, such that it is inundated on an approximate 2-year recurrence interval) shows characteristics such as drift lines, sediment deposits on the surface or surrounding plants, or flattening of vegetation. The floodplain of incised streams may be restricted to within the channel itself and the previous floodplain (now a terrace) may be inundated rarely or infrequently. In these instances, look for indicators along the sides and within the incised channel. Floodplains on smaller order, incised streams may not be continuous but rather may be present in some locations and absent in others. In many cases there should be evidence of a floodplain if the stream has perennial flow.

Depositional features are often absent in very small channels. Sometimes there may be depositional features along the side of the channel or on the lee side of obstructions in the channel (e.g. in the hydraulic shadow of logs, boulders, etc.), the tops of which are below bankfull elevation. These features should not score as highly as well-developed bankfull depositional features, but are nonetheless evidence of deposition.

Strong – Depositional features are obvious throughout the reach, or there are some substantial depositional features present.

***Moderate* –** Depositional features are present throughout most of the reach, or there are some moderate depositional features present.

***Weak* –** Depositional features are infrequent along sampling reach, and the features are weak.

***Absent* –** Indications of depositional bar, floodplain connection, or other depositional features are lacking.

Figure 17. Example of depositional feature in small stream (channel width 0.5 m)

Figure 18. Point bar (Willamette Valley, approximate channel width 3 m). Also note seep areas (on right), indicated by oxidized iron.

Figure 19. “Strong” depositional features in a small headwater stream (western Cascades, channel width 0.9 m)

6. Sinuosity

Measure the stream's sinuosity. (Figure 20)

Sinuosity is a measure of a stream's "crookedness." Specifically, it is the total stream length measured along the stream thalweg divided by the straight line valley length (Figure 20). Higher ratios indicate more and/or larger curves in the stream. Sinuosity is related to the gradient, but can also be influenced by parent material and obstructions (natural or otherwise). Typically higher gradient streams are less sinuous than lower gradient streams, and perennial streams are more sinuous than intermittent or ephemeral streams. Sinuosity is the natural result of the stream dissipating the force of its flow.

Note: Sinuosity may not be an applicable indicator for highly modified or managed streams, but even so, sinuosity is sometimes evident in the path of the thalweg in the bottom of a cement lined canal. Any modifications or artificial restrictions on a stream's sinuosity should be noted on the assessment form and taken into consideration when drawing conclusions from the total score for the reach.

Strong – Ratio > 1.2. (i.e., stream has numerous, closely-spaced bends, very few straight sections)

Moderat*e* – 1.1 < Ratio ≤ 1.2. (i.e.., stream is a combination of sinuous and straight sections)

Weak – 1.03 < Ratio ≤ 1.1. (i.e.,., stream has very few bends and mostly straight sections)

Absent – Ratio ≤ 1.03. (i.e., the stream is essentially straight)

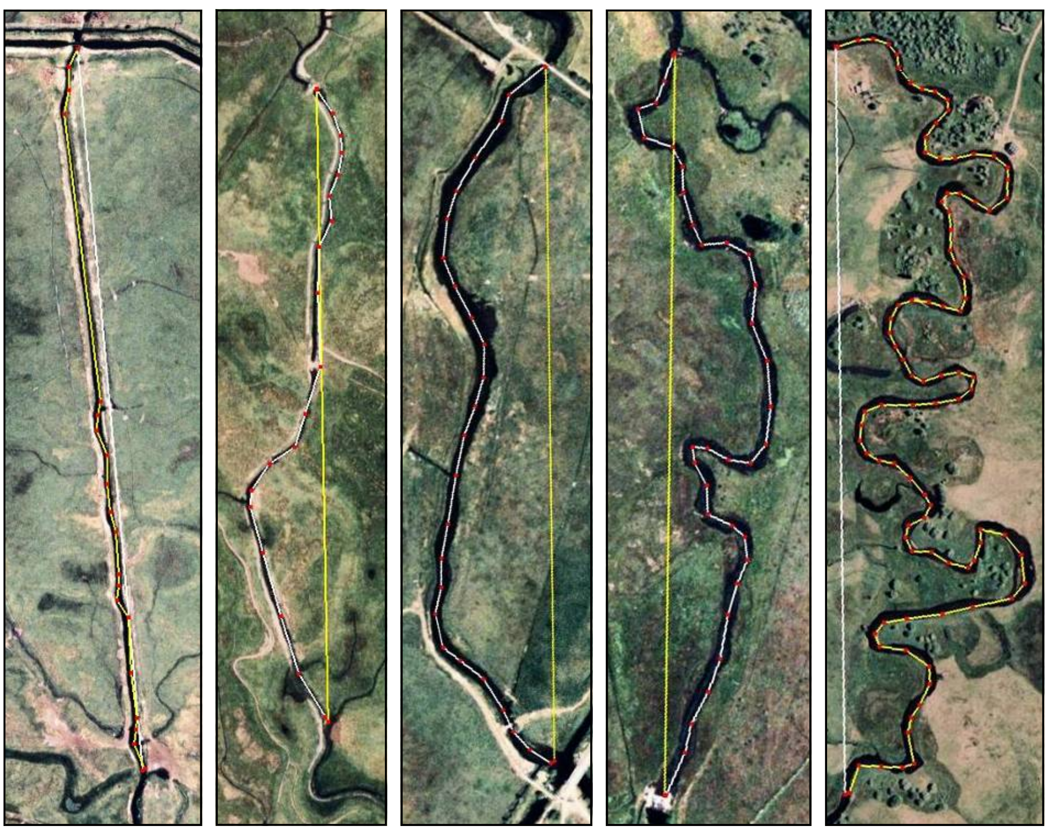

Figure 20. Varying degrees of sinuosity, from left to right: "absent" (sinuosity of 1.01), "weak" (1.07), "moderate" (1.14), "strong" (1.27), and "strong" (2.18) (Upper Klamath Lake basin). (These pictures are used for illustrative purposes; alterations to streams should be noted on the assessment form.)

7. Headcuts And Grade Controls

Is there a headcut at the upstream end of the reach being evaluated? Are there one or more headcuts within the reach being evaluated? Are there grade controls within the reach being evaluated? (Secondary Indicator) (Figures 21, 22, 23, 24, and 25)

A headcut is an active erosion feature expressed as an abrupt vertical drop in the bed of a stream. It often resembles a small intermittent waterfall (or a miniature cliff) and *may* have a deep pool at the base resulting from the turbulent scour produced during high flows. Head cuts are transient structures of the stream and often exhibit relatively rapid upstream movement during periods of high flow. Intermittent or perennial streams sometimes begin at a head cut, particularly common in the drier east side and in the mountains. Groundwater seepage may also be present from the face or base of a headcut.

A grade control is a structural feature in the channel that separates an abrupt change in grade of the stream bed or a point where a headcut has been stopped by an obstruction. Grade controls may consist of bedrock outcrops, large stones or large roots which extend across the channel, or accumulations of large woody debris (Figures 21 and 23). Sediment typically accumulates immediately upstream of grade controls. Pipes and hard bottomed culverts can also serve as grade control – and should be counted when they are functioning as grade control. These structures separate an abrupt change in grade of the stream bed.

The strength of this indicator is based on the number and relative size of the features compared to the channel size and bed slope. Assess these features by comparing the dimensions of the headcut/grade control to the dimensions of the channel, and by determining if the feature affects the direction of the thalweg flow path.

Note: To be considered as "grade control," sediment particles should be larger than the vast majority of other sediment particles in the channel, such that they are not mobilized during channel-forming flows (i.e., boulders may provide grade control in a sand-bed stream, but are unlikely to provide a similar function in a high-energy cobble-bed stream). Structural features comprised of coarse sediment organized fluvially in repeating sequences should be evaluated using Indicator 2 (In-channel Structure).

Strong – One or more large headcuts or grade control features are present within the reach.

Moderate – One or more medium or several small headcuts or grade control features are present within the reach.

Weak – One or two small headcuts or grade control features are present within the reach.

Absent – No headcuts or grade control features are present within the reach.

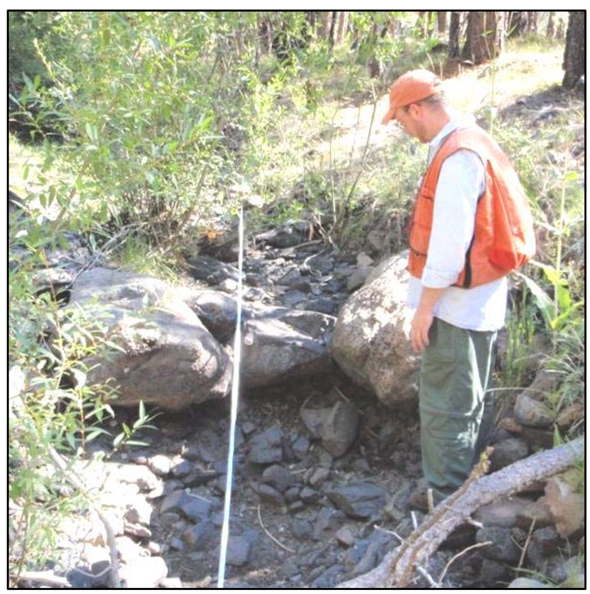

Figure 21. Grade control comprised of very large sediment particles (channel width 2.8 m). This is a medium-sized feature, given the channel dimensions.

Figure 22. Stream channel with headcuts and grade controls “absent” (Blue Mountains, channel width 2.4 m)

Figure 23. Grade control of woody debris and roots (western Cascades, channel width 0.7 m). This is a medium-sized feature, given the channel dimensions.

Figure 24. Headcut, viewed from downstream (Blue Mountains, approximate channel width outside of the scour zone is 0.5 m). This is a large feature, given the channel dimensions.

Figure 25. Headcut, viewed from upstream (Upper Klamath Basin, approximate channel width outside of the scour zone is 0.8 m). This is a medium-sized feature, given the channel dimensions.

B. Hydrologic Indicators

8. Groundwater (Wet Channel) / Hyporheic Saturation (Dry Channel)

Groundwater discharge to a stream indicates longer flow durations and more sustained baseflow between precipitation events. Observing flow in a channel does not conclusively indicate groundwater discharge to the channel within the reach being observed. Similarly, observing a dry stream bed does not conclusively indicate that the channel does not receive groundwater discharge. So separate assessment measures are used for this indicator when the channel is wet, versus when the channel is dry. When assessing this indicator, choose the location along the reach that will be most likely to show the presence of groundwater or hyporheic saturation (e.g., tails of riffles, deep pools). This assessment strategy indicates whether there are groundwater inputs anywhere along the reach, not whether groundwater is entering the stream throughout the entire reach.

<u>When the channel is wet</u>: Are there signs of groundwater discharge to the stream along the reach, or is there a seasonal high water table?

<u>Groundwater Table</u>: the presence of a seasonal high water table or groundwater discharge (i.e. seeps or springs) from the bank indicates a relatively reliable source of baseflow to a stream. The presence of pools or standing water are indicators of the height of the water table. A water table can also be inferred by the presence of wetlands in close proximity to the stream (i.e., within 2 channel widths) above the elevation of the streambed. The height of the water table can also be observed by digging a hole in the adjacent floodplain approximately one channel width away from the streambed (to avoid intercepting bank storage). The presence of water standing in the hole above the elevation of the channel bottom after waiting for at least 30 minutes (longer for clayey soils) indicates the presence of the water table. This hole can be dug with a shovel, auger, or probe. If soil conditions prevent digging an adequately deep hole, assess this indicator as best you can and note the depth of refusal in the “Notes” section.

Strong – Groundwater table higher than stream height is readily observable adjacent to the reach, or pools or standing water are apparent along the reach.

***Moderate* –** Groundwater table present, but nearly equal to the stream height.

Weak – Groundwater table present, but well below the stream height or indicators of groundwater discharge are present, but require considerable time to locate.

Absent – No indication of groundwater table in close proximity to stream bed elevation (within 30 cm of streambed surface).

<u>When the channel is dry</u>: Is the streambed / hyporheic zone saturated?

<u>Hyporheic Saturation</u>: even when there is no visible flow above the channel bed, there may be flow in, or groundwater discharge into, the hyporheic zone (Figure 26).

The hyporheic zone is the site of groundwater discharge to the stream, downstream flow, and biological and chemical activity associated with aquatic functions of the stream. The presence of hyporheic saturation can be assessed by making a hole in the thalweg (where possible) and seeing whether the hole fills with water (similar to the method for observing water table height described above). The hole may be dug with a shovel, but using an auger, probe, or pounding in a steel bar are recommended to minimize disturbance to the channel. If soil conditions prevent digging an adequately deep hole, assess this indicator as best you can and note the depth of refusal in the “Notes” section.

Strong – Hyporheic zone is saturated (i.e., standing water visible in excavated hole) to streambed surface.

Moderate – Hyporheic zone is saturated in close proximity to stream bed elevation (within 10 cm of channel bottom for channels < 1 meter wide; within 20 cm for channels with width between 1 and 5 meters; within 30 cm for channels > 5 meter wide).

Weak – Hyporheic zone is saturated well below streambed surface.

Absent – No saturation of the hyporheic zone within 50 cm of the streambed surface.

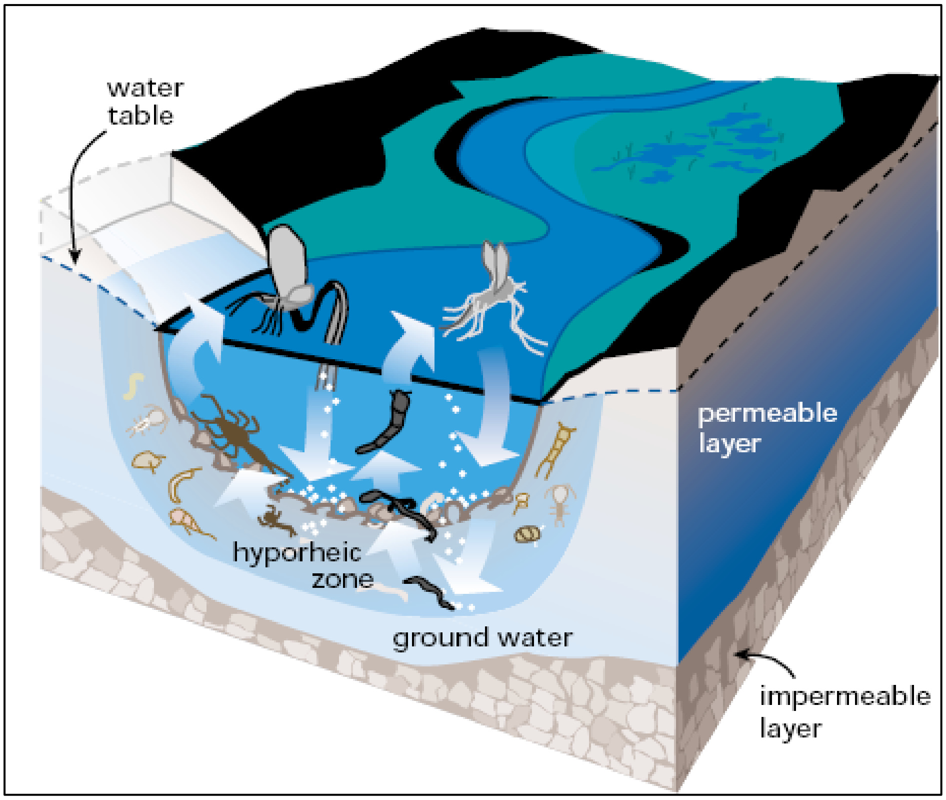

Figure 26. Idealized depiction of hyporheic zone and groundwater aquifer (from FISRWG, 1998).

9. Springs and Seeps

Are springs or seeps observed or mapped in the reach being evaluated or in an upstream reach? (Figure 27)

Springs and seeps often are present at toeslopes of adjacent hillslopes but may also be present at the heads of secondary channels, at the toe of stream banks, and at grade controls and headcuts. The presence of springs and seeps suggest that the stream is supported at least partly by groundwater except during droughts. Score this category based on the abundance of these features observed within the reach. USGS and other maps often identify springs; however the accuracy with which these features are identified is often greater in arid and semi-arid areas, and less so in forested areas and wetter climates.

Note: If a spring or seep exists within the assessment reach, indicate the location of that feature on the assessment form. If a spring within or upstream from the reach is mapped, check USGS and state or local records for any discharge data and attach that to the field assessment form.

Strong – A spring or seeps occur within the stream reach or a mapped spring occurs within the reach. *If a spring is mapped in the reach but is not observed in the reach, this indicator should be rated moderate.*

Moderate – A spring or seeps are observed immediately upstream of the reach or a mapped spring occurs within a mile upstream of the assessment reach.

Weak – A spring or seeps are observed upstream of the reach, or a mapped spring occurs more than a mile upstream of the assessment reach

Absent – No springs or seeps are mapped or observed within, or upstream of, the reach.

Figure 27. Seep discharging from fractured bedrock on channel margins.

10. Evenly Dispersed Leaf Litter and Loose Debris

Are leaves (freshly fallen or older leaves that may be "blackish" in color and/or partially decomposed) or other available aerially deposited debris accumulating in the thalweg? (Secondary Indicator) (Figures 28, 29, and 30)

Perennial streams (with deciduous riparian vegetation) should continuously transport plant material through the channel. Leaves and other aerially deposited debris will occur throughout the length of non-perennial stream channels, whereas there will be little to no leaves or debris present in the stronger flowing areas (riffles) with small accumulations on the upstream side of obstructions. Assessing this indicator may be more difficult during autumn in deciduous forests when sampling between rain events. In areas where vegetation is non-deciduous, or is sparse or absent, the presence of other forms of light debris that could be aerially deposited uniformly on the landscape should be assessed (Figure 30).

<u>Dry channels</u>: The distribution of aerially deposited debris should be assessed for the thalweg, comparing the distribution of debris in the thalweg to the surrounding channel and uplands.

Note: The scoring range is reversed for this indicator. "Strong" indicates less flow and receives fewer points than "Absent".

Strong – Leaf or other aerially deposited litter is present and abundant throughout the length of the stream.

Moderate – Leaf litter or other aerially deposited debris is present throughout most of the stream's reach with some accumulation on the upstream side of obstructions and in pools.

Weak – Leaf litter or other aerially deposited debris is present, mostly located in small packs along the upstream side of obstructions and in pools.

Absent – Leaf litter or other aerially deposited debris is not present in the fast moving areas of the reach, but there may be some present in the pools.

Figure 28. "Weak" distribution of leaf litter, with accumulations at discrete locations (western Cascades, channel width 1.7 m)

Figure 29. "Strong" abundance and distribution of leaf litter (Klamath Mountains, approximate channel width 1.5 m)

Figure 30. "Strong" distribution of light organic debris (Blue Mountains, channel width 0.8)

11. Debris Piles and Wrack Lines

Are there accumulations of debris in piles or lines in the channel or on the active floodplain? (Secondary Indicator) (Figures 31, 32, and 33)

Debris piles are defined as twigs, sticks, logs, leaves, trash, plastics, and any other floating materials piled up on the upstream side of obstructions in the stream, on the stream bank, in overhanging branches, and/or in the floodplain that indicate high stream flows. Wrack lines are twigs, sticks, logs, leaves, trash, plastics, and any other floating materials piled up / deposited in lines parallel to the channel's direction of flow. Ephemeral streams usually exhibit fewer or no drift lines within their channels unless downstream of a storm drain or extensive urban runoff. The magnitude of the accumulation of drift may be influenced by watershed characteristics and sources of debris. For example, streams in watersheds dominated by herbaceous vegetation may not exhibit large drift piles. When assessing the strength of coverage by debris piles look at all the obstructions in the reach that could support a debris pile and assess strength based on the percentage of obstructions that actually have a debris pile.

Dry channels: Focus the assessment of debris piles on the thalweg.

Strong – Debris piles are prevalent along the upstream side of most obstructions within the channel and / or wrack lines are prevalent in the floodplain along the length of the reach.

Moderate – Debris piles are on the upstream side of many obstructions and dispersed throughout the reach or wrack lines are present along parts of the reach.

Weak – Small debris piles are present on the upstream side of one or two of the obstructions or one wrack line exists along the reach.

Absent – No debris piles or wrack lines are present.

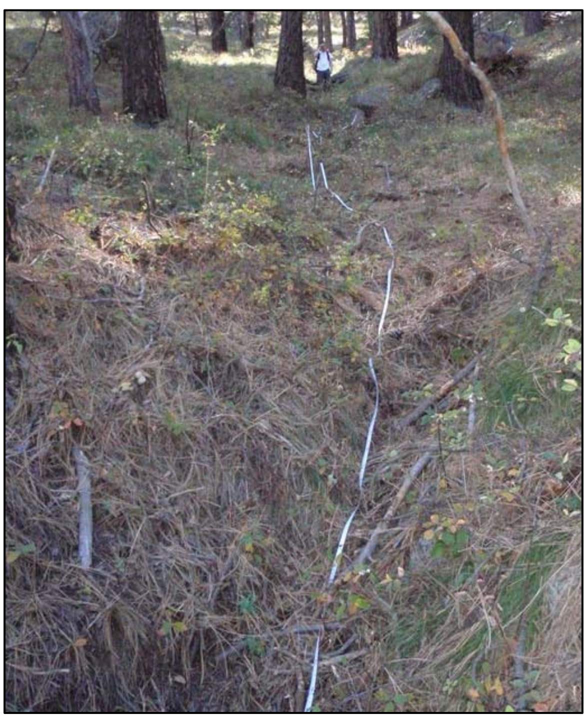

Figure 31. "Weak" abundance of debris piles; most debris is distributed rather than aggregated (Blue Mountains, channel width 0.8 m)

Figure 32. "Weak" abundance of debris piles (foothills of the western Cascades; channel width 0.5 m)

Figure 33. Example of debris pile.

12. Redoximorphic Features in the Toe of Bank

Are there redoximorphic features present in soils at the toe of the bank, at the base of head cuts above the streambed, or in the hyporheic zone? (Secondary Indicator) (Figures 34 and 35)

Soils with sufficient periods of inundation or saturation that contain iron (Fe) and manganese (Mn) may develop distinctive color features. Such redoximorphic ("redox") features form by the processes of reduction, translocation, and/or oxidation of iron and manganese oxides. Thus, the presence of redox features in soils in the stream bed or bank provides evidence of extended annual periods of base flow. Types of redox features include:

- <u>Redox concentrations</u>: Bodies of apparent accumulation of Fe-Mn oxides. Includes soft masses and pore linings, but <u>does</u> not include nodules and concretions.
- <u>Redox depletions</u>: Bodies of low soil chroma (≤ 2) having values of 4 or more where Fe-Mn oxides have been stripped or where both Fe-Mn oxides and clay have been stripped. Redox depletions contrast contrast distinctly or prominently with the soil matrix[6].
- <u>Reduced matrix</u>: A soil matrix that has low chroma and high value, but in which the color changes in hue or chroma when the soil is exposed to air.
- <u>Gleyed matrix: A soil matrix that has bluish, greenish, or grayish colors, and high values and low chroma.</u> *While technically not a "redoximorphic feature," the presence of gleyed soils is a strong indicator of saturated soil conditions.*

Soils immediately adjacent to the stream bed along the stream bank may have redoximorphic features. Use an auger, soil probe or spade to obtain at least a 30- to 35-cm (12- to 14-inch) deep core and examine the soil pedon for redoximorphic features. The soil sample should be representative of the major streambed/bank soil type observed throughout the assessment

[6] The soil matrix is the dominant soil volume that is continuous in appearance. When three colors occur, such as when a matrix, depletions, and concentrations are present, the matrix may represent less than 50 percent of the total soil volume.

reach. Look for redoximorphic features in the surface and in the subsoil. Note that in cumulic (alluvial) soils with thick surfaces, redoximorphic features may only be found much deeper in the profile. Also, redoximorphic features can be masked by the presence of high organic matter concentrations (i.e. N 2.5/, 2.5Y 2.5/1 colors in the Munsell Soil Color Charts).

Saturated soils, such as those found in the streambeds of perennial streams, have limited or no contact with oxygen and will remain reduced, thereby producing low chroma or gleyed soils. Soils subject to repeated periods of alternating aerobic and anaerobic conditions, such as those found along the banks of perennial streams, often have a dark colored matrix with brightly colored redoximorphic features.

Note: While this indicator does not assess the presence or absence of hydric soils, the definition and discussion of redoximorphic features in the guide *Field Indicators of Hydric Soils in the United States* is nonetheless a useful reference.[7]

Figure 34. Masses of oxidized iron in a sandy soil (from NRCS, 2006).

Figure 35. Soil matrix that has been depleted of iron and manganese oxides (scale in inches). Concentrations of oxidized iron are also present (from NRCS, 2006).

[7] http://www.usace.army.mil/cw/cecwo/reg/techbio.htm under the *Plants and Soils* heading

C. Biological Indicators

13. Wetland Plants In or Near Streambed

What is the wetland indicator status of hydrophytic plants found in the streambed or within one-half channel width of the streambank?

The USACE wetland delineation procedure uses a plant species classification system which identifies hydrophytic plants. This same system can be used as an indicator of the duration of soil saturation in stream channels. Small, low gradient, low velocity intermittent and perennial streams with adequate sunlight will often have Obligate (OBL) and Facultative Wetland (FACW) plants or Submerged Aquatic Vegetation (SAV) growing in the stream bed. SAV grows completely underwater (Figure 36).

Wetland plant designations can be found in the *National List of Plant Species that Occur in Wetlands: Northwest R9* (1988) and the 1993 *Northwest Region 9 Supplement*. The score for this indicator is based on the most hydrophytic wetland plant found in the assessed reach (e.g., if both FACW and OBL species are found, the score for this indicator would be 1.5).

Note: Abundance and prevalence throughout the reach is not a factor in scoring this indicator, but if the reach is covered with wetland species and the stream scores very low overall the site may be more appropriately considered as a wetland than a stream.

Figure 36. Example of submerged aquatic vegetation.

14. Fibrous Roots and Rooted Plants in Thalweg (Upland Plants)

Are fibrous roots of woody upland plants present in the thalweg of the stream? Are rooted herbaceous upland plants growing in the thalweg of the stream? (Figure 37)

Fibrous roots are small diameter (<1 cm or < 0.25 in), shallow, wide spreading roots without bark that often form dense masses in the top few inches of the soil. Fibrous roots of perennial, woody plants (i.e., trees and shrubs) are those which provide for water and nutrient uptake. Because oxygen is needed for respiration, fibrous roots are intolerant of saturation, unless they are roots of water tolerant plants. Thus, in substrates where water is persistent, or frequent high energy flows disturb the bottom substrate, fibrous roots may be infrequent or absent.

Because streamflow often deters upland plant establishment by removing seeds, scouring plants, and preventing aeration of roots, herbaceous upland plants are also generally absent in the thalweg of perennial streams.

Observe the bottom of the stream and determine if very small (fibrous) roots are present. Focus on the presence of rooted plants in the thalweg of the stream. Fibrous roots or plants growing on any part of the bank of the stream should not be considered. Note that during dry periods and in the growing season, fast growing fibrous roots may grow across the bottom of a dry stream that would not be present or survive during normal flow.

Note: The scoring range is reversed for this indicator. A higher score is given for the absence of upland fibrous roots and rooted plants.

Strong – Fibrous roots or rooted upland plants are present in many places along the reach.

Moderate – Fibrous roots or rooted upland plants are present in approximately half of the reach.

Weak – Fibrous roots or rooted upland plants are present in one or two places along the reach.

Absent – Fibrous roots or rooted upland plants are not present in the reach.

Figure 37. Example of an upland plant's fibrous roots growing in a stream channel.

15. Streamer Mosses or Algal Mats

Are there streamer mosses present in the streambed? Are algal mats present in the reach? (Secondary Indicator) (Figures 38, 39, 40, and 41)

Bryophytes (mosses and liverworts) are long-lived, non-vascular (without lignin) plants which inhabit a wide range of habitats. Some bryophytes have growth forms that trap moisture for survival; however some growth forms do not efficiently trap moisture and require a sustained (or recurring) presence of water in order to survive. Mosses of the streamer morphology – with long flowing stems – indicate a sustained or recurring presence of water (Figures 38 and 39).

Algal matting is another indicator of duration of inundation. Look for clumps of filamentous algae attached to the streambed or substrate (Figure 40). Algal mats are also evident in dry channels (especially dry pools), and appear as a crust-like layer on top of the streambed. The crust-like layer often appears to be salts or other minerals left behind when the last remaining water evaporated out of the pool, but upon closer inspection may reveal a dried mat of filamentous algae rather than a crystalline/mineral residue. Algal matting often occurs in association with prismatic cracking of the streambed, which indicates high clay content in the streambed and is another sign of water loss through evaporation (Figure 41). The presence of algal matting indicates that the stream held water long to support algal growth sufficient to form a mat.

Note: Only the presence of streamer mosses and attached or matted filamentous algae are being assessed – growth of other mosses (cushion, turfs, etc.) or algae (non-filamentous, floating, etc.) should not be considered for this indicator.

Strong – Streamer mosses are present throughout the reach.

Moderate – Streamer mosses are present in approximately half of the reach, and / or attached filamentous algae are present throughout the reach.

Weak – Streamer mosses and / or attached filamentous algae are present in the reach.

Absent –Streamer mosses and / or attached filamentous algae are not present.

Figure 38. Example of desiccated streamer mosses (Blue Mountains).

Figure 39. "Strong" abundance of streamer mosses (Northern Basin and Range, channel width 0.8 m).

Figure 40. Example of dried attached filamentous algae.

Figure 41. Example of algal mat on top of fine-textured streambed.

16. Iron-Oxidizing Bacteria, Fungi, or Flocculent Material

In slow moving or stagnant areas of the stream, are there clumps of "fluffy" rust-red material in the water? Are orange-red flocculent materials or stained rocks present in the stream? Are there red or rust colored stains (usually an "oily sheen" or "oily scum" will accompany these areas) on the bank or in the streambed? (Figures 42 and 43)

Iron-oxidizing bacteria and fungi, and associated flocculent material, are often associated with groundwater. Iron-oxidizing bacteria/fungus in streams derive energy by oxidizing iron, originating from groundwater, from the ferrous form ($Fe2+$) to the ferric form ($Fe3+$). In large amounts, iron-oxidizing bacteria and fungi discolor the stream substrate, giving it an orange-red appearance. In small amounts, it can be observed as an oily sheen on the water's surface. This indicates that the stream is being recharged by groundwater, and these features are most commonly seen at seeps or springs.

Filmy deposits on the surface or banks of a stream are often associated with the greasy "rainbow" appearance of iron-oxidizing bacteria. This is a naturally occurring phenomenon where there is iron in the groundwater, but can also be caused by organic acids associated with leaf litter and septic tanks. A sudden or unusual occurrence may indicate a petroleum product release or septic tank problem. One way to differentiate iron-oxidizing bacteria from petroleum releases is to trail a small stick or leaf through the film. If the film breaks up into small islands or clusters, it is most likely bacterial in origin; if the film swirls together, it is most likely a petroleum product.

Note: Springs or seeps with iron-oxidizing bacteria, fungus or flocculent materials present should be assessed for both Indicator 9 (Springs and Seeps) <u>and</u> Indicator 16 – (Iron-Oxidizing Bacteria, Fungi, Flocculent Material).

Strong – Iron-oxidizing bacteria, fungi or flocculent materials are present in many places in the reach.

Moderate – Iron-oxidizing bacteria, fungi or flocculent materials are present in a few places in the reach.

Weak – Iron-oxidizing bacteria, fungi or flocculent materials are present in one or two small places in the reach.

Absent – There are no iron-oxidizing bacteria, fungi or flocculent materials present in the reach.

Figure 42. Example of iron-oxidizing microorganisms.

Figure 43. "Strong" abundance of iron-oxidizing microorganisms.

17. Macroinvertebrates

Is there evidence of aquatic macroinvertebrates within the reach? (Figures 44 and 45; Also see Appendix C)

Many macroinvertebrates require the presence of water, and in many cases flowing water, for their growth and development. Such macroinvertebrates are good indicators of streamflow duration because they require aquatic habitat to complete specific life stages. For example, clams cannot survive outside of water, in contrast to some stoneflies or alderflies that resist desiccation in some seasons of the year by burrowing into the hyporheic zone. Some macroinvertebrates can survive short periods of drying in damp soils below the surface, or in egg or larval stages resistant to drying. Others are quick to colonize temporary water and complete the aquatic portion of their life cycle during the wettest part of the year when sustained flows are most likely.

This indicator includes the range of macroinvertebrates typically associated with stream habitats including: Coleoptera (aquatic beetles), Diptera (true flies), Ephemeroptera (mayflies), Megaloptera (dobsonflies and alderflies), Mollusca (snails and clams), Odonata (dragonflies and damselflies), Plecoptera (stoneflies), Trichoptera (caddisflies), and Astacoidea (crayfish).

Macroinvertebrates of the Pacific Northwest (Adams and Vaughan, 2003)[8] provides a useful, compact and inexpensive field guide for general identification of several aquatic macroinvertebrate families found in Oregon streams. A condensed field guide for use with this method is included in Appendix C.

The scoring system for this indicator was informed by a literature review and synthesis completed by the Xerces Society for Invertebrate Conservation (Mazzacano and Black, 2008).[9] Several taxa and lifestages have been identified as either "Perennial Indicators" or "Intermittent Indicators" (Table 3); there is a high level of confidence that these indicator taxa are associated with the prolonged presence of water. (These taxa are also "Single Indicators"; see Section 3.)

Table 3. Indicator status of various macroinvertebrate taxa

Perennial Indicator Taxa / Lifestage

- Juga *spp.* (pluerocerid snail)
- Freshwater mussels (Margaritiferidae, Unionidae); *less likely in small high-gradient streams*

Larvae/pupae of:

- Philopotamidae (finger-net caddisfly)
- Hydropsychidae (net-spinning caddisfly)
- Rhyacophilidae (freeliving caddisfly)
- Glossosomatidae (saddle case-maker caddisfly), *esp. in forested headwater streams*

Nymphs of:

- Pteronarcyidae (giant stonefly)
- Perlidae (golden stonefly)

Larvae of:

- Elmidae (riffle beetle)
- Psephenidae (water penny), *esp. in eastern regions*

Larvae/nymphs of (*esp. in larger streams in eastern Oregon*):

- Gomphidae (clubtail dragonfly)
- Cordulegastridae (biddies)
- Calopterygidae (broadwinged damselfly)

Intermittent Indicator Taxa / Lifestage

Larvae/pupae of:

- Limnephilidae (Northern caddisfly)

Nymphs of:

- Capniidae (small winter stonefly)
- Nemouridae (forestfly)

Larvae/adults of:

- Dytiscidae (predaceous diving beetle)
- Hydrophilidae (water scavenger beetle)

Larvae/nymphs of:

- Lestidae (spread-winged damselfly)

Ephemeral Indicator Taxa / Lifestage

Larvae/pupae of:

- Culicidae (mosquito)

[8] Published by The Xerces Society. Portland, OR (www.xerces.org)
[9] Available at http://www.xerces.org/aquatic-invertebrates/

This indicator is assessed using a minimum 20-minute search time to sample the range of habitats present, including water under overhanging banks or roots, accumulations of organic debris (e.g. leaves), woody debris, and the substrate (pick up rocks and loose gravel, also look for empty clam shells washed up on the bank in the coarse sand). **A kicknet or D-frame net and a hand lens are required to collect and identify specimens.** Place the kicknet perpendicular against the streambed and stir the substrate upstream of the net for a minimum of one minute, empty contents of the net into a white tray with fresh water for counting and identification. Many individuals will appear the same until seen against a contrasted color background, and some bivalves and other macroinvertebrates can be pea-sized or smaller. Sweeping grass and shrubs in the riparian zone immediately adjacent to the active channel with a funnel-shaped insect net may collect emergent aquatic insects such as stoneflies or caddisflies.

Dry channels*:* Focus the search on the sandy channel margins for mussel and aquatic snail shells, any remaining pools for macroinvertebrates, and under cobbles and other larger bed materials for caddisfly casings. Casings of emergent mayflies or stoneflies may be observed on dry cobbles or on stream-side vegetation.

Notes:

- Time estimates for scoring do not reflect time spent on identifying individuals, rather they are wholly focused on searching / gathering effort.
- **This indicator does not differentiate between live organisms and shells, casings, and exuviae** (i.e., the external coverings of the larvae and nymphs). In other words, mussel shells are treated the same as live mussels, and caddisfly cases are treated the same as live caddisflies (Figure 45)
- The assessment is based only on what is observed, not on what would be predicted to occur if the channel were wet, or in the absence of disturbances or modifications. Disturbances and modifications should be described in the notes section and taken into account when drawing conclusions.
- For greatest efficiency macroinvertebrates should be searched concurrently with the amphibian search (Indicator 18).

Strong – At least one of the Perennial Indicator taxa is present, or at least 5 families within the orders of Ephemeroptera, Plecoptera, or Trichoptera (EPT) are present.

Moderate – At least one of the Intermittent Indicator taxa is present, or at least 2 families within the EPT orders are present, or at least 5 taxa of aquatic macroinvertebrates are present.

Weak – At least one aquatic macrovinvertebrate is present.

Absent – No aquatic macroinvertebrates are found.

Figure 44. Example of caddisfly casings of the *Limnephilidae* family. Note that presence of these casings would meet the "single indicator" criteria for macroinvertebrates.

Figure 45. Abundant caddisfly casings from in the Blue Mountains. Note that presence of these casings would meet the "single indicator" criteria for macroinvertebrates.

18. Amphibians and Snakes

Are amphibians and snakes that require aquatic habitats present in the reach? (Secondary Indicator) (Figures 46 and 47)

Amphibians by definition are associated with aquatic habitats, and some amphibians require aquatic habitat for much or all of their lives. In Oregon, there are likewise three snake species that require aquatic habitat for significant portions of their life history. This indicator focuses on the life history stages of salamanders, frogs, toads, and snake species, which require aquatic habitat by indicating life history stages for these species as FAC, FACW, or OBL (see Table 4).

This indicator is assessed using a minimum 20-minute search time to sample the range of habitats present and can be searched concurrently with the macroinvertebrate search (Indicator 17) for greatest efficiency. Various life stages of frogs, salamanders, and tadpoles can be found under rocks, on stream banks and on the bottom of the stream channel. They may also appear in benthic samples. **Using kicknets or smaller nets and tubs for specimen collection and identification is recommended.** Frogs will alert you of their presence by jumping into the water for cover, usually following an audible "squeak". Certain frogs and tadpoles, as well as adult and larval salamanders typically inhabit the shallow, slower moving waters of stream pools and near the sides of the bank. *Amphibians of Oregon, Washington and British Columbia* (Corkran and Thomas, 2002)[10] is a useful field guide for identifying amphibians of the Pacific Northwest.

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[10] *Amphibians of Oregon, Washington and British Columbia* (1996). C. Corkran and C. Thomas, Lone Pine Publishing, Redmond, WA.

Many of the obligate frog (tadpole-adult) and salamander species such as the Tailed frog (Figure 46), the Torrent salamanders, and the two Giant Salamander species will be found in the fast flowing portions of a stream. The three snake species listed in the table below will usually be found along the streambank, within the wetted margin of the stream, or on exposed rocks within the stream channel[11].

Amphibian eggs, also included for this indicator, can be located on the bottom of rocks, attached to vegetation in backwaters or along the stream margin, and in or on other submerged debris (Figure 47). They are usually observed in gelatinous clumps or strings of eggs, unlike snail and insect eggs, which are also often found on the bottom of rocks or attached to debris.

Table 4 lists amphibians and snakes likely to be found in Oregon and the water-dependent life history stages for each. All egg masses, tadpoles, or salamander larvae count as OBL for a water-dependent life stage. Please note amphibian breeding adults require water, therefore adult FACW and FAC species found breeding should be scored as OBL. For instance, the adult Western Toad is listed as FAC, but would be scored as OBL if found breeding.

Table 4. Water-dependent Life Stages of Amphibians and Snakes of the Pacific Northwest (Note: OBL: Obligate, requires surface or hyporheic water; FACW: Facultative Wet, strong preference for surface or hyporheic water; FAC: Facultative, uses but does not depend on surface or hyporheic water.)

Species	Common Name	Water-Dependent Life Stages			
		Eggs	Larva / Tadpole	Juve.	Adult
Aquatic Salamanders					
Ambystoma gracile	Northwest Salamander	OBL	OBL	FACW	FACW
Ambystoma macrodactylum	Long-toed Salamander	OBL	OBL	FACW	FACW
Ambystoma tigrinum	Tiger Salamander (rare)	OBL	OBL	FACW	FACW
Taricha granulosa	Roughskin Newt	OBL	OBL	FAC	FAC
Dicamptodon copei	Cope's Giant Salamander	OBL	OBL	OBL	OBL
Dicamptodon tenebrosus	Pacific Giant Salamander	OBL	OBL	OBL	FACW
Rhyacotriton spp.	Torrent Salamanders (rare)	OBL	OBL	OBL	OBL
Frogs and Toads					
Ascaphus truei	Tailed Frog	OBL	OBL	OBL	OBL
Spea intermontana	Great Basin Spadefoot (Eastern Oregon)	OBL	OBL	FAC	FAC

[11] *Reptiles of the Northwest: California to Alaska; Rockies to the Coast* (2002), A. St. John, Lone Pine Publishing, Redmond, WA.

Species	**Common Name**	**Water-Dependent Life Stages**			
		Eggs	**Larva / Tadpole**	**Juve.**	**Adult**
Bufo boreas	Western Toad	OBL	OBL	FAC	FAC
Bufo woodhousii	Woodhouse's Toad (Eastern Oregon)	OBL	OBL	FAC	FAC
Pseudacris regilla	Pacific Treefrog	OBL	OBL	FACW	FAC
Rana aurora	Red-Legged Frog	OBL	OBL	FACW	FACW
Rana boylii	Foothill Yellow-Legged Frog	OBL	OBL	OBL	OBL
Rana cascadae	Cascades Frog	OBL	OBL	FACW	FACW
Rana catesbeiana	Bullfrog	OBL	OBL	FACW	FACW
Rana pretiosa	Oregon Spotted Frog	OBL	OBL	OBL	OBL
Rana luteiventris	Columbia Spotted Frog	OBL	OBL	OBL	OBL
Snakes					
Thamnophis atratus	Western Aquatic Garter Snake (SW Oregon)		OBL	OBL	OBL
Thamnophis elegans	Wandering Garter Snake		FACW	FACW	FACW
Thamnophis sirtalis	Common Garter Snake		FACW	FACW	FACW

Notes:

- Time estimates do not reflect time spent identifying individuals, rather they are wholly focused on searching / gathering effort.
- The assessment is based only on what is observed, not on what would be predicted to occur in the absence of disturbances or modifications. Disturbances and modifications to the stream should be described in the notes section and taken into account when drawing conclusions.
- For greatest efficiency, the amphibian/ snake search should be done concurrently with the macroinvertebrate search (Indicator 17).

Strong – At least one individual, egg or egg mass of an OBL water-dependent life stage or two or more individuals, eggs or egg masses of at least two species listed as FACW for any water-dependent life stage is present.

Moderate – At least one individual, egg or egg mass of a FACW water-dependent life stage or two or more individuals, eggs or egg masses of one or more species listed as FAC for any water-dependent life stage is present.

Weak – At least one individual, egg or egg mass of a water-dependent life stage is present.

Absent – No water-dependent amphibian or snake life stages are found.

Figure 46. Tailed frog (Ascaphus truei), an "obligate" species whose presence would meet the "single indicator" criteria for amphibians.

Figure 47. Amphibian egg mass found on the underside of a rock.

19. Fish

Are there fish in the stream?

Fish are an obvious indicator of flow presence and duration. Fluctuating water levels of intermittent and ephemeral streams provide unstable and stressful habitat conditions for some fish communities. However, the strongly seasonal precipitation pattern in Oregon means intermittent streams may flow continuously for several months; thus, some native fish species have evolved to use intermittent streams for significant portions of their lifespan.

When looking for fish, all available habitats should be searched, including pools, riffles, root clumps, and other obstructions (polarized sunglasses are helpful to reduce surface glare). In small streams, the majority of species usually inhabit pools and runs. Also, fish will seek cover once aware of your presence, so be sure to look for them slightly ahead of where you are walking along the stream. Check several areas along the stream sampling reach, especially underneath undercut banks.

Strong – Several fish or a few different species of fish are found in the reach.

Moderate **–** A few fish or two different species are found in the reach.

Weak **–** One or two fish are found in the reach.

Absent – No fish are found in the reach.

20. Lichen Line (Used Only in Arid Regions and Alpine Areas)

Is there a line on the rocks in the stream bed, or on the banks, below which no lichen grows? (Secondary Indicator) (Figures 48 and 49)

Lichens are a symbiotic association of fungi and algae growing together. Generally, they are tolerant of dry conditions and temperature extremes and can colonize bare rock and survive in arctic and alpine conditions. However, they grow very slowly and are not very tolerant of physical abrasion or inundation. Lichens may occur on rocks, large woody debris, live trees and other hard surfaces extending out of the streambed. If lichens are present, identify whether there is a distinct horizontal line below which the substrate does not change but no lichens grow (Figure 49). This indicator applies only in arid regions and alpine areas.

Note: As used below, "height" means elevation above the streambed at a cross-sectional point along the reach. The "height" of the lichen line may vary between locations along the length of the reach.

Strong – Lichens are present along the length of the reach and form a line at approximately the same height.

Moderate – A few lichens are present in the reach and most stop at the same height above the streambed.

Weak – Lichens are present, but they do not form a clear height line along the reach.

Absent **–** Lichens are not present in or near the channel, or if present are found throughout the reach, including in the thalweg.

Figure 48. Example of lichen line.

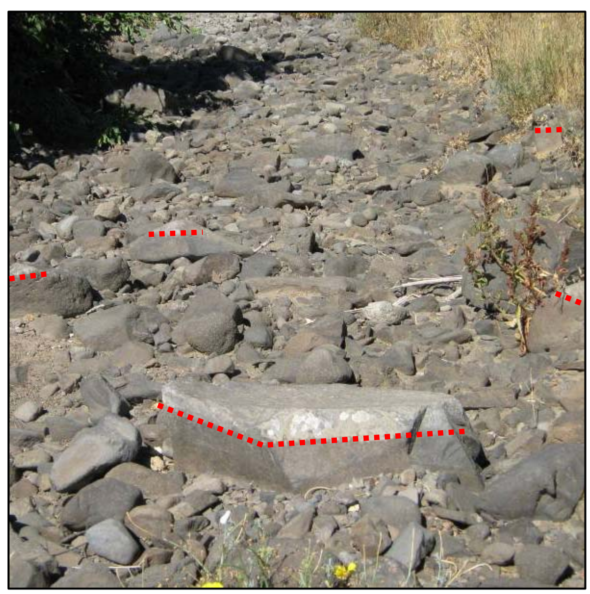

Figure 49. "Strong" distribution of lichen lines (Columbia Plateau, approximate channel width 4 m).

21. Distinct Riparian Vegetation Corridor (Used Only in Arid Regions)

Is there a distinct change in vegetation between the surrounding uplands and the riparian corridor along the stream channel?

Especially in arid regions, intermittent and perennial streams often support riparian areas that contrast markedly with adjacent plant communities. A distinct change in vegetation between the surrounding lands and the riparian area (top of bank and immediately adjacent areas within a channel width) may indicate the presence of seasonal moisture. Such changes may be evidenced by the occurrence of less drought tolerant species, vegetation types, or plant communities.[12] For instance, upland grasses and shrubs may transition abruptly or gradually to riparian vegetation (e.g. willows, cottonwood, sedges, etc.).

Note: This indicator applies only in the Arid West Region. Also note on the assessment form any reasons why this indicator would not be present, for example livestock grazing.

Strong – A distinct riparian vegetation corridor exists along the entire stream reach.

Moderate – A distinct riparian vegetation corridor exists along part of the stream reach or there is some change in vegetation towards less drought tolerant species along the entire stream reach.

Weak **–** There is some change in vegetation towards less drought tolerant species along parts of the stream reach.

Absent – There is no change in vegetation towards less drought tolerant species along the stream reach.

Figure 50. Riparian corridor is "absent" along this drainageway (Northern Basin and Range).

Figure 51. "Strong" riparian corridor, as indicated by distinct transition from upland to riparian species and continuity of riparian vegetation along entire stream reach.

[12] *Wetland Plants of Specialized Habitats in the Arid West* (Lichvar and Dixon, 2007) lists wetland and upland plants (and their wetland indicator status) in the arid west, grouped by habitat. (http://www.crrel.usace.army.mil/library/technicalpublications-2007.html)

SECTION 3: Drawing Conclusions

The results of the field assessment are used to make a finding as to whether the weight of the observations indicates perennial, intermittent, or ephemeral streamflow.

The method indicates the stream is perennial when the following criteria is met:

1. A numerical value of at least 25 points.

If the stream segment being evaluated does not meet the above criteria, the method indicates the stream is intermittent when any of the following criteria are met:

2. A numerical value of at least 13 points.

Or

3. One or more fish are found in the segment.

Or

4. One or more individuals of an amphibian or snake life stage identified as Obligate or Facultative Wet (Table 4) are present.

Or

5. Two or more individuals classified as “Perennial Indicator” or “Intermittent Indicator” (Table 3) are present; or, two or more caddisfly cases, mussel shells, or aquatic invertebrate exuviae (i.e., the external coverings of the larvae and nymphs) associated with the sustained presence of water are present.

If the stream has a bed and banks but does not meet any of the above criteria, the method indicates the stream is ephemeral. If the stream does not have a bed and banks and does not meet any of the above criteria, it may be more appropriate to consider the stream as a swale, wetland, or upland.

As discussed in the introductory sections on *Ditches and Modified Natural Streams* and *Scoring*, if the channel does not meet any of the above criteria and the practitioner believes the channel to be perennial or intermittent s/he must clearly describe on the assessment form the evidence supporting this assertion. This may occur in highly polluted or recently manipulated streams. In those cases the actual observed indicators should be scored as usual, and the indicators that could potentially be there were it not for the pollution/manipulation should be described and the “Notes” section of the datasheet.

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Appendix B: Streamflow Duration Field Assessment Form

The Field Assessment Form is provided on the following two pages

Oregon Streamflow Duration Field Assessment Form (Interim Version – March 2009)

Project # / Name		Evaluator Attended ☐ Orientation ☐ Field Training
Address		Date
Waterway Name	Coordinates at downstream end (ddd.mm.ss)	Lat. N
Reach Boundaries		Long. W
Precipitation w/in 48 hours (cm)	Channel Gradient (%)	Channel Width (m)

Observed Hydrology:

- "Dry Channel": ☐ Water Absent; ☐ No surface flow but at least one pool present
- "Wet Channel": ☐ Surface flow present but not spatially continuous; ☐ Continuous surface flow

☐ Disturbed Site / Difficult Situation (Describe in "Notes")		Absent	Weak	Moderate	Strong
Geomorphology	1. Continuous Bed and Bank	☐ 0	☐ 1	☐ 2	☐ 3
	2. In-channel Structure / Organized Sequences	☐ 0	☐ 1	☐ 2	☐ 3
	3. Soil texture or stream substrate sorting	☐ 0	☐ 1	☐ 2	☐ 3
	4. Erosional Features (☐ Check this box if >50% of the streambed consists of exposed bedrock)	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	5. Depositional Features	☐ 0	☐ 1	☐ 2	☐ 3
	6. Sinuosity	☐ 0	☐ 1	☐ 2	☐ 3
	7. Headcuts And Grade Controls	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	GEOMORPHOLOGY SUBTOTAL:				______
Hydrology	8. Groundwater (Wet) / Hyporheic (Dry)	☐ 0	☐ 1	☐ 2	☐ 3
	9. Springs And Seeps (Note Locations)	☐ 0	☐ 1	☐ 2	☐ 3
	10. Evenly Disbursed Leaf Litter / Loose Debris ▼	☐ 1.5	☐ 1	☐ 0.5	☐ 0
	11. Debris Piles And Wrack Lines	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	12. Redoximorphic Features In Toe Of Bank	☐ Absent = 0		☐ Present = 1.5	
	HYDROLOGY SUBTOTAL:				______
Biology	13. Wetland Plants In / Near Streambed	☐ FAC 0.5 ☐ FACW 0.75	☐ OBL 1.5	☐ SAV 2	☐ None
	14. Fibrous Roots / Rooted Plants In Thalweg ▼	☐ 3	☐ 2	☐ 1	☐ 0
	15. Streamer Mosses And Algal Mats	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	16. Iron Oxidizing Bacteria, Fungus, Flocculent	☐ 0	☐ 1	☐ 2	☐ 3
	17. Macroinvertebrates	☐ 0	☐ 1	☐ 2	☐ 3
	18. Amphibians	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	19. Fish	☐ 0	☐ 1	☐ 2	☐ 3
	20. Lichen Line (Arid Regions and Alpine Areas Only)	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	21. Riparian Corridor (Arid Regions Only)	☐ 0	☐ 1	☐ 2	☐ 3
	BIOLOGY SUBTOTAL:				______

Single Indicators: ☐ Fish ☐ Amphibians ☐ Macroinvertebrates

★ TOTAL SCORE: ______

Flow Duration (select only one)

- **Ephemeral** ☐ Total Score < 13
- **Intermittent** ☐ Total Score ≥ 13 **or** Single Indicator
- **Perennial** ☐ Total Score ≥ 25

Note: Scoring scale is reversed for indicators marked with ▼.

Notes (explanation of any single indicator conclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

☐ Prolonged Abnormal Rainfall / Snowpack

- ☐ Below Average
- ☐ Above Average

☐ Natural or Anthropogenic Disturbance

☐ Other: ___________________________

Describe and Explain any Indicators of Questionable Applicability:

Other Notes (sketch of site, description of photos, depth of observed groundwater, etc.)

Appendix C: A field guide to accompany the macroinvertebrate scoring portion of the Oregon Streamflow Duration Assessment Method

The Field Guide is provided on the following four pages

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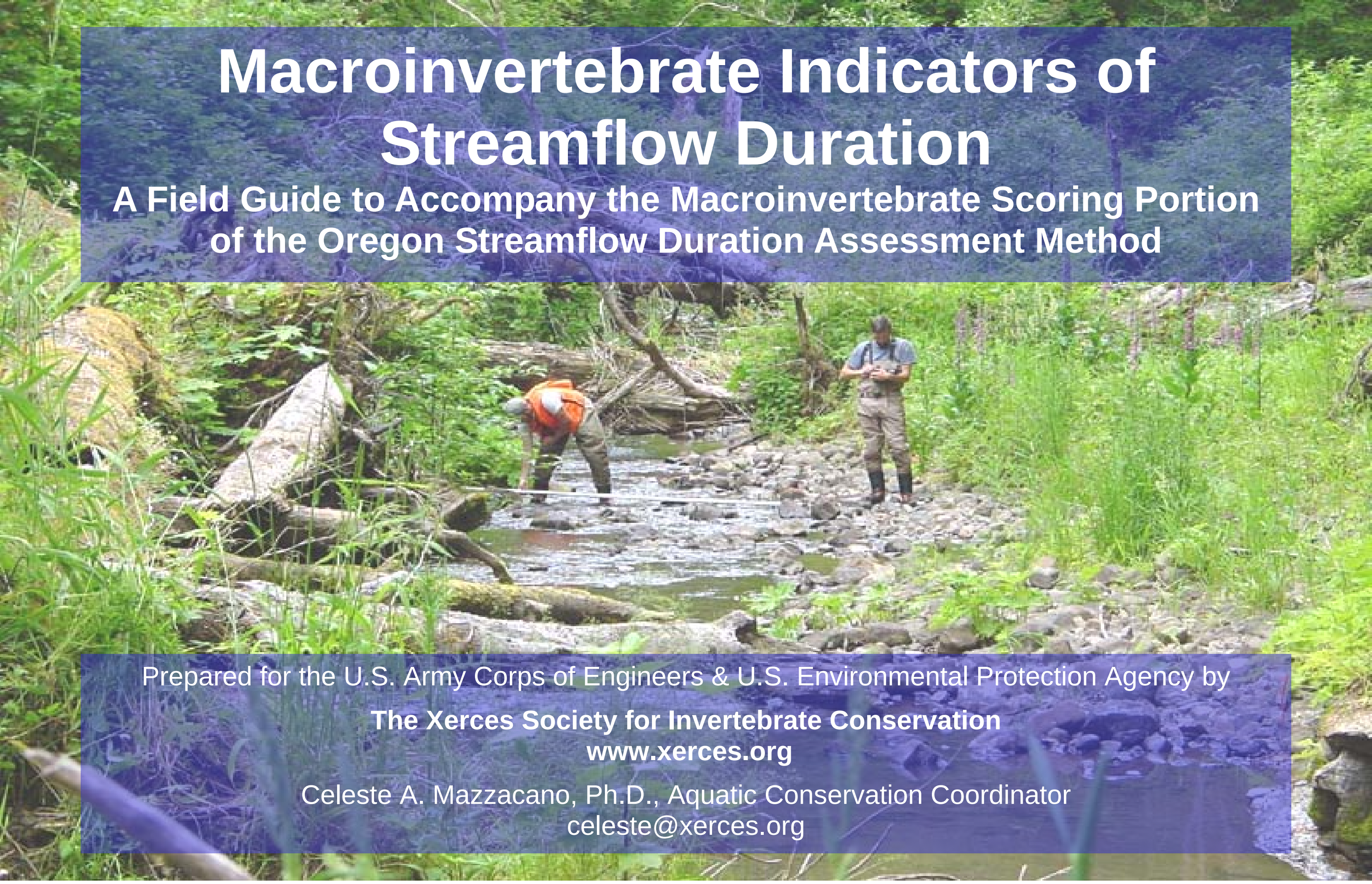
Macroinvertebrate Indicators of Streamflow Duration

A Field Guide to Accompany the Macroinvertebrate Scoring Portion of the Oregon Streamflow Duration Assessment Method



Prepared for the U.S. Army Corps of Engineers & U.S. Environmental Protection Agency by

The Xerces Society for Invertebrate Conservation
www.xerces.org

Celeste A. Mazzacano, Ph.D., Aquatic Conservation Coordinator
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EPHEMEROPTERA: MAYFLIES

Larvae (nymphs): elongated body, may be cylindrical or flattened, 3-20 mm (0.1-0.8 in.); tip of abdomen with three (sometimes two) long slender cerci ("tails"); developing forewing pads visible; plate-like, feathery, or fringed gills at sides of abdomen; some types have larger fore-gills that form a shield like cover over other gills; conspicuous eyes; slender antennae

Heptageniidae
(flathead mayfly)

Ephemerellidae
(spiny crawler mayfly)

Isonychiidae
(brush-legged mayfly)

Leptophlebiidae
(prong gill mayfly)

Ephemeridae
(common burrower mayfly)

Baetidae
(small minnow mayfly)

Caenidae
(little squaregill mayfly)

MOLLUSCA: MUSSELS & SNAILS

Freshwater mussels, Margaritiferidae (*Margaritifera* spp), Unionidae (*Anodonta* & *Gonidea* spp.): bivalved shell with two oblong halves; can reach >15 cm (6 in.) ; more common in larger rivers with softer substrate

Gonidea angulata
(western ridged mussel)

Anodonta nuttalliana
(winged floater)

Margaritifera falcata
(western pearlshell)

Juga snails: dark reddish-brown to black shell, smooth or ridged; pale lines may spiral with coils; 10-30 mm (0.4-1.2 in.)

PLECOPTERA: STONEFLIES

Larvae (nymphs): elongate, slightly flattened body with "roachlike" appearance; 5-35 mm (0.2-1.4 in.); long slender antennae; two pairs of wing pads visible on older larvae; tip of abdomen has two "tails" (cerci); fingerlike or filamentous gills may be visible on bases of the legs, thorax, or underside of abdomen

Pteronarcyidae
(giant stonefly)

Perlidae (golden stonefly)

Capniidae (snowfly)

Nemouridae
(forestfly)

Peltoperlidae
(roachfly)

TRICHOPTERA: CADDISFLIES

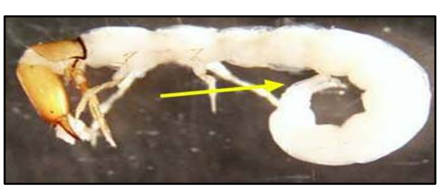
Larvae: elongate, caterpillar-like body; antennae reduced & inconspicuous; no wing pads; tip of abdomen has pair of short, clawed, anal prolegs, but no "tails" (cerci); 2-40 mm (0.08-1.6 in.); filamentous gills may be present in some types; some are free-living & spin silken nets, others build elongated, cylindrical, coiled, or saddle-shaped portable cases from stones, twigs, leaves, & other organic material; cases may persist in dry channels

Glossosomatidae
(saddle case-maker)

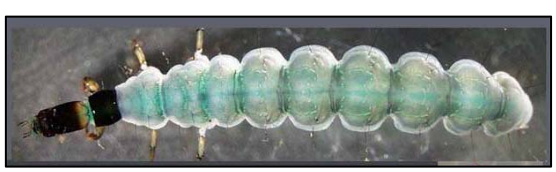
Limnephilidae
(Northern caddisfly)

Philopotamidae
(finger-net caddisfly)

Helicopsychidae
(snail case-maker)



Hydropsychidae
(net-spinning caddisfly)



Rhyacophilidae
(green rockworm)

Leptoceriade
(longhorned case-maker)

COLEOPTERA: AQUATIC BEETLES

Larvae: body shapes vary; most types elongated, cylindrical, some dome-shaped; may have long filaments at the sides or tip of abdomen; well-developed, tough head and mouthparts; no wing pads; 2-70 mm (0.08-2.8 in.)
Adults: body shapes vary; often oval and slightly flattened, some types cylindrical; forewings form hard smooth shiny covers (elytra) when folded, meet in straight line down the back, covering membranous hindwings and most of abdomen; legs may be flattened or fringed with swimming hairs; 1-40 mm (0.04-1.6 in.)

Dytiscidae (predaceous diving beetle, **adult** (top) & **larva**)

Gyrinidae (whirligig beetle, **larva** (left) & **adult**)

Psephenidae (water penny, **larvae**)

Elmidae (riffle beetle, **larva** and **adults**)

Hydrophilidae (water scavenger beetle, **adult**)

Haliplidae (crawling water Beetle, **adult**)

ODONATA: DRAGONFLIES & DAMSELFLIES

Larvae (nymphs): **dragonflies** = stout, cylindrical to flattened body; abdomen ends in 3 short stiff points; **damselflies** = slender elongated body with 3 flattened leaf-like gills at tip of abdomen; both have large eyes, wing pads, long extendable "lower lip" (labium) that masks the lower part of head when not in use

Gomphidae
(clubtail dragonfly)

Calopterygidae
(broadwinged damselfly)

Libellulidae
(skimmer dragonfly)

Aeshnidae
(darner dragonfly)

Macromiidae
(river skimmer dragonfly)

Coenagrionidae
(narrowwinged damselfly)

HEMIPTERA: AQUATIC TRUE BUGS

Larvae (nymphs) & **adults**: body slender, oval to elongate, may be flattened; 1-65 mm (0.04-2.6 in.); cone– or needle-like beak arises from front of head, folded under body when not in use; have developing wing pads (nymphs) or wings (adults); **adult** forewings thickened & leathery at the base, membranous at the tips, cross at tips when folded; legs may be flattened like oars or fringed with swimming hairs

Gerridae (water strider, **nymph**)

Nepidae (water scorpion, **adult**)

Belostomatidae (giant water bug, **nymph**)

Notonectidae (backswimmer, **adult**)

Corixidae (water boatman, **adult**)

DIPTERA: AQUATIC & SEMI-AQUATIC TRUE FLIES

Chironomidae (non-biting midge, **pupa** & **larvae**)

Tipulidae (crane fly, l**arvae**)

Dixidae (dixid midge, **larva**)

Ceratopogonidae (biting midge, **larva**)

Athericidae (watersnipe fly, **larva**)

Culicidae (mosquito, **larva**

Blepharicidae (netwinged midge, **larva**)

ADDITIONAL GROUPS OF AQUATIC INVERTEBRATES

Class Oligochaeta (aquatic earthworm)

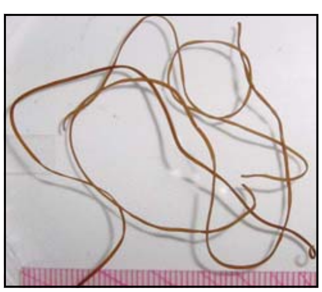
Subclass Hirudinea (leeches)

Order Isopoda (aquatic sowbug)

Order Decapoda (crayfish)

Order Amphipoda (scud, side swimmer)

Class Turbellaria (flatworms)



Phylum Nematomorpha (horsehair worm)

Order Megaloptera, Family Corydalidae (dobsonfly/fishfly **larva**, left) & **Family Sialidae** (alderfly **larvae**, right)

To read the complete report, "Macroinvertebrates as Indicators of Stream Duration", visit www.xerces.org/aquatic-invertebrates/

The Xerces Society for Invertebrate Conservation, 4828 SE Hawthorne Blvd., Portland OR 97215, 503-232-6639