Component III Channel Habitat Type Classification

Table of Contents

Component III
Channel Habitat Type Classification

INTRODUCTION

The Watershed Fundamentals component of this manual describes how the setting and structure of the landscape influences the shape of the stream channels. Drawing on several existing stream classification systems, we have assigned a basic number of channel types for Oregon streams that we are calling Channel Habitat Types1 (CHTs). This stream classification will enable you to better understand how land use impacts can alter the channel form, and to identify how different types of channels will respond to restoration efforts. Both channel modifications and restoration will ultimately effect fish habitat.

The stream classification system is described in this component, along with mapping instructions. In Appendix III-A, you will find more detailed descriptions for each of the channel habitat types, including a drawing and photo of the physical setting common to the unit, an example from a topographic map, and a list of physical attributes common to these types of streams. In addition, Appendix III-A presents background material on stream classification, theory, and methodology. The overall assessment process is designed to identify areas of the watershed in need of enhancement and restoration. To help evaluate restoration options, we have included general guidelines for restoration by channel type in Appendix III-A. The channel type classifications apply to broad areas; therefore, a more thorough field verification of actual conditions will be necessary before project implementation.

Because this stream classification is a composite of existing work, we expect that changes and additions to the individual stream types may be made as the classification is applied in Oregon and field data is compiled. At that point, channel type "variants" within each CHT can be identified.

Critical Questions

1. What is the distribution of CHTs throughout the watershed?

2. What is the location of CHTs that are likely to provide specific aquatic habitat features, as well as those areas which may be the most sensitive to changes in watershed condition?

Assumptions

1. Stream channels form specific patterns in response to the surrounding geology and geomorphology, and these patterns can be used to identify CHTs.

2. Channel habitat types have consistent responses to changes in inputs of sediment, water, and wood across the State of Oregon.

3. The distribution of CHTs throughout the stream network and the condition of the characteristics within the CHTs influence aquatic habitat quality.

Materials Needed

You will need the following equipment and supplies to complete the mapping:

[1] Terms that appear in bold italic throughout the text are defined in the Glossary at the end of this component.

- 1:24,000-scale Oregon Department of Forestry (ODF) base maps (from Start-Up and Identification of Watershed Issues component)

- A Mylar overlay the size of the base map (optional)

- Sharp pencil, colored pencils, permanent marking pens (fine-point) in a variety of colors

Additional materials or data, where available:

- Recent ***stereo aerial photographs*** covering the entire assessment area (from Start-Up and Identification of Watershed Issues component)

- Stereoscope for 3-D viewing of aerial photographs. Although a mirrored stereoscope (with magnification) is preferable, a simple lens stereoscope is adequate.

- Aerial photo scale for measuring ***riparian area*** widths etc. Scale should be the same as the aerial photographs used.

- Map wheel for measuring lengths.

- Stream survey results, if available

Necessary Skills

The minimum skills necessary to produce the CHT maps include (1) the ability to read and use topographic maps, and (2) an eye for visualizing 3-D landscape patterns from topographic maps. The ability to use aerial photographs and a general understanding of the local geology and the geologic processes shaping the stream system in the watershed will aid in the accomplishment of this task, but is not required. Complex channel networks and channel sensitivity issues may require the aid of a hydrologist or geomorphologist.

Final Products of the CHT Classification Component

The final products from this step include:

- Map CHT-1: Channel Segment Map
- Map CHT-2: Preliminary Channel Habitat Type Map
- Map CHT-3: Final Channel Habitat Type Map
- Form CHT-1: Channel Habitat Type Field Verification
- Form CHT-2: CHT Summary Sheet
- Form CHT-3: Confidence Evaluation
- Short summary report (optional)

METHODS

Overview

The methodology presented here describes the steps to divide streams in the watershed into different CHTs. ***Stream segments*** are initially broken out based on channel gradient (Step 2) and ***channel confinement*** (Step 3), and mapped on Map CHT-1. The stream segments are then grouped together based on channel pattern and valley width, and assigned to a tentative CHT (Step 4); a preliminary CHT map (Map CHT-2) is then produced. Although channel pattern, valley width, and channel gradient can be determined with reasonable accuracy from topographic maps, channel confinement is difficult and in some cases impossible to determine from maps alone, and may require additional work. Consequently, methods for improving the quality or confidence in your mapping are discussed in Step 5; including the use of stream survey information, consulting with local experts, using aerial photographs, and field-verifying initial calls. All field-verification information is recorded on Form CHT-1. When the analyst is satisfied with the CHT calls that have been made, a final CHT map is produced (Map CHT-3), along with a form that summarizes the distribution of CHTs in the watershed (Form CHT-2). Copies of Map CHT-3 and Form CHT-2 are distributed to the other analysts. Channel Habitat Type sensitivity is evaluated in Step 6. In Step 7, the analyst evaluates confidence in the final mapping products. Finally, in Step 8, the CHT analyst will prepare for the Watershed Condition Evaluation.

Step 1: Prepare Maps and Materials

Gather all of the items listed in the Materials section. Base maps of the watershed showing the entire stream network, and watershed and subwatershed boundaries, should have been prepared in the Start-Up and Identification of Watershed Issues component (refer to that component if you have not received a base map).

US Geological Survey (USGS) maps at the 7.5-minute or 1:24,000 scale have been used to prepare the base maps. Keep in mind that some of the individual maps used to make up the base map of the watershed may have a different ***contour interval*** than others. Be sure to check the contour intervals, as the accuracy of your stream typing is dependent on your ability to know and use this information. Scale and contour dimensions are found on the bottom center of the maps used to make up the base map. Maps with large areas of little relief may show intermediate contours only in those areas. The stream segments and CHTs from the following steps can be drawn directly on copies of the base map.

Before beginning, take a moment to study the base map. Notice the network of streams, their positions within the watershed, and the patterns of similarities between streams within sub-basins or areas of similar topography and size. Note that not all the CHTs described in this section will necessarily be present in your watershed, and that the distribution of types may vary from the headwaters to the mouth of the watershed. You will want to familiarize yourself with the attributes of each CHT before mapping them in your watershed. Figure 1 illustrates the basic characteristics of each CHT; Appendix III-A provides detailed descriptions of each CHT.

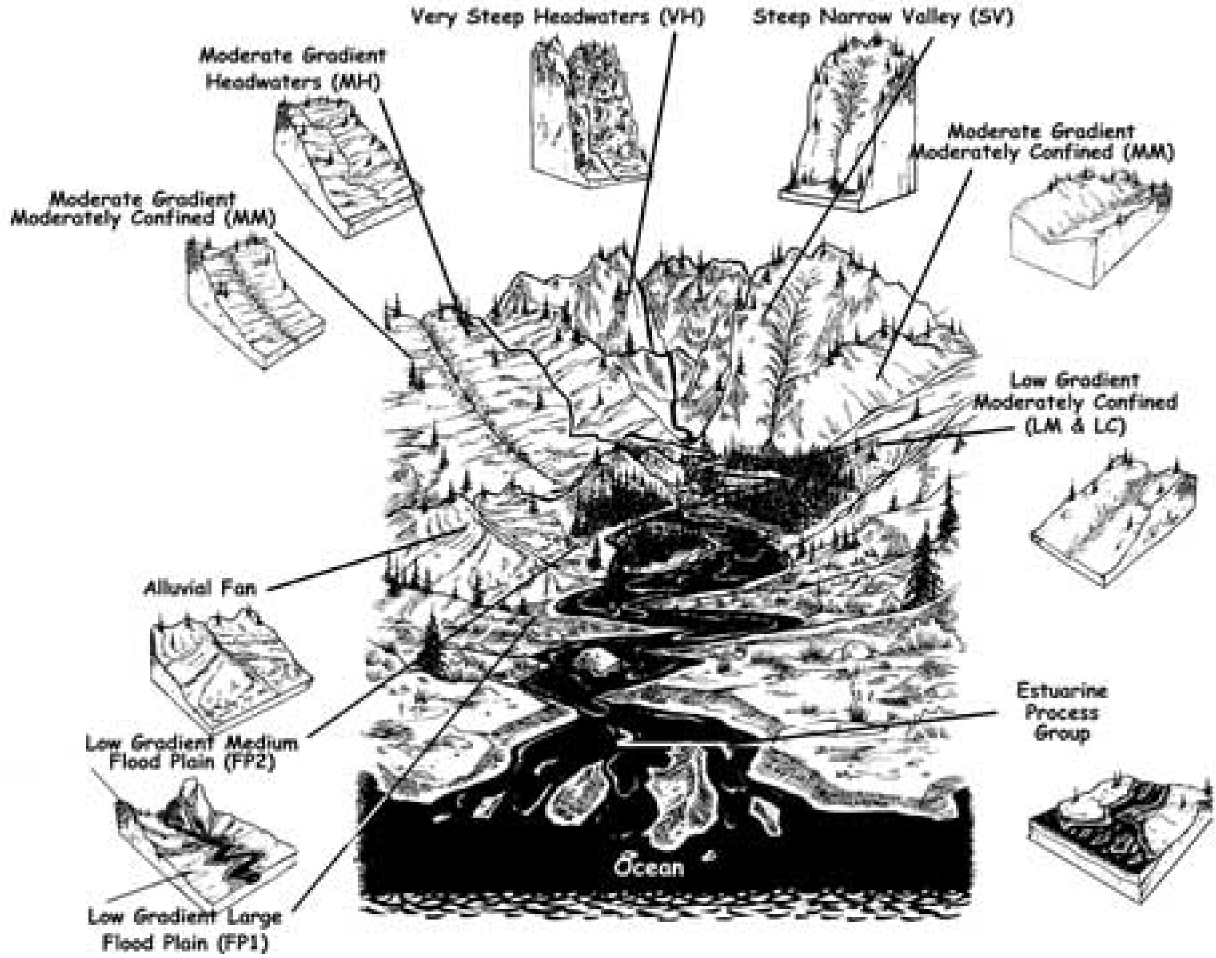

Figure 1. Examples of CHTs and their relative position in the watershed.

Step 2: Break Out Stream Segments Based on Gradient Class

The first cut at dividing the channel network into similar types is based on ***channel gradient class***. Six different gradient classes are used (shown in the box below) Segments may vary in length, but will be similar with respect to channel gradient. Sixteen percent is chosen as the upper limit of the channel network due to the dominance of terrestrial rather than fluvial processes in these areas.

Channel gradient is determined by dividing the difference in elevation by the horizontal distance of any given length of stream. Determining this ratio from the base map can de done in a number of ways. In one method, measure the distance between contours or number of contours within a given distance either with a ruler (for relatively straight channels), or using a map wheel (for sinuous channels). Table 1 provides information for determining slope from 1:24,000-scale maps with a 20-foot or 40-foot contour interval.

CHANNEL GRADIENT CLASSES

<1%	4-8%
1-2%	8-16%
2-4%	>16%

Another approach would be to use a gradient template printed on a clear piece of Mylar that can be laid over the stream channel; the gradient is read directly from the template. Channel segments must be relatively straight to use this approach, however. Examples of gradient templates are found in Schuett-Hanes et al. (1994).

Table 1. Determining channel slope on 1:24,000-scale maps.

Channel Slope (%)	20-ft contour interval		40-ft contour interval	
	Distance Between Contours (ft)	Contours per 1,000 ft of Channel	Distance Between Contours (ft)	Contours per 1,000 ft of Channel
1	2,000	-	4,000	-
2	1,000	1	2,000	-
4	500	2	1,000	1
8	250	4	500	2
16	125	8	250	4

A third method to map channel gradient is to employ a ***Geographic Information System*** (GIS), although this method requires an expertise that may render it impractical. In addition, field verification of GIS products is necessary. (See the sidebar below, Using GIS to Map Gradient, for more information.)

Determining channel gradient from topographic maps is subject to a certain amount of error. In particular, lower-gradient channels are more subject to mapping and analyst calculation error than steeper channels. This problem should be taken into consideration when field-verification sites are selected. This potential error, coupled with the overall greater sensitivity/responsiveness of lower-gradient channels, is the rationale for having a greater number of gradient classes in the lower range.

In order to prevent an unmanageable number of segments within any given stream system, a minimum segment length of 1,000 feet is suggested. Another rule of thumb is that segments should cover a minimum of three contours. Major waterfalls should be broken out as separate segments regardless of length. Additional segment breaks are located at junctions of major tributaries, because the addition of water, sediment, or wood can alter physical characteristics and fish habitat. It is important to be as consistent as possible when identifying segment breaks.

An example is provided in Figure 2 of three segments delineated in the “Skunk Creek” subwatershed. Segment breaks are first drawn on Map CHT-1 using a pencil line drawn across the channel to mark the upstream and downstream boundary of each segment. The stream segments are then numbered using a sub-basin code and sequential number (for example SC1, SC2, and SC3 for Skunk Creek segments 1, 2, and 3; see Figure 2). This numbering by sub-basin allows for a minimum of renumbering should segments be divided or combined, and allows for a common, site-specific reference for all analysts.

USING GIS TO MAP GRADIENT

Preliminary channel gradients have been successfully mapped using a Geographic Information System (GIS). GIS programs can be written to calculate and code channel gradients between individual contours or to “smooth” them by a running average. If GIS resources are available to your watershed council, this may be another tool for the mapping exercise. However, employment of other tools is recommended to supplement the GIS mapping.

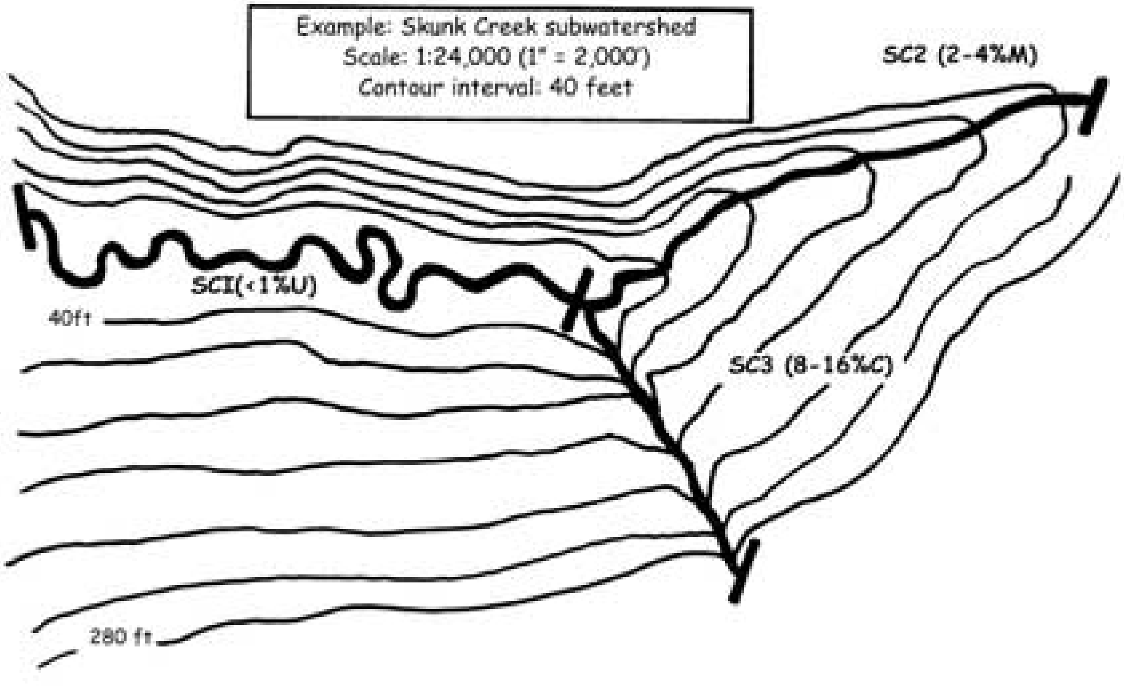

Figure 2. The stream segments delineated in a subwatershed are numbered using a sub-basin code and sequential number (e.g., SC1, SC2, and SC3 for Skunk Creek segments 1, 2, and 3). This numbering by sub-basin allows for a minimum of renumbering should segments be divided or combined, and allows for a common, site-specific reference for all analysts. Each segment is also labeled with the appropriate gradient class.

Each segment is also labeled with the appropriate gradient class. For example, segment SC1 is 4.2 inches long as measured with a map wheel (8,400 ft), and crosses no contour lines. Therefore, the gradient is <0.5% (<40 ft/8,400 ft), and the segment is labeled as "<1%." For segment SC2, the distance between the 40-foot contour and the 200-foot contour is 2.2 inches (4,400 ft); therefore, the gradient is 3.6% [(200 - 40)/4,400], and the gradient class is labeled as "2-4%." Finally, for segment SC3, the distance between the 280-foot contour and the 40-foot contour is 1.2 inches (2,400 ft); therefore, the gradient is 10% [(280 - 40)/2,400], and the gradient is labeled as "8-16%."

Step 3: Estimate Channel Confinement

Channel confinement is difficult to determine from topographic maps and has been the subject of considerable confusion. This is unfortunate, as the ability of a stream to move laterally directly affects aquatic habitat quality and is of prime concern to land managers. Much of the problem is due to misinterpretation of terminology. Definitions related to channel confinement and entrenchment discuss the ratio of the active channel width to the floodplain width (Moore et al. 1997, Washington Forest Practices Board 1997, Rosgen 1996, Overton et al. 1995). Unfortunately, floodplain width is often interpreted as valley width or some measure of historic floodplain. For the purposes of this manual, we have adopted the most commonly used and scientifically valid definition, which defines confinement as the ratio of the ***bankfull width*** to the width of the modern floodplain. Bankfull width is the width of the channel at the point at which overbank flooding begins, and often occurs as flows reach the 1.5-year ***recurrence interval*** level. Modern floodplain is defined as the flood-prone area (Rosgen 1996), but geomorphologists caution that it may or may not correspond to the 100-year floodplain. Obviously, this is an area where consistency by the analyst is important.

Table 2. Channel confinement classes.

Map Code	Confinement Class	Floodplain Width
U	Unconfined	>4x bankfull width
M	Moderately confined	>2x but <4x bankfull width
C	Confined	<2x bankfull width

Confinement classes are presented in Table 2. While determination of this ratio solely from topographic maps is prone to error, especially in low-gradient streams entrenched into historic terraces or alluvial valleys, this exercise presents a first cut at determining channel confinement.

Referring to the example shown in Figure 2 for "Skunk Creek," note the meandering and sinuous channel pattern of segment SC1. This meandering channel pattern, combined with the low gradient of the reach, is often indicative of streams with wide floodplains. The confinement class ("U" [unconfined] for segment SC1) should be noted in pencil on Map CHT-1 next to the gradient class, as shown in Figure 2. For segment SC2 in the figure, note how the contour lines approach the channel at approximately right angles. This suggests that the valley may allow some room for a narrow floodplain to develop. The initial estimate of confinement for segment SC2 would be marked on Map CHT-1 as "M" (moderately confined). Segment SC3 appears from the map to be an example of a confined valley (note the V-shape of the contours as they approach the stream) with little room for floodplain development, and would be marked on the map as "C" (confined).

Step 4: Assign Initial CHT Designation

Following segment mapping of the channel network, segments can be clustered into groups of similar gradient, confinement, and size, and mapped on Map CHT-2. Using the variables of channel gradient, confinement, and where appropriate, size and valley form, produces a consistent, accurate, and concise framework to define the typing system. It is often beneficial to start CHT grouping in headwater regions, where the "choices" of probable CHTs are limited. **The most difficult areas to group are usually low-gradient reaches**. Table 3 provides a list of CHTs into which most channels can be placed. A more complete description of these channel types is located in Appendix III-A. Note that any system with the goal of organizing channels statewide into a limited number of channel types works better for some channel types than others. As such, the descriptors for each CHT are general, and variability of channel conditions within each CHT exists. The analyst is encouraged to note "variant" conditions within each of the channel types. In some cases, it may be necessary to modify or add channel types to fit unusual situations. These alterations to the channel types presented should be kept to a minimum and documented thoroughly.

Following Table 3 is a key (Figure 3) that provides a general guide for assigning CHTs. You are strongly cautioned, however, that the key is meant only as a tool, and will not always result in assignment of the appropriate CHT. You are encouraged to employ as many tools as possible in assigning CHTs.

Table 3. Channel Habitat Types.

Code	CHT Name	Gradient	Channel Confinement	Size
ES	Small Estuary	<1%	Unconfined to moderately confined	Small to medium
EL	Large Estuary	<1%	Unconfined to moderately confined	Large
FP1	Low Gradient Large Floodplain	<1%	Unconfined	Large
FP2	Low Gradient Medium Floodplain	<2%	Unconfined	Medium to large
FP3	Low Gradient Small Floodplain	<2%	Unconfined	Small to medium
AF	Alluvial Fan	1-5%	Variable	Small to medium
LM	Low Gradient Moderately Confined	<2%	Moderately confined	Variable
LC	Low Gradient Confined	<2%	Confined	Variable
MM	Moderate Gradient Moderately Confined	2-4%	Moderately confined	Variable
MC	Moderate Gradient Confined	2-4%	Confined	Variable
MH	Moderate Gradient Headwater	1-6%	Confined	Small
MV	Moderately Steep Narrow Valley	3-10%	Confined	Small to medium
BC	Bedrock Canyon	1->20%	Confined	Variable
SV	Steep Narrow Valley	8-16%	Confined	Small
VH	Very Steep Headwater	>16%	Confined	Small

Note: Stream size refers to the ODF designations based on average annual streamflow. Small streams possess flows less than or equal to 2 cubic feet per second (cfs). Medium streams possess flows greater than 2 but less than 10 cfs. Large streams possess flows of 10 cfs or greater. Stream sizes are mapped at 1:24,000 for the entire state, with the exception of the southeast quarter of the state.

To demonstrate the use of the key in Figure 3, we will use the three segments from the Skunk Creek example. Figure 4 is an overview of the subwatershed that contains Skunk Creek. Segment SC1 is less than 2% gradient and unconfined. From the key, then, we see that this segment may be either an FP3 CHT if it is a small stream (according to the ODF size classification), an FP2 CHT if it is medium-sized, or an FP1 CHT if it is a large stream. Referring to Appendix III-A, we find that the FP1 CHT is found in large streams, FP2 in large or medium streams, and FP3 is found in small to medium-sized streams. So because segment SC1 is labeled “L” (this information will be on your base map), it is either an FP1 or FP2 CHT. Reading the descriptions from Appendix III-A, we find that the FP1 type is usually found at the lowest end of the stream basin (as in this example), and may have stream gradients of ≤1% (as in the case of segment SC1). Consequently, we would type segment SC1 as an FP1 CHT.

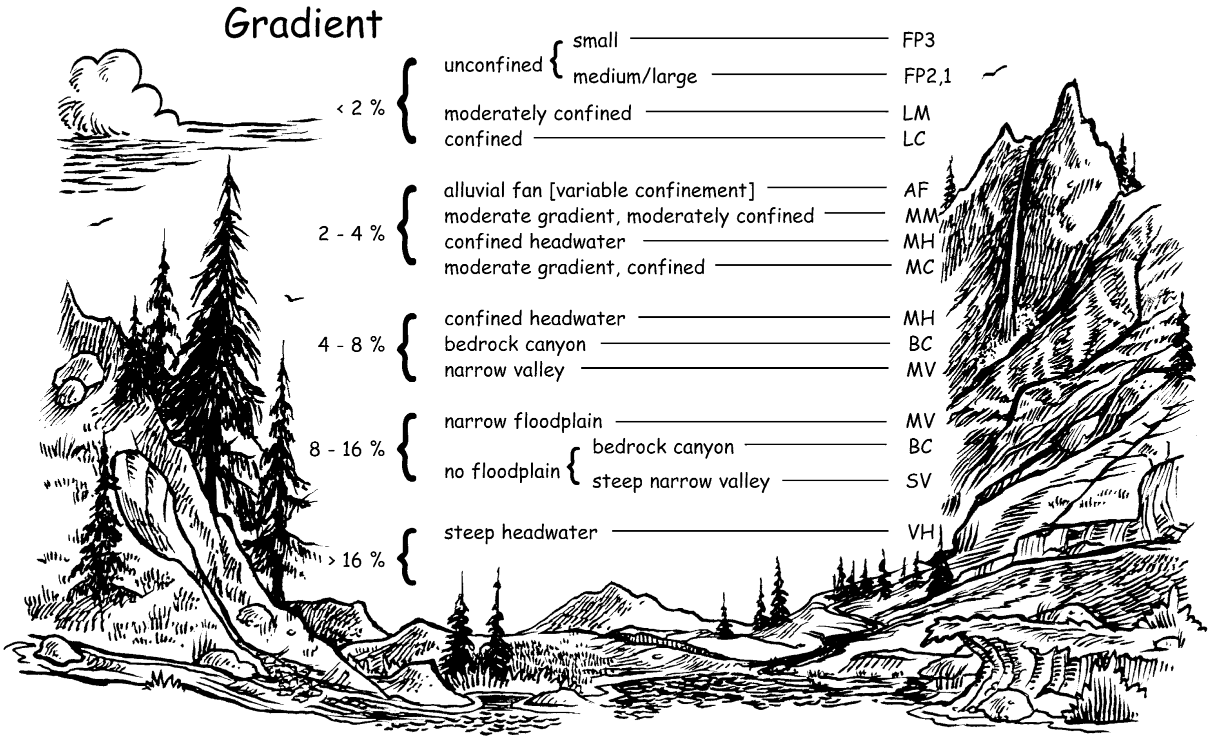

Figure 3. This flow chart provides a general guide for assigning CHTs.

Continuing with our example, segment SC2 was in the 2% to 4% gradient class and moderately confined. Using the key provided in Figure 3, we find that the possible CHTs are AF (Alluvial Fan), MM (Moderate Gradient Moderately Confined), or MH (Moderate Gradient Headwater). Channel Habitat Type MC (Moderate Gradient Confined) is eliminated because it applies to segments that are confined. Referring to the descriptions for the three possible choices from Appendix III-A, we find that the description of the AF type does not fit the characteristics observed on the topographic map, and so can be eliminated. Reading the description of the MH type given in Appendix III-A, we find that this CHT occurs in headwater locations, usually in small streams. The description for CHT MM appears to best fit segment SC2.

Using the key for segment SC3 we find three possible choices for the 8-16% gradient range: MV (Moderately Steep Narrow Valley), BC (Bedrock Canyon), and SV (Steep Narrow Valley) types. From the description in Appendix III-A, we can probably eliminate the BC type; although it is difficult to tell without field observations, it does not appear to be a deep canyon or gorge. The descriptions of both the MV and SV types appear to fit segment SC3 well, and without further investigation we may not be able to decide which of the two is most appropriate.

After the segments have been grouped into CHTs, prepare a preliminary CHT map (Map CHT-2) with each segment color-coded to a particular CHT. You may wish to make a photocopy of Map CHT-1, or use a Mylar overlay on Map CHT-1. Sign and date the map. Because most preliminary CHT maps will be modified, preparation of a GIS version of the map at this point may not be prudent.

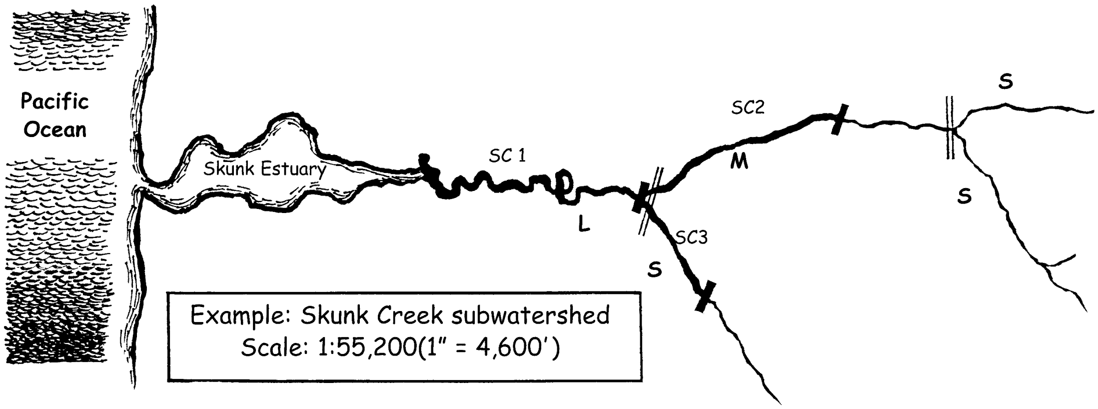

Figure 4. This overview of the example Skunk Creek subwatershed provides stream size classification (large, medium, small), which helps in classifying CHT.

Step 5: Improve the Mapping

The following subsections offer suggestions for improving the Preliminary Channel Habitat Type Map. These tools, as well as additional information gathered from other watershed analysts, should be employed in the production of the Final Channel Habitat Type Map.

Compare with Stream Surveys

Oregon Department of Fish and Wildlife (ODFW) stream habitat surveys will likely be available for some parts of your watershed. These field observations can be consulted to verify your segmenting for those areas covered by the survey. (See Caution sidebar.) In areas with extensive survey information, it may be beneficial to use this information as a tool in initial segment delineation. Consult the summary for each surveyed reach for the following attributes: channel slope and confinement, valley floor types, channel form, and adjacent landforms.

CAUTION

Some surveyed stream reaches have been found to be inconsistently defined, and do not necessarily correspond to changes in the indicator attributes above. Also remember that the segments delineated above will be combined into CHTs that may correspond with ODFW reaches. If a reach includes more than one of your preliminary segment breaks, or extends beyond an obvious change in channel gradient or confinement, then you may need to consult the line-by-line field data for the stream within your segment breaks rather than the reach summary information.

Consult an Expert

Local experts (agency personnel, consultants, etc.) may volunteer to assist the watershed council with the watershed assessment. Although this stream classification is new, these experts will be familiar with similar channel classifications and may be able to assist you. Work through the mapping procedures first, then ask your local expert to check your work or help with questions you have. In addition, local residents are usually very knowledgeable about stream conditions. While locals may not be familiar with terms such as channel confinement, they likely would know if flood flows are contained within the channel for a particular section of stream.

Aerial Photographs

If you have experience in using aerial photographs and access to photos, you can improve your confidence in assigning CHTs by viewing the stream system with photographs. Attributes such as valley features, presence of side-channels, and gravel deposition are often observable from aerial photographs. It should be noted, however, that many features of small, forested stream channels cannot be determined from aerial photographs.

Field Verification

The purpose of the field assessment is not only to verify CHT calls, but also collect data concerning specific channel characteristics. These characteristics reflect the type and magnitude of channel processes and give an indication of the response of the channel to alteration of factors, which influence channel form and maintenance.

A field visit to a sampling of different CHTs identified from the initial map exercise will also help you build confidence in the mapping procedure and identify local differences in controls leading to variations in channel form. Where time, resources, and opportunities allow, conduct a field verification and complete the Channel Habitat Type Field Verification form (Form CHT-1) for each area visited. Where practical, attach the corresponding portion of the topographic map on the back of the form to show the locations of field observations/measurements for the segment in question.

In order to efficiently gather this type of information, a sampling design must focus on representative reaches and allow extrapolation to other channel segments. The following are guidelines for selecting field sites:

- Sample a variety of the gradient and confinement classes present in the watershed.
- Increase sample size in channel segments that are likely to respond to changes in the input factors of wood, sediment, flow (unconfined to moderately confined channels with minimal vertical or horizontal controls, as well as low-gradient reaches).
- Sample segments that capture the geographic and geologic variability within the watershed.
- Sample upstream and downstream of major tributary confluences to determine gross differences in sub-basin characteristics.
- Sample segments that reflect the general range of land management intensity.
- Sample segments that have been subjected to events capable of altering overall ***morphologic features*** (debris flow or dam break flood segments, segments that have undergone significant widening or aggradation, etc.)
- Sample key fish habitat areas, if known.
- Sample areas of known or suspected habitat degradation.

There is no set minimum number of segments that should be sampled , but increasing the sample size will greatly increase the accuracy and usefulness of the final product.

Following application of the tools presented above, produce the Final Channel Habitat Type Map (Map CHT-3). Form CHT-2 (CHT Summary Sheet) should also be produced. If GIS is available, Map CHT-3 can first be digitized, and Form CHT-2 generated from the GIS. If GIS is not available, a map wheel can be used to determine CHT mileage in the watershed. This information, along with the CHT map, allows the analysts to understand the extent and location of various CHTs.

Step 6: Determine CHT Sensitivity

While clustering stream segments into CHTs addresses the critical question concerning channel type distribution in the watershed, it does not address the second question concerning identification of those portions of the channel network that are the most responsive to changes in the factors which impact channel development. Differences in gradient, confinement, and bed ***morphology*** suggest that different channel types are more or less responsive to adjustment in channel pattern, location, width, depth, sediment storage, and bed roughness (Montgomery and Buffington 1993). These changes in channel characteristics will in turn trigger alterations of aquatic habitat conditions. The more responsive areas are most likely to exhibit physical changes from land management activities, as well as restoration efforts.

In general, responsive portions of the channel network are those that lack the terrain controls which define confined channels. These unconfined or moderately confined channels display visible changes in channel characteristics when flow, sediment supply, or the supply of roughness elements such as ***large woody debris*** (LWD) are altered. These areas are commonly referred to as response reaches, and usually possess an active floodplain. At the other end of the responsive spectrum would be those channels whose characteristics and form are not easily altered, such as a Bedrock Canyon. Some channels, such as Alluvial Fans, can have a broad range of sensitivity, ranging from low to high. Figure 5 identifies the general responsiveness of CHTs.

In Appendix III-A, each of the CHTs is rated with respect to the general sensitivity of the channel to changes in the input factors of wood, sediment, and peak flows. A rating of low, moderate, or high is assigned based on the anticipated response of the channel. Table 4 describes the anticipated magnitude of response associated with these qualitative ratings. The CHT descriptions given in Appendix III-A present more detailed information concerning anticipated channel response. The most accurate sensitivity calls are made with the help of field verification.

Step 7: Evaluate Confidence in Mapping

Fill out the Confidence Evaluation (Form CHT-3) for mapping the CHTs. If the type or quality of information used to map the watershed differs significantly from area to area, fill out a form that evaluates each general area (i.e., high-gradient streams all over the watershed, surveyed stream reaches, a particular tributary). The form is self-explanatory.

As a final step in mapping, the analyst should highlight on Map CHT-3 those CHTs that are considered highly responsive.

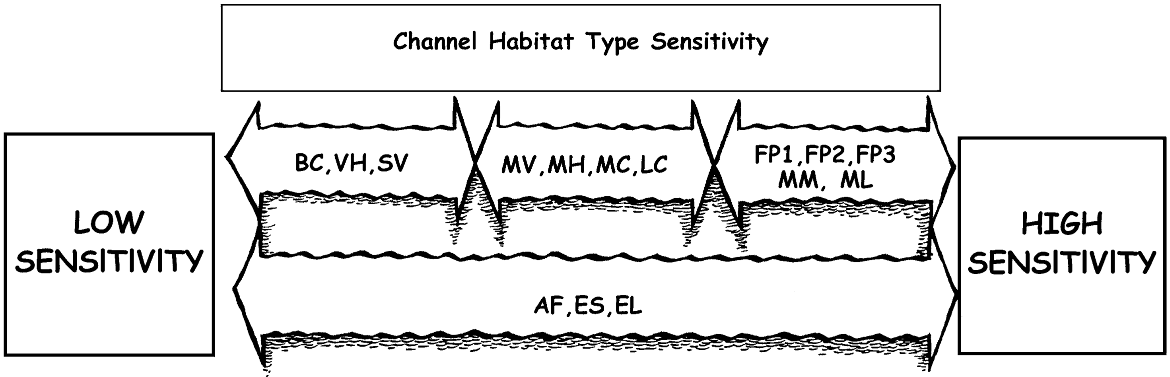

Figure 5. Different channel types respond differently to adjustment in channel pattern, location, width, depth, sediment storage, and bed roughness. Such changes may not only result in alteration of aquatic habitat, but the more responsive areas are most likely to exhibit physical changes from land management activities and restoration efforts.

Step 8: Prepare for Condition Evaluation

The final portion of the CHT assessment procedure is preparation for the Watershed Condition Evaluation component of the watershed assessment. In addition to finalizing the CHT map and associated forms, the analyst should review the channel information collected. This review should lead the analyst to a point where he/she knows not only the type and likely location of sensitive stream channels in the watershed, but where an understanding is gained of overall channel condition. Often the analyst will be capable of determining the dominant processes that are most responsible for channel condition. **It is useful to prepare a short written summary of channel conditions for presentation during the Watershed Condition Evaluation stage of the process.**

As an example of the type of information brought forth during the Watershed Condition Evaluation, suppose the channel analyst has determined that a particular portion of the stream channel network is highly responsive, moderate gradient, moderately confined, and undergoing significant bank erosion and widening. The channel analyst learns from the sediment sources analyst that numerous recent landslides that reach the channel have occurred in the basin just upstream from the sensitive reach. Together, the analysts theorize that recent increases in landslide frequency have resulted in excessive amounts of sediment being delivered to the channel, resulting in the channel widening. This type of “cross referencing” to determine key linkages is one of the ultimate goals of the entire assessment procedure. If the channel analyst can bring forth not only the where and what of the stream network, but some rudimentary understanding of the why, then a clearer picture of overall watershed health emerges.

Table 4. Channel response descriptions.

Rating	LWD	Fine Sediment	Coarse Sediment	Peak Flows
High	Critical element in maintenance of channel form, pool formation, gravel trapping/sorting, bank protection.	Fines are readily stored with increases in available sediment resulting in widespread pool filling and loss of overall complexity of bed form.	Bedload deposition dominant active channel proces; general decrease in substrate size, channel widening, conversion to plane-bed morphology if sediment is added.	Nearly all bed material is mobilized; significant widening or deepening of channel.
Moderate	One of a number of roughness elements present; contributes to pool formation and gravel sorting.	Increases in sediment would result in minor pool filling and bed fining.	Slight change in overall morphology; localized widening and shallowing.	Detectable changes in channel form; minor widening, scour expected.
Low	Not a primary roughness element; often found only along channel margins.	Temporary storage only; most is transported through with little impact.	Temporary storage only; most is transported through with little impact.	Minimal change in physical channel characteristics, some scour and fill.

REFERENCES

Cupp, C.E. 1989. Stream Corridor Classification for Forested Lands of Washington. State of Washington, Timber/Fish/Wildlife Ambient Monitoring Program, Olympia.

Frissell, C.A., W.J. Liss, C.E. Warren, and M.D. Hurley. 1986. A Hierarchical Framework for Stream Habitat Classification: Viewing Streams in a Watershed Context. Environmental Management 10(2):199-214.

Gregory, S.V., G.A. Lamberti, and K.M.S. Moore. 1989. Influence of Valley Floor Landforms on Stream Ecosystems. US Department of Agriculture Forest Service General Technical Report PSW-110, pp. 3-8.

Humphrey, J.H., R.C. Hunn, and G.B. Shea. 1985. Hydraulic Characteristics of Steep Mountain Streams During Low and High Flow Conditions, and Implications for Fishery Habitat. In Proceedings, Symposium on Small Hydropower and Fisheries. American Fisheries Society, Denver, Colorado.

Leopold, L.B. 1994. A View of the River. Harvard University Press, Cambridge, Massachusetts.

Montgomery, D.R., and J.M. Buffington. 1993. Channel Classification, Prediction of Channel Response, and Assessment of Channel Condition. Washington State Timber/Fish/Wildlife Report TFW-SH10-93-002, Olympia.

Moore, K., K. Jones, and J. Dambacher. 1997. Methods for Stream Habitat Surveys. Aquatic Inventory Project, Natural Production Program: Oregon Department of Fish and Wildlife.

Oregon Department of Land Conservation and Development. 1987. Estuary Plan Book.

Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitwell, and K.A. Duncan. 1995. User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho. US Forest Service Intermountain Research Station, INT-GTR-322, Boise, Idaho.

Paustian, S.J. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26.

Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena 22:(169-199).

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology.

Schuett-Hanes, D., A. Pleus, L. Bullchild, and S. Hall. 1994. Ambient Monitoring Program Manual. Northwest Indian Fisheries Commission, TFW-AM9-94-001, Olympia, Washington.

Washington Forest Practices Board. 1997. Standard Methodology for Conducting Watershed Analysis. Version 4.0.

Whittier, T.R., R.M. Hughes, and D.P. Larsen. 1988. Correspondence Between Ecoregions and Spatial Patterns in Stream Ecosystems in Oregon. Canadian Journal of Fisheries and Aquatic Science 45:1264-1278.

GLOSSARY

channel confinement: Ratio of bankfull channel width to width of modern floodplain. Modern floodplain is the flood-prone area and may correspond to the 100-year floodplain. Typically, channel confinement is a description of how much a channel can move within its valley before it is stopped by a hill slope or terrace.

channel gradient class: Channel gradient is the slope of the channel bed along a line connecting the deepest points (thalweg) of the channel. Channel reaches are then grouped according to gradient into stream gradient classes (<1%, 1-2%, 2-4%, etc.)

Channel Habitat Types (CHT): Groups of stream channels with similar gradient, ***channel pattern***, and ***confinement***. Channels within a particular group are expected to respond similarly to changes in environmental factors that influence channel conditions. In this process, CHTs are used to organize information at a scale relevant to aquatic resources, and lead to identification of restoration opportunities.

channel pattern: Description of how a stream channel looks as it flows down its valley (for example, braided channel or meandering channel).

contour interval: A line of equal elevation drawn on a topographic map.

Geographic Information System (GIS): A computer system designed for storage, manipulation, and presentation of geographical information such as topography, elevation, geology etc.

large woody debris (LWD): Logs, stumps, or root wads in the stream channel, or nearby. These function to create pools and cover for fish, and to trap and sort stream gravels.

morphologic features: From the Greek root meaning structure or form; in stream channels, those physical features (such as gradient and confinement) that reflect the influence of processes which operate on a landscape scale (such as geology and climate).

morphology: A branch of science dealing with the structure and form of objects. Geomorphology as applied to stream channels refers to the nature of landforms and topographic features.

recurrence interval(s) (return interval): Determined from historical records. The average length of time between two events (rain, flooding) of the same size or larger. Recurrence intervals are associated with a probability. (For example, a 25-year flood would have a 4% probability of happening in any given year.)

riparian area: The area adjacent to the stream channel that interacts and is dependent on the stream for biologic integrity.

stereo aerial photo: Pairs of photos taken from the air that can be viewed through a stereoscope to reveal three-dimensional features of the landscape.

stream segment: Contiguous stream reaches that possess similar stream gradient and confinement, and which can be used for analysis.

Appendix III-B
Blank Forms

Form CHT-1: Channel Habitat Type Field Verification

Name:____ Date:______________
Watershed/sub-basin:____
Segment location:____
Oregon stream size:____
Preliminary channel habitat type:_________________________ Final channel habitat type:__________
Stream name:____
Township/Range/Section:____
Average of__________observations/measurements over_____________length (ft) of channel.
Channel slope:
Single or multiple channels:
Floodplain width:
Bankfull channel width (from top of right bank to top of left bank):
Ratio of floodplain width to bankfull width:
Describe material in stream banks:
Size of average bed particles: silt/clay (<0.062 mm); sand (0.062 to 2.0 mm); gravel (2 to 64 mm); cobbles (64 to 257 mm); boulders (257 to 2,032 mm); bedrock

Rough sketch of valley and stream cross section—add scale:

Comments:

Channel habitat type determination:

- ☐ Same as initial type
- ☐ Differs from initial channel habitat type by:
  Can be extrapolated to the following areas:
- ☐ Divided into additional type (CAUTION: Can you provide the same mapping resolution everywhere appropriate in the basin based on this field verification? If not, lumping is better.)

Form CHT-2: CHT Summary Sheet

Analysts Name:

Date: **Page** **of**

Watershed:

Sub-basin	ES	EL	FP1	FP2	FP3	AF	LM	LC	MM	MC	MH	MV	BC	SV	VH
Entire Watershed															

Form CHT-3: Channel Habitat Type Classification Confidence Evaluation

Name:____ Date:_____________________

Technical expertise or relevant experience:____

Watershed Name:__________________________ Subwatershed Name:______________________________

Channel types:____

Resources used:

- ☐ Topographic maps
- ☐ ODF stream sizes
- ☐ Other ________________________________
- ☐ Field verification
- ☐ Stream surveys

Confidence in base map stream coverage:

- ☐ Local expert says high / low (circle one) degree of accuracy based on field experience (provide name of local expert):
- ☐ High degree of accuracy because stream mapping based primarily on field verification of presence/absence of streams (provide source of info/mapping):
- ☐ No verification; suspect some streams not mapped (explain rationale):
- ☐ No verification; suspect many streams not mapped (explain rationale; what types?):
- ☐ Additional criteria/relevant information (describe):

Confidence in channel habitat typing:

- ☐ **Low to moderate:** Unsure of procedures, didn't consult expert, didn't use field surveys, no field verification
- ☐ **Moderate:** Understood and followed procedures, but no field verification
- ☐ **Moderate:** Some field verification, but found range of conditions hard to type
- ☐ **Moderate to high:** Field surveys available and useful for many streams, but no field verification
- ☐ **Moderate to high:** Some field verification on questionable segments only
- ☐ **High:** Used field surveys and field-verified many segments of all types
- ☐ **If none of the above** categories fits, describe your own confidence level and rationale:

Recommendations for additional field verification, if any, and why: