A BIOLOGICAL STRATEGY TO PROTECT AND RESTORE SALMONID HABITAT IN THE UPPER COLUMBIA REGION

A Draft Report to the Upper Columbia Salmon Recovery Board
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Acronyms and Definitions

Assessment Unit -	Comprised of either a portion of a primary sub-watershed or the entire sub-watershed, and, if the former, are used to categorize that sub-watershed into smaller units.
CCD -	Cascadia Conservation District
CCNRD -	Chelan County Natural Resource Department
CCT -	Colville Confederated Tribes
DPS -	Distinct Population Segment
Ecological concerns -	Specific features of freshwater habitat and ecology that influence the productivity and abundance of salmonids that restoration projects are meant to address.
ESU -	Evolutionary Significant Unit
Focal species -	Non-ESA listed species of interest.
Geo-fluvial processes -	The processes of water and sediment movement in river catchments and channels and their floodplains – together with the forms produced by those processes.
ICTRT -	Interior Columbia Technical Recovery Team
MaSA -	Major Spawning Area
MiSA -	Minor Spawning Area
MPG -	Major Population Group
Primary sub-watershed -	Those lands and adjacent streams that make up a substantial amount of flow entering the major river within a watershed. Secondary or tertiary sub-watershed are streams that may enter into either the major river of a watershed or primary sub-watershed, usually at the HUC 6 level.
Priority actions -	The RTT has defined a two-tiered approach for both protection and restoration activities. Tier I protection activities would be to protect high functioning habitat that has natural geo-fluvial processes in place, while Tier II activities would be to protect habitat areas that are in need of restoration. For restoration actions, Tier I activities would restore fluvial-geomorphic processes, while Tier II activities would increase instream habitat complexity. See Section 3.3 for further information.
Priority areas -	The RTT defines priority areas in four categories, depending on the condition of the existing habitat. See Section 3.3 for further information.

Process-based restoration -	Projects that will result in long-term changes to natural watershed and fluvial processes. Projects like riparian plantings, increasing flows, removing structures that limit floodplain connectivity are all examples of projects that restore natural processes.
Reach -	Generally composed of geomorphically similar subsections of an assessment unit
RTT -	Regional Technical Team
Species of concern -	ESA-listed or non-listed species that habitat projects are focused on.
UCR -	Upper Columbia Region
UCSRB -	Upper Columbia Salmon Recovery Board
USBOR -	United States Bureau of Reclamation
VSP -	Viable Salmonid Population
WDFW -	Washington Department of Fish and Wildlife
YN -	Yakama Nation

Table of Contents

List of Tables

List of Figures

Use of this document

This biological strategy identifies the key biological considerations in protecting and restoring habitat. We encourage project sponsors to use this strategy for identifying the locations and types of projects with a high likelihood of providing biological benefit for the recovery of ESA-listed salmonids (focal species) by improving abundance, productivity (freshwater), spatial structure, and diversity for these species and other species of concern (e.g., Westslope cutthroat trout and Pacific lamprey).

The RTT recommends that use of this document begin with understanding the background information provided in Sections 1-3 and Appendices A and B; followed by examination of Appendix E (detailed summary of habitat status and ecological concerns for each assessment units); and finally, a familiarization with the new scoring criteria (Appendix C).

In addition, in Table 3 the RTT lists the assessment units for each watershed (also in Appendix E) in the hope that the assessment units as described in Table 3 will serve as the definitive assessment-unit list for the Upper Columbia Region. The RTT has also provided additional information pertaining to completed assessments, with recommendations for future assessments (Table 4). Appendix D defines the necessary components of an assessment with recommendations on how project sponsors can use assessments to develop projects.

Finally, the RTT encourages further dialogue with stakeholders to ensure that the concepts, criteria, and other information in this document are understood and useable.

Changes from Previous Versions of the Biological Strategy

The RTT intends that this revision of the previous draft Biological Strategy (RTT 2008) will accomplish four objectives:

1) Better define the prioritization of habitat actions.
2) Update the technical appendices and the text within the main body of the strategy with new information regarding restoration strategies and priorities.
3) Provide revised technical scoring criteria for habitat restoration, protection, assessment, and design projects submitted for funding through various sources.
4) Updated the informational-needs section.

This report is an update to and replaces all earlier versions of the Biological Strategy provided to the UCSRB (RTT 2000; RTT 2002; RTT 2008). We anticipate the need for future updates as our understanding of salmonid ecology and restoration science improves and we achieve various restoration and protection objectives.

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1.0 Introduction

This document outlines the biological considerations for the protection and restoration salmonid habitat in the Upper Columbia Region (UCR). Our intent in documenting these considerations is to provide a technical foundation for setting priorities based on available information and the professional judgment of the natural resource scientists that are familiar with the region. This report was developed by the Regional Technical Team (RTT), which was formed in 2000 by request of the Upper Columbia Salmon Recovery Board (UCSRB) to provide technical support to the UCSRB.

The UCSRB is a partnership among Chelan, Douglas, and Okanogan counties, the Yakama Nation, and Colville Confederated Tribes in cooperation with local, state, and federal partners. The mission of the UCSRB is to restore viable and sustainable populations of salmon, steelhead, and other species of concern (e.g., Westslope cutthroat trout and Pacific lamprey) through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia Region.

The RTT performs the following functions: 1) recommend region-wide approaches to protect and restore salmonid habitat, 2) guide the development of and evaluate salmonid recovery projects within the UCR, 3) review and coordinate monitoring and evaluation activities to the extent possible, and 4) develop and guide salmonid recovery monitoring plans. The RTT may adopt other functions when considered appropriate by the members, as described in the RTT Operating Procedures (last updated 2012).

The RTT uses a scientific foundation (see Section 2.1) to identify projects that will best contribute to the recovery of salmonids and other species of concern.

This document is the RTT's biological strategy to protect and restore salmonid habitat in the Upper Columbia Region. The intent of the document is to provide support and guidance on implementing the Upper Columbia Spring Chinook and Steelhead Recovery Plan (Recovery Plan (UCSRB 2007)), which also includes actions for bull trout.

The species of concern addressed in this strategy are those listed for federal protection under the ESA including spring Chinook salmon (*Oncorhynchus tshawytscha)*, steelhead (*O. mykiss*), and bull trout (*Salvelinus confluentus)*. However, other species of interest include summer Chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*), westslope cutthroat trout (*O. clarki*) and Pacific lamprey (*Entosphenus tridentada)*. This strategy recognizes the ongoing reintroduction of coho salmon (*O. kisutch*) to the Wenatchee and Methow Subbasins and the future reintroduction of spring Chinook to the Okanogan Subbasin.

The UCR (Figure 1) comprises the mainstem Columbia River and its tributaries upstream of Rock Island Dam to the tailrace of Chief Joseph Dam, including four major subbasins, or watersheds; the Wenatchee, Entiat, Methow, and Okanogan. This UCR description is consistent with the Evolutionarily Significant Unit (ESU) boundary for the extant major population group (MPG) for spring Chinook salmon, the Upper Columbia Recovery Unit for bull trout, but not for the

steelhead Distinct Population Segment (DPS). The steelhead DPS extends downstream to the confluence with the Yakima River and includes one historic population (Crab Creek) excluded from the Upper Columbia Region as currently defined (Figure 1; ICTRT (2007)). For technical and biological purposes, this report will not consider actions and recommendations for areas and watersheds downstream of Rock Island Dam.

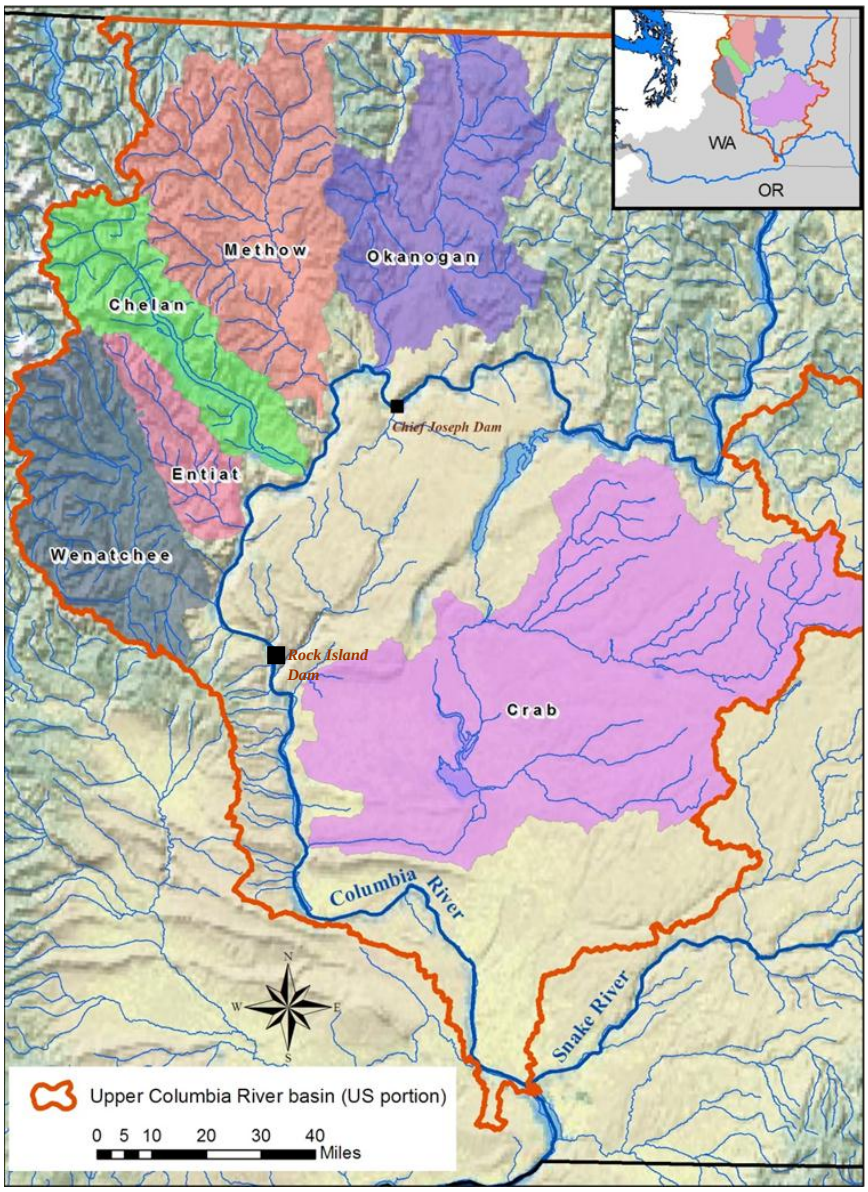

Figure 1. Map of the Upper Columbia Region and Crab Creek.

2.0 Development of Restoration Activities in the Upper Columbia Region

The RTT has worked with the various stakeholders within the UCR and other regions to generate criteria and recommendations on how to develop habitat restoration projects and criteria for habitat protection. The following sections summarize the background information upon which the RTT bases its recommended approach.

2.1. Scientific Foundation

Threatened, endangered and unlisted salmonids and other species of concern (e.g., Pacific lamprey) are found in most, but not all watersheds in the Upper Columbia Region. Originally, the RTT biological strategy (RTT 2000) adapted the work of MacDonald et al. (1996) who identified Significant Sub-watersheds (HUC-6 level) for spring Chinook salmon, summer Chinook salmon, sockeye salmon, summer steelhead, bull trout, and westslope cutthroat trout. That framework was generally consistent with the concepts that were more formally defined in the Viable Salmonid Population (VSP) criteria for listed species, described in McElhany et al. (2000). However, unlike the Significant Sub-watershed framework, the VSP criteria provide a link to ESA recovery. With the incorporation of the VSP construct, the UCSRB (2007) adopted the same biological principles for developing their recommendations as were used by the Interior Columbia Technical Recovery Team (ICTRT) for ESU/DPS and population viability criteria.

2.1.1. VSP Framework Summary

The following is a brief summary of the VSP framework. Appendix A provides additional details on the VSP framework.

Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, productivity (population growth rate), spatial structure, and diversity (defined in Appendix A). A viable distinct population segment (DPS) or, evolutionary significant unit (ESU, as applied to Pacific salmon) is **naturally** self-sustaining, with a high probability of persistence over a 100-year time period.

The structure for determining viability comprises major spawning areas (MaSA) within watersheds that collectively make up independent populations, a number of which can form major population groups (MPGs), that, when combined make up a DPS or ESU (Figure 2). Viability is ultimately determined at the DPS/ESU level.

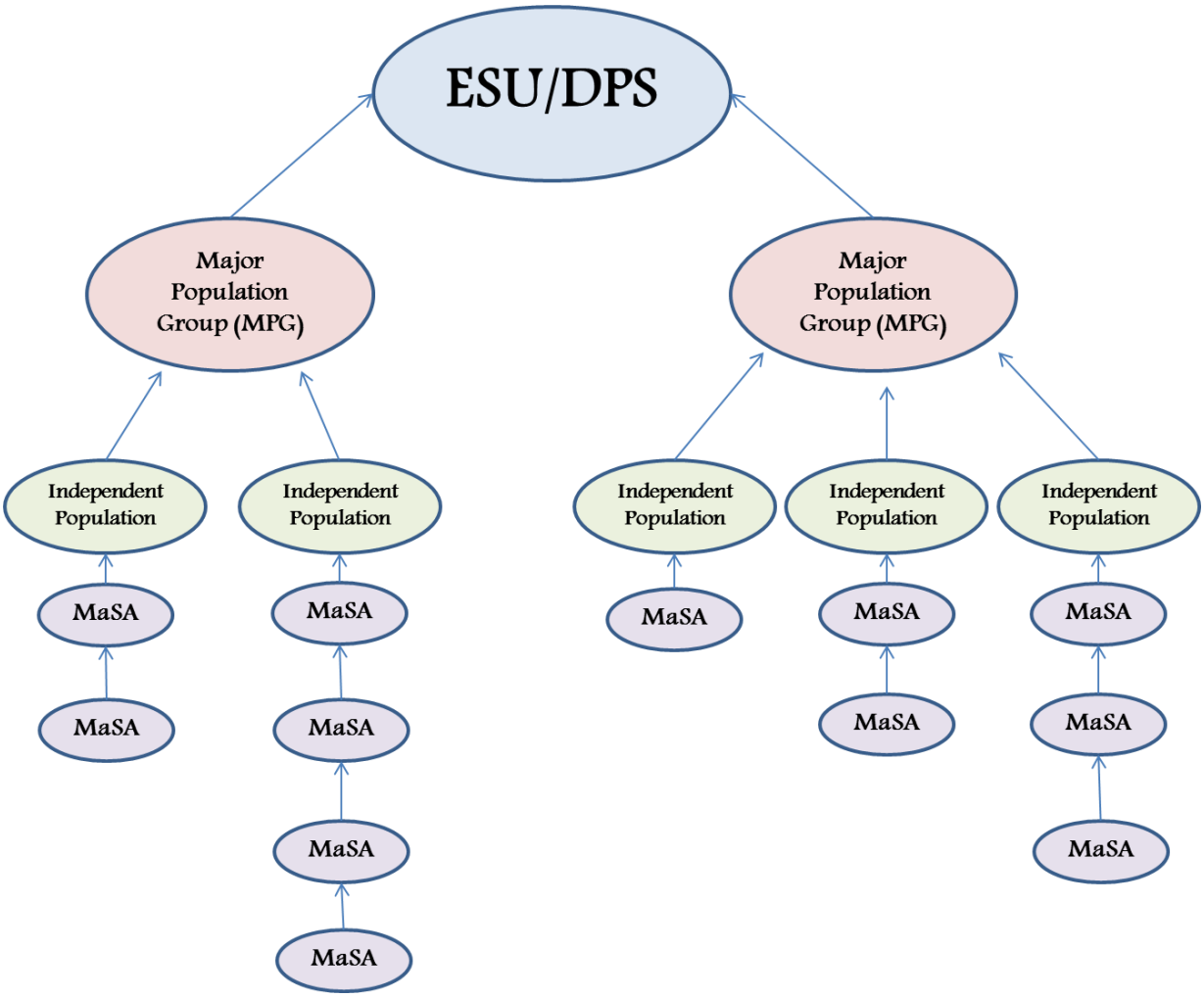

Figure 2. Overview diagram of the hierarchy for the components of ESU/DPS viability.

The ICTRT (2007) established four categories for populations based on *intrinsic potential*[1]: Basic, Intermediate, Large, and Very Large. The ICTRT then assigned species-specific minimum abundance and productivity thresholds associated with the categorizations. In the UCR, the population-viability criteria for each population of spring Chinook salmon and steelhead are shown in Table 1.

[1] Intrinsic potential was based on available Geographic Information System (GIS) data layers showing stream characteristics (e.g. channel width, gradient, valley confinement) and empirically derived relationships between habitat type, stream structure, landscape processes, and spawning.

Table 1. Hierarchical organization and abundance and productivity thresholds (UCSRB 2007[a]) for spring Chinook salmon and steelhead populations within the Upper Columbia Region.

ESU	Major Population Grouping	Independent Population	Minimum Abundance Threshold	Productivity Threshold
Upper Columbia Steelhead DPS	East Cascades	Wenatchee	1,000	1.1
		Entiat	500	1.2
		Methow	1,000	1.1
		Okanogan[b]	500	1.2
		Crab Creek	Not defined	
	Spokane River	Not defined (extinct)		
	Kettle/Colville/Sanpoil	Not defined (extinct)		
Upper Columbia Spring Chinook ESU	East Cascades	Wenatchee	2,000	1.2
		Entiat	500	1.4
		Methow	2,000	1.2
		Okanogan	Not defined (extinct)	
	Spokane River	Not defined (extinct)		
	Kettle/Colville/Sanpoil	Not defined (extinct)		

[a] The criteria in UCSRB (2007) differs from recommendations from the ICTRT (2007). The ICTRT recommended that at least one population per MPG meet the "highly viable" criteria, which would primarily increase the threshold for productivity. The UCSRB elected to keep the criteria that all populations have to meet "viability" criteria.

[b] The viability criteria for Okanogan steelhead are for only the US portion of the population. Including the Canadian portion of the population increases the categorical level of the population from "Basic" to "Intermediate" (500 to 1,000).

2.1.2. Other Considerations

The RTT biological strategy provides guidance on habitat actions that are expected to contribute to improved status of the VSP parameters. However, factors other than habitat conditions may limit the response of the target species to those actions. For example, improving the quality and quantity of summer and winter rearing habitat should increase population productivity by improving egg-to-smolt (migrant) survival. Nevertheless, increases in spawners may not be realized if survival outside the tributaries decreases during the same time period. Likewise, spawner composition comprised of high proportions of hatchery-origin fish on the spawning grounds has been identified as a high risk factor for diversity and potentially productivity throughout the UCR (UCSRB 2007), but improvements to the habitat will not directly affect spawner composition, which will require the reform of hatchery programs. Therefore this biological strategy focuses on within-basin improvements such as increasing the egg-to-smolt survival of the target populations because hatchery reform and factors affecting survival outside of the UCR's tributaries are not within the purview of the RTT.

2.2. Ecological Processes

Process-based Restoration

The RTT defines *natural stream/watershed processes* as those processes affecting habitat form and functions at large spatial and temporal scales. Connectivity to the floodplain, absence of

barriers, and large, intact riparian zones are all features of natural stream/watershed processes. *Process-based restoration* refers to projects that will result in long-term changes to natural watershed and fluvial processes. Another way to look at process-based restoration is that it addresses the cause or source of the ecological concern, and not just the symptom. Projects like riparian plantings, increasing flows, removing structures that limit floodplain connectivity and channel migration are all examples of projects that restore natural processes.

To implement successful restoration projects, one must understand the ecological processes that shape and form the river and associated landscapes. Many restoration projects fail because of misunderstanding of or lack of consideration for natural processes operating at various spatial and temporal scales and how human activities and other factors affect or control those processes (Frissell and Nawa 1992; Roni et al. 2002). Because these factors and processes operate at multiple spatial and temporal scales, restoration ecologists and practitioners must view the river holistically as a continuous "riverscape" (Fausch et al. 2002). The basis of the riverscape construct is that ecosystem processes operating at different scales form a nested, interdependent system where one level influences other levels. Thus, an understanding of one level is greatly informed by those levels above and below it. Furthermore, many processes that create habitat operate on time scales of decades or longer (e.g., channel migration and the formation of off-channel habitat) (Leopold et al. 1992). Interrupting natural ecosystem processes can result in the loss of fish habitat over multiple time scales.

In simple terms, one can view the riverscape at three interconnected spatial scales: the geographic scale, the watershed scale, and the habitat/reach scale (Naiman et al. 1992; Montgomery and Buffington 1998). At the geographic scale, factors such as geology, soils, vegetation, and climate serve as ultimate "top down" spatial controls (Leopold et al. 1992; Montgomery and Bolton 2003). These factors operate over large areas, remain stable over relatively long time periods, and act to shape the overall character and attainable conditions within a watershed or basin. Factors at the watershed scale are a function of geographic-scale factors and refer to more local conditions of geology, landform, and biotic processes that operate over smaller areas and shorter time periods and can be viewed as "bottom up" spatial controls. These factors include processes such as stream flows, temperature, sediment input, and channel migration. Factors operating at both the geographic and watershed scales serve to define flow (water and sediment) characteristics, which in turn shape habitat/reach-scale characteristics within broadly predictable ranges. Habitat/reach-scale factors include pool-riffle ratios, channel size, riparian vegetation, substrate composition, large woody debris, and bank stability. This is the scale at which fish species exploit resources and reproduce. This is also the scale at which most restoration occurs (Fausch et al. 2002).

Human activities that disrupt natural watersheds tend to act on watershed processes that form suitable habitat conditions at the habitat/reach scale (Opperman et al. 2005). For example, human activities can alter connectivity and the delivery of woody debris, water, sediment, and nutrients to a stream (Gregory et al. 2003; Stockner 2003; Opperman et al. 2005). Interruption of these processes reduces habitat quality and quantity at the habitat/reach scale by decreasing spawning and rearing space, food, and migration corridors. Therefore, restoration actions can focus on watershed processes or on habitats themselves (Figure 3). For example, some restoration

techniques, such as re-vegetation, road removal, and establishing normative stream flows focus on restoring natural processes at the watershed scale. These techniques affect sediment supply, delivery of organic material, and channel migration. In contrast, other techniques focus on manipulating or enhancing habitat directly. Examples include wood and boulder placement, nutrient enrichment, and creating new habitat (Gregory et al. 2003; Stockner 2003; Morley et al. 2005). Unless well planned, with an in-depth understanding of ultimate controls and processes across multiple spatial and temporal scales, most habitat-enhancement actions tend to be relatively short lived if the disruption of the underlying process is not corrected (Fausch et al. 2002).

Successful restoration requires a holistic approach that considers processes operating at multiple spatial and temporal scales (Figure 3). A watershed or ecosystem assessment of current and historical conditions and disrupted processes is necessary to identify restoration opportunities consistent with reestablishing the natural processes and functions that create habitat (Roni et al. 2002). It is also essential to determine the appropriate sequencing of restoration actions, and how to prioritize actions (Roni et al. 2002). In general, restoration of watershed processes should precede or be conducted in conjunction with habitat enhancement. This is not to say that habitat enhancement techniques are inappropriate, but rather to emphasize the importance of coupling enhancement efforts with restoration of watershed processes. Clearly, in some locations (e.g., heavily urbanized areas) restoration of watershed processes may not be feasible. Habitat-enhancement techniques may be the only solution in these areas. In other areas, habitat enhancement techniques fall within the context of watershed processes and therefore are appropriate restoration measures.

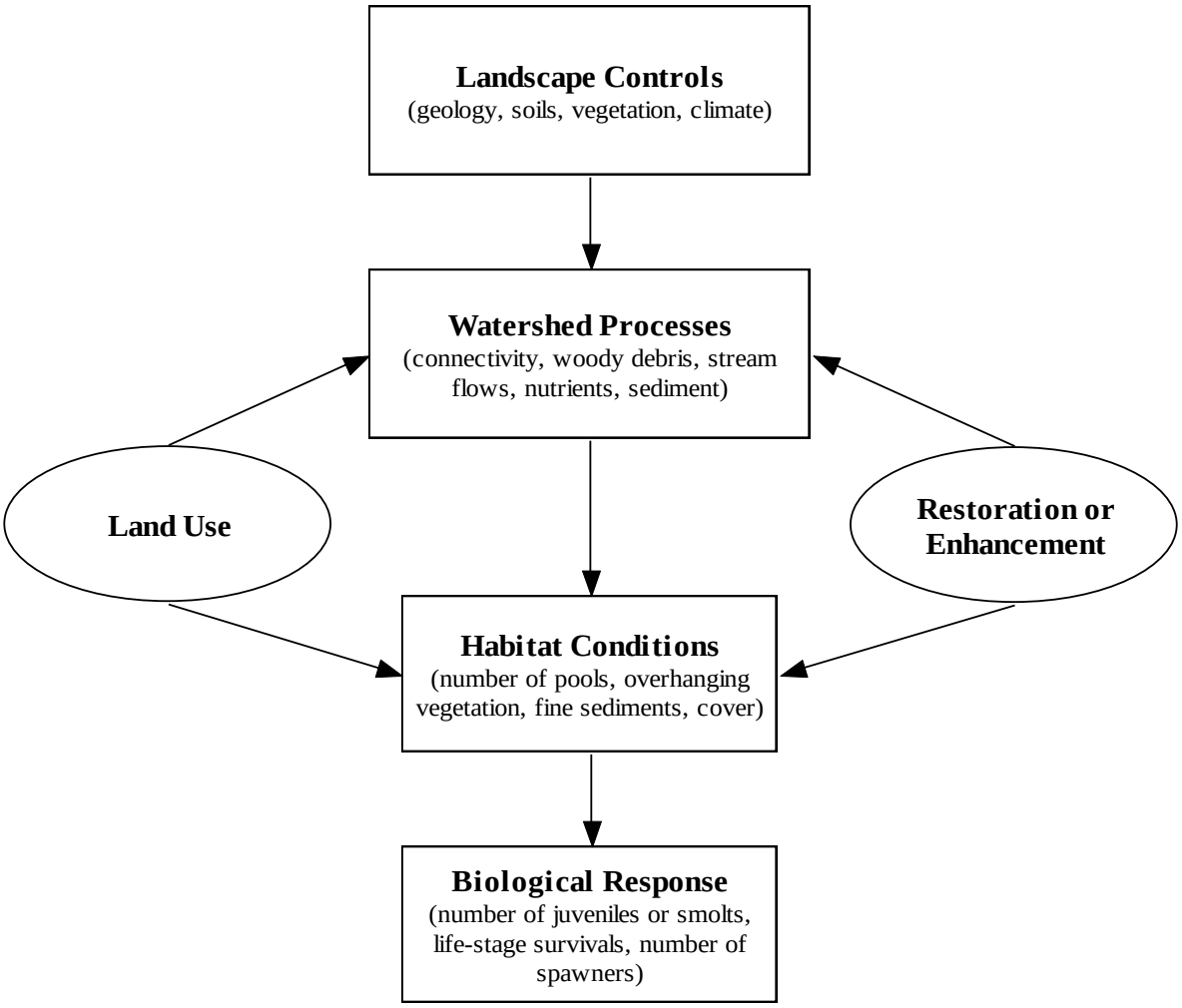

Figure 3. Simple model showing linkages between landscape controls and watershed processes, and how land use and restoration or enhancement can influence habitat and biota (modified from Roni (2005)).

2.3. Ecological Concerns

Ecological concerns were formerly known as limiting factors. Ecological concerns are those specific features of freshwater habitat and ecology that influence the productivity and abundance of salmonids, and that restoration projects are meant to address. Appendix B shows the ecological concerns based on Hamm (2012). Understanding the ecological concerns, what specific areas they apply to and what actions can be used to address them is important in habitat restoration success.

3.0 Priorities in Habitat Preservation and Restoration

3.1. Habitat Protection Overview

The highest priority for protecting biological productivity should be to allow natural geo-fluvial processes, such as unrestricted stream channel migration and sediment transport, instream

complexity, and floodplain function. The principal means to meet this objective is to protect the channel-migration zone and the riparian zone beyond the channel-migration zone, especially *when these features are functioning at a high level*. Predetermined riparian protection measures (i.e., buffer strip widths) for each site may not be biologically effective because riparian function depends on site-specific considerations including channel type, aspect, dominant tree species, floodplain character, presence of wetlands or off-channel features, and the potential for channel migration. Some areas have more acute needs for protection, because they may be within significant spawning or rearing areas, or may be at imminent risk to future habitat degradation. Other areas, though degraded, may have high value because of restoration potential. In general, habitat protection should target the highest functioning habitat at the greatest risk of degradation, or those habitats with the greatest potential for restoring geo-fluvial processes.

Protection of existing stream flows in virtually all subbasins in the UCR is important to maintaining biological productivity. Currently, the primary means to protect existing flows are regulatory in nature. Additionally, some UCR streams need increased flows to address chronic sources of mortality to salmonids; although, inadequate flows may occur naturally in some areas (such as the upper Methow). Diversion of water for out-of-stream uses (principally for irrigation and municipalities) is the most tangible impact to instream flow needs for fish. In addition, degradation of floodplain (and some upland) habitats exacerbates the peak and nadir of seasonal flows in all UCR subbasins, which may dramatically reduce the productivity and expression of diverse life histories in region salmonid populations. The means to protect or increase flows are discussed in the section on habitat restoration.

3.2. Habitat Restoration Overview

The highest priority for increasing biological productivity in degraded areas is to restore the complexity of the stream channel and floodplain function. The RTT recommends a range of strategies for habitat restoration in the UCR, based on a fundamental emphasis on promoting properly functioning geo-fluvial processes that control habitat diversity, instream flows, and water quality throughout the watershed. Most of these efforts will likely be on the lower stream reaches and aggradation zones (typically areas of low stream gradient where deposition of substrate materials occurs). Restoration in these areas would benefit a broad range of species and populations. Examples of restoration strategies may include, but are not limited to those in Table 2.

Table 2. Non-prescriptive list of suggested habitat restoration strategies for various locations in the Upper Columbia recovery region (not in priority order, and only appropriate assessment can determine the suitability of each action for a specific area).

Restoration Strategies	
Off Channel / Floodplain Restoration	Side Channel Reconnection
Provide improved fish passage	Screen Diversions Compliance to Standards
Riparian Restoration	Road Management
Instream Structures	Large Wood Restoration
Exotic Species Control	Increase Nutrients to Watershed
Water Quantity Restoration	Channel Restoration

Restoration Strategies	
Decrease Water Temperature	Sediment Reduction

Actions that rectify the sources of the habitat degradation can have more benefits to biological productivity in the long run than addressing specific instream complexity needs. Using *process-based restoration* may be economically more efficient, and more permanent than measures that mechanically alter the stream channel at the habitat or reach scales.

In some situations, restoration projects may accomplish both short-term and long-term objectives. For example, securing large wood (LW) to stabilize erosive banks may allow interim stream bank protection and increase salmonid habitat, while passive restoration and revegetation will ensure proper functioning riparian conditions for the long term. The RTT recognizes these projects can be biologically effective when the initiation of the short-term strategy has been integrated with the long-term strategy and designed and implemented in accordance with the sequencing and prioritization determined from an appropriate assessment. Each active restoration project should be reviewed on a case-by-case basis.

4.0 Priorities Across Varied Landscapes

Previously (RTT 2002; RTT 2008), the RTT used a categorization system to describe drainages in respect to the current condition of fish habitat. It remains important to categorize streams on the current habitat conditions, but the RTT has deemphasized current conditions so that projects that are proposed in habitat that is currently not functioning well do not get a reduced priority rating. A discussion of priorities follows the discussion on categorization based on geography and habitat condition (below). The RTT also revised its scoring, or ranking criteria to reflect the revised language within this section (Appendix C).

4.1. Geographic Categories

4.1.1. Watershed

The largest geographic category that pertains to habitat within the UCR is the watershed, also known as a subbasin (Table 3). A watershed is the total area of land and adjacent waters commonly named after the major rivers that drain them. Watersheds are also classified using Hydrologic Unit Codes (HUC). Hydrologic unit codes are a way of identifying all of the drainage basins in the United States in a nested arrangement from largest to smallest. Within the UCR, watersheds are considered to be at the HUC 5 level.

Primary sub-watershed

Primary sub-watersheds are those lands and adjacent streams that make up a substantial amount of flow entering the major river within a watershed (Table 3). Secondary or tertiary sub-watersheds are streams that may enter into either the major river of a watershed or primary sub-watershed, usually at the HUC 6 level.

Assessment Units

Assessment Units comprise either a portion of a primary sub-watershed or the entire sub-watershed, and, if the former, are used to categorize that sub-watershed into smaller units.

Reach

A reach is generally composed of geomorphically similar subsections of an assessment unit.

Table 3. Description of assessment units in the Upper Columbia Region (based on Table 5-10 of UCSRB 2007, and recent updates). Note: river miles may change based on the dynamics of the river.

Watershed (sub-basin)	Assessment Unit (or primary sub-watershed)	River miles	Secondary and tertiary sub-watersheds	Fish Use	Comment
Wenatchee	Lake Wenatchee			Adult holding and juvenile rearing for sockeye. Spring Chinook, steelhead holding and possibly rearing. Cutthroat and bull trout rearing. bull trout foraging, migrating, overwintering (FMO).	For migratory bull trout-"rearing" occurs in spawning reaches and when juveniles leave after1 to 4 years they enter foraging, migrating, and overwintering areas where they are considered subadults until grown to maturity, then return to spawn. Post spawn, adults then re-enter FMO
	Upper Wenatchee (Chiwaukum Creek to Lake Wenatchee)	35.8 - 54	Beaver, Chiwaukum (RM 4.3-0); Skinny Cr (RM 1.3-0)	MaSA for spring Chinook and steelhead. Stronghold for summer Chinook. Bull trout FMO	
	Middle Wenatchee (Tumwater Canyon; Icicle River to Chiwaukum Creek)	25.5-35.8		MaSA for steelhead. Stronghold for summer Chinook. Bull trout FMO	
	Lower Wenatchee (Icicle River to confluence with Columbia River	0-25.5		MaSA for steelhead. Stronghold for summer Chinook	
	Little Wenatchee River	0 - 7.8		MaSA for spring Chinook, MiSA for steelhead. Bull trout FMO, possible spawning and rearing (SR)	
	White River	0 - 14.3	Napeequa (RM 2.2-0), Panther creeks (RM 0.7-0)	MaSA for spring Chinook, MiSA for steelhead. Stronghold for sockeye. Bull trout SR, FMO	
	Nason Creek	0 - 17	Coulter, Roaring, Gill Whitepine, Kahler creeks	MaSA for spring Chinook and steelhead. Stronghold for coho. Bull trout FMO, possible SR upper part of reach	
	Chiwawa River	0 - 35	Chickimin, Big Meadow, Rock,	MaSA for spring Chinook and steelhead.	

Watershed (sub-basin)	Assessment Unit (or primary sub-watershed)	River miles	Secondary and tertiary sub-watersheds	Fish Use	Comment
			Clear, Phelps creeks	Bull trout SR, FMO	
	Icicle Creek	0 - 26	French, Jack, Eightmile, Fourth-of-July creeks	MiSA for spring Chinook salmon and a MaSA (in the lower 2 miles) for steelhead. Bull trout FMO with SR in upper tribs	Boulder field at RM 5.6 currently considered a barrier to Chinook salmon
	Chumstick Creek	0 - 12.4	Eagle, Little Chumstick, Sunitsch, Freund Canyon, creeks	MaSA for steelhead.	Current extent of passage to RM 10 (priority is downstream from RM 10)
	Peshastin Creek	0 - 16.3	Ingalls (RM 9.8-0), Mill, Ruby, Shaser, Tronsen, Scotty, Kings creeks	MiSA for spring Chinook and MaSA for steelhead. Bull trout FMO with SR in Ingalls and Etienne	
	Mission Creek	0 - 16.3	Brender, Yaksum, Sand, East Fork creeks	MiSA for steelhead.	
Entiat	Upper-middle Entiat	26 - 34		Stronghold for bull trout spawning and rearing	
	Middle Entiat	16 - 26	Roaring, Stormy, Mud creeks	MaSA for spring Chinook and steelhead. Bull trout FMO	
	Lower Entiat	0 - 16		MaSA for spring Chinook and steelhead. Bull trout FMO	
	Mad River	0 - ?	Tillicum	MaSA for spring Chinook and steelhead. Bull trout FMO with SR above Young Cr	
Methow	Upper Methow	61 - 75	Goat, Little Boulder creeks	MaSA for spring Chinook and steelhead, portion of core area for bull trout. Bull trout FMO, with SR in Goat	
	Upper-Middle Methow	51.6 - 61	Hancock, Wolf	MaSA for spring Chinook and steelhead, portion of core area for bull trout (including local population in Wolf Creek). Bull trout FMO	Previously, Wolf and Hancock were grouped together. They should be considered separately.
	Middle Methow	27.5 - 51.6		MaSA for steelhead and summer Chinook. Bull trout FMO	
	Lower Methow	0 - 27.5		MiSA for steelhead. Bull trout FMO	
	Early Winters Creek	0 - ?		MaSA for spring Chinook and steelhead. Local population (possibly including resident population) bull trout. Bull trout resident above falls at Hwy 22, migratory SR and FMO below falls	
	Lost River	0 - 11.4		MaSA for spring Chinook and steelhead. Local population (two distinct groups in upper and lower with break at Monument Creek confluence) bull trout. Lower lost	

Watershed (sub-basin)	Assessment Unit (or primary sub-watershed)	River miles	Secondary and tertiary sub-watersheds	Fish Use	Comment
				is FMO for migratory bull trout with SR in vicinity of (and in lower) Monument Creek. Landslide in Gorge is migratory barrier between upper and lower populations.	
	Wolf Creek	0-?		Bull trout SR with FMO in lower creek.	
	Upper Chewuch	20 - 35	Thirtymile, Andrews, Lake creeks	MaSA for spring Chinook and steelhead. Two local populations of bull trout (SR in Lake Creek and upper Chewuch).	
	Lower Chewuch	0 - 20	Twentymile, Eightmile, Boulder, Cub creeks	MaSA for spring Chinook and steelhead. Bull trout FMO, with some SR in lower Eightmile	
	Upper Twisp	14 - 31	Reynolds, South, North creeks	MaSA for spring Chinook and steelhead. Local population of bull trout. Bull trout SR upstream of Reynolds, with FMO below	
	Lower Twisp	0 - 14	Little Bridge, Poorman, Buttermilk creeks	MaSA for spring Chinook and steelhead. Bull trout FMO with SR in Buttermilk	
	Beaver Creek	0 - 10	Frazier, Lightning, Blue Buck, and South Fork Beaver creeks	MaSA for steelhead. Bull trout SR in Blue Buck, FMO for lower Beaver.	
	Gold Creek	0 - 5.5	South Fork, North Fork, Crater, Foggy Dew creeks	MiSA for steelhead Bull trout SR in Foggy Dew and Crater, FMO for Gold	
	Libby Creek	0 - 7.4	North Fork Libby, South Fork Libby creeks	MiSA for steelhead. Bull trout use is uncertain, maybe FMO lower Libby.	
Okanogan	Inundated Okanogan	0 - 15.1		A few tagged migratory bull trout have explored lower Okanogan briefly in late spring and early summer before migrating back to Methow.	
	Okanogan River 01	15.1 - 25.75	Chiliwist and Loup Loup creeks		
	Okanogan River 02	25.75 - 31.5	Salmon Creek		
	Okanogan River 03	31.5 - 41.1	Wanacut, Johnson, and Omak Creeks		
	Okanogan River 04	41.1 - 52.6	Tunk Creek		
	Okanogan River 05	52.6 - 57.3	Aeneas and Bonaparte creeks		
	Okanogan River 06	57.3 - 74.3	Wildhorse spring, Whitestone, Siwash, and Antonie creeks		
	Okanogan River 07	74.3 - 78.9	Ninemile, Tonasket creeks, Similkameen River		
	Lower Similkameen	0 - 3.7			
	Middle Similkameen	3.7 - 6.6			

Watershed (sub-basin)	Assessment Unit (or primary sub-watershed)	River miles	Secondary and tertiary sub-watersheds	Fish Use	Comment
	Upper Similkameen	6.6 - 8.9			
	Chiliwist Creek	0 -0.3			
	Loup Loup Creek	0 - 1.4			
	Lower Salmon Creek	0 - 4.5			
	Upper Salmon Creek	4.5 - 17.6			
	Lower Omak Creek	0 - 5.6			
	Upper Omak Creek	5.6 - 26.6	Stapaloop, Swimptkin, Trail creeks		
	Wanacut Creek	0 - 1.3			
	Johnson Creek	0 - 7.5			
	Tunk Creek	0 - 0.75			
	Aeneas Creek	0 - 0.75			
	Bonaparte Creek	0 - 0.99			
	Siwash Creek	0 - 1.8			
	Lower Antoine Creek	0 - 0.89			
	Upper Antoine Creek	0.89 - 11.9			
	Wild Horse Spring Creek	0 - 0.68			
	Tonasket Creek	0 - 2.17			
	Nine Mile Creek	0 - 5.22			
	Canada				
	Ellis Creek	To be completed			
	Haynes Creek	To be completed			
	Inkaneep Creek	To be completed			
	Lower Shuttleworth Creek	To be completed			
	Upper Shuttleworth Creek	To be completed			
	Lower Shingle Creek	To be completed			
	Upper Shingle Creek	To be completed			
	McLean Creek	To be completed			
	Okanogan Lake	To be completed			
	Okanagan River 09	To be completed			
	Okanagan River 10	To be completed			
	Okanagan River 11	To be completed			
	Okanagan River 12	To be completed			
	Osoyoos Lake	To be completed			
	Skaha Lake	To be completed			
	Testalinden Creek	To be completed			
	Vaseux Creek	To be completed			
	Vaseux Lake	To be completed			

4.2. Assessments

Assessments are an important component of defining habitat improvement actions in the most appropriate locations. In general, assessments characterize the current geo-fluvial processes that are affecting habitat quality and identify potential actions that could ameliorate the factors that are reducing habitat quality. Some assessments also review the underlying geomorphic processes, both historic and current, to assist project sponsors and reviewers in understanding the factors that may increase the likelihood of a project's success in a specific area.

Assessments have historically been completed at tributary and reach scales. At the tributary scale, an assessment usually does not identify specific areas for habitat projects; however, reach–scale assessments may identify project types and locations for achieving specified outcomes (depending on the goals and objectives of the assessment).

Appendix E defines the various types of assessments that have been completed within the UCR and what each type of assessment should include, and also offers some recommendations on how to use an assessment to assist in project development.

Table 4 summarizes completed assessments by subbasin, highlighting additional assessment needs.

Table 4. Completed assessments by sub-watershed and type, including suggested future priorities.

Sub-basin	Status	Location	Assessment Type	Reference
Wenatchee	**Completed**	Nason Creek (RM 0-4.6)	Channel Migration Zone Study	CCNRD (http://uc.ekosystem.us/?p=Page_ec733ae6-e3f7-4356-8dd7-284f4c7ed896)
			Habitat (geomorphic and habitat condition)	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/wenatchee/nasoncreek/2011-geomorphicassmt-lowernason.pdf)
		Nason Creek (RM 4-14)	Tributary	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/wenatchee/nasoncreek/tributary-assmt.pdf)
		Nason - Upper White Pine RM (12-14.5)	Reach	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/wenatchee/upperwhitepine/uwp-reachassmt.pdf)
		Nason - Lower White Pine RM (9.45-11.55)		USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/wenatchee/lowerwhitepine/reachassmt.pdf)
		Nason - Kahler (RM 4.65-8.9)		USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/wenatchee/kahler/kahlerreachassmt.pdf)
		Peshastin RM (0-7)		YN (http://host119.yakama.com/Habitat/UCHR/documents/Lower%20Peshastin%20Reach%20Assessment/Peshastin%20RA.pdf)
		Upper Wenatchee (Lake Wenatchee-Tumwater Canyon)		YN (http://uc.ekosystem.us/?p=Page_ec733ae6-e3f7-4356-8dd7-284f4c7ed896)

Sub-basin	Status	Location	Assessment Type	Reference
	Future Priorities	Icicle (boulder field-Upper Icicle)	Reach	TU
Entiat	**Completed**	Entiat RM (0-26)	Tributary	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/entiat/tribassmt/index.html)
		Preston RM (22.7-23.3)	Reach	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/entiat/prestonreach/completereport.pdf)
		Stormy RM (17.9-18.1)		USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/entiat/stormyreach/stormy-assmt2.pdf)
		Entiat 3D RM (24-25)		YN (?)
		Entiat 1A, 1B, 1C, 1E, 1D (RM 0.8-4.3, RM 6.3-6.9)		USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/lowerentiat/finalRA.pdf,
	Future Priorities	Entiat 2A (RM 16.1-17.9)	Reach	Reclamation (completed by 2013)
		Entiat 3E (RM 25.1-34.0)		YN (completed by 2013)
		Entiat 1D, 1F, 3C (RM 4.3-6.3, RM 6.9-10.6; RM 23.3-24)		TBD (completed by 2016)
Methow	**Completed**	Methow Subbasin (RM 0-80)	Tributary	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/methow/geomorphicassessment/geomorph2008.pdf)
		Big Valley (RM 54.2-60)	Reach	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/methow/bigvalley/bv-reachassmt.pdf)
		Middle Methow (Twisp River confluence to Chewuch River confluence) (RM 40-51.5)	Reach	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/methow/m2reachassmt/m2reach.pdf)
			Geomorphic and hydraulic modeling	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/methow/m2geomorphology/m2finalreport.pdf)

Sub-basin	Status	Location	Assessment Type	Reference
		Chewuch (RM 0-20)	Reach	YN (http://host119.yakama.com/Habitat/UCHR/documents/Chewuch%20Reach%20Assessment/Chewuch%20River%20RA.pdf)
		Lower Twisp (RM 0-15)		YN (http://host119.yakama.com/Habitat/UCHR/documents/Lower%20Twisp%20Reach%20Assessment/Lower%20Twisp%20river%20RA.pdf)
		Libby Creek (RM 0 to 1.4)		YN (http://host119.yakama.com/Habitat/UCHR/documents/Libby%20Creek%20Reach%20Assessment/Lower%20Libby%20Reach%20Assessment_071612.pdf)
		Methow mainstem, Winthrop to Wolf Creek (51.5-54.2)	Habitat (geomorphic and habitat condition)	USBOR (http://www.usbr.gov/pn/programs/fcrps/thp/ucao/winthrop/winthrop.pdf)
	Future Priorities	Methow mainstem, Weeman Bridge to Lost River	Reach	YN
		Methow Silver (RM 29-40, RM 52-55)		USBOR Scoping
		Libby Creek (RM 1 to RM 4)		YN
		Gold Creek		YN
		Upper Chewuch River (30 Mile to 20 Mile Creek)		YN
		Lower Libby Creek (1st Mile)		YN
		Little Bridge Creek		YN
		Middle Twisp (Newby Crk to War Crk)		YN

4.3. Priorities for Habitat Protection and Restoration

Restoring the productivity of salmon and steelhead habitat in the Upper Columbia will require a prioritization of habitat actions to maximize the benefit derived from limited funding. Figure 4 depicts the RTT-recommended prioritization hierarchy for habitat protection and restoration in the Upper Columbia. The protection of high quality, properly-functioning habitat will prevent further degradation of production potential, and should be considered high priority.

However, protection of high-quality habitat is inherently a defensive action, and while preventing salmon production from getting worse, does not provide a net overall gain in production. Therefore focusing salmon-recovery funds entirely on protection would never lead to recovery because degraded habitats would remain such without purposeful restoration efforts. The RTT believes that the most effective model for implementing the prioritization hierarchy depicted in Figure 4 would rely on regulatory measures for protecting functional habitat, and devote limited recovery funds to the restoration of degraded geo-fluvial processes and habitats. Unfortunately, deficiencies in existing land-use regulations hinder the utilization of this model in practice, and restoration dollars must be applied to protection measures to arrest continued decline in the availability of quality habitat.

It has been a challenge for the RTT to craft recommendations that balance the pressing needs for both protection and restoration actions. Pragmatism dictates a benefits-based solution to this dichotomy because recovery is the goal. Therefore the RTT does not suggest dogmatically adhering to the idealized prioritization hierarchy shown in Figure 4, but suggests that while it behooves each project sponsor to follow the principles represented in Figure 4, there is a need to recognize that the projects that will score the highest in a given funding round are those with the highest potential for addressing the ecological concerns and improving and/or maintaining the freshwater survival of species of concern relative to the other projects scored within that round.

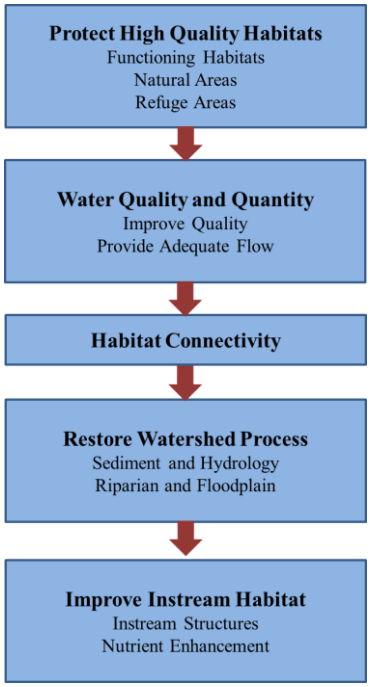

Figure 4. Sequencing of habitat projects, allowing for other considerations (e.g., project cost, cost-benefit ratio, social and political) that should provide for the best long-term success in addressing habitat restoration and protection needs (modified from Figure 4 of Roni (2010)).

4.3.1. Priority Areas

Priority areas are identified within Appendix E.

Priority 1
Priority 1 areas represent high quality functioning habitat. In general, they comprise large, often contiguous blocks of high-quality habitat and sub-watersheds supporting multiple native fish populations. Few barriers exist to restrict connectivity among sub-watersheds and through the mainstem river corridor. Exotic species may be present but are not dominant.

Priority 2
Priority 2 areas support important aquatic resources, but may have a higher level of fragmentation than Priority 1 areas, resulting from habitat disturbance or loss. Connectivity among sub-watersheds may still exist or could be restored within the watershed so that it is possible to maintain or rehabilitate life history patterns and dispersal. Exotic species may be present but are generally not dominant throughout the watershed.

Priority 3
Priority 3 areas are strongly fragmented by habitat loss, most notably either through loss of connectivity with historically occupied habitat or through reductions in flow or disruption of

habitat-forming processes. Exotic species are most likely present and may be dominant throughout portions of the watershed.

Priority 4
Priority 4 areas contain both functional and non-functional habitats that historically supported one or more native focal species or species of concern. Exotic species may now be dominant in one or more sub-watersheds.

4.3.2. Priority Actions

4.3.2.1. Protection

As discussed above, protecting high-quality, functioning habitat is a high priority. The RTT uses the following tiers for prioritizing habitat protection projects:

Tier 1
Tier I habitat has high quality functioning geo-fluvial processes (connectivity to the floodplain, absence of barriers, and large, intact riparian zones are all features of properly functioning habitat). In general, high quality, functioning habitat should have little need for restoration activities.

Tier 2
Tier II habitat areas may have some degree of degradation where restoration activities would restore high-quality habitat and/or function, but are not feasible with current land ownership.

Consideration
Consideration should also be given to whether a highly functioning parcel of land is under imminent risk of degradation that would reduce the functionality of the habitat.

4.3.2.2. Restoration

The highest restoration priority is designated for projects that restore or improve water quantity and quality, connectivity, and fluvial geomorphic function and processes (see Figure 4), especially in areas with high biological importance to focal species and/or other species of concern (that is, Priority 1 and 2 areas). The suggested actions have been broken into tiers, with Tier 1 actions having the highest priority. The tiers are summarized below.

4.3.3. Tier 1 Actions

Tier 1 actions are those that restore fluvial geomorphic processes. Specific examples include reconnecting fragmented habitat by removing barriers, restoring floodplain connection (Table 5).

4.3.4. Tier 2 Actions

Tier 2 actions are those that may increase habitat complexity within the channel, including development of engineered log jams (ELJ), placement of boulders, or other structures that could capture large wood material (Table 5).

Table 5. Priority habitat restoration actions categorized by ecological concerns that may occur throughout the Upper Columbia Region (certain ECs were removed from those depicted in Appendix B because they are not relevant in the UCR).

Ecological Concern	Ecological Concern Sub Category	Tier 1 Actions/Strategies	Tier 2 Actions/Strategies
Habitat Quantity	Anthropogenic Barriers	Remove barriers	Partially remove barrier, or build passage options
	Natural Barriers	Evaluate options	
	HQ-Competition	Reduce population of non-native competitors	Restrict access of non-native competitors
Injury and Mortality	Predation	Reduce population of non-native predators	Restrict access of non-native predators
	Pathogens	Follow best management practices for hatchery programs	
	Mechanical Injury	Remove source of injury	Bring diversion screens under NMFS compliance
	Contaminated Food	Reduce contaminants from entering water	
Food	Altered Primary Productivity	Estimate the amount of nutrients that are needed on an assessment unit scale prior to implementing a region-wide effort	Increase nutrients to the watershed using hatchery carcasses and/or carcass analogs within the current and historic range of anadromy consistent with stream carrying capacity and recovery objectives
	Food-Competition	Reduce population of non-native competitors	Restrict access of non-native competitors
	Altered Prey Species Composition and Diversity	Reduce population of non-native competitors	Restrict access of non-native competitors; Reintroduce extirpated native fish
Riparian Condition	Riparian Condition	Protect intact riparian zones; Restore (plant) native riparian vegetation	Protect property to be able to restore habitat
	LW Recruitment		
Peripheral and Transitional Habitats	Side Channel and Wetland Conditions	Remove levees	Place culverts in levees, or partially remove levees
	Floodplain Condition		
Channel Structure and Form	Bed and Channel Form	Remove levees	Place culverts in levees, or partially remove levees
	Instream Structural Complexity	Install structures that will capture large wood	ELJs, boulders
Sediment Conditions	Decreased Sediment Quantity		
	Increased Sediment Quantity	Fix or eliminate roads that are contributing to unnatural levels of sediment delivery	Decrease road density or install run-off drainage in upper watershed
Water Quality	Temperature	Increase riparian function; Increase hyporheic flow by increasing floodplain function and connectivity	
	Oxygen	No specific action identified; actions under temperature, increased water quantity and riparian cover should address oxygen.	
	Gas Saturation	Reduce flow over structure that is causing supersaturation	Install gas abatement structures below structure causing supersaturation
	Turbidity	Decrease road density or install run-off drainage in upper watershed	
	pH	No specific action identified at this time.	
	Toxic Contaminants	Reduce contaminants from entering water	
Water Quantity	Decreased Water Quantity	Strategic acquisition of water for instream benefits is pursued wherever feasible	Transition to ground water if feasible

Ecological Concern	Ecological Concern Sub Category	Tier 1 Actions/Strategies	Tier 2 Actions/Strategies
	Altered Flow Timing	Investigate collaborative approach with all stakeholders to revise flow strategies if feasible	
Population Level Effects	Reduced Genetic Adaptiveness	Follow best management practices for hatchery programs	Remove barriers if it is preventing life-history expression
	Small Population Effects		
	Demographic Changes		
	Life History Changes		

4.3.5. Summary

Table 6 summarizes priority areas and the tiered actions. It is important to note that Table 6 should be viewed as guidance, but all actions should be explored within each priority area if particular ecological concerns can be addressed.

Table 6. Summary of priority areas and potential actions within each area.

Priority Areas	Tier I Action		Tier II Action	
	Restoration	Protection	Restoration	Protection
1	• Estimate the amount of nutrients that are needed on an assessment unit scale prior to implementing a region-wide effort • Follow best management practices for hatchery programs	• Protect intact riparian zones	• Increase nutrients to the watershed using hatchery carcasses and/or carcass analogs within the current and historic range of anadromy consistent with stream carrying capacity and recovery objectives	
2	• Restore (plant) native riparian vegetation. • Remove levees • Reduce population of non-native competitors • Follow best management practices for hatchery programs • Remove source of injury • Install structures that will capture large wood • Strategic acquisition of water for instream benefits is pursued wherever feasible	• Protect property to be able to restore habitat	• Bring diversion screens under NMFS compliance • Place culverts in levees, or partially remove levees • ELJs, boulders • Transition to ground water if feasible	
3	• Remove barriers • Reduce population of non-native competitors • Follow best management practices for hatchery programs • Remove source of injury • Install structures that will capture large wood • Fix or eliminate roads that are contributing to unnatural levels of sediment delivery • Strategic acquisition of water for instream benefits is pursued wherever feasible	• Protect property to be able to restore habitat	• Partially remove barrier, or build passage options • Place culverts in levees, or partially remove levees • Restrict access of non-native competitors • Bring diversion screens under NMFS compliance • ELJs, boulders • Decrease road density or install run-off drainage in upper watershed • Transition to ground water if feasible	
4	• Remove barriers • Reduce population of non-native competitors • Follow best management practices for hatchery programs Remove source of injury • Install structures that will capture large wood		• Restrict access of non-native competitors • Bring diversion screens under NMFS compliance • Place culverts in levees, or partially remove levees • ELJs, boulders • Decrease road density or install run-off	

Priority Areas	Tier I Action		Tier II Action	
	Restoration	Protection	Restoration	Protection
	• Fix or eliminate roads that are contributing to unnatural levels of sediment delivery • Strategic acquisition of water for instream benefits is pursued wherever feasible		drainage in upper watershed • Transition to ground water if feasible	

5.0 Objectives by Subbasin and Watershed

The following narratives for each subbasin provide objectives for protection and restoration of habitats that are designed to remedy ecological concerns (limiting factors) for corresponding independent populations, as identified in Appendix G (Habitat Matrices) of the Recovery Plan (UCSRB 2007). The information in Appendix E of this document provides greater detail, outlining the status of fish use in each watershed, and identifying secondary and tertiary tributaries, major spawning areas, and recommend prioritized actions for habitat protection and restoration. These prioritized actions are based on the criteria discussed in Section 3.3.3 above.

5.1. The Wenatchee Subbasin

The Wenatchee River is unique among subbasins in the Upper Columbia Region in that it supports the greatest diversity of populations and overall abundance of salmonids. The basin has many MaSAs for both spring Chinook salmon and steelhead, and important spawning and rearing areas for summer Chinook, sockeye salmon, bull trout, Pacific lamprey, and Westslope cutthroat trout.

Many factors have contributed to habitat degradation in the Wenatchee Basin. The historical pattern of land use in the Wenatchee Basin follows a familiar pattern for basins in the Pacific Northwest. Although beaver trapping began in the early 1800s, and no doubt had an effect on riparian conditions, mining was probably the first major activity affecting riparian and stream conditions. Mining began in the Wenatchee Basin in the 1860s (Mullan et al. 1992).

After the advent of mining was a period of intense livestock grazing. Grazing pressure was highest from the late 1800s to the 1930s, with subsequent reductions as allotment systems replaced the open range. Water diversion began in the mid 1880s, affecting stream flow and in some cases (e.g., downstream of Dryden Dam), may have come close to completely drying up the river, undoubtedly affecting adult salmonid migration and juvenile rearing capacity (Mullan et al. 1992).

Timber harvest began in the 1920s, and up until 1955, selective harvest or "high grading" was the primary harvest method. Since then, partial cutting and clear-cutting have predominated. The 1980s represent the period of most intense harvest. In addition, the building of roads associated with forest harvest has increased sediment load in various streams throughout the watershed.

In the Wenatchee subbasin several of the factors discussed above have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many assessment units within the basin. However, some of the assessment units contain headwater areas that are in relatively pristine condition and serve as "strongholds" for listed species and species of concern.

The primary habitat conditions in the Wenatchee Basin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead (and bull trout and Pacific lamprey) include a lack of habitat diversity and quantity, excessive sediment load, obstructions, a lack of channel stability, low flows, and high summer temperatures. Habitat diversity is affected by channel confinement, loss of floodplain connectivity and off-channel habitat, reduced quantities of large woody debris, and a lack of riparian vegetation. The mainstem and many of its tributaries also lack high-quality pools and spawning areas associated with pool tail-outs. The lack of pools in many areas is probably directly related to the loss of riparian vegetation, removal of large wood, and channel confinement.

Many areas within the assessment units have high potential for protection and restoration of habitat. Using the criteria discussed above in Section 3.3.3, the RTT has prioritized each assessment unit within the basin, ecological concerns within each assessment unit, and actions associated with each ecological concern.

In the following, the assessment units are prioritized for restoration and protection potential. A summary of the ecological concerns is presented, but more detailed information on species use, assessment unit descriptions, tributaries, factors affecting habitat conditions, ecological concerns, level of certainty and/or data gaps, and actions per ecological concern can be found in Appendix E.

For restoration, the RTT has identified the priority assessment units (in descending order) as:

- Nason Creek
- Upper Wenatchee
- Icicle Creek
- Peshastin Creek
- Lower Mainstem
- Mission Creek
- Little Wenatchee
- White River
- Middle Wenatchee
- Chumstick Creek, and
- Chiwawa River

These assessment units have various ecological concerns associated with them (Table 7). In all assessment units, riparian condition varies between a relatively high priority to a relatively low priority; but it is listed in all except the Little Wenatchee. Many of the assessment units also list instream structural complexity as a concern, as well as side channel and wetland connectivity (Table 7).

Table 7. Ecological concerns within each assessment unit of the Wenatchee sub-basin. Numbers within each row relate to the priority of each ecological concern within that assessment unit, with 1 representing the highest priority.

Assessment Unit (in priority order)	Ecological Concerns (numbers are the priority)												
	Channel Structure and Form (Instream Structural Complexity)	Channel Structure and Form (Bed and Channel Form)	Peripheral and Transitional Habitat (Side Channel and Wetland Connections)	Peripheral and Transitional Habitat (Floodplain Condition)	Riparian Condition (riparian condition and LW recruitment)	Habitat Quantity (Anthropogenic Barriers)	Habitat Quantity (Lasting Natural Barriers)	Water Quantity (Decreased Water Quantity)	Water Quality (Temperature)	Sediment Conditions (Increased Sediment Quantity)	Food (Altered Primary Productivity or Prey Species Composition & Diversity)	Injury or Mortality (Mechanical Injury)	Species Interactions (Introduced Competitors and Predators)
Nason	4	2	1		3					6	5		7
Upper Wenatchee	1		2		3								
Icicle Creek	4				6	2	1	3		7		5	8
Peshastin	2		4		6	5		1	3				
Lower Wenatchee	5		1		2			3	4				
Mission Creek	4	8	2		5	6		1	7	3			
Little Wenatchee				1						2	3		4
White River	1		2		3						4		
Middle Wenatchee						1							
Chumstick			6		2	5		1	4	3			
Chiwawa			5	4		2					1		3

For protection, the RTT has prioritized the assessment units, but not specific areas within the assessment units. Greater detail on where potential protection areas might occur can be found in most of the completed assessments (see Table 4). Table 8 prioritizes the assessment units for protection within a tiered approach (i.e., Tier I is the highest priority).

Table 8. Assessment unit prioritization for protection projects.

Assessment unit	Tier
Nason Creek	I
White River	
Upper Wenatchee River	
Chiwawa River	
Little Wenatchee	II
Middle Wenatchee River	
Icicle Creek	III
Lower Wenatchee River	
Mission Creek	IV
Chumstick Creek	
Peshastin Creek	

5.2. The Entiat Subbasin

Many factors have contributed to habitat degradation in the Entiat Basin. The historical pattern of land use in the Entiat Basin follows a familiar pattern in the Pacific Northwest. Although beaver trapping began in the early 1800s, and no doubt had an effect on riparian conditions, mining was probably the first major activity affecting riparian and stream conditions.

Water diversion began in the mid 1880s, affecting stream flow and in some cases, may have come close to completely drying up the river, undoubtedly affecting adult migration and rearing capacity (Mullan et al. 1992). Timber harvest began in the 1920s, and up until 1955, selective harvest or "high grading" was the primary harvest method. Since then, partial cutting and clear-cutting have been the predominant practices. The 1980s represent the period of most intense harvest.

In the Entiat subbasin several of the factors discussed above have reduced habitat diversity, connectivity, water quantity and quality, and riparian function in many assessment units within the basin. However, some of the assessment units contain headwater areas that are in relatively pristine condition and serve as "strongholds" for listed species and species of concern.

The primary habitat conditions in the Entiat Basin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead (and bull trout and Pacific lamprey) include stream channel configuration and complexity that has been reduced due to logging in the riparian, flood control measures that straightened the channel and removed large woody debris from the river channel. These historic and ongoing activities have led to a condition with low instream habitat diversity including few pools, lack of large wood accumulations, and disconnected side channels, wetlands, and floodplains. The result is a reduction in resting and rearing areas for both adult and juvenile salmon throughout the Entiat River.

Many areas within the assessment units have high potential for protection and restoration of habitat. Using the criteria discussed above in Section 3.3.3, the RTT has prioritized each assessment unit within the basin, the ecological concerns within each assessment unit, and the actions associated with each ecological concern.

In the following, the assessment units are prioritized for restoration and protection potential. A summary of the ecological concerns is presented, but more detailed information on species use, assessment unit descriptions, tributaries, factors affecting habitat conditions, ecological concerns, level of certainty and/or data gaps, and actions per ecological concern can be found in Appendix E.

For restoration, the RTT has identified the priority assessment units (in descending order) as:

- Middle Entiat (Stillwaters)
- Lower Entiat
- Upper-Middle Entiat
- Mad River

These assessment units have various ecological concerns associated with them (Table 9). In all three assessment units, bed and channel form is listed as the primary ecological concern, while side channel and wetland connection and instream structural complexity are also issues (Table 9).

Table 9. Ecological concerns within each assessment unit of the Entiat sub-basin. Numbers within each row relate to the priority of each ecological concern within that assessment unit.

Assessment Unit (in priority order)	Ecological Concerns (numbers are the priority)									
	Channel Structure and Form (Instream Structural Complexity)	Channel Structure and Form (Bed and Channel Form)	Peripheral and Transitional Habitat (Side Channel and Wetland Connections)	Riparian Condition (riparian condition and LW recruitment)	Habitat Quantity (Anthropogenic Barriers)	Water Quantity (Decreased Water Quantity)	Water Quality (Temperature)	Sediment Conditions (Increased Sediment Quantity)	Food (Altered Primary Productivity or Prey Species Composition & Diversity)	Injury or Mortality (Mechanical Injury)
Middle Entiat (Stillwater Reach)	3	1	2	4	8	9	10	6	5	7
Lower Entiat	2	3	1	4		8		6	7	5
Upper-Middle Entiat	1								2	
Mad River		1		3	5			2	4	

For protection, the RTT has prioritized the assessment units, but not specific areas within the assessment units. Greater detail on where potential protection areas might occur can be found in most of the completed assessments (see Table 4). Table 10 prioritizes the assessment units for protection within a tiered approach (i.e., Tier I is the highest priority).

Table 10. Assessment unit prioritization for protection projects.

Assessment unit	Tier
Middle Entiat (Stillwater Reach)	I
Upper-Middle Entiat	II
Mad River	
Lower Entiat	

5.3. The Methow Subbasin

Many factors have contributed to habitat degradation in the Methow Basin. Although beaver trapping began in the early 1800s, and no doubt had an effect on riparian conditions, mining was probably the first major activity affecting riparian and stream conditions. Mining began in the Methow Basin in the 1870s (Mullan et al. 1992).

After the advent of mining was a period of intense livestock grazing. Grazing pressure was highest from the late 1800s to the 1930s, with subsequent reductions as allotment systems replaced the open range. Water diversion began in the mid 1880s, reducing stream flow and in some cases, may have come close to completely drying up the river, undoubtedly affecting adult migration and rearing capacity (Mullan et al. 1992).

Timber harvest began in the 1920s, and up until 1955, selective harvest or "high grading" was the primary harvest method. Since then, partial cutting and clear-cutting have been the predominant practices. The 1980s represent the period of most intense harvest.

The Methow River has a high proportion of pristine habitat in the upper portions of major tributaries. The primary habitat conditions in the Methow Basin that currently limit abundance, productivity, spatial structure, and diversity of salmon and steelhead (and bull trout and Pacific lamprey) are mostly found in the middle and lower mainstem and lower portions of major tributaries that have been affected by state highways, county roads, and housing and agricultural development that have diminished the overall function of the stream channel and floodplain. This has impaired stream complexity, wood and gravel recruitment, floodwater retention, and water quality. Additionally, late summer and winter instream flow conditions often reduce migration, spawning, and rearing habitat for native salmonids. This problem is partly natural (a result of watershed-specific weather and geomorphic conditions) but is exacerbated by irrigation withdrawals.

Many areas within the assessment units have high potential for protection and restoration of habitat. Using the criteria discussed above in Section 3.3.3, the RTT has prioritized each assessment unit within the basin, the ecological concerns within each assessment unit, and the actions associated with each ecological concern.

In the following, the assessment units are prioritized for restoration and protection potential. A summary of the ecological concerns is presented, but more detailed information on species use, assessment unit descriptions, tributaries, factors affecting habitat conditions, ecological concerns, level of certainty and/or data gaps, and actions per ecological concern can be found in Appendix E.

For restoration, the RTT has identified the priority assessment units (in descending order) as:

- Upper Methow River
- Lower Twisp River
- Upper-middle Methow River
- Lower Chewuch River
- Beaver Creek
- Middle Methow River
- Wolf Creek
- Gold Creek
- Libby Creek
- Upper Twisp River
- Upper Chewuch River
- Early Winters Creek
- Lost River
- Lower Methow River

These assessment units have various ecological concerns associated with them (Table 11). In all assessment units, riparian condition varies between a relatively high priority to a relatively low priority. Most of the assessment units list bed and channel form as a concern, while many assessment units also list instream structural complexity, as well as side channel and wetland connectivity (Table 11).

Table 11. Ecological concerns within each assessment unit of the Methow sub-basin. Numbers within each row relate to the priority of each ecological concern within that assessment unit, with 1 representing the highest priority.

Assessment Unit (in priority order)	Ecological Concerns (numbers are the priority)											
	Channel Structure and Form (Instream Structural Complexity)	Channel Structure and Form (Bed and Channel Form)	Peripheral and Transitional Habitat (Side Channel and Wetland Connections)	Peripheral and Transitional Habitat (Floodplain Condition)	Riparian Condition (riparian condition and LW recruitment)	Habitat Quantity (Anthropogenic Barriers)	Water Quantity (Decreased Water Quantity)	Water Quality (Temperature)	Sediment Conditions (Increased Sediment Quantity)	Food (Altered Primary Productivity or Prey Species Composition & Diversity)	Injury or Mortality (Mechanical Injury)	Species Interactions (Introduced Competitors and Predators)
Upper Methow	4	2	3		5	9	1		7	6		8
Lower Twisp	5	3	4		6		1	2	7	8		9
Middle Methow	2	3	1		5		4					6
Lower Chewuch	3		2		4	8	5		1	6		7
Upper – middle Methow	2	1	3		4	5				6		7
Beaver Cr.		2			4	3	1		5		6	7
Wolf Cr.	2		3		4		1					
Gold Cr.		1		3	4	2	6		5		7	8
Libby Cr.		1			2		3					4
Upper Twisp	2	3	1		4				6	5		7
Upper Chewuch		4	3		2				1			
Early Winters		4			3	6	2		1	5		
Lost River		2		1	3					4		
Lower Methow	3	2	1		4							

For protection, the RTT has prioritized the assessment units, but not specific areas within the assessment units. Greater detail on where potential protection areas might occur can be found in most of the completed assessments (see Table 4). Table 12 prioritizes the assessment units for protection within a tiered approach (i.e., Tier I is the highest priority).

Table 12. Assessment unit prioritization for protection projects.

Assessment unit	Tier
Lower Twisp River	I
Middle Methow River	
Upper Methow River	
Upper Middle Methow River	
Lower Chewuch River	
Upper Twisp River	II
Upper Chewuch River	

Assessment unit	Tier
Beaver Creek	
Early Winters Creek	III
Lost River	
Gold Creek	IV
Libby Creek	
Lower Methow River	

5.4. The Okanogan Subbasin

Many factors have contributed to habitat degradation in the Okanogan Basin. Although beaver trapping began in the early 1800s, and no doubt had an effect on riparian conditions, mining was probably the first major activity affecting riparian and stream conditions. Trappers and traders moved to the Okanogan Basin in the early to mid-1800s. In the later 1800s, gold mining brought a major influx of people to the valley. Mining in the Fraser River basin in British Columbia spurred large cattle drives up the Okanogan River Valley between 1859 and 1870. It is likely that the influx of cattle diminished the riparian areas within the valley to some unknown extent.

After the advent of mining was a period of intense livestock grazing. Grazing pressure was highest from the late 1800s to the 1930s, with subsequent reductions as allotment systems replaced the open range. Water diversion began in the mid 1880s, reducing stream flow and in some cases, may have come close to completely drying up the river, undoubtedly affecting adult salmonid migration and rearing capacity (Mullan et al. 1992).

The Okanogan/Similkameen is the largest and most complex subbasin in the region. Barriers, poor water quality and low late-summer instream flows (mainstem and tributary) limit the survival, distribution, and productivity of both anadromous and inland salmonids. Transboundary planning and implementation are ongoing and critical because more than half of the subbasin is within British Columbia.

Summer water temperatures often exceed lethal tolerance levels for salmonids along the Okanogan River mainstem. These high temperatures are partially due to natural phenomena (low gradient, aspect, high ambient air temperatures, upstream lake effects) but are exacerbated by various anthropogenic activities including dam operations irrigation, and land management. High water temperatures and low flows in summer and fall may limit adult run timing as well as juvenile salmonid rearing in the mainstem and in several tributaries.

There are three substantial barriers to upstream migration in the Okanogan Subbasin: lack of stream flow in lower Salmon Creek (between the Okanogan Irrigation District diversion dam and the confluence with the Okanogan River), and Conconully Dam in the upper Salmon Creek watershed. Enloe Dam on the Similkameen River is also a barrier to fish passage; although there is debate whether anadromous salmonids historically passed the natural waterfalls that existed prior to construction of the dam. Correction of these and other barriers in smaller creeks would result in lasting and important increases in salmon and/or steelhead spatial structure, productivity, and abundance and would enable colonization and expansion from core populations.

Many areas within the assessment units have high potential for protection and restoration of habitat. Using the criteria discussed above in Section 3.3.3, the RTT has prioritized each assessment unit within the basin, the ecological concerns within each assessment unit, and the actions associated with each ecological concern.

In the following, the assessment units are prioritized for restoration and protection potential. A summary of the ecological concerns is presented, but more detailed information on species use, assessment unit description, tributaries, factors affecting habitat conditions, ecological concerns, level of certainty and/or data gaps, and actions per ecological concern can be found in Appendix E.

For restoration, the RTT has identified the priority assessment units[2] (in descending order) as:

- Upper Salmon Creek
- Loup Loup Creek
- Okanogan River 01
- Upper Omak Creek
- Okanogan River 04
- Upper Antoine Creek
- Lower Salmon Creek
- Okanogan River 05
- Okanogan River 02
- Nine Mile Creek
- Lower Similkameen River
- Johnson Creek
- Lower Antoine Creek
- Okanogan River 03
- Middle Similkameen River
- Lower Omak Creek

These assessment units have various ecological concerns associated with them (Table 13). In all assessment units, riparian condition varies between a relatively high priority to a relatively low priority. Most of the assessment units list bed and channel form as a concern, while many assessment units also list increased sediment quantity, predation, introduced predators and competitors, temperature and instream structural complexity as concerns (Table 13).

Table 13. Ecological concerns within each assessment unit of the Okanogan sub-basin. Numbers within each row relate to the priority of each ecological concern within that assessment unit, with 1 representing the highest priority.

Asses.	Ecological Concerns (numbers are the priority)

[2] There are many more assessment units identified within the Okanogan Basin, but the ones listed are the top priority at this time.

Unit (in priority order)	Channel Structure	Channel Structure and Form (Bed and	Peripheral and Transitional Habitat (Side Channel and	Peripheral and Transitional Habitat (Floodplain	Channel structure and form (Bed and	Riparian Condition (riparian condition	Habitat Quantity (Anthropogenic Barriers)	Habitat Quantity (Lasting Natural Barriers)	Water Quantity (Decreased Water	Water Quantity (Altered Flow	Water Quality (Temperature)	Water Quality (Gas Supersaturation)	Water Quality (Water Geo-chemistry)	Sediment Conditions (Increased Sediment Quantity)	Food (Altered Primary Productivity or Prey Species Composition &	Injury or Mortality (Mechanical Injury)	Injury or Mortality (Predation)	Injury or Mortality (Pathogens)	Injury or Mortality (Harassment/ Poaching)	Species Interactions (Introduced Competitors and Predators)
Inundated Okanogan	4	3								1	7			2	5	8	6			
Okanogan River 01	11	4	5			6				8	3			1	2	9	7			10
Okanogan River 02	12	6	2	5		11				8	1			3	4	9	7			10
Okanogan River 03	11	5	6			9				8	3			1	2	10	7			4
Okanogan River 04	12	8	2	9		7				10	1			4	5	3	6			11
Okanogan River 05	11	8	4			7				9	1			2	3	6	5			10
Okanogan River 06	9	3	6	5		2					4			1		8	7			10
Okanogan River 07	8	3		2		5					1			4			6			7
Lower Similkameen	7					6					1			2			3			4
Middle Similkameen			7			8					1	6		2			3	5	9	4
Upper Similkameen			7								1	6		2			3	5	8	4
Loup Loup Creek	5					4	2		1					3						
Lower Salmon Creek	9	4				5	7		1	2				6	3					8
Upper Salmon Creek	0	4				5			1	2				3			8		7	6
Lower Omak Creek	5	7				6			3		4			2						1
Upper Omak Creek	5	3				6	1		4					2						7
Wanacut Creek	6	5				4			1		3			2						
Tunk Creek	6	5				3			1		4			2						
Aeneas Creek	5	6				2	1						3		4					
Bonaparte Creek	6	5				3			1		4			2						
Lower Antoine Creek	6	5				3			1		4			2						
Upper Antoine Creek	5	4				6	1		2					3						
Wild Horse Spring Creek	5					2	4		3					1						
Tonasket Creek	7	6		4		2			1		5			3						

Asses. Unit (in priority order)	Ecological Concerns (numbers are the priority)																			
	Channel Structure	Channel Structure and Form (Bed and	Peripheral and Transitional Habitat (Side Channel and	Peripheral and Transitional Habitat (Floodplain	Channel structure and form (Bed and	Riparian Condition (riparian condition and LW recruitment)	Habitat Quantity (Anthropogenic Barriers)	Habitat Quantity (Lasting Natural Barrier)	Water Quantity (Decreased Water Quantity)	Water Quantity (Altered Flow Timing)	Water Quality (Temperature)	Water Quality (Gas Supersaturation)	Water Quality (Water Geo-chemistry)	Sediment Conditions (Increased Sediment Quantity)	Food (Altered Primary Productivity or Prey Species Composition &	Injury or Mortality (Mechanical Injury)	Injury or Mortality (Predation)	Injury or Mortality (Pathogens)	Injury or Mortality (Harassment/ Poaching)	Species Interactions (Introduced Competitors and Predators)
Nine Mile Creek	7	6		4		5	2		1					3						
Siwash Cr.	5					3			1		4			2						
Chiliwist Cr.						4	2		1					3						

For protection, the RTT has prioritized the assessment units, but not specific areas within the assessment units. Greater detail on where potential protection areas might occur can be found in most of the completed assessments (see Table 4). Table 14 prioritizes the assessment units for protection within a tiered approach (i.e., Tier I is the highest priority).

Table 14. Assessment unit prioritization for protection projects.

Assessment unit	Tier
Lower Omak Creek	I
Upper Salmon Creek	
Okanogan River 07	II
Middle Similkameen River	
Loup Loup Creek	
Nine Mile Creek	
Upper Omak Creek	
Okanogan River 02	III
Okanogan River 05	
Bonaparte Creek	IV

5.5. The Foster Creek and Moses Coulee Subbasins

Relative to other subbasins in the region, the habitats in these streams have limited capability to sustain natural populations of salmonids. This limitation is mostly a result of very low levels of precipitation and resultant stream flows, and the topography near the streams as they enter the Columbia River. Some human activities may have reduced survival and distribution of salmonids—particularly steelhead/rainbow trout. There is anecdotal evidence that juvenile salmon and steelhead rear and overwinter in the mouths of Foster and Rock Island creeks. Steelhead are also known to spawn in Foster Creek. Sediment from upland activities may affect spawning and rearing conditions; agricultural practices that reduce upland erosion would have sustainable benefits. Conversion of upland, riparian, and wetland habitats into arable land probably reduced water storage and runoff patterns.

The immediate strategy should be to monitor the presence of salmonids (at several life stages) in streams suspected to support salmonids (Foster Creek and Rock Island Creek). For these streams, assess habitat condition and evaluate barriers to upstream passage, and develop a strategy to increase productivity where appropriate.

5.6. Squilchuck and Stemilt and other small tributaries of the mainstem Columbia River.

There are many small tributaries that drain directly into the Columbia River between the Wenatchee River and Crab Creek. Squilchuck, Stemilt, Colockum, Tarpiscan, Trinidad, Quilomene, Skookumchuck, Whiskey Dick, and Johnson creeks have documented juvenile *O. mykiss* in habitat that ranges from several hundred feet to several miles, depending on natural or manmade barriers (WDFW unpublished data). Recent spring spawning ground surveys have identified adult steelhead presence, redds, or carcasses in Squilchuck, Tarpiscan, Trinidad, Tekison, Quilomene, Brushy, Skookumchuck, and Johnson creeks (WDFW unpublished data).

The immediate strategy for these streams should include a combination of protection and restoration. For tributaries that are largely in public ownership and do not have anthropogenic barriers protection should be the primary strategy. These tributaries include (Tarpiscan, Tekison, Quilomene, Brushy, Skookumchuck, and Whiskey Dick creeks). Additionally, Trinidad Creek, currently in private ownership, offers a unique opportunity for protecting a small, groundwater fed stream with known steelhead spawning in a rapidly developing area. For other systems such as Stemilt and Squilchuck creeks, strategies should include increasing late summer instream flows, if it can be shown to contribute to sustainable habitat conditions, and develop and implement an approach to correct passage barriers, if it can be shown that sufficient flows will be available to sustain spawning or rearing in the newly accessible habitats.

5.7. Unlisted Species of Concern

Sockeye Salmon (Lake Wenatchee): Sockeye salmon in the Wenatchee Basin would benefit from habitat actions already identified in Section 4.1 for listed species that improve and protect habitat along the Wenatchee River migration corridor.

Habitat actions in the White and Little Wenatchee Rivers that maintain or improve the quality of spawning gravels are also important because these are the only spawning areas for this population. Within the White River, actions to protect existing habitat, restore the flood plain and riparian restoration upstream of the Sears Creek Bridge would benefit sockeye salmon. Within the Little Wenatchee River, reducing sedimentation between Lost Creek and Rainy Creek, along with floodplain restoration upstream of Lost Creek, would be of particular benefit. Sockeye salmon redds are more sensitive to bed scour than spring Chinook redds due to the depth of egg deposition. Actions that reduce bed scour (such as road maintenance and floodplain connection) would have even greater benefit to sockeye salmon.

Sockeye salmon depend heavily on a lake-rearing environment so maintaining a functional ecosystem in Lake Wenatchee is critical to the long-term persistence of this population (Quinn 2005). A critical component of a functional Lake Wenatchee ecosystem is maintaining sufficient primary and secondary productivity to support growth and survival of sockeye smolts (Stockner 1987). Nutrient enrichment within the White and Little Wenatchee Rivers, and within Lake Wenatchee itself would likely increase growth and survival of juvenile sockeye rearing in the Lake

(Stockner 1987; Griswold et al. 2003; Pieters and co-authors 2003). However, adfluvial bull trout in the lake pose substantial predation risk to rearing sockeye salmon.

Sockeye Salmon (Okanogan): Sockeye salmon in the United States portion of the Okanogan Basin would benefit from habitat actions already identified in Section 4.4 for listed species, which improve and protect habitat along the Okanogan River migration corridor. High summer water temperatures in the Okanogan River delay migrations for adults and force them to hold in lotic rather than lentic environments, potentially using up more energy in order to find cold water refugia and possibly increasing pre-spawn mortality (which appears high for this stock).

Currently there is a water flow management model used by water managers in Canada that has successfully reduced both redd scour and desiccation by balancing flood control with fish habitat requirements. Okanogan sockeye have responded to better water flow management and adult returns have reached the hundreds of thousands within the last few years. Continued use of this model is important for minimizing density-independent mortality events and guiding future decisions regarding sockeye salmon management.

Habitat restoration actions in Canada should be focused on removing barriers to migration such as occurs at Okanagan Falls Dam, and Okanagan Lake Dam. Increased access to additional rearing areas will most likely increase production. The Okanagan River in Canada has been extensively diked and channelized resulting in poor riverine environments for fish of all species. Habitat actions that focus on setting back dykes and restoring natural floodplain function and channel morphology would result in expanded spawning areas.

Summer Chinook: *Wenatchee River*—Actions already identified in Section 4.1 to protect and restore the mainstem Wenatchee River from the confluence to Lake Wenatchee will have additional benefits for summer Chinook salmon. Specifically, side-channel reconnection in the lower Wenatchee River corridor would be helpful for high-water refugia for outmigrants.

Entiat River—Actions already identified in Section 4.2 to protect and restore the mainstem Entiat River from the confluence to Stillwaters Reach will have additional benefits for summer Chinook salmon. Specifically, side-channel reconnection in the lower Entiat River corridor would be helpful for high-water refugia for outmigrants. Existing instream habitat restoration projects appear to have benefits to summer Chinook salmon rearing (Polivka 2010).

Methow River—Actions already identified in Section 4.3 to protect and restore the mainstem Methow River from the confluence with the Columbia River to the Winthrop (few spawn upstream (Hillman et al. 2011)) will have additional benefits for summer Chinook salmon.

Okanogan River— Actions already identified in Section 4.4 to protect and restore the mainstem Okanogan and Similkameen Rivers will have additional benefits for summer Chinook salmon.

Cutthroat trout: Actions already identified in section 4.1, 4.2, and 4.3 to protect and restore habitat for anadromous fish will also benefit cutthroat trout. Reductions in brook trout range and density would benefit cutthroat trout by reducing competition for food and space (Griffith 1988).

Cutthroat trout distribution above anadromous barriers is generally on USFS lands. Some linkages between invertebrate food resources and forest management activities have been identified. Continued stewardship of those lands consistent with the Northwest Forest Plan should provide adequate protection.

Pacific lamprey: Actions already identified 4.1, 4.2, and 4.3 (possibly 4.4) to protect and restore habitat will likely have additional benefits for lamprey. However, there are numerous information gaps for lamprey that should eventually be funded. The USFWS has been identifying various conservation measures that could be used to aid in recovery of lamprey (Luzier et al. 2011).

Coho Salmon: Naturally producing coho salmon in the Wenatchee and Methow basins[3] would benefit from restoring instream complexity and floodplain enhancement by reconnecting side channels and off channel habitats. Locations in the Wenatchee Basin with the greatest potential to benefit coho salmon include Nason Creek and the mainstem Wenatchee River. Within the Methow Basin, off channel habitats and instream complexity should be restored in the Mainstem Methow River and the Chewuch River. In general, these actions have already been identified for benefits to steelhead and spring Chinook and are covered within Sections 4.1 and 4.3.

5.8. Information Needs

The effects of altered fluvial processes on life stage specific survival in many UCR streams are not fully understood. Stream channels in many areas are constrained by railroads, highways, dikes, and development. These constraints result in reduced channel sinuosity, flood aggravation, reduced gravel recruitment, reduced large woody debris recruitment, and lost connection to side channels. Information needs include historical and current channel migration rates, factors affecting current channel migration rates, options to restore floodplain function, and appropriate types and locations of restoration. Much of this information has been collected and made available by the various assessments summarized in Table 4.

As described in UCSRB (2007), more information is needed on the water balance and the relation of surface and groundwater in Upper Columbia streams. A hydrologic assessment should identify critical ground-water recharge areas and determine locations where groundwater contributes to surface water. This assessment should include measuring interactions between groundwater management and surface water flows during critical periods. The role of upslope forest and range management on water balance and hyporheic flows needs to be further understood. However, these assessments are often difficult, time-consuming, and expensive, leading to the likelihood that there may never be a comprehensive assessment of ground-water across the entire Upper Columbia basin.

Where it has not occurred already, or in progress, an inventory and assessment of fish passage barrier and screens, and a prioritization of these passage issues should be pursued. A comprehensive inventory would include identification and prioritization of both artificial and natural barriers (culverts, diversions, diversion dams, gradients, etc.), and the locations of water diversions (both gravity and pump). Inventories have been completed (excluding small pump

[3] Coho salmon have been reintroduced by the YN.

screens) in the Wenatchee, Entiat, Methow, and portions of the Okanogan subbasins, yet full assessments of these structures may be required to correct the barriers in a systematic and strategic order. The Wenatchee barrier inventory or the Okanogan screen assessment could be used as examples.

A better understanding of habitat-productivity relations in Upper Columbia streams (as is being addressed through the ISEMP program[4]) would help guide land and water management decisions contributing to recovery of salmonids in the region. Increased effort and continuation of upstream/downstream salmonid migrant trapping, parr and spawning ground surveys in representative streams has greatly contributed to our knowledge base, and has resulted in appropriate resource allocation decisions.

The extent of salmonid spawning and rearing in small-order tributaries to the Columbia River is not well known. Many streams (such as Douglas, Sand, Rock Island, Colockum, Stemilt, Squilchuck, Tarpiscan, Trinidad, Quilomene, and Skookumchuck creeks) appear to offer rearing habitat and overwinter refuges that could be important to the population and spatial structure and dispersal patterns of salmonids in the ESU/DPS. The presence, extent, and distribution of *O. mykiss* in some of these streams has been evaluated and monitored; however, a more comprehensive evaluation would be needed to determine the current and potential future roll of these systems in the Upper Columbia steelhead DPS.

Appendix F identifies specific informational needs within the entire UCR. This information was initially gleaned from the Biological Strategy (RTT 2002) and the recovery plan (UCSRB 2007). However, the Monitoring and Data Management Committee (MaDMC) periodically updates and prioritizes the informational needs (Appendix F).

5.8.1. Adaptive Management Process and Recommendations to Improve Informational

In January, 2010, the RTT hosted the first five-year analysis and synthesis workshop. This workshop is a component of the UCSRB's adaptive management process for salmon and steelhead recovery in the UCR. Topics at the workshop were:

- Status of VSP by population and ESU: fish status and trend
- Implementation, limiting factors, and threats
- Habitat status and trend
- Habitat action effectiveness, and
- Data gaps and research needs

A report of the workshop was adopted by the RTT in October 2010 (Ward et al. 2010). Based on the information that was presented at the workshop and captured within Ward et al. (2010),

[4] The integrated status and effectiveness monitoring project (ISEMP) was created to systematically answer questions such as "what is the best way to measure stream habitat?" and "what is the best way to measure salmonid populations?". This program was created to assist BPA in meeting "off-site" mitigation requirements as part of the FCRPS BiOp.

the RTT developed recommendations to improve our understanding of the topics that were discussed at the workshop. Table 15 below summarizes the recommendations by the RTT. Through the adaptive management process of the UCSRB, it is hoped that these issues will be addressed in the near future.

Table 15. Recommendations of the RTT to improve understanding of various issues throughout the UCR. Page numbers referenced below are associated with Ward et al. (2010).

Recommendation	Assigned To	Comments
Chapter 1: Status of VSP for Each Population and the ESA – Fish Status and Trend		
Status data from the Canadian portions of the Okanagan steelhead population should be incorporated into the overall status assessment that has until now focused on the portion of the Okanogan subbasin with the US. The abundance and productivity benchmarks to use are the ICTRT minimum threshold of 1000 fish and the respective productivity on the viability curve. For spatial structure, major and minor spawning areas within Canada need to be identified/delineated and then monitored to complement similar monitoring in the US portion of the Okanogan. (p.14)	RTT/CCT/First Nations/NOAA fisheries Science Center	May need to work through the recovery criteria with Canadian stream info in hand. Need to designate major and minor spawning areas for spatial structure. Also need a monitoring connection so that abundance and redd locations can be included in future status assessments.
A working definition of what a "trend" is, relative to NOAA recovery criteria, should be developed so that future changes in status can be compared to a tangible guideline. (p. 14)	IT/NOAA Fisheries/RTT	There are some trend assessments included in the NOAA BRT 5 year update. These could be expanded, modified, and related to the viability curve. Casey has additional ideas for how to use the viability integration table to track progress in both SS-D and AP simultaneously.
Agreement on statistical methods and/or biological indicators is needed to determine the definition of trend with respect to this and other juvenile fish data in order to definitively answer the key management question. (p.15)	RTT/WDFW and PUD hatchery monitoring/ISEMP	Andrew Murdoch is working on a project to evaluate statistical models for accuracy and precision of smolt outmigration estimates. Might need additional work to cover other smolt trapping locations (i.e. YN and CCT traps in Nason and White R., and Okanogan). Then a group effort to bring it all together.
A statistical analysis of a comparison between traps within, and among subbasins is needed. Duration (years), variance, and autocorrelation (not shown on any of the graphs) will be important considerations in these analyses. (p.15)	See previous	See previous
A spatially balanced genetic sampling program for Chinook salmon and steelhead should be established throughout the Upper Columbia that can be repeated at intervals to understand the status and trends in genetic diversity. This program would be particularly useful if it was designed 1) to monitor the influences of hatchery impacts to population genetic structure, 2) to help understand what the desired condition for SS/D might be, and 3) elucidated the contribution of rainbow trout production and diversity to steelhead, something that recent studies suggest may be significant. (p.18)	RTT/IT/PUD hatchery M&E	Need a comprehensive review of the PUD hatchery M&E program and an assessment of what the "gap" really is as a first step.
Status data from the Canadian portions of the Okanogan steelhead population should be	IT/NOAA Fisheries/RTT	Seepage #1, second recommendation.

Recommendation	Assigned To	Comments
incorporated into the overall status assessment that has until now focused on the portion of the Okanogan subbasin within the U.S. Included within this assessment should be the identification, delineation, and monitoring of major and minor spawning areas within Canada. Likewise, the Canadian portions of the Okanogan should be included within a spatially balanced genetic sampling program (see above point). (p.18)		
Chapter 2: Implementation, Limiting Factors, and Threats		
The RTT recommends that project planners and those auditing the progress of action implementation should evaluate projects on the basis of ecological limiting factors; in particular, a limiting factor is an aspect of the environment that controls the growth of a population of salmon/steelhead. More effort needs to be made to describe the limiting factors in terms of life stage survival limitations of the populations, rather than just the human induced degradation or threats that might be contributing to reduced survival. These are not mere rhetorical distinction: properly focusing on ecological limiting factors, rather than perceived threats and limitations, could substantially improve likelihood of success (and reduce the cost) of recovery efforts. (p.23)	RTT/IT	Derek is working with Lynn at NOAA to arrange a presentation from David Hamm. Depending on timing and information, may want to bring to RTT and IT.
The highest priority for improving the status of all populations, when productivity is less than 1.0, is to increase productivity. Actions that increase juvenile survival (e.g., smolts/redd) and growth are the highest priority for improving VSP status. For example, efforts to gain and maintain access to the middle reaches of Salmon Creek and upper Omak Creek should continue and are critical to achieving a viable population of steelhead in the Okanogan. (p.23)	WATs	General guidance; may not be a specific short term action that needs follow up.
Accurate and comprehensive data entry into the Habitat Work Schedule is a critical step in tracking implementation progress in the future. (p.23)	WATs	Each sub-basin is working on this. UCSRB will update the regional HWS Guidance document this year.
WATs should use the Habitat Work Schedule to compare the history of implemented projects in their watersheds with RTT recommendations, particularly focusing on high priority actions. The results of this comparison should be used to adjust implementation schedules so that actions addressing identified limiting factors are planned. (p.23)	WATs	Crosswalk with priorities is also done in the MYAP.
Moderate and low priority barriers should be corrected, but not right away. Other factors besides these barriers may limit the population and need to be addressed first. Also, in some cases, other action types and actions in other watersheds need to be addressed before these moderate and low priority barriers are corrected. (p.25)	WATs / IT	Combine with next entry
The RTT Barrier Prioritization Framework should be applied to the Okanogan and Methow Subbasins. (p.25)	RTT / MRC / SOWAT	
In the Wenatchee and Entiat, despite some gains that could be made to capacity, the habitat above many of the moderate to low priority barriers is degraded such that there are potential decreases in productivity.	WHSC / EHSC	Follow guidance from RTT barrier prioritization framework. May need additional recommendation for the upper Chumstick.

Recommendation	Assigned To	Comments
(p.25)		
Inventories should be updated and periodically re-evaluated for priorities. (p.25)	WATs	
The RTT supports and encourages actions that promote and maintain access to the middle reaches of Salmon Creek and upper Omak Creek by steelhead. Providing access to these habitats is critical to achieving a viable population of steelhead in the Okanogan. (p.27)	SOWAT	
Recommendation	Assigned To	Comments
Regional monitoring programs (e.g. ISEMP, OBMEP et al.) are collecting a lot of data that could be used in the adaptive management process. The UCSRB staff should work with these programs to develop a process for reporting the results for all relevant metrics so adaptive management planners can make use of those results. Key Management Questions may need to be revised in light of the relevant metrics reported by these monitoring programs. Multi-metric indices of watershed health and/or decision-support models may need to be developed in order to better interpret complex status/trend data. (p.31)	RTT / MaDMC/ ISEMP/ OBMEP	Jordan et al. need to follow through with answering the extra questions about the data before and as part of the process for modifying the KMQ.
Now that subtleties are being uncovered in actual data, scientists need to work with managers to make sure that data reporting structures are established in a way that the appropriate time and space scales are being applied to particular questions. (p.31)	RTT / MaDMC/ ISEMP/ OBMEP	See previous
Chapter 3: Habitat Status and Trend		
It is encouraging that these smaller-scale wood structures appear to benefit juvenile fish but the studies have some sample size and duration limitations. We recommend continuing with the studies to increase sample size and evaluate the effectiveness over multiple seasons, years, and locations. (p.53)	ISEMP/USFS	Continue K. Polivka studies
Small-scale structures are recommended as a component of larger overall efforts to achieve habitat diversity objectives for the lower Entiat if properly sited and, in particular, if they are used in combination with larger channel-spanning structures and are not put in at the expense of existing functional riparian habitat. (p.53)	EHSC	Link to K. Polivka current and future monitoring
Chapter 4: Habitat Action Effectiveness		
An analysis of spring Chinook genetic samples collected in the Entiat Subbasin is needed to assess VSP diversity criteria for de-listing. (p.59)	RTT / MaDMC	Need to make this one component of the previous recommendation regarding the genetic sampling.
A reference condition for genetic variation for steelhead and spring Chinook in the Upper Columbia needs to be developed so that we can better define the VSP diversity goal and how to track progress toward that goal.	RTT / MaDMC/NOAA Fisheries	Probably a long time horizon on this one. Need to allow hatchery reform to be implemented, then give the populations several generations to respond.
Patterns of genetic diversity are a high risk factor for all Upper Columbia spring Chinook and steelhead populations. Consistent and efficient genetic analyses are prominent data gaps.	RTT / MaDMC	Need to make this one component of the previous recommendation regarding the genetic sampling.
Determine the effects of exotic species and predatory	RTT / MaDMC/	Some studies are underway in the Priest

Recommendation	Assigned To	Comments
native species on recovery of salmon and steelhead and the feasibility to eradicate or control their numbers.	NOAA Fisheries/ Mid-C PUDs	Rapids and Wanapum pools.

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Appendix A. Viable Salmonid Population Framework

Introduction

Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, productivity (population growth rate), spatial structure, and diversity. A viable ESU/DPS is **naturally** self-sustaining, with a high probability of persistence over a 100-year time period.

The following defines the VSP parameters:

Abundance is the number of fish produced by natural processes that have spent their entire life cycle in nature (i.e., natural-origin fish). This is often referred to as gravel-to-gravel survival or fish originating from naturally spawning parents that hatch in a stream's gravel and that survive to spawn naturally themselves years later.

Productivity is a measure of reproductive effectiveness at the population level. Typically it is stated as the number of adult offspring (recruits; which adds the number of adults harvested or taken for broodstock to the number actually arriving on the spawning grounds – this primarily applies to salmon as there is no recreational harvest of wild steelhead) produced per parent (spawner). In its most basic form it is calculated by dividing the total number of spawners in any year into the number of adult recruits that are subsequently produced by these spawners. Although it is used as an indicator of population health and resilience, it is only appropriate to do so if it has been standardized for two very strong confounding effects: 1) yearly variations in survival rates (e.g. marine conditions), and 2) yearly variations in the density of spawners relative to habitat capacity. Once standardized for these two confounding effects, values obtained for population productivity are indicative of a population's resilience and likelihood of persistence. A population with a low standardized productivity is at greater extinction risk than one with a high standardized productivity.

Spatial structure is the range or distribution of wild fish (adult spawners) within a population's habitat range. Any viability evaluation must consider spatial structure within a population (or group of populations) because spatial structure affects extinction risk (McElhany et al. 2000).

Diversity refers to the distribution of traits within and among populations of salmon and steelhead. These traits include anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, physiology and molecular genetic characteristics. A combination of genetic and environmental factors largely causes phenotypic diversity. Variation or diversity in these and other traits is important to viability because a) it allows fish to successfully utilize a wider array of environments; b) it reduces the risks posed by random natural events (e.g., different ocean distribution patterns mean not all fish are at risk from local or regional varying ocean conditions); and c) genetic diversity allows fish to adapt to changing environmental conditions. Habitat, harvest, and hatchery factors can all affect diversity. In the case of hatchery programs, gene flow influences patterns of diversity within and among salmon and steelhead populations.

ESU/DPS Viability Criterion

Since major population groups (MPGs) are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS spatial structure and diversity. Having all MPGs within an ESU/DPS at low risk provides the greatest probability of persistence for the ESU/DPS. The ESU/DPS viability criterion defined by the ICTRT (ICTRT 2007) is as follows:

All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS should be at low risk.

The ICTRT explains that the major objectives of the ESU/MPG-level viability criteria are to ensure preservation of basic historical metapopulation processes, including:

1. Genetic exchange across populations within an ESU over a long time frame;
2. The opportunity for neighboring populations to serve as source areas in the event of local population extirpations;
3. Populations distributed within an ESU/DPS so that they are not all susceptible to a specific localized catastrophic event.

In addition, the presence of viable populations across MPGs would preserve a high level of diversity, promoting long-term evolutionary potential for adaptation to changing conditions (ICTRT 2007).

Major Population Group Viability Criteria

The ICTRT recommended MPG-level viability criteria that take into account the level of risk associated with the MPG's component populations (Figure A1). While individual populations meeting viability criteria are expected to have low risk of extinction, the MPG-level criteria ensure robust functioning of the metapopulation and provide resilience in case of catastrophic loss of one or more populations. MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations. The ICTRT developed the following MPG- level criteria considering relatively simple and generalized assumptions about movement or exchange rates among individual populations. In developing these criteria, the ICTRT assumed that catastrophes do not increase dramatically in frequency, that populations are not lost permanently (because of catastrophe or anthropogenic impacts), and that permanent reductions in productivity, including long-term, gradual reductions in productivity, do not occur (ICTRT 2005).

Major Population Group Viability Criteria
(ICTRT 2007)

The following five criteria should be met for an MPG to be regarded as at low risk (viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.

2. At least one population should be classified as "Highly Viable."

3. Viable populations within an MPG should include some populations classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate," generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.

4. All major life history strategies (e.g. spring and summer-run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.

5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.

Figure A1. Major Population Group Viability Criteria (ICTRT 2007).

Specifically, the first criterion for one-half of the populations to meet "viability standards" refers to the "Viable" standard, or less than 5 percent risk of extinction within 100 years. In the second criterion, "Highly Viable" means less than 1 percent risk of extinction within 100 years. These criteria follow recommendations in McElhany et al. (2000). The presence of viable populations in each of the extant MPGs and some number of highly viable populations distributed throughout the ESU/DPS would result in sustainable production across a substantial range of environmental conditions. This distribution would preserve a high level of diversity within the ESU/DPS, and would promote long-term evolutionary potential for adaptation to changing conditions. The presence of multiple, relatively nearby, highly viable, viable, and maintained populations acts as protection against long-term impacts of localized catastrophic loss by serving as a source of re-colonization.

Population-Level Viability Criteria

To be determined to be viable, populations should meet criteria for all four VSP parameters (abundance, productivity, spatial structure, and diversity). The abundance and productivity criteria are related to population size. The ICTRT developed criteria for characterizing the relative size and complexity of Interior Columbia Basin steelhead and Chinook salmon populations based on their analysis of the intrinsic or historical potential habitat available to the population (ICTRT 2005). This analysis used available Geographic Information System (GIS) data layers showing

stream characteristics (e.g. channel width, gradient, valley confinement) and empirically derived relationships between habitat type, stream structure, landscape processes, and spawning. The ICTRT built a model that also incorporated information from local biologists and recovery planners to identify natural barriers to migration and other local variations (ICTRT 2007).

The ICTRT categorized historical population sizes as Basic, Intermediate, Large, and Very Large, and set minimum abundance thresholds for viable salmonid populations of each type. The abundance thresholds are associated with minimum productivity thresholds, based on modeling studies described in ICTRT 2007a and 2007b. Abundance and productivity are linked, within limits; above a certain threshold, higher productivity can compensate for lower abundance and vice versa.

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Appendix B. Ecological concerns, categories, sub-categories, and definitions (based on Hamm (2012)). Not all of the ecological concerns within the table are relevant to the UCR.

Ecological Concern	Definition	Included Categories	Ecological Concern-Sub Category	Definition	Included Categories
Habitat Quantity	Insufficient quantity of total habitat or habitat diversity due to the elimination of access	Connectivity, Access, Structure, Simplification, Availability	Anthropogenic Barriers	Loss of access to habitat and/or habitat sub-types due to anthropogenic activity. Includes partial or ephemeral barriers.	Access, Barriers, Flap Gates, Tidal Gates, Culverts, Obstacles, Obstructions, Passage Issues, Blocked
			Natural Barriers	Lasting natural barriers to stream or estuary access, including waterfalls, sand bars, log jams, sufficiently steep gradients or insufficient water. May represent the end of good quality habitat	Water Falls, Sand Bar, Bar Breach, Log Jams, Steep Gradient, Thermal Barriers, Low Water
			HQ-Competition	Limited physical space and the protection from predators or physical forces it provides, due to the addition of competing salmonid stocks, species or hatchery produced fish.	Refugia, Hatchery Fish, Predation, Stocking, Swamping
Injury and Mortality	Lethal and sub-lethal effects due to other organisms, including human activities	Death, Injury, Predation	Predation	Introduced salmon predators or changes to the habitat that increase native predator numbers or increase predator success.	Invasive/Exotic Fish or Invertebrate Predators Native Fish, Native Bird, Native Pinnipeds, Fishing
			Pathogens	Increased mortality due to disease causing organisms or parasites.	Disease, Sea Lice, Introduced Diseases, Native Diseases, Whirling Disease, Myxobolus Cerebralis, Gyrodactylus, Sea Lice, Ulcerative dermal necrosis (UDN), IHNV, VHSV, Kudoa, Henneguya, White Spot, Ich, Gill Amoeba
			Mechanical Injury	Mortality or injury due to anthropogenic structures or as the result of mechanical forces due to anthropogenic structures	Inadequate screening, Barging, Snagging, Stranding, Entrainment
			Contaminated Food	Toxics substances found in prey that negatively affect salmon. Includes persistent toxic substances that are concentrated as they are consumed and move to the next trophic level .	Bioaccumulation Toxicity, PBDEs, PCBs, Oil, Organochlorides, Pesticides
Food	Insufficient or inadequate food for salmonids.	Competition, Prey Availability, Species Interactions	Altered Primary Productivity	Alteration of ecological dynamics affecting the quantity, quality and/or species composition of phytoplankton or detritus resulting in insufficient food available for salmonids or prey species.	Micro and Macro-Detrital Inputs, Loss of Marine Derived Nutrients, Carcasses, Down-welling, Ocean Conditions, Detritus, Phytoplankton
			Food-Competition	Insufficient food due to the addition of competing salmonid stocks, species or hatchery produced fish.	Hatchery Fish, Increased Natural Competitors, Invasive Species
			Altered Prey Species Composition and Diversity	Alteration of ecological dynamics affecting the species composition, distribution or nutritional quality of zooplankton, macroinvertebrates, forage-fish or other prey resulting in insufficient food for salmonids.	Species Diversity, Prey Species Abundance, Invasive Species, Altered Food Web Dynamics
Riparian Condition	Degradation of the habitat adjacent to streams, rivers, lakes and nearshore environments.	Impaired Riparian Function/Condition, microclimate,	Riparian Condition	Disturbance to streamside ecological relationships, including but not limited to, loss of flora, erosion and increased light and temperatures	Bank degradation, Cover, Canopy, Inability to supply organic matter and filter sediments, Insufficient buffers, Light, Loss of natural shade

Ecological Concern	Definition	Included Categories	Ecological Concern-Sub Category	Definition	Included Categories
	Impairment of the near-bank environment to support plants including large trees that help stabilize stream banks, provide shade, add primary production to the aquatic ecosystem and includes the supply of mature trees into streams as LWD.	lack of shade	LWD Recruitment	Loss of mature streamside trees that may become instream structures and associated decline in habitat complexity	LWD supply, Mature riparian, Mature trees
Peripheral and Transitional Habitats	Loss and/or degradation of the peripheral habitat of streams and rivers, including standing water, connected channels and areas that are periodically inundated during high flows.	High quality over-winter rearing habitat, Summer rearing habitat, Peripheral Habitat, Habitat Diversity, (Key) Habitat Quantity/Quality, Refugia Habitat	Side Channel and Wetland Conditions	Degradation, elemination and loss of access to peripheral freshwater habitat, including side-channels and freshwater wetlands.	Side Channels, Loss of peripheral habitat, Freshwater Wetlands, Swamp, Oxbows, Ponds, Alcoves
			Floodplain Condition	Degradation, elemination and loss of access to the over or beyond bank habitat, of streams and rivers that is periodically inundated during high flows.	Floodplain, Bank condition, Overbank area, Diking
			Estuary Conditions	Loss and degradation of saltwater transition zone	Estuary, Salt-water transition zone, Lagoon, Estuary plume, Delta, Slough, Pocket estuary
			Nearshore Conditions	Loss and degradation of shallow water nearshore habitat	Beaches, Tidal flats, Eelgrass beds, Eelgrass meadows, Kelp forest, Baitfish spawning grounds
Channel Structure and Form	Changes to river, stream, lake, estuarine tributary and distributary channel form, including instream structural complexity, width to depth ratios, sinuosity and bedload movement such as the loss (scour) or fill (aggradation) of the channel.	Channel Conditions, Channel Form, Channel morphology, Channel Instability, Channel Stability, Loss of Spawning Substrate due to high flow, Bedload Movement	Bed and Channel Form	Changes to river, stream, lake, estuarine tributary and distributary channel form, including width to depth ratios, sinuosity and bedload movement such as the loss (scour) or fill (aggradation) of the channel.	Loss of sinuosity, Bank hardening, Channel incision, Channelized, Aggradation, Bed substrate stability, Armoring, Bridge crossings, Confinement, Nearshore sediment loss, Beach erosion
			Instream Structural Complexity	Decline of the instream habitat quality. Based on the degree of habitat complexity and variety, includes the quantity and variability of stream depth and pools of varying size and depth.	LWD, Pools, Boulders, Bank overhang, Cover, Habitat structure, Instream habitat, Habitat, Stream complexity, Habitat diversity, (Key) Habitat quantity/quality, Refugia habitat, Channel conditions, Instream roughness, Poor gravel/sediment sorting, Rugosity
Sediment Conditions	Reduction of the quantity or quality of spawning habitat due to changes to the background (natural) quantity, rate, and size of sediment inputs to the stream system.	Sediment, Stream Spawning Habitat, Spawning Gravel, Beach Spawning Habitat (lake), Substrate, Benthic Habitat	Decreased Sediment Quantity	Decreased input of sediment to the stream system or some part of the stream system.	Substrate Quantity, Scour, Entrenchment, Loss of Spawning Habitat, Lack of spawning Gravel, Sediment transport
			Increased Sediment Quantity	Increased input of sediment to the stream system.	Bank Erosion, Excessive sedimentation, Aggradation, Sediment Load, Excess Fines, Embeddedness, Sediment Size Ratio
Water Quality	Degraded chemical, physical, and biological characteristics of		Temperature	Water temperature deviations, either in intensity or duration, sufficient to have adverse effects on listed salmonids	High temperature

Ecological Concern	Definition	Included Categories	Ecological Concern-Sub Category	Definition	Included Categories
	water with respect to its suitability for a salmon, excluding toxins and pathogens.		Oxygen	Oxygen concentration deviations sufficient to induce adverse effects in listed salmonids.	Eutrophication, Excess nutrients, Oxygen depleted bottom water
			Gas Saturation	Pathological condition due to saturated gases leaving solution into an animals tissue.	Gas bubble disease (GBD), Dissolved gasses, Nitrogen
			Turbidity	Increased concentrations of suspended fine particulate matter sufficient to have adverse effects in listed salmonids, including reduction of their foraging ability and/or degradation of ecosystem function.	Suspended sediments, Plume Effects,
			pH	Acidity/alkalinity deviations sufficient to adversely effect salmonids or the species on which they feed.	Alkalinity, Ocean acidification, CO2
			Salinity	Salinity at concentrations harmful to salmon	Refuge from salinity regimes
			Toxic Contaminants	Direct exposure to toxic substance in the water column.	Short-term Toxicity, Stormwater Discharge, Outfalls, Wastewater, Non-point Source Pollution, Spills, Marine Debris, Point Source Pollution, Copper, Mercury
Water Quantity	Detrimental effects of deviations to the background (natural) amount and timing of water quantity instream, including lowered water quality and barriers to access.	Changes in Flow Regime, Spring Freshets, Piped Outfalls of Surface and Ground Water, Withdrawals, Flow-Related Plume Changes	Increased Water Quantity	Habitat disturbance associated with abnormally (compared to background) high water flow and increased "flashiness", including loss of channel substrate and the flushing of young fish downstream.	High flow, High volume, Flooding, Increased velocity, Increased peak flows, Decreased flood lag time, Redd scouring, Flashiness, Increased runoff, Water storage capability, Road density
			Decreased Water Quantity	Habitat disturbances associated with abnormally (compared to background) low water flow, including but not limited to, increased temperature, loss of sediment, nutrients and barriers to passage and redd dewatering.	Low Volume, Plume Changes, Redd Dewatering, Water Withdrawals, Surface Impoundments, Diversions, Lake Level
			Altered Flow Timing	Habitat changes associated with alterations to the background (natural) timing of water quantity instream.	Water Releases, Impervious Surfaces, Urbanization, Low Flows, Dewatering
Population Level Effects			Reduced Genetic Adaptiveness	Genetic changes that result in the loss of adaptedness to the habitat or set of habitats a population experiences.	Domestication Selection, Harvest selection, Outbreeding depression, Loss of lifehistory types
			Small Population Effects	Reductions in reproductive rate, loss of genetic resilience or loss of genetic adaptedness in a population due to reductions in abundance that result in further losses of abundance.	Depensation, Loss of genetic diversity, Inbreeding, Genetic Drift, Increased predator effectiveness
			Demographic Changes	Changes to the age, size or developmental makeup of a population that result in a reduction to abundance, fecundity or reproductive rate.	Smaller size at return/maturity, greater age at return/maturity, reduced egg quality

Ecological Concern	Definition	Included Categories	Ecological Concern-Sub Category	Definition	Included Categories
			Life History Changes	Changes to the behavior of individuals that result in a population wide loss of adaptedness, including changes in the composition of life-history types or the timing of migration and reproduction.	Changes to migration timing, loss of reproductive strategies, loss of life-history types (timing of release), increased residual/precocial males/females, run timing, increased jacks/jills

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Appendix C. Project Evaluation Criteria.

Introduction

In the following, scoring criteria for each project type are defined, including the rationale behind each criterion. The RTT believes that the inclusion of the scoring rationale will increase understanding of the reasons the RTT has chosen the criteria and thereby assist project sponsors in the development of project proposals.

Adequacy of Proposal

Because the proposal is the primary instrument by which the RTT evaluates a potential project, the clarity and completeness of the proposal is critical to the RTT's ability to assess and score the potential benefits of the project. If a proposal does not clearly identify objectives and methods, and include all supporting materials (figures, maps, references, etc.) necessary for a reviewer to adequately understand the proposed project, it will likely score low.

Cost Effectiveness

Cost effectiveness scoring will be determined for all project types. To determine cost effectiveness, the RTT will score each proposal as described below for benefit (all scores except cost effectiveness). As has been done historically, the benefit scores will be compiled and averaged at the annual scoring meeting. Once the benefit scores are averaged for a specific project, benefit scores and costs for all the projects are used to develop a 1:1 benefit:cost ratio that is based on percentiles (Figure 1; using regression analysis). The **magnitude of the benefit** (the vertical distance between the benefit score of a particular project and the one:one benefit to cost line; Figure C1) is calculated for each project. Projects are then ranked based on the magnitude of the benefit and assigned to a bin, which is associated with a score (Figure C2).

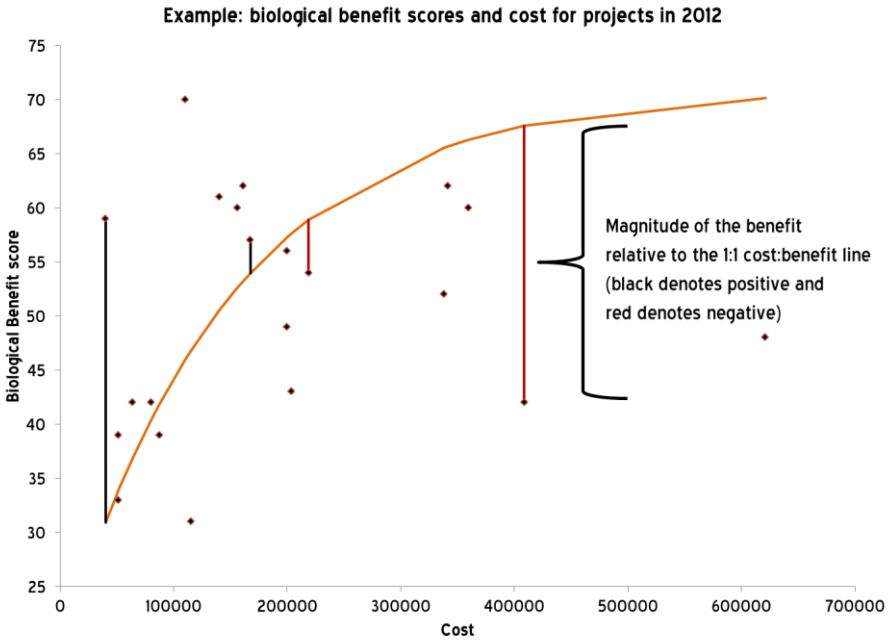

Figure C1. Example of benefit:cost one to one line and the biological benefit scores and costs associated with the 2012 open solicitation projects.

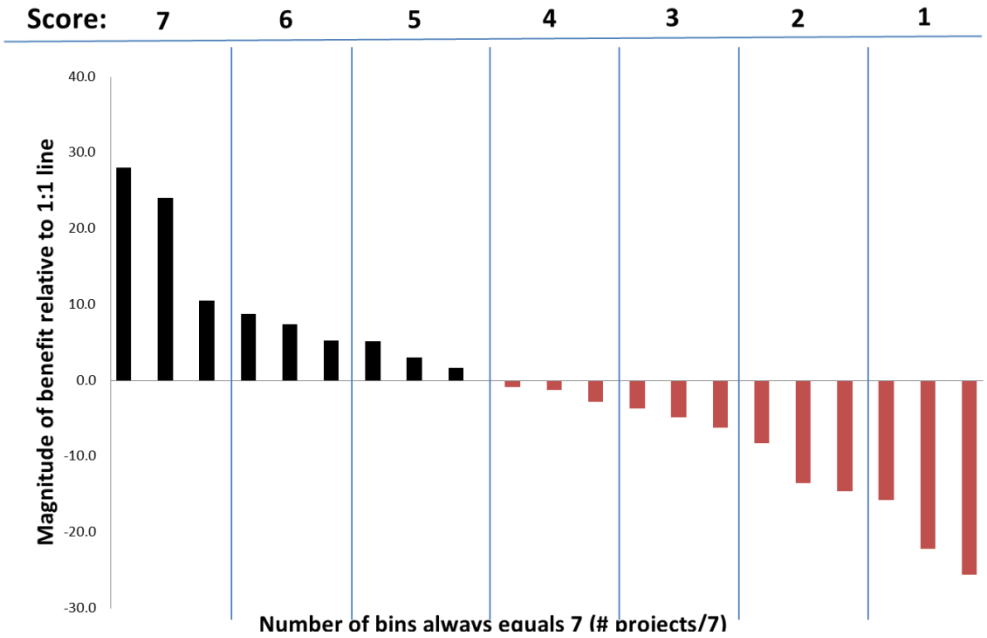

Figure C2. Ranked scores (based on the magnitude of the benefit from Figure C1) and associated scores.

Scoring Criteria

The RTT determined that the scoring criteria should be based on various factors, such as ecological concerns and overall effect on freshwater productivity. These factors form the basis for evaluating each of the four project types (i.e., *restoration project*, *protection project*, *design project*, or *assessment project*). Each category has been assigned separate criteria for scoring.

Each criterion is weighted. Weighting allows the RTT to account for the importance of each criterion relative to the other criteria within each category. For example, the criterion addressing a primary ecological concern will be weighted higher than the criterion of landowner acceptance. Both criteria are important, but addressing a primary ecological concern is more important for a project to be successful than landowner acceptance from a technical perspective at the time of scoring. The weight assigned to each question generates contrast in total scores among the different projects.

Restoration Projects

1. **Addresses Primary Ecological Concerns (25% of total score)**

    a) *Extent to which the proposed restoration project will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix E)?*

    - **Rationale**: Proposed restoration actions must address **primary** ecological concerns limiting the freshwater survival and/or distribution of fish species within a priority sub-watershed or assessment unit. Projects that address more than one primary ecological concern, or fully rectify a single ecological concern, achieve the highest scores.

      Scores are also affected by sequencing. That is, projects that address ecological concerns that are unlikely to affect freshwater survival or distribution without first correcting other primary ecological concerns would achieve relatively low scores unless the proposed sequencing is justified by extenuating circumstances.

    - **Scoring**:
        - 0 = no change in ecological concern(s) at priority sub-watershed or assessment unit scale;
        - 1-6 = intermediate change;
        - 7 = fully rectifies ecological concern(s) at priority sub-watershed or assessment unit scale.

2. Methodology, Location, and Scale of the Restoration Project (15% of total score)

a) Extent to which the proposed restoration project is sited within a priority spawning/rearing area (as identified in Appendix E), or provides access to habitat that would function as priority spawning/rearing habitat?

- **Rationale**: Streams vary in intrinsic potential (i.e., potential quality and quantity of spawning/rearing habitat) because of differences in geology, geomorphology, valley width, elevation, stream size, gradient, and other factors. The RTT has incorporated intrinsic potential in identifying the priority restoration areas listed in Appendix E. Projects that improve habitat quantity and quality within streams of high intrinsic potential, or provide access to such habitat, will achieve the highest scores. For projects that are targeting only bull trout, known habitat use by life stage will be used since intrinsic potential has not been developed for bull trout.

- **Scoring**:
  - See Tables C1, C2 and C3.
  - If a project is targeted at both spring Chinook salmon and steelhead, the RTT will use the higher of the two intrinsic potential scores.
  - Table 3 is for projects that only focus on bull trout and not spring Chinook and/or steelhead. If a project is proposed for all three species, the highest score will prevail.

Table C1. Summary of intrinsic potential values for the entire UCR. All of the intrinsic potential values were summarized for the entire UCR, then subdivided into eight categories that correspond to a score.

Score	Chinook salmon	Steelhead
0	0	0
1	0.00001-0.07151	0.00001-0.14926
2	0.07152-0.13794	0.14927-0.29708
3	0.13795-0.20436	0.29709-0.44489
4	0.20437-0.27078	0.44490-0.59271
5	0.27079-0.33721	0.59272-0.74052
6	0.33722-0.40363	0.74053-0.88834
7	> 0.40363	> 0.88834

Table C2. Intrinsic potential values for each assessment unit (D. Holzer, NMFS, personal communication), with a value corresponding to the categories defined in Table C1.

Assessment Unit (in priority order)	Intrinsic Potential			
	Spring Chinook		Steelhead	
	Value	Score	Value	Score
Wenatchee				
Nason	0.2359	4	0.3622	3
Upper Wenatchee	0.1927	3	0.5703	4
Icicle Creek	0.0343	1	0.5723	4
Peshastin	0.0412	1	0.3130	3
Lower Mainstem	0.0282	1	0.2121	2
Mission Creek	0.0200	1	0.1904	2
Little Wenatchee	0.1068	2	0.1569	2
White River	0.2198	4	0.3188	3
Middle Wenatchee River	0.0144	1	0.0260	1
Chumstick Creek	0.0621	1	0.2373	2
Chiwawa River	0.4158	7	0.8146	6
Entiat				
Stillwater Reach	0.2200	4	0.3473	3
Lower Entiat	0.0513	1	0.1679	2
Upper-Middle Entiat	0.2255	4	0.1803	2
Mad River	0.0102	1	0.1521	2
Methow				
Upper Methow (IP score is from Chewuch confluence to end of anadromy)	0.3030	5	0.8531	6
Lower Twisp	0.2014	3	0.3898	3
Upper-Middle Methow (IP score is from Texas Cr to Chewuch confluence)	0.2578	4	0.5560	4
Lower Chewuch	0.2247	4	0.7964	6
Beaver	0.0	0	0.1904	2
Middle Methow River (IP score is from Texas Cr to Chewuch confluence)	0.2578	4	0.5560	4
Wolf Creek	0.0065	1	0.0486	2
Gold Creek	0.0	0	0.0898	1
Libby Creek	0.0	0	0.0679	1

Assessment Unit (in priority order)	Intrinsic Potential			
	Spring Chinook		Steelhead	
	Value	Score	Value	Score
Upper Twisp River	0.0492	1	0.2941	2
Upper Chewuch River	0.3118	5	0.3876	3
Early Winters Creek	0.0086	1	0.1119	1
Lost River	0.0285	1	0.1117	1
Lower Methow River	0.1147	2	0.1876	2
Okanogan				
Inundated Okanogan	NA	NA	0.0172	2
Okanogan River 01	NA	NA	0.0097	1
Okanogan River 02	NA	NA	0	0
Okanogan River 03	NA	NA	0	0
Okanogan River 04	NA	NA	0.0378	1
Okanogan River 05	NA	NA	0.0015	1
Okanogan River 06	NA	NA	0.0333	1
Okanogan River 07	NA	NA	0.1326	1
Similkameen (all)	NA	NA	0.0	0
Loup Loup Creek	NA	NA	0.0232	1
Lower Salmon Creek	NA	NA	0.0646	1
Upper Salmon Creek	NA	NA	0.1807	2
Lower Omak Creek	NA	NA	0.1393	1
Upper Omak Creek	NA	NA	0.2269	2
Wanacut Creek	NA	NA	0.0097	1
Tunk Creek	NA	NA	0	0
Aeneas Creek	NA	NA	0	0
Bonaparte Creek	NA	NA	0.0194	1
Antoine Creek	NA	NA	0	0
Wild Horse Spring Creek	NA	NA	NA	0
Tonasket Creek	NA	NA	0	0
Nine Mile Creek	NA	NA	0.0182	1
Chiliwist Creek	NA	NA	0.0186	1

Table C3. Bull trout use of habitat and associated score.

Bull trout spawning	Score	Watershed
Bull trout are not known to spawn, rear, or migrate in area	0	
10% or less of bull trout spawning in the watershed spawn here	1-3	Icicle, Peshastin, Chiwaukum, Nason, Lower Methow
11-50% of bull trout spawning in the watershed spawn here	4-5	White/Little Wenatchee, Entiat River, Chewuch, Upper Methow
51-75% of bull trout spawning in the watershed spawn here	5-6	Mad River, Twisp
Greater than 75% of bull trout spawning in the watershed spawn here	7	Chiwawa

b) Extent to which the restoration project is appropriately scaled and scoped.

- **Rationale**: Projects must be placed so that they function within the fluvial-geomorphic context of the stream reach or watershed. Projects sited without consideration of stream flows, sediment dynamics, and geomorphology will likely fail or provide limited long-term physical and biological benefit, and thus will receive the lowest scores. Similarly a project may be too small in scope to achieve the purported benefits.

- **Scoring**:
  - 0 = scale and location of project cannot provide projected benefits;
  - 1-6 = intermediate (scale and scope will provide some benefits);
  - 7 = scale and location ideal for providing projected benefits.

3. Longevity of Proposed Restoration Action (15% of total score)

a) Over what time period will the proposed restoration action and its benefits persist?

- **Rationale**: Restoration projects that promote long-term habitat improvements, and/or require little to no on-going maintenance are likely to have the greatest biological benefit and will receive higher scores. Projects that treat only symptoms of degraded watershed processes, or

require continued on-going maintenance are unlikely to persist for long periods. These projects will receive lower scores.

- **Scoring**:
    - 0 – 3 = restoration project that will persist for less than 10 years (or require on-going maintenance within this time period);
    - 1-6 = 20-50 years (or some maintenance will be required);
    - 7 = 50+ years (and little to no maintenance).

b) Extent to which the project promotes natural stream/watershed processes that are consistent with the fluvial geomorphology at the reach or assessment unit scale?

- **Rationale**: The RTT defines *natural stream/watershed processes* as those processes where habitat functions at large spatial and temporal scales. Connectivity to the floodplain, absence of barriers, and large, intact riparian zones are all features of natural stream/watershed processes. As discussed within the body of the biological strategy, "process based restoration" refers to projects that will result in long-term changes to natural watershed and fluvial processes. Projects like riparian plantings, increasing flows, removing structures that limit floodplain connection are all examples of projects that restore natural processes.

- **Scoring**:
    - 0 = project does not promote watershed process;
    - 1-6 = project support intermediate levels of watershed process;
    - 7 = project fully restores watershed process.

4. Benefits to Freshwater Survival (30% of total score)

a) Extent to which the project would improve freshwater survival of target species at the primary sub-watershed or assessment unit scale?

- **Rationale**: Habitat restoration projects are implemented to increase freshwater survival and/or distribution of target fish species. Therefore, it is important to assess the effects of restoration actions on pre-spawn survival, egg-smolt survival, and spawner distribution. These metrics are evaluated at the scale of the primary sub-watershed or assessment unit.

Scoring:

- 0 = no benefit to freshwater survival;
- 1-6 = intermediate (e.g., 10% increase in survival; score = 1, if there is a 50-75% increase in survival; the score = 6);
- 7 = highest possible benefit to freshwater survival (e.g., > 75%).

5. **Cost Effectiveness of Restoration Project (15% of total score)**

a) How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?

- **Rationale**: There are limited funds available for salmon recovery. Therefore, it is important to ensure that the cost of a proposed project is commensurate with the potential benefit.
- **Scoring**:
  - See introduction
- **Note:** This will be scored after the collective RTT scores for the rest of the criteria (in the scoring meeting).

Comments to be included in regard to this criterion (not part of the scoring):

1. Does the RTT believe that there are potential cost efficiencies that could be gained?
2. Are there any costs the RTT feels could be improved?
3. Was there a "value engineering review" (mostly design projects)?

Scoring sheet for restoration projects.

Project Name: _____					
Reviewer:_____	**Project Type: Restoration**				
Topic/Issue	**Question**	**Potential Score**	**Weighting factor**	**Total Maximum Potential Score**	**Score (by RTT member; 1-7)**
Address Primary Ecological Concerns (25% of total score)	*Extent to which the proposed restoration project will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix E)?*	7	3.57	25	
Methodology of Restoration Project (15% of total score)	*Extent to which the proposed restoration project is sited within a priority spawning/rearing area (as identified in Appendix E), or provides access to a priority spawning/rearing habitat?*	7	1.07	7.5	
	Extent to which the restoration project is appropriately scaled and scoped.	7	1.07	7.5	
Longevity of Proposed Restoration Action (15% of total score)	*Over what time period will the proposed restoration action and its benefits persist?*	7	1.07	7.5	
	Extent to which the project promotes natural stream/watershed processes that are consistent with the fluvial geomorphology at the reach or assessment unit scale?	7	1.07	7.5	
Benefits to Freshwater Survival (30% of total score)	*Extent to which the project would improve freshwater survival of target species at the primary sub-watershed or assessment unit scale?*	7	4.29	30	
Cost Effectiveness of Restoration Project (15% of total score)	*How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?*	7	2.14	20	
	Grand total	49		100	

Protection Projects

1. **Placement of Protection Project (30% of total score)**

a) Extent to which the proposed protection project is sited within a priority spawning/rearing area (as identified in Appendix E)?

- **Rationale**: Streams vary in intrinsic potential (i.e., potential quality and quantity of spawning/rearing habitat) because of differences in geology, geomorphology, valley width, elevation, stream size, gradient, and other factors. Projects that protect habitat within or along streams of high intrinsic potential will achieve the highest scores.

- **Scoring**:
    - See Table C1, C2 and C3.

b) Extent to which the project protects high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?

- **Rationale**: Maintaining high-quality habitat within priority spawning and rearing areas is critical to the viability of target fish populations. Thus, protecting these areas, or areas with high restoration potential, is important to the conservation of the target species.

- **Scoring**:
    - 0 = project does not protect high-quality habitat or habitat restoration is precluded;
    - 1-6 = intermediate (habitat that cannot be restored to high quality without protecting it first);
    - 7 = project protects high-quality habitat.

c) Extent to which the protection project is connected with other protected properties?

- **Rationale**: Large parcels of high-quality riparian/floodplain habitat may have a greater effect on freshwater survival than will smaller, disconnected parcels of high-quality riparian/floodplain habitat. Therefore, projects protecting smaller, isolated "islands" of habitat will receive lower scores than large, connected parcels of high-quality habitat.

- **Scoring**:

- 0 = project protects a small (e.g., percentage of parcel acreage ≤ 25% of riparian or floodplain habitat) isolated parcel;
- 1-6 = intermediate (26-80% of parcel acreage);
- 7 = project protects either a large (81-100% of parcel acreage), or expands existing protected parcels of high-quality riparian/floodplain habitat.

2. Potential Loss of Habitat Without Project (35% of total score)

a) What would be the anticipated loss in freshwater survival and/or distribution of target species if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of target species at the assessment unit scale)?

- **Rationale**: Freshwater survival is related to the quality of stream habitat. The loss of high quality habitat will result in reduced freshwater survival or distribution of target fish species.

- **Scoring**:
  - 0 = there would be no reduction in freshwater survival or distribution if the proposed area is not protected;
  - 1-6 = intermediate (e.g., 10% reduction in survival; score = 1, 50-75% reduction in survival; the score = 6);
  - 7 = there would be a large (> 75%) reduction in freshwater survival or distribution if the proposed area is not protected.

3. Threat (15% of total score)

a) How imminent is the threat to the proposed land?

- **Rationale**: Because salmon recovery funds are limited, the most pressing concerns need to be addressed first. When evaluating proposals, it is necessary to predict the extent to which a project will change habitat conditions and assess the significance of that change to fish populations. Therefore, to evaluate a habitat protection project, one must have a reasonable basis for comparing what would happen with and without the project. The ability to predict the fate of a proposed parcel of land for protection or easement is poor, but improved when informed by knowledge of the intentions of the present landowner, market conditions, and local critical areas and zoning laws among others. Scoring protection projects by

default as if all extant habitat values will be lost but for the project, would substantially and artificially inflate the value of these projects as compared to restoration projects.

- **Scoring**:
  - 0 = No clear threat of habitat degradation exists at this time (e.g. what might or could happen is the only threat).
  - 1-6 = The threat to high quality habitat is not imminent, but the project proponent makes a compelling argument that this protection opportunity will not exist in the future and/or is required for restoration to occur.
  - 7 = There is a demonstrated imminent threat to the property that could lead to loss of high quality habitat.

4. **Cost Effectiveness of Protection Project (15% of total score)**

   a) *How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?*

- **Rationale**: As with restoration projects, the benefits associated with protecting a parcel of riparian/floodplain habitat should justify the cost of the acquisition or conservation easement.

- **Scoring**:
  - See introduction

- **Note:** This will be scored after the collective RTT scores for the rest of the criteria (in the scoring meeting).

Comments to be included in regard to this criterion (not part of the scoring):

1. Does the RTT believe that there are potential cost efficiencies that could be gained?
2. Are there any costs the RTT feels could be improved?
3. Was there a "value engineering review" (mostly design projects)?

5. **Conditions Affecting the Project (5% of total score)**

   a) *Are there any conditions regarding the protection of the property that could limit the existing high quality habitat?*

- **Rationale**: Purchase of a property with explicit provisions for activities or anthropogenic features that may affect the quality of habitat may reduce the

overall value of the purchase or conservation easement in terms of salmon recovery. Scores will be assigned based on whether there are activities or conditions regarding the purchase (or conservation easement) that are detrimental to riparian, floodplain, and stream conditions.

- **Scoring**:
    - 0-3 = conditions on the purchase (or conservation easement) of the property exist that will have some effect on the protection of existing high quality habitat;
    - 4-6 = conditions exist on the purchase (or CE), but will likely have minimal impact to high quality habitat;
    - 7 = no conditions exist that could impact the protection of high quality habitat in perpetuity.

Scoring sheet for protection projects

Project Name: _____					
Reviewer:_____	Project Type: Protection				
Topic/Issue	**Question**	**Potential Score**	**Weight**	**Total Maximum Potential Score**	**Score (by RTT member; 1-7)**
Placement of Protection Project (30% of total score)	*Extent to which the proposed protection project is sited within a priority spawning/rearing area (as identified in Appendix E)?*	7	1.64	11.5	
	Extent to which the project protects high-quality habitat or habitat that can be restored to high quality with appropriate restoration actions?	7	1.50	10.5	
	Extent to which the protection project is connected with other protected properties?	7	1.14	8.0	
Potential Loss of Habitat Without Project (35% of total score)	*What would be the anticipated loss in freshwater survival and/or distribution of target species if the proposed area was developed (i.e., what habitat values would be lost and to what degree would that loss reduce freshwater survival and/or distribution of target species at the assessment unit scale)?*	7	5.0	35	
Threat (15% of total score)	*How imminent is the threat to the proposed land?*	7	2.14	15	
Cost Effectiveness of Restoration Project (15% of total score)	*How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?*	7	2.14	15	
Conditions Affecting the Project (5% of total score)	*Are there any conditions regarding the protection of the property that could limit the existing high quality habitat?*	7	0.71	2.5	
	Grand total	49		100	

Assessment Projects

1. **Address Primary Ecological Concerns (25% of total score)**

    a) *Extent to which the proposed assessment will inform the development of projects that will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix E)?*

    - **Rationale**: All assessments proposed should link directly to restoration or protection actions addressing **primary** ecological concerns that limit freshwater survival and/or distribution of fish species. Assessment projects that inform actions that address more than one primary ecological concern, or fully rectify a single ecological concern, will achieve the highest scores. Sequencing will also affect scores.

    - **Scoring**:
        - 0 = assessment will result in projects that do not change ecological concern(s) at priority sub-watershed or assessment unit scale;
        - 1-6 = intermediate change (based on proportional change of ecological concern, e.g., a 10% change in the ecological concern would get 1 point, while a 75% change would get 6 points);
        - 7 = assessment will result in projects that fully rectify ecological concern(s) at priority sub-watershed or assessment unit scale.

2. **Area covered by Assessment (20% of total score)**

    a) *Extent to which the proposed assessment is sited within a priority spawning/rearing area (as identified in Appendix E)?*

    - **Rationale**: Streams vary in intrinsic potential (i.e., potential quality and quantity of spawning/rearing habitat) because of differences in geology, geomorphology, valley width, elevation, stream size, gradient, and other factors. The RTT has incorporated intrinsic potential in identifying the priority areas listed in Appendix E. Assessment projects that inform actions that improve habitat quantity and quality within priority areas, or provide access to such habitat, will achieve the highest scores.

    - **Scoring**:
        - See tables C1, C2 and C3.

    b) *Extent to which the assessment is appropriately scaled and scoped?*

- **Rationale**: Assessment projects must be sufficiently comprehensive to anticipate the physical and ecological issues that potentially influence the effectiveness of the restoration projects they will inform.

- **Scoring**:
  - 0 = scale and location of project cannot provide projected benefits;
  - 3.5 = intermediate (scale, location, and scope should be expanded to achieve full benefit);
  - 7 = the assessment is robust with respect to all factors potentially influencing the success of subsequent projects.

3. Use of Information (20% of total score)

a) Extent to which the assessment will fill data gaps identified in Appendix F of the Biological Strategy and will provide information that will lead directly to restoration and/or protection actions.

- **Rationale**: An assessment must be designed to lead to specific projects, or inform critical data gaps, as identified by the RTT in Appendix F of the Biological Strategy.

- **Scoring**:

  - 0 = assessment will not lead to management actions, nor will it fill an important data gap;
  - 3.5 = intermediate (the assessment should be expanded to inform additional data gaps);
  - 7 = assessment will lead to management actions, or it will fill an important data gap.

4. Methods (20% of total score)

b) Are the methods outlined within the assessment proposal adequate to achieve the stated objectives?

- **Rationale**: The assessment must clearly describe the methods that will be used to gather and analyze the information. The proposal should demonstrate that it is using an accepted approach. If it is innovative, the proposal should discuss how the methods will achieve the stated objectives of the assessment and demonstrate the benefits of the methods relative to a standard method.

- **Scoring**:
    - 0 = the methods do not appear adequate to achieve the stated objectives;
    - 1-6 = intermediate (methods need substantial changes to achieve stated objectives (1 point), or a few changes (6 points));
    - 7 = the methods appear adequate to achieve the stated objectives.

5. Cost Effectiveness of Assessment Project (10% of total score)

c) How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?

- **Rationale**: For an assessment project, it is important that the cost reflects the appropriate amount of effort to obtain the information.
- **Scoring**:
    - See introduction

Comments to be included in regard to this criterion (not part of the scoring):

1. Does the RTT believe that there are potential cost efficiencies that could be gained?
2. Are there any costs the RTT feels could be improved?
3. Was there a "value engineering review" (mostly design projects)?

6. Dissemination of information (5% of total score)

d) Is there an avenue described for disseminating information to interested parties upon completion of the assessment?

- **Rationale:** It is important that the proposal clearly identify how this information will be disseminated and accessed (e.g., on the web) once the project is complete.
- **Scoring:**
    - 0 = no description of information dissemination or accessibility;
    - 1-6 = some description of information dissemination and accessibility;
    - 7 = full description of information dissemination and accessibility.

Scoring sheet for assessment projects

Project Name: _____					
Reviewer:_____	**Project Type: Assessment**				
Topic/Issue	**Question**	**Potential Score**	**Weight**	**Total potential score**	**Score (by RTT member; 1-7)**
Address Primary Ecological Concerns (25% of total score)	*Extent to which the proposed assessment will inform the development of projects that will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix E)?*	7	3.57	25	
Area covered by Assessment (20% of total score)	*Extent to which the proposed assessment is sited within a priority spawning/rearing area (as identified in Appendix E)?*	7	1.43	10	
	Extent to which the assessment is appropriately scaled and scoped?	7	1.43	10	
Use of Information (20% of total score)	*Extent to which the assessment will fill data gaps identified in Appendix F of the Biological Strategy and will provide information that will lead directly to restoration and/or protection actions.*	7	2.86	20	
Methods (20% of total score)	*Are the methods outlined within the assessment proposal adequate to achieve the stated objectives?*	7	2.86	20	
Cost Effectiveness (10% of total score)	*How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?*	7	1.43	10	
Dissemination of information (10% of total score)	*Is there an avenue described to disseminate information to interested parties once the assessment is completed?*	7	0.71	5	
	Grand total	49		100	

Design Projects

1. **Address Primary Ecological Concerns (25% of total score)**

    a) *Extent to which the proposed design will lead to the development of projects that will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix E)?*

    - **Rationale**: All designs proposed should link directly to restoration or protection actions addressing **primary** ecological concerns that limit freshwater survival and/or distribution of fish species. Design projects with a direct linkage to development of actions addressing more than one important ecological concern, or fully rectifying a single ecological concern, achieve the highest scores. Sequencing also affects scores.

    - **Scoring**:
        - 0 = design will result in no change in ecological concern(s) or will not directly lead to the development of actions addressing ecological concerns;
        - 1-6 = intermediate change (based on proportional change of ecological concern, e.g., a 10% change in the ecological concern would get 1 point, while a 75% change would get 6 points);
        - 7 = design will result in projects that address more than one primary ecological concern, or fully rectify a single ecological concern.

2. **Area covered by Design (25% of total score)**

    a) Extent to which the proposed project (created from the design) is sited within a priority spawning/rearing area, or creates or provides access to habitat that could function as priority spawning/rearing habitat?

    - **Rationale**: Streams vary in intrinsic potential (i.e., potential quality and quantity of spawning/rearing habitat) because of differences in geology, geomorphology, valley width, elevation, stream size, gradient, and other factors. Design projects directly leading to actions that improve habitat quantity and quality within priority areas, or provide access to such habitat, will achieve the highest scores.

    - **Scoring**:
        - See tables C1, C2 and C3.

b) Extent to which the design is appropriately scaled and scoped?

- **Rationale**: Projects must be designed so that they will function within the fluvial-geomorphic context of the stream reach or watershed. Projects that are sited without consideration of stream flows, sediment dynamics, and geomorphology will likely fail or provide limited long-term physical and biological benefit and will receive the lowest scores. Similarly a project may be too small in scope to achieve the purported benefits.

- **Scoring**:
  - 0 = scale and location of project cannot provide projected benefits;
  - 3.5 = intermediate (scale, location, and scope should be expanded to achieve full benefit);
  - 7 = the design is robust with respect to all factors potentially influencing the success of the project.

3. Methods (25% of total score)

a) Are the methods outlined within the design proposal adequate to achieve the stated objectives?

- **Rationale**: The design must clearly show the methods that will lead to an action (project). The project proponent should demonstrate that the methods proposed are an accepted approach. If they are innovative, then the proponent should discuss how the methods will achieve the stated objectives of the design and demonstrate the benefits of the innovative method relative to a standard method.

- **Scoring**:
  - 0 = the methods do not appear adequate to achieve the stated objectives;
  - 1-6 = intermediate (methods need substantial changes to achieve stated objectives (1 point), or a few changes (6 points));
  - 7 = the methods appear adequate to achieve the stated objectives.

4. Cost Effectiveness of Design Project (15% of total score)

a) How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?

- **Rationale:** For a design, it is important that the cost reflects the appropriate amount of effort to develop appropriate actions.
- **Scoring:**
    - See introduction

Comments to be included in regard to this criterion (not part of the scoring):

1. Does the RTT believe that there are potential cost efficiencies that could be gained?
2. Are there any costs the RTT feels could be improved?
3. Was there a "value engineering review" (mostly design projects)?

5. Level of completeness (10% of total score)

a) To what level of completion will the design be developed?

- **Rationale**: It is important that the project proponent clearly identify how complete the design will be (e.g., permit-ready, bid-ready, etc.); information such as whether there will be a preferred alternative chosen, whether permits will be applied for or in-hand once the design is complete, will assist the RTT in determining the level of completeness of the proposed design.
- **Scoring**:
    - 0 = no description of what stage of development the design will be in when completed;
    - 1 = 10% completion;
    - 3 = 30% completion;
    - 5 = 90% completion;
    - 7 = 100% design.

b) Are there milestones for future check-ins with the RTT as the design progresses?

- **Rationale:** Future check-in prior to full project development assists the project proponent and the RTT in ensuring that the best possible alternative for an action is designed.

- **Scoring**:
    - 0 = no check-in with RTT;
    - 7 = Check-in clearly identified.

Scoring sheet for design projects

Project Name: _____					
Reviewer:_____	**Project Type: Design**				
Topic/Issue	**Question**	**Potential Score**	**Weight**	**Total potential score**	**Score (by RTT member; 1-7)**
Address Primary Ecological Concerns (25% of total score)	*Extent to which the proposed design will lead to the development of projects that will reduce the effects of **primary** ecological concerns (as identified in the UCRTT Biological Strategy, Appendix A)?*	7	3.57	25	
Area covered by Design (25% of total score)	*Extent to which the proposed project (created from the design) is sited within a priority spawning/rearing area, or creates or provides access to priority spawning/rearing habitat?*	7	1.79	12.5	
	Extent to which the design is appropriately scaled and scoped?	7	1.79	12.5	
Methods (25% of total score)	*Are the methods outlined within the design proposal adequate to achieve the stated objectives?*	7	3.57	25	
Cost effectiveness (15% of total score)	*How cost effective is the proposed project compared to other projects being proposed within the same funding cycle?*	7	2.14	15	
Level of completeness (10% of total score)	*To what level of completion will the design be developed?*	7	0.71	5	
	Are there milestones for future check-ins with the RTT as the design progresses?	7	0.71	5	
Grand total		42		100	

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Appendix D. Definitions and Use of Assessments Made in the Upper Columbia Region.

Definitions

Assessment Unit - Assessment Units are an area of a watershed or primary sub-watershed that is used to categorize a geographic area into smaller units within either a primary sub-watershed or the mainstem major rivers.

Ecological concerns (formerly "limiting factors") - Those specific features of freshwater habitat and ecology that influence the productivity and abundance of salmonids that restoration projects are meant to address.

Fluvial geomorphic processes - The processes of water and sediment movement in river catchments and channels and their floodplains – together with the forms produced by those processes.

Reach - A reach is generally composed of geomorphically similar subsections of an assessment unit.

Introduction

In the UCR, many assessments have been completed or are in progress. These assessments have focused on describing specific areas (e.g., tributary, reach, etc.) in terms of current processes that are affecting habitat quality and suggests (to varying degrees, depending on the specific objectives of the funding agency) restoration or protection actions that would either protect or improve salmonid habitat. In addition, some assessments review the underlying geomorphic processes, historical, current, and future trends, for a better understanding on how projects that are developed from the assessment will function over time and integrate with the geomorphic processes.

Purpose

The purpose of this appendix is to define the different types of assessments, make recommendations on what should be included within the assessment, and suggest how potential project sponsors may be able to use an assessment to develop proposed projects.

Components

The following is an outline of the minimal components that should be included in an assessment.

I. Assessments Objectives

i. Identify pertinent watershed-scale characteristics including dominant forms and processes; not everything, just the characteristics that influence salmonid habitat and fluvial geomorphic processes.
ii. Identify systemic problems (if any); identify root problem (cause) not the symptom (effect).
iii. Delineate the tributary into valley segments and reaches as appropriate based on geomorphic characteristics. Prioritize reaches for assessment based on perceived restoration potential based on identified problems (variance from "normal" or degree of departure from the natural functioning condition).

1. *Reach*
    a. Identify past, existing (baseline), future trends, and potential target conditions (the forms and processes that define the reach – just the characteristics that influence salmonid habitat and fluvial geomorphic processes).
    b. Identify potential actions to improve (or protect in some cases) habitat supported by or based on documented conditions.

II. Ecological Concerns

a. Habitat
b. Geomorphological

i. Natural
ii. Anthropogenic

III. Hydraulics (Suggest this is done roughly at the reach-scale and included in the assessment; then repeated more precisely at the project scale and included with an alternatives analysis or conceptual design during proposal development).

a. Measured
b. Modeled

IV. Historic Conditions

a. Geomorphological
b. Habitat (if possible)
c. Qualitative or inferred Hydraulic conditions (if possible)

V. Existing Conditions (At tributary and reach scale)

a. Habitat
b. Geomorphological
c. Hydraulic

VI. Future Trends (At tributary and reach scale)

a. Habitat
b. Geomorphological

VII. Desired Conditions (Suggest that this is done with a robust analysis of system changes (how and why did conditions change from past to present?). Based on historic changes and trends, identify target future conditions, then apply professional experience and quantitative of qualitative logical evidence to support the targets.)

a. Habitat
b. Geomorphological
c. Hydraulic

VIII. Potential Projects (Suggested approach: (1) identifying geomorphically appropriate projects from the Reach Assessment; (2) prioritize those projects through the RTT filter based on biological benefit; and (3) select projects from the prioritized list based on landowner cooperation/willingness.)

a. Action type
    i. Specific
        1. Location
            a. sub-reach
            b. RM

Recommendations on Use of Assessments

IX. Use of Assessments

a. Naming protocol of Assessment

   i. "Reach" (includes detailed geomorphic information in addition to detailed habitat and hydraulics).

   ii. "Rapid" (should not be used in place of a full Reach Assessment; may provide basic geomorphic context for a project that has already received universal support and is commonly accepted as a priority within the basin enabling the project to proceed on an expedited basis; can be used to evaluate the need and/or level of effort required for a larger Reach Assessment).

b. RTT review

   i. Memorandum (as prescriptive as possible; see example below)

      1. Does assessment comport with biological strategy?
      2. What may be lacking?
      3. Suggested changes to Assessment (if warranted)

c. Project Development

   i. Review Assessment
   ii. Review RTT memo
   iii. Design based on guidance from memo and Assessment

      1. Project sponsors are encouraged to coordinate at the *reach* level to ensure that projects are coordinated and provide the largest biological benefit and implemented in the appropriate sequence.

      2. If guidance cannot be followed, show (detail) why.

Example of RTT memo reviewing assessment and ensuring that the projects comport with the Biological Strategy:

DRAFT MEMORANDUM

To: UC RTT
UC Project Sponsors

From: Joint RTT/USBOR workgroup

Re.: Guidance on the implementation of the Lower Entiat Reach Assessment

Date: February 1, 2012

Introduction
Members of the RTT and USBOR (the core team) met on January 24, 2012 to discuss guidance on project development related to the Lower Entiat Reach of the Entiat River Basin. Members present from the RTT included: Kate Terrell, Mike Ward, Karl Polivka, and Chuck Peven. Members from the USBOR were Steve Kolk, Terril Stevenson, and Rob Richardson. Derek Van Marter from the UCSRB facilitated the meeting.

The purpose of the meeting was to develop a memorandum considering the recently completed Reach Assessment (USBOR 2012)[5] and the biological strategy of the RTT (currently being revised). The intent of this memorandum is to provide detailed guidance to the Lead Entities and potential project sponsors in developing projects that are geomorphically and biologically appropriate for the Lower Entiat Assessment Area (LEAA); the lower 16 miles of the Entiat River.[6]

Goals and Objectives
The goal (desired future condition) of restoration activities in the Lower Entiat is to *rehabilitate habitat in the LEAA to improve spring Chinook salmon, steelhead, and bull trout[7] populations in the Entiat River*.

The biological objectives associated with this reach are:

1. Increase summer and winter rearing habitat for juvenile steelhead and spring Chinook salmon;

2. Increase resting and holding areas for various life stages of spring Chinook salmon, steelhead, and bull trout; and

3. Ensure that geomorphically appropriate methods are used to rehabilitate habitat within the LEAA.

[5] USBOR (U.S. Bureau of Reclamation). 2012.Lower Entiat Reach Assessment. US BOR, Boise, ID. 92 pages plus appendices.
[6] The Reach Assessment only focused the lower 7 miles of the river, although much of information presented within it would apply to the river as far upstream as RM 16.
[7] Bull trout are not a target species for the FCRPS Action Agencies, but they are a focus species for the UCSRB and RTT. All of the actions proposed should benefit this species too.

Guidance on Project Development

Process

The workgroup reviewed the Lower Entiat Reach Assessment and draft tables that are currently being revised for the RTT's Biological Strategy pertaining to the LEAA. In addition, information being developed for the Expert Panel Process by a subgroup of the Expert Panel/RTT was also reviewed.

After goals and objectives were identified, the core team reviewed the information depicted in Table 1 and developed further detail in the last column to better identify exact locations when possible.

The core team developed recommendations based on biological benefit and geomorphic appropriateness.

Table 1. Potential actions that could be developed for the Lower Entiat assessment area.

Form or Process [a, b]	RTT Input (biological strategy and expert panel)			Reach Assessment			Potential Actions
	Ecological Concern (EC) [b]						
	EC 1	EC 2 (subcategory)	Percent of PFC [c]	Existing Condition [a]	Target Condition [a]	Action types [a]	
Pools				0.5 per mile	3.5 – 4.0 per mile	Placement of large structure	ELJs near existing natural features (islands/bedrock); create pools in conjunction with other actions; pocket pools also provide rearing and refugia; incorporate additional cover with pools where possible.
Sinuosity				Roughly 1.1	Roughly 1.1	Removal of riprap	River right @ RM 4
LWD	Channel structure and form	instream structural complexity	25	2.3 logjams per mile; 132 individual pieces per mile	5 – 10 logjams per mile; as many individual pieces providing cover along the banks as possible	Placement of LWD; riparian planting; fence and maintain a riparian buffer	ELJs near existing natural features (islands, bedrock, bends); Two islands (~RM 6.3) ELJ placement; River right (~RM 5.3) island ELJ placement; River left (RM 4.0) Harrison Side Channel; River left wood placement for cover (~RM 3.1) downstream of fire station; River right (~RM 0.8) wood placement in side channel right bank; generally ELJ placement at head of any side channel; generally wood placement for cover anywhere socially acceptable.
Channel geometry				Incised 1 to 20 feet	Incised 1 to 20 feet		N/A
River bed and banks	Channel structure and form	bed and channel form	80	Armored with large boulders and riprap	Armored with large boulders	Remove riprap	River right (~RM 6.6) riprap near Roaring Ck bridge; River right (~RM 4.1) riprap at Harrison levee
Off-channel habitat	Peripheral and transitional habitats	Side channel and Wetland Conditions	80	Few side channels	Few side channels, but more than existing	Placement of LWD; removal of levees; excavate side channels; breach levees with culverts	Lower Entiat river left side channel (~RM 6.2 culverts) reconnection; H-D (~RM 5.0) side channel reconnection; River Right (~RM 5.6) floodplain reconnection; River Right (~RM 4.45) side channel enhancement. Harrison side channel adaptive mgmt. (~RM 4.0); River right floodplain and side channel (~RM 2.4) development; River right (~RM 1.9) side channel development; River right (~RM 0.8) side channel development in

Form or Process [a, b]	RTT Input (biological strategy and expert panel)			Reach Assessment			Potential Actions
	Ecological Concern (EC) [b]		Percent of PFC [c]	Existing Condition [a]	Target Condition [a]	Action types [a]	
	EC 1	EC 2 (subcategory)					
							backwater zone.
Floodplain connection				Limited to narrow active floodplain and further reduced by levees	Limited to narrow active floodplain between terraces and reduced only by levees protecting vital infrastructure	Remove levees	River right levee (~RM 5.5) and interaction with floodplain; River left upstream of Harrison ~ 5 yr floodplain blocked from levee; River right (~RM 2.5) levee/push-up and side channel development.
Riparian condition	Riparian condition	Riparian condition	25	Partially mature trees; riparian area generally 25 feet wide	Dense mature trees; riparian area at least 100 feet wide	Riparian planting; fence and maintain a riparian buffer	Increase riparian area in conjunction with other actions; refer to previous prioritization report
Food productivity	Food	Altered primary productivity and food competition	21				
Water quantity	Water quantity	Decreased water quantity	50				Focus on increased low flow in conjunction with other actions

[a] Reach Assessment
[b] Draft update of the RTT Biological Strategy
[c] PFC = properly functioning condition; from draft update to for the Expert Panel process

Results
In the following, the core team discussed each form or process (first column in Table 1) in greater detail.

Pools
The LEAA is lacking instream habitat complexity (see below), including pools. These are essential habitat features used by all of the focal species. The current condition in the LEAA is approximately 0.5 large pools per mile. The target condition is 3.5-4 large pools per mile and many more small (pocket) pools.

Recommended Actions
The following actions are recommended by the core team to assist in project development:

Increase the number of channel-spanning pools by installing large structures within the wetted channel through;

1. Placement of engineered log jams (ELJ) at the apex of islands and/or side channels and/or in locations where flow can be forced against bedrock (Figure 1);

2. Placement of large boulders or clusters of boulders in *over-widened* reaches (the channel is *over-widened* if the low-flow width is greater than about 80 ft in a plane-bed section of the river, not including immediately upstream of islands, where a river will widen naturally; see Figure 2 for specific areas, including rankings) and/or in locations where flow can be forced against bedrock, and/or in long-straight reaches to develop small (pocket) pools and hydraulic diversity;

3. Placement of individual or a few pieces of large wood along the bank to create small (pocket) pools and cover without severely impacting the riparian zone to do so.

Large woody debris
Historically, large wood complexes were prevalent in the LEAA. The current condition for LWD is 2.3 log jams and 132 individual pieces per mile, while the target condition is 5-10 log jams per mile and as many individual pieces to provide cover along the banks as possible.

Recommended Actions
In general, the core team recommends large wood be placed at the apex of islands, or inlets to side channels. The core team recommends the following actions (see Figure 1):

1. Place ELJ at the apex of the islands at approximate river mile (RM) 6.3;

2. Place ELJ at approximate RM 5.3 at apex of island at river right;

3. Place ELJ at approximate RM 3.9 at apex of island at river left (upstream of fire station);

4. Place ELJ at approximate RM 5.3 at apex of island at river right;

5. Place ELJ at approximate RM 0.8 at inlet of potential new side channel.

River bed and banks
The LEAA is naturally armored in a handful of areas with large coble and boulders; however, there are a few areas of rip-rap that should be addressed.

Recommended Actions

The core team recommends the following actions:

1. Remove rip rap on river right near Roaring Creek Bridge near RM 6.5. Care should be taken to estimate potential river response from riprap removal in this location as downstream impacts to habitat features (such as existing islands and side channels) will likely be affected.;

2. Remove rip rap on river right near RM 4.2 (Harrison levee) to improve channel migration processes.

Off-channel habitat and floodplain connection

Currently there are few side channels and the floodplain access is confined. Based on the Reach Assessment, historically, the occurrence of side channels and associated floodplain connection was limited. This limitation increases the biological significance of existing and restored side channels and floodplains

Recommended Actions

The core team recommends that this type of habitat rehabilitation should be vigorously pursued where it is geomorphically appropriate. The core team recommends the following actions (see Figure 1):

1. Provide access and flow into the side channel on river right at RM 6.0. Flow and access is currently block by the levee;

2. Remove levee on river right at approximate RM 5.5 to access the floodplain. An existing side channel has formed along the base of the levee, and potential impacts to this side channel should be considered if the levee is removed;

3. Remove levee on river right at approximate RM 5.0;

4. Remove existing levee at the Harrison side channel and allow the floodplain to function (~RM 4);

5. Remove levee on river right at approximate RM 2.5;

6. Remove levee on river right at approximate RM 2.3;

7. Remove levee on river right at approximate RM 1.9;

8. Develop side channel habitat within backwater zone of influence at approximate RM 0.8.

Riparian Condition

Currently, the riparian zone associated with the LEAA is made up of partially mature trees and is generally less than 25 feet wide. The core team recognizes that there are various definitions of how far and to what extent the riparian zone should be rehabilitated. Therefore, we encourage all project developers to develop riparian conditions that have the largest footprint possible in the specific area where they are feasible to work on, preferably upwards towards 100 feet, if possible.

Potential Actions

Specific areas that the core team recommends for riparian restoration can be found within the *Final Draft Report, Entiat River Watershed Riparian Areas Prioritization Project, Chelan County*, WA dated June 25, 2007 (http://cascadiacd.org/entiat-watershed-reports_257.html):

Water quantity
The core team does not have specific project recommendations, but encourages all project sponsors to incorporate water savings in any of the projects that are developed for the other categories as possible.

Please direct all questions concerning this memorandum to Derek Van Marter, Rob Richardson, Kate Terrell, and Chuck Peven.

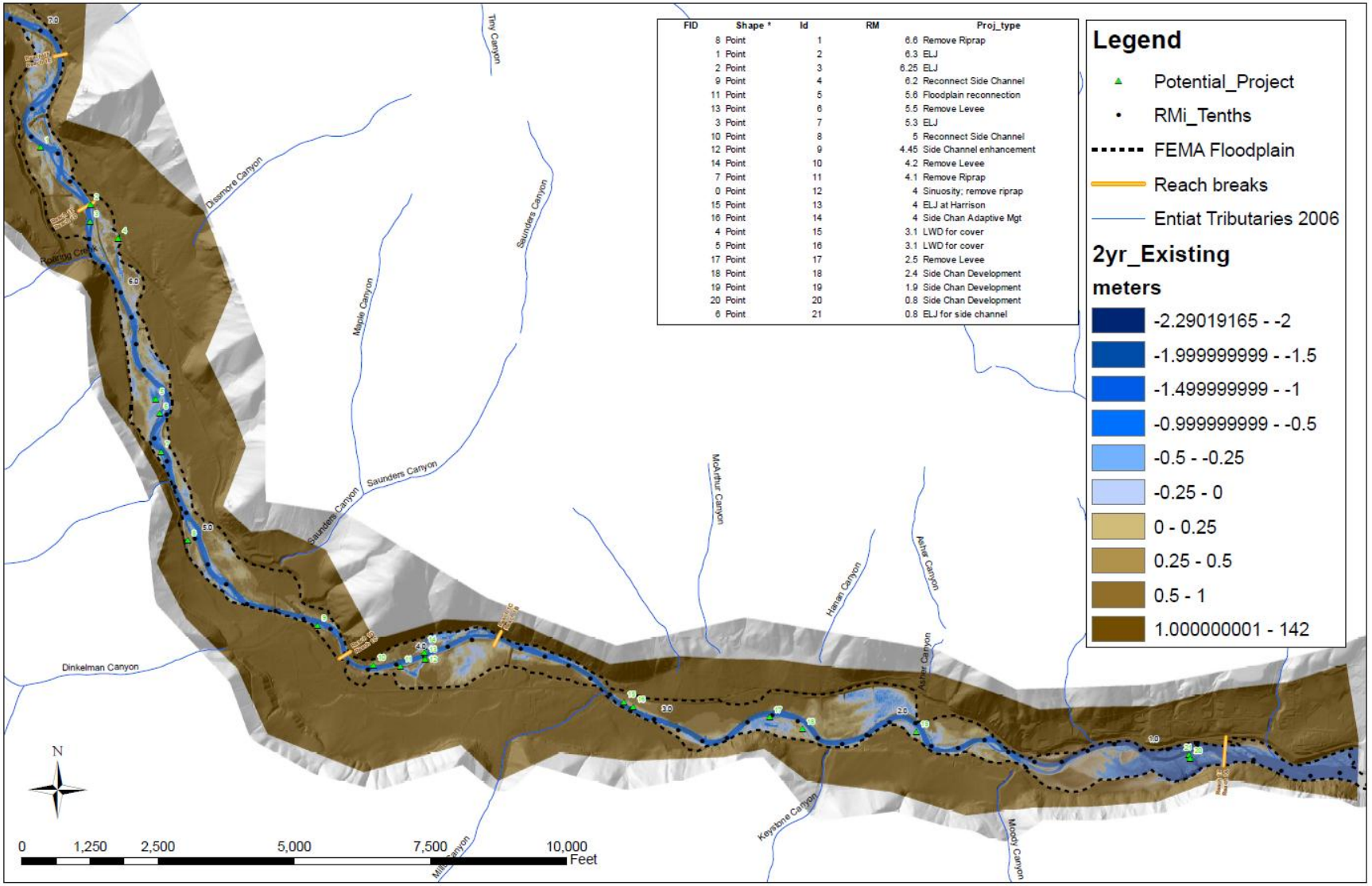

Figure 1. Map of lower seven miles of the Entiat River with recommended (potential) project locations identified (Rob Richardson, USBOR, personal communication).

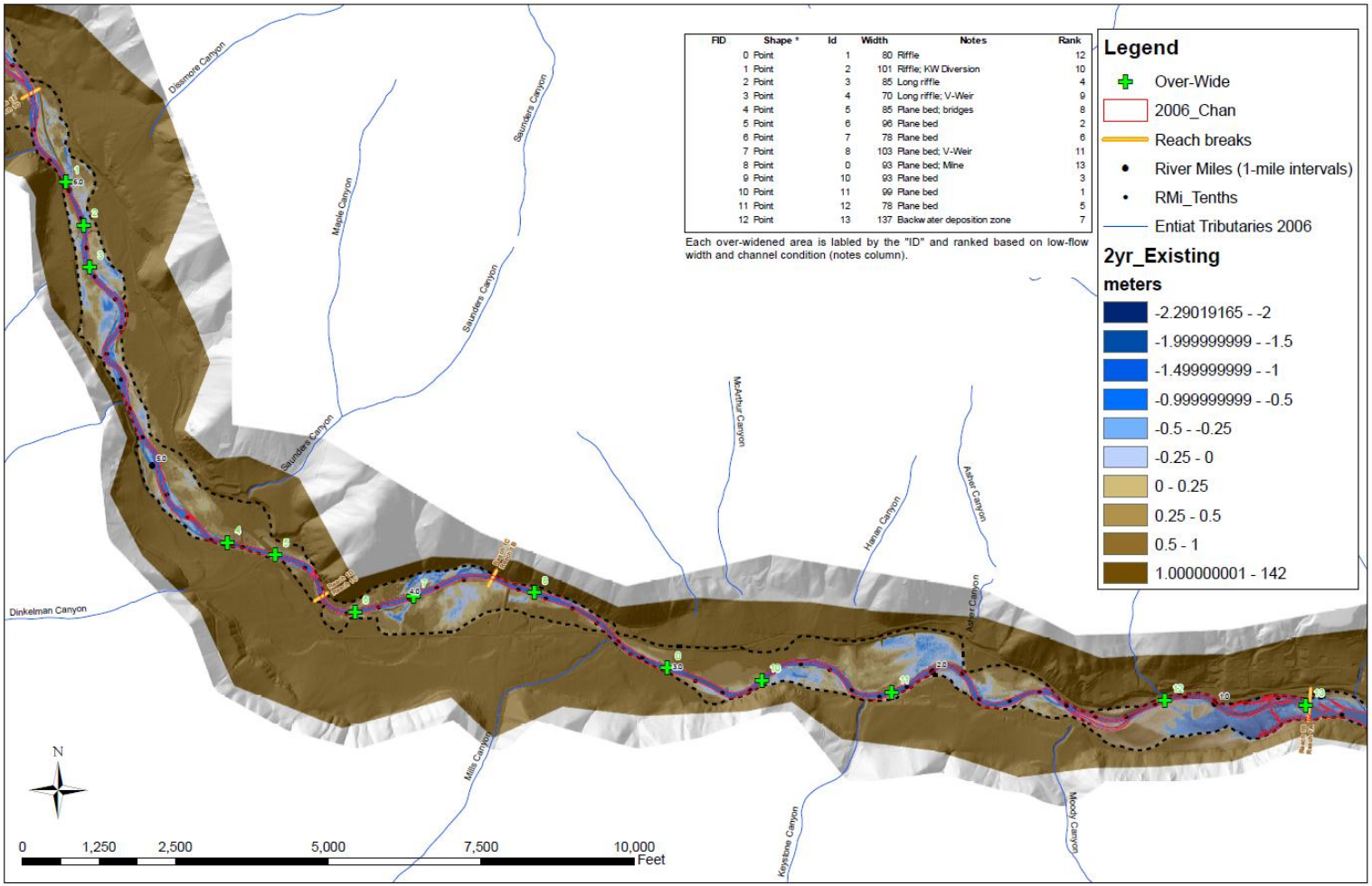

Figure 2. Map of Lower Entiat River where sites have been identified and ranked (see legend; ranking based on the width and the channel character at that particular site (excludes immediately upstream of islands where natural widening occurs)) for being over-widened (Rob Richardson, USBOR, personal communication).

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Appendix E. Assessment Unit Detailed Summary, Description, and Priority Reaches and Actions

Table of Contents

List of Tables

List of Figures

Introduction

The RTT Biological Strategy balances stream and watershed form and processes with the habitat requirements of fish. This approach provides the best opportunity to improve the long-term viability of fish populations. This is accomplished by protecting areas that provide important habitat for sensitive aquatic species and by restoring degraded habitat through the implementation of appropriately sited and scaled habitat actions that address ecological concerns.

The term "ecological concerns" may be new to some readers. It is used below in favor of "limiting factors" for two reasons. First, the latter label was frequent used to describe habitat conditions that often were not the factor limiting the abundance or freshwater productivity of a particular population. Second, the former term is now being broadly used throughout the region in an effort to better standardize the manner in which habitat conditions are characterized (Appendix B). Each summary below includes a prioritized list of ecological concerns as well as further guidance on the habitat actions or action types that the RTT recommends be implemented to remedy the concern. The RTT did not attempt to place habitat protection within the prioritized list of restoration actions (preventing future habitat degradation is a top priority regardless of location).

There are many potentially beneficial actions in each sub-watershed that did not make the prioritized list. These lower priority actions may in turn become priorities once higher-priority actions are implemented, or with better knowledge. The priority order is a relative rank and there is no quantitative scale to judge how much more important one action is than another. The priority rank does not imply a sequence that should be rigidly followed; rather, we expect that many ecological concerns will be addressed in several priority areas simultaneously within each subbasin.

Universal Ecological Concerns and Actions

Several ecological concerns are common. To avoid redundancy, the RTT lists those "universal" concerns and actions only in this subsection.

Marine-derived nutrients

Salmon, steelhead, and Pacific lamprey once contributed large amounts of marine-derived carbon, nitrogen and phosphorus to freshwater ecosystems in the Upper Columbia Region (UCR). Marine derived nutrient (MDN) levels have declined with the decreased abundance of salmon. Research on food webs in and along anadromous streams suggest the direct (e.g., ingestion of adult carcasses by juveniles) and indirect (e.g., decreased vigor of riparian vegetation) effects of decreased MDN are profound.

There are many efforts across the region to replace MDN by placing carcasses or their analogs in streams. However, the RTT observes that the science of fertilizing lotic systems with fish or fish byproducts is new. Thus, the RTT thinks it is prudent to learn from the many other on-going efforts in this regard before launching extensive and expensive fertilization efforts in the UCR. If fertilization efforts are proposed in the interim, the RTT recommends that they at least follow these basic tenets:

- The area proposed for treatment should be known to be short of nutrients.
- Fish carcasses and/or carcass analogs should be placed only within the current and historic range of anadromy consistent with stream carrying capacity and recovery objectives.
- Efforts should be located so as to take advantage of existing monitoring programs.

Future habitat degradation

The RTT believes that reducing the likelihood of future habitat degradation is critical if the UCR is going to achieve the overarching goal of providing high quality habitat to enhance salmonid restoration. Therefore, the RTT recommends that in order to achieve this, there is a need to:

- Protect existing ***intact and functioning*** habitats that benefit sensitive or listed salmonids. Large, undisturbed areas with a high threat of development or future degradation would be the highest priority, but also areas that have some degradation and an opportunity to conduct restoration activities, in addition to those areas (usually identified if a Reach Assessment has been completed) trending towards recovery naturally within a reasonable period of time.

Riparian Condition

All assessment units have varying degrees of riparian degradation. In most of the assessment units that begin on USFS land, riparian areas may be mostly intact, but can still be affected by recreational use.

In all assessment units,

- The RTT recommends that, if riparian restoration is a high priority action, then projects (e.g., replanting, etc.) should be done in conjunction with other actions unless a robust assessment has been completed that can be used to restore specific areas without decreasing other geo-fluvial processes, like side-channel connection.

Treatment of Roads (reduce sediment delivery)

Throughout all of the UCR watersheds, there are areas where roads have been developed that are either in need of repair or should be obliterated. Many of these roads deliver elevated levels of fine sediments to streams.

- The RTT recommends that where possible, roads that are contributing to elevated levels of fine sediment to streams are fixed or eliminated. Channel-adjacent roads should be the highest priority for elimination. The RTT further recommends that the inventory of forest

roads be reduced to a level the USFS is able to reasonably maintain for roads on their property.

Instream Flow

In all watersheds, there are secondary streams or sections of the main-stems that have reduced water quantity. In some streams (e.g., Lower Twisp River), it can be the primary ecological concern.

- The RTT recommends that strategic acquisition of water for instream benefits be pursued wherever feasible. The priority level will depend on quantity and location.

Unscreened Water Diversions and Out of Compliance Screens

In many assessment units, intake screens for irrigation are not in compliance with NMFS criteria.

In many assessment units, water diversions are not screened or existing intake screens for irrigation are not in compliance with NMFS criteria.

- The RTT recommends that if an inventory of unscreened water diversions and fish screens has not been completed, one is developed and completed.
- Bring all water diversions and fish screens into compliance.

Priority Areas and Actions

While the RTT Biological Strategy (2008) included an assessment of the all the actions and/or action types identified in the Recovery Plan (UCSRB 2007), the Implementation Schedule has been updated since the completion of the Recovery Plan, and a shorter, more concise format, including more specific prioritization within the subbasins, was requested by UCSRB staff to identify specific priority actions within priority areas. In 2009, the RTT developed a spreadsheet-based document that outlined priority areas and actions for restoration and protection of habitat in the UCR. Within that spreadsheet exercise, not all assessment units were considered with a sub-watershed.

Based on the priorities used in the 2009 spreadsheet exercise, the RTT further determined priority actions for all assessment units within the UCR (Table E1). Further in this appendix, we list specific actions to address specific ecological concerns. Some of the actions in Table E1 are not discussed in the summary because the actions in Table E1 are more general, while those later are more specific.

Table E1. Priority (within each subbasin) areas and actions for habitat restoration projects in the Upper Columbia Region by assessment unit.

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
Wenatchee			
Nason	Priority 2	Restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Various assessments have been completed (BOR 2009a, 2009b, 2009c). Some projects have been implemented (side-channel reconnections) and various other projects are in development, with some soon to be implemented.
Upper Wenatchee	Priority 1	Increase LW retention and recruitment to increase complexity in a manner that is consistent with natural channel structure and function.	An assessment was recently completed (Inter-fluve 2012). An implementation plan to determine appropriate locations and prescriptions is currently being developed by stakeholders. Preference for actions that enhance natural accumulations of LW.
Icicle Creek	Priority 2	Assess passage at boulder field, reconfigure Icicle/City of Leavenworth diversions	If the boulder field is currently inhibiting passage due to anthropogenic effects, then take measures to improve upstream adult passage over the boulder field. *(EDT and ICTRT intrinsic potential model predict very large increases in capacity for steelhead with access to the upper Icicle).*
Peshastin	Priority 2	Increase instream flow and channel complexity	Develop a restoration plan that includes restoration of natural processes where possible, normative flow levels, migration corridors, and holding and rearing habitat in lower Peshastin Creek.
Lower Mainstem (Mouth to Tumwater Canyon)	Priority 2	Restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Side-channel and/or off-channel connection or other actions that address causal mechanisms for ecological concerns.

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
Mission Creek	Priority 3	Increase water quantity, and restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Need additional information on fish use and assessment of habitat degradation.
Little Wenatchee	Priority 1	Increase floodplain connection.	Not a priority at this time
White River	Priority 1	Restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and instream structure complexity.	Mostly in the lower few miles. Not a priority at this time
Middle Wenatchee River	Priority 1	None	Continue to assess passage at Tumwater Dam and adopt management practices of passage is compromised. Not a priority at this time
Chumstick Creek	Priority 3	Increase water quantity, and reestablish riparian.	Practically all passage barriers have been addressed. Not a priority at this time
Chiwawa River	Priority 1	Remove anthropogenic barriers, if warranted.	Investigate whether to replace culverts at Minnow and Deep creeks. Not a priority at this time
Lake Wenatchee	Priority 1	Protect remaining near-shore habitat and investigate means to reduce impacts of bulkheads if possible.	Not likely to be able to do much in this AU. Additional information on fish use may be helpful, but only if it leads to potential actions.
Entiat			
Middle Entiat (Stillwater Reach)	Priority 1	Remove or modify levees, undersized bridges that reduce habitat potential, bank armoring, and other human features that affect channel form and function. Increase LW recruitment and retention to increase complexity in a manner that is consistent with natural channel structure and function.	Setback or modification might achieve partial process reconnection and would be of lower benefit for this ecological concern. In some cases modification (i.e. hydraulic connection only) would not address this ecological concern. Should be appropriately sited and scaled and numerically consistent with the Entiat watershed DIP and the ISEMP monitoring design.
Lower Entiat	Priority 2	Where possible, restore natural geo-fluvial processes, for example, structure and form, including instream structural complexity, floodplain interaction, and sediment transport. Large woody material, log structure or log jam, rootwads	This area is set for implementation of projects in 2014. Small to moderate sized structures need to be strategically placed in lower energy areas such as side-channels, or along the banks in appropriate locations.

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
Mad River	Priority 1	Restore natural geo-fluvial processes, for example, structure and form**,** floodplain interaction, and sediment transport.	Not a priority at this time
Upper-Middle	Priority 1	Where possible, restore natural geo-fluvial processes, for example, structure and form, including instream structural complexity, floodplain interaction, and sediment transport.	Not a priority at this time
Methow			
Upper Methow	Priority 2	Restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Channel migration, LW recruitment, or other actions that address causal mechanisms for ecological concerns. Implementation of Lynn and Maquire (BOR; 2008).
Lower Twisp	Priority 2	Increase instream flow; restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	MVID west efficiencies to increase instream flow. Where possible remove dikes and levees and manage roads to allow for natural channel migration. These actions will likely have additional benefits to other limiting factors such as water temperatures. Implementation (Inter-fluve 2010b). Suspend practice of effecting diversions with push-up berms.
Upper-Middle Methow	Priority 2	Restore natural geo-fluvial processes, for example, channel structure and form and migration, floodplain interaction, and sediment transport.	Channel migration, LW recruitment, or other actions that address causal mechanisms for ecological concerns. Complete Assessment of "Silver Reach" area.
Lower Chewuch	Priority 2	Increase instream flow; restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Still may be some opportunities with the Chewuch and Fulton irrigation and Barkley withdrawals (i.e. maintaining the ongoing agreement with Trout Unlimited). These actions will likely have additional benefits to other limiting factors such as water temperatures. Use all assessments that have been completed for this area to guide location and specific actions. These actions will have additional benefits to other limiting factors such as water temperatures. Encourage USFS road planning work to address sediment. Beaver reintroduction that could be universal need.
Beaver	Priority 2	Increase instream flow; restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport.	Now that structural passage barriers are nearly complete, efforts should focus on guaranteed water in the creek and connection with the Methow River. Other protection and restoration measures that contribute to increasing or maintaining instream flow would also be a priority. Determine if temperature is an issue.
Middle Methow	Priority 2	Increase instream flow; restore natural geo-fluvial processes, for example, channel migration, floodplain interaction, and sediment transport. Reduce death and injury to juvenile salmon and steelhead. Reduce juvenile	Suspend practice of effecting diversions with push-up berms. Reduce entrainment of juvenile fish into diversion-associated channels.

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
		stranding.	
Wolf Creek	Priority 2	Ensure screening is in compliance with NMFs protocols and investigate alternatives to reduce or eliminate stranding of fish.	Water is diverted into a small secondary channel and then screened water is in turn diverted from that channel. Even with good shut-down protocols, fish get stranded in the secondary channel.
Gold Creek	Priority 2	Restore natural geo-fluvial processes, for example, channel structure and form and migration, floodplain interaction, and sediment transport.	Not a priority at this time
Libby Creek	Priority 2	Restore natural geo-fluvial processes, for example, channel structure and form and migration, floodplain interaction, and sediment transport.	Not a priority at this time
Upper Twisp River	Priority 1	Restore natural geo-fluvial processes, for example, channel structure and form and migration, floodplain interaction, and sediment transport.	Not a priority at this time
Upper Chewuch River	Priority 1	Restore natural geo-fluvial processes, for example, floodplain interaction, and sediment transport.	Not a priority at this time
Early Winters Creek	Priority 1	Restore natural geo-fluvial processes, for example, floodplain interaction, and sediment transport.	Not a priority at this time
Lost River	Priority 1	Restore natural geo-fluvial processes, for example, channel structure and form and migration, and floodplain interaction.	Not a priority at this time
Lower Methow River	Priority 2	Increase instream flow; restore natural geo-fluvial processes, for example, channel migration, floodplain interaction	Not a priority at this time
Okanogan			
Upper Salmon Creek	Priority 2	Increase winter water quantity.	
Loup Loup Creek	Priority 1	Increase water quantity; add small log structures to increase complexity and jump start gravel sediment processes.	
Okanogan River 01	Priority 4	Reconnect big side channel at Conservancy Island - a few smaller spots downstream - motorcycle track; ensure pump screens	

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
		are in compliance with current criteria.	
Upper Omak Creek	Priority 2	Remove barriers	
Okanogan River 04	Priority 4	Side-channel at Peterson and Wilson; reduce predator densities; ensure pump screens are in compliance with current criteria.	
Upper Antoine Creek	Priority 2	Remove barriers and conduct watershed assessment	
Lower Salmon Creek	Priority 4	Restore year round flows	
Okanogan River 05	Priority 3	Reduce predator densities; ensure pump screens are in compliance with current criteria.	
Okanogan River 02	Priority 3	Ensure pump screens are in compliance with current criteria.	
Nine Mile Creek	Priority 1	Gravel augmentation and complexity projects to restore gravel sediment processes in lower 1 mile.	
Similkameen Lower	Priority 2	Create ground water feed off channel habitats (Driscol Island)	
Johnson Creek	Priority 2	Remove barriers and conduct watershed assessment	
Lower Antoine Creek	Priority 1	Gravel augmentation and complexity projects to restore gravel sediment processes	
Okanogan River 03	Priority 4	Ensure pump screens are in compliance with current criteria.	
Similkameen Middle	Priority 2	Create ground water feed off channel habitats (Klein site and North side)	
Lower Omak Creek	Priority 1	Protection and ground water inputs during summer and winter	
Okanogan River 06	Priority 4	Reconnect side channels and off-channel habitats.	Not a priority at this time
Inundated Okanogan	Priority 4	Reduce predator densities; ensure pump screens are in compliance with current criteria.	Not a priority at this time
Okanogan River 07	Priority 2	Restore Natural flow patterns	Not a priority at this time
Bonaparte	Priority 1	Reduce fines; flood plain	Not a priority at this time

Assessment Unit (in priority order)	Priority Area Designation	Priority Action Type	Comments
Creek		reconnection; and improve complexity	
Tunk Creek	Priority 2	Reduce fines; flood plain reconnection; and improve complexity	Not a priority at this time
Aeneas Creek	Priority 3	Remove barriers.	Not a priority at this time
Chiliwist Creek	Priority 4	Remove barriers; Remove livestock and replant riparian	Not a priority at this time
Similkameen Upper	Priority 2	No actions identified.	Not a priority at this time
Siwash Creek	Priority 4	Supplement flows.	Not a priority at this time
Tonasket Creek	Priority 3	Restore complexity and gravel sediment process in lower 1 mile.	Not a priority at this time
Wild Horse Spring Creek	Priority 4	Livestock Fencing; Lawn Removal supplement flows with groundwater	Not a priority at this time
Wanacut Creek	Priority 4	Supplement flows with ground water and reestablish gravel processes	Not a priority at this time

Intrinsic Potential

Priority areas were identified by examining the intrinsic potential (IP) within each assessment unit. Intrinsic potential is the amount of stream area available for production (spawning) with assumed historical (pre ~1850) conditions. A value was calculated by weighting the stream area using general characteristics such as width, gradient, and valley confinement, plus a few others that serve as modifiers. A weighting mechanism was developed by comparing current spawning densities (redd locations recorded by GPS) to their underlying combination of habitat characteristics, and then assigning weights to the various classes based on observed preferences (Tables E2, E3).

The analysis is intended to provide a simple and objective overview of the distribution of historical production potential across the tributary habitats used by Interior Columbia basin yearling type Chinook and steelhead populations. The values generated provide a good way of comparing area to area, (or population to population), as the relative values are probably more significant than the absolute totals. Additionally, the weighted values reflect historical conditions and do not incorporate anthropogenic effects directly.

Table E2. Summary of intrinsic potential values for the entire UCR. All of the intrinsic potential values were summarized for the entire UCR, then subdivided into eight categories that correspond to a score.

Score	Chinook salmon	Steelhead
0	0	0
1	0.00001-0.07151	0.00001-0.14926
2	0.07152-0.13794	0.14927-0.29708
3	0.13795-0.20436	0.29709-0.44489
4	0.20437-0.27078	0.44490-0.59271
5	0.27079-0.33721	0.59272-0.74052
6	0.33722-0.40363	0.74053-0.88834
7	> 0.40363	> 0.88834

Table E3. Intrinsic potential values for each assessment unit (D. Holzer, NMFS, personal communication), with a value corresponding to the categories defined in Table E2.

Assessment Unit (in priority order)	Intrinsic Potential			
	Spring Chinook		Steelhead	
	Value	Score	Value	Score
Wenatchee				
Nason	0.2359	4	0.3622	3
Upper Wenatchee	0.1927	3	0.5703	4
Icicle Creek	0.0343	1	0.5723	4
Peshastin	0.0412	1	0.3130	3
Lower Mainstem	0.0282	1	0.2121	2
Mission Creek	0.0200	1	0.1904	2
Little Wenatchee	0.1068	2	0.1569	2
White River	0.2198	4	0.3188	3
Middle Wenatchee River	0.0144	1	0.0260	1
Chumstick Creek	0.0621	1	0.2373	2
Chiwawa River	0.4158	7	0.8146	6
Entiat				
Stillwater Reach	0.2200	4	0.3473	3
Lower Entiat	0.0513	1	0.1679	2
Upper-Middle Entiat	0.2255	4	0.1803	2

Assessment Unit (in priority order)	Intrinsic Potential			
	Spring Chinook		Steelhead	
	Value	Score	Value	Score
Mad River	0.0102	1	0.1521	2
Methow				
Upper Methow (IP score is from Chewuch confluence to end of anadromy)	0.3030	5	0.8531	6
Lower Twisp	0.2014	3	0.3898	3
Upper-Middle Methow (IP score is from Texas Cr to Chewuch confluence)	0.2578	4	0.5560	4
Lower Chewuch	0.2247	4	0.7964	6
Beaver	0.0	0	0.1904	2
Middle Methow River (IP score is from Texas Cr to Chewuch confluence)	0.2578	4	0.5560	4
Wolf Creek	0.0065	1	0.0486	2
Gold Creek	0.0	0	0.0898	1
Libby Creek	0.0	0	0.0679	1
Upper Twisp River	0.0492	1	0.2941	2
Upper Chewuch River	0.3118	5	0.3876	3
Early Winters Creek	0.0086	1	0.1119	1
Lost River	0.0285	1	0.1117	1
Lower Methow River	0.1147	2	0.1876	2
Okanogan				
Inundated Okanogan	NA	NA	0.0172	2
Okanogan River 01	NA	NA	0.0097	1
Okanogan River 02	NA	NA	0	0
Okanogan River 03	NA	NA	0	0
Okanogan River 04	NA	NA	0.0378	1
Okanogan River 05	NA	NA	0.0015	1
Okanogan River 06	NA	NA	0.0333	1
Okanogan River 07	NA	NA	0.1326	1
Similkameen (all)	NA	NA	0.0	0
Loup Loup Creek	NA	NA	0.0232	1

Assessment Unit (in priority order)	Intrinsic Potential			
	Spring Chinook		Steelhead	
	Value	Score	Value	Score
Lower Salmon Creek	NA	NA	0.0646	1
Upper Salmon Creek	NA	NA	0.1807	2
Lower Omak Creek	NA	NA	0.1393	1
Upper Omak Creek	NA	NA	0.2269	2
Wanacut Creek	NA	NA	0.0097	1
Tunk Creek	NA	NA	0	0
Aeneas Creek	NA	NA	0	0
Bonaparte Creek	NA	NA	0.0194	1
Antoine Creek	NA	NA	0	0
Wild Horse Spring Creek	NA	NA	NA	0
Tonasket Creek	NA	NA	0	0
Nine Mile Creek	NA	NA	0.0182	1
Chiliwist Creek	NA	NA	0.0186	1

Appendix E1. Wenatchee River Basin Assessment and Strategy

Spring Chinook and Steelhead Population Structure

The Wenatchee River spring Chinook salmon and steelhead populations (Figures E1 and E2) are part of the UCR spring Chinook ESU and steelhead DPS, respectively. Important spawning and rearing areas occur throughout the basin. Bull trout, cutthroat trout, and lamprey[8] all inhabit the Wenatchee Basin and important habitat exists and is in need of restoration to varying degrees for these other important species of concern.

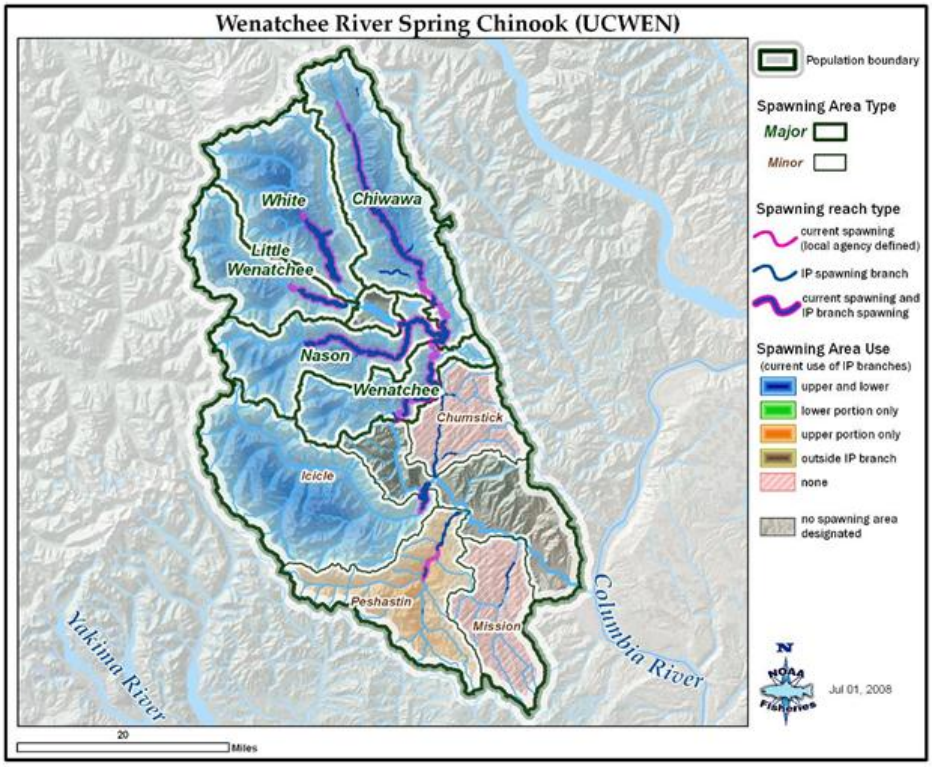

Figure E1. Wenatchee River spring Chinook salmon population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 3.1.1-5 from (ICTRT 2008)).

[8] The distribution of lamprey is uncertain, although they have not been documented upstream of Tumwater Dam in recent years.

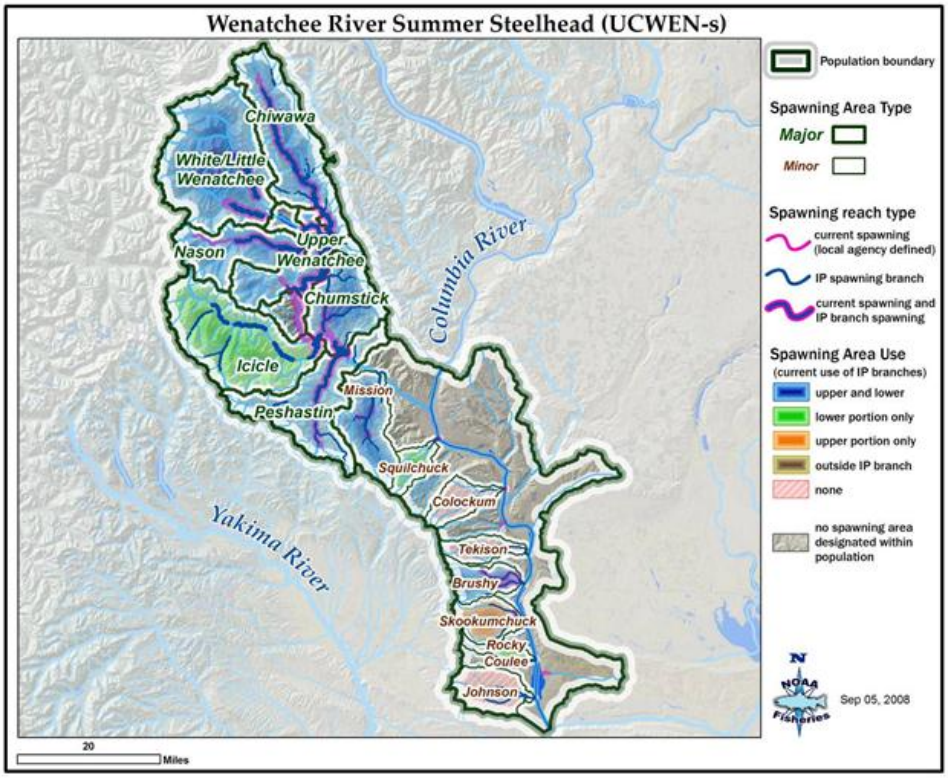

Figure E2. Wenatchee River steelhead population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 4.1.1-5 from ICTRT 2008).

Priority areas

Based on Table E1 above, the priorities for areas for restoration and protection actions are summarized in Table A4:

Table E4. Assessment unit priority for restoration and protection actions in the Wenatchee River basin (note there is no distinction between some assessment units for protection priority).

Restoration		**Protection**	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Nason Creek	1	Nason Creek	1
Upper Wenatchee River	2	White River	1
Icicle Creek	3	Upper Wenatchee River	1
Peshastin Creek	4	Chiwawa River	1
Lower Wenatchee River	5	Little Wenatchee River	2

Restoration		Protection	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Mission Creek	6	Middle Wenatchee River	2
Little Wenatchee River	Not a priority at this time	Icicle Creek	3
White River	Not a priority at this time	Lower Wenatchee River	3
Middle Wenatchee River	Not a priority at this time	Peshastin Creek	4
Chumstick Creek	Not a priority at this time	Mission Creek	4
Chiwawa	Not a priority at this time	Chumstick Creek	4

In the following, a detailed summary and assessment of each assessment unit is provided for the Wenatchee River Basin.

Assessment Unit: Mainstem Upper Wenatchee River

Species: Sockeye salmon, spring and summer Chinook salmon, steelhead, bull trout.

Assessment Unit Description: Wenatchee River mainstem (Lake Wenatchee to Tumwater Canyon; 35.8-54)

Current fish use status: MaSA for spring Chinook and steelhead. Migration corridor for sockeye, spring Chinook salmon, coho salmon, steelhead and bull trout. Spawning and rearing habitat for spring and summer Chinook salmon and steelhead. Foraging and overwintering for bull trout. Rearing habitat may be limited in upper sections.

Secondary and tertiary sub-watersheds: Beaver, Chiwaukum (RM 4.3-0); Skinny (RM 0-1.3) creeks.

Factors Affecting Habitat Conditions:

- Geologic confinement in some areas limits potential for habitat complexity.
- Natural high temperatures (from lake).
- The state highway, railroad, and private land development affect woody recruitment, channel migration, and gravel recruitment.
- The state highway cut off a large oxbow near Nason Creek confluence.
- Historical log drives and resultant loss of wood recruitment has reduced channel complexity.

Ecological Concerns and (subcategories) in priority order:

1. Channel Structure and Form (Instream Structural Complexity)
2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
3. Riparian Condition (Riparian Condition)

Level of Certainty/Data gaps

- Recent assessment sponsored by the YN (RTT/BOR 2012).
- There is agreement among RTT members on the potential for additional impacts on this assessment unit, and therefore it is a high priority area.
- Current information shows that juvenile fish leave the tributaries that enter this assessment unit and appear to move downstream to Tumwater Canyon, or possibly the lower sections of this assessment unit. Increasing habitat complexity and additional floodplain connection may increase rearing (and potentially survival) in this assessment unit.

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Instream Structural Complexity)

- Restore habitat diversity by enhancing large woody material recruitment, retention, and complexity; see Inter-Fluve (2012) for additional information on specific areas where this could occur.

2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

    - Improve fish access to oxbows and historical side channels that have been cut off from main channel; see Inter-Fluve (2012) for additional information on specific areas where this could occur.

3. Riparian Condition (Riparian Condition)

    - River Road modification and relocation; see Inter-Fluve (2012) for additional information on specific areas where this could occur.

Assessment Unit: Middle Wenatchee River

Species: Sockeye salmon, spring and summer Chinook salmon, steelhead, bull trout.

Assessment Unit Description: Wenatchee River mainstem (Tumwater Canyon - downstream of Chiwaukum Creek – Icicle River RM: 25.5-35.8.

Current fish use status: MaSA for steelhead. Migration corridor for sockeye, spring Chinook salmon, coho salmon, steelhead and bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for spring (rearing only) and summer Chinook salmon and steelhead.

Secondary and tertiary sub-watersheds: none.

Factors Affecting Habitat Conditions:

- Geologically confined in some areas.
- The state highway negatively affects gravel, large wood recruitment, and possibly water quality.

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Anthropogenic Barriers)

Level of Certainty/Data gaps

- Fish handling operations at Tumwater Dam may impede passage at certain times of the year for certain species.[9]
- Bed channel form may be restricted by the current highway, but because of the narrow floodplain in the canyon, the effects on the biological and geo-fluvial processes are likely minimal.
- Little is known about the physical and chemical effects of highway maintenance to the riparian zone, water quality, and juvenile salmonids.
- Known area for juvenile rearing for fish from upstream tributaries for spring Chinook and steelhead.
- Naturally confined in some areas.

Ecological concerns and habitat action recommendations in priority order:

[9] Tumwater Dam itself has not been shown to impede passage (except maybe for Lamprey). Operational protocols at the adult fish trap have been shown to cause delays, but in the absence of daily 24/7 trap operation/blockage that does not seem to occur. There is a known hydraulic barrier downstream from the dam which affects most species at certain flows, but is not the result of the dam itself.

1. Habitat Quantity (Anthropogenic Barriers)

    - Change management actions if passage delay is shown to be biologically significant at Tumwater Dam.

Assessment Unit: Lower Wenatchee River

Species: Sockeye salmon, spring and summer Chinook salmon, steelhead, bull trout.

Assessment Unit Description: Wenatchee River mainstem (Tumwater Canyon (downstream of Icicle Creek – confluence with Columbia; RM: 0-25.5).

Current fish use status: MaSA for steelhead. Migration corridor for sockeye, spring Chinook salmon, coho salmon, steelhead and bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for spring (rearing only) and summer Chinook salmon, coho salmon, and steelhead.

Secondary and tertiary sub-watersheds: Icicle, Chumstick, Peshastin, and Mission creeks are separate assessment units (see below). Derby Creek.

Factors Affecting Habitat Conditions:

- Geologic confinement in some areas.
- Land development, state highway and railroad affect floodplain function and channel migration, woody material and gravel recruitment.
- Riparian habitat and off-channel habitat have been significantly lost or degraded in this assessment unit.
- A relatively high proportion of the water quantity can be removed in low flow years, which could lead to higher temperatures and reduced rearing area.

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
2. Riparian Condition (Riparian Condition)
3. Water Quantity (Decreased Water Quantity)
4. Water Quality (Temperature)
5. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Field and aerial surveys give strong indication of channel constriction and riparian habitat loss. Historical photos indicate loss of floodplain connection.
- The relation of fish habitat and instream flow in this reach was studied in 1980s; this assessment needs to be refined.
- A relatively high proportion of subyearling spring Chinook and juvenile steelhead are known to migrate from the tributaries (Chiwawa, Nason creeks, etc.) in the fall and overwinter in Tumwater Canyon. It is uncertain to what extent the Lower Wenatchee River downstream of Tumwater Canyon is currently used for juvenile over-winter rearing

and whether this assessment unit could be used for over-winter rearing if habitat conditions were improved.

- Assess groundwater surface water interaction.
- Assess the effects of temperature in the Lower Wenatchee through the TMDL process.

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)[10]

    - Above Sleepy Hollow bridge
    - Near monitor
    - At Cashmere
    - Others yet to be identified
    - Upstream of Goodwin Bridge on river left
    - Monitor flats – explore opportunities that do and do not involve under the highway (e.g., immediately downstream of county park)

2. Riparian Condition (Riparian Condition)

    - Sites yet to be comprehensively identified; prefer that it be in conjunction with side channel and off-channel restoration and protection projects.

3. Water Quantity (Increase Water Quantity)

    - Water right purchase and lease
    - Water banking
    - Conversion of small pumps to wells
    - Improve irrigation efficiencies
    - Change point of diversion to Columbia River where feasible (e.g., Wenatchee Irrigation District)

4. Water Quality (Temperature)

    - None (actions under floodplain connection, riparian and water quantity should affect temperature).

5. Channel Structure and Form (Instream Structural Complexity)

    - Engineered log structures in geomorphically appropriate areas

[10] It should be noted that the RTT does not encourage development of side channels in properly functioning floodplain.

Assessment Unit: Little Wenatchee River

Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat and bull trout.

Assessment Unit Description: Little Wenatchee River (RM: 0-7.8).

Current fish use status: MaSA for spring Chinook, MiSA for steelhead. Spawning and rearing habitat for sockeye, spring Chinook salmon, steelhead and bull trout. Primary rearing for sockeye is in Lake Wenatchee.

Secondary and tertiary sub-watersheds: Not in anadromous zone.

Factors Affecting Habitat Conditions:

- In general, the current conditions in the anadromous zone of this river are functioning well, and therefore, actions are not considered to be high priority compared to other areas within the Wenatchee Basin.
- Past riparian harvest and log drives below the waterfalls may have affected stream channel morphology and function.
- Habitat above the waterfalls is intact and relatively pristine, need to protect and maintain stream channel and floodplain integrity.
- Brook trout are numerous both downstream (in anadromous area), and upstream of falls)

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitat (Floodplain Condition)
2. Sediment Conditions (Increased Sediment Quantity)
3. Food (Altered Primary Productivity)
4. Species interaction (Competition)

Level of Certainty/Data gaps

- Field habitat analysis has been completed on public lands, enabling high confidence in assessment.
- Some uncertainty exists on effects of logging and road management on stream channel function, water temperature, flow, and possible input of large wood.
- The RTT concludes that the Little Wenatchee is currently well protected and at very low risk of development.

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitat (Floodplain Condition)

    - Dispersed campgrounds should be addressed;

- Restore stream channel, floodplain, and riparian vegetation function near the current gravel operation.

2. Sediment Conditions (Increased Sediment Quantity)

    - USFS road maintenance and actions
    - Decommission roads that are affecting sediment deliver to stream

3. Food (Altered Primary Productivity)

See discussion under *Universal Ecological Concerns and Actions*.

Assessment Unit: White River

Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat and bull trout.

Assessment Unit Description: Little Wenatchee River (RM: 0-14.3).

Current fish use status: MaSA for spring Chinook and MiSA for steelhead. Spawning and rearing habitat for sockeye, spring Chinook salmon, steelhead and bull trout. Primary rearing for sockeye is in Lake Wenatchee.

Secondary and tertiary sub-watersheds: Napeequa (RM 0-2.2), Panther creeks (RM 0-0.7).

Factors Affecting Habitat Conditions:

- Past riparian harvest and log drives have altered wood accumulations and channel morphology.
- Habitat is intact and contiguous, but development pressures place a critical need to continue to protect and maintain stream channel and floodplain integrity

Ecological Concerns and (subcategories) in priority order:

1. Channel Structure and Form (Instream Structural Complexity)
2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
3. Riparian Condition (Riparian Condition)
4. Food (Altered Primary Productivity)

Level of Certainty/Data gaps

- Field habitat analysis has been completed on public lands, enabling high confidence in assessment.
- Field analyses are incomplete on private lands, yet reviews of aerial photographs in combination with field reviews have allowed strong inferences on habitat needs.
- There is a high level of concern about impacts of land development on this stream, which leads to a strong consensus among RTT members on the priority of this watershed in the region.

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Instream Structural Complexity)

    - Restore instream habitat diversity by enhancing large woody material recruitment, retention, and complexity in lower two miles.

2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

- Restore wetland complexes that connect to stream channel in the lower four miles.

3. Riparian Condition (Riparian Condition)

    - Focus riparian plantings in flood plain areas, residential development, and impacted side-channel habitat between Sears Creek and confluence with Lake Wenatchee.

4. Food (Altered Primary Productivity)

See discussion under *Universal Ecological Concerns and Actions*.

Assessment Unit: Nason Creek

Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat and bull trout.

Assessment Unit Description: Nason Creek (RM: 0-17).

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, coho salmon, steelhead and bull trout.

Secondary and tertiary sub-watersheds: Coulter, Roaring, Gill, Whitepine, and Kahler creeks.

Factors Affecting Habitat Conditions:

- The state highway, railroad, and private land development affect large wood recruitment, channel migration, and gravel recruitment.
- Lack of marine nutrients (see discussion under *Universal Ecological Concerns and Actions*.
- Brook trout are abundance throughout the watershed.

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
2. Channel structure and form (Bed and Channel Form)
3. Riparian Condition (Riparian Condition)
4. Channel structure and form (Instream Structural Complexity)
5. Food (Altered Primary Productivity)
6. Sediment Conditions (Increased Sediment Quantity)
7. Species Interaction (Competition)

Level of Certainty/Data gaps

- Reach assessments have been conducted and impediments have been identified.
- There is some uncertainty about the most appropriate means to restore floodplain function, given the existing social and logistical constraints.
- The cumulative effects of timber harvest, development, and road densities on stream channel function and sediment delivery are not fully known.

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

    - Reconnect side channels and off-channel habitat, where appropriate, from Whitepine Creek to the confluence with Nason Creek; for additional specific information, see (BOR 2009a; 2009b; 2010a).

2. Channel structure and form (Bed and Channel Form)

    - Increase large wood complexes from Whitepine Creek to the confluence with Nason Creek
    - Remove (or modify) levees, berms, and roads where feasible.
    - Restore channel structure and form to reduce sediment transport capacity and competency in order to counteract recent incision and confinement where it unnaturally occurs (i.e.: adjacent road and rail corridors).

3. Riparian Condition (Riparian Condition)

    - Focus riparian plantings in floodplain areas, residential developments, and side-channel reconnections from Whitepine Creek to the confluence with Nason Creek.

4. Channel structure and form (Instream Structural Complexity)

    - Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity.

5. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

6. Sediment Conditions (Increased Sediment Quantity)

    - USFS road maintenance and actions
    - Decommission roads that are affecting sediment deliver to stream

Assessment Unit: Chiwawa River

Species: Spring Chinook salmon, steelhead, cutthroat and bull trout.

Assessment Unit Description: Chiwawa River (RM: 0-35).

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, steelhead and bull trout.

Secondary and tertiary sub-watersheds: Chickimin, Big Meadow, Rock, Alder, Clear, and Phelps creeks.

Factors Affecting Habitat Conditions:

- Most of this watershed is in public ownership and protected as Wilderness Area or under the Northwest Forest Plan. Habitat within these areas is essentially pristine.
- There is limited housing development in private parcels, and some logging on the lower Chiwawa River that could be affecting riparian and floodplain conditions.

Ecological Concerns and (subcategories) in priority order:

1. Food (Altered Primary Productivity)
2. Habitat Quantity (Anthropogenic Barriers)
3. Species Interactions (Competition and Genetic Integrity)
4. Riparian Condition (Riparian Condition)
5. Peripheral and Transitional Habitat (Floodplain Condition)

Level of Certainty/Data gaps

- The cumulative effects of timber harvest, development, and road densities on stream channel function and sediment delivery are not fully known, but of concern.
- In some areas, dispersed recreation appears to have impacted riparian function and potentially other floodplain function.
- Replacement of culverts in Minnow Creek and Deep Creek need further investigation. Minnow Creek has non-native brook trout that could have negative interactions with bull trout, and Deep Creek is high gradient from its confluence with the Chiwawa to the first barrier, and was not considered anadromous fish habitat in the barrier inventory (BOR 2012).
- The RTT concludes that the Chiwawa River is currently well protected and at very low risk of development.

Ecological concerns and habitat action recommendations in priority order:

1. Food (Altered Primary Productivity)

- See discussion under *Universal Ecological Concerns and Actions*.

2. Habitat Quantity (Anthropogenic Barriers)

    - Investigate whether to replace culverts at Minnow and Deep creeks (pending further investigation mentioned above).

3. Species Interactions (Competition and Genetic Integrity)

    - Brook trout management for Minnow Creek and Schaefer Lake.

4. Riparian Condition

    - Management of recreational areas to reduce impacts to riparian areas in USFS campsites in the middle/upper watershed, and in dispersed recreation areas in the lower parts of the watershed.

5. Peripheral and Transitional Habitat (Floodplain Condition)

    - Restore floodplain function at impacted areas.

Assessment Unit: Icicle Creek

Species: Spring Chinook salmon, steelhead, cutthroat, redband, and bull trout.

Assessment Unit Description: Icicle Creek (RM: 0-26).

Current fish use status: The ICTRT (2008) designated Icicle Creek as a MiSA for spring Chinook salmon and a MaSA (in the lower 2 miles) for steelhead.[11] Spawning and rearing habitat for spring Chinook salmon, coho salmon, steelhead and bull trout.

Secondary and tertiary sub-watersheds: French, Jack, Eightmile, and Fourth-of-July creeks.

Factors Affecting Habitat Conditions:

- Land development downstream of Leavenworth Hatchery has affected stream channel migration, recruitment of large wood, and off channel habitat.
- There is a barrier to migration on Icicle Creek possibly in the boulder field near Snow Creek. The recovery plan assumed that steelhead and bull trout could get past the boulder field but spring Chinook could not.
- Water withdrawals in Icicle Creek (primarily between Rat Creek and the hatchery) likely contribute to low flows which could affect high summer temperatures in lower Icicle Creek. Temperatures may also be moderated by the discharge from the LNFH.
- The Icicle Road upstream of Chatter Creek at places may confine the stream channel and affect floodplain function.

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Natural Barriers)
2. Habitat Quantity (Anthropogenic Barriers)
3. Water Quantity (Decreased Water Quantity)
4. Channel Structure and Form (Instream Structural Complexity)
5. Injury or Mortality (Mechanical Injury)
6. Riparian Condition (Riparian Condition)
7. Sediment Conditions (Increased Sediment Quantity)
8. Species Interaction (Competition)

[11] Regarding spring Chinook salmon in Icicle Creek, the ICTRT (2008) stated: " . . . there is uncertainty regarding passage of spring Chinook salmon at the Boulder field in Icicle Creek. The opinion of local biologists is that the boulder field was always a barrier (even though road debris has made it artificially enhanced); recent studies using marked hatchery fish from the LNFH (Cappellini 2001) and historical information from the Wenatchi Tribe support that assumption." For steelhead, the ICTRT (2008) stated, "The Icicle Creek MaSA has consistently had redds in the lower two miles, but not within core branch spawning reaches identified by the intrinsic analysis. Most of these core reaches are located above the Leavenworth National Fish Hatchery (and above the boulder field) where passage has been blocked until recently. However, the United States Fish and Wildlife Service (USFWS) intend to continue to provide passage during portions of the year that should allow for re-occupation of this MaSA (J. Craig, USFWS, personal communication)."

Level of Certainty/Data gaps

- Field and aerial reconnaissance of lower Icicle Creek provide strong certainty of need for stream channel, riparian, and floodplain restoration, where feasible.
- The adult passage conditions at the boulder field near Snow Creek are not certain. The recovery plan assumed that steelhead and bull trout could get past the boulder field but spring Chinook could not. There are current assessments in progress that are attempting to determine whether there was historical passage here.

Ecological concerns and habitat action recommendations in priority order:

1. Habitat Quantity (Lasting Natural Barriers)

    - Determine if there was historic passage near at the Snow Creek boulder field.

2. Habitat Quantity (Anthropogenic Barriers)

    - If the barrier near Snow Creek on the Icicle is determined to be anthropogenic, then develop alternatives and provide passage.

3. Water Quantity (Increase Water Quantity)

    - Improved hatchery intake
    - Improve instream flow through water use effciencies
    - Water right purchase and lease
    - Water banking
    - Conversion of small pumps to wells
    - Improve irrigation efficiencies

4. Channel Structure and Form (Instream Structural Complexity)

    - Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity where feasible.

5. Injury or Mortality (Mechanical Injury)

    - Develop designs and make Icicle/Leavenworth & LNFH-Cascade screens compliant with current NMFS screen criteria.

6. Riparian Condition (Riparian Condition)

    - Riparian plantings where appropriate from hatchery to the confluence with the Wenatchee River (assuming these are areas that are not producing the large sediment inputs where major stream bank restoration is needed).

7. Sediment Conditions (Increased Sediment Quantity)

   - Restore riparian function and channel migration processes from the LNFH to the confluence with the Wenatchee River.
   - Remove USFS road at Trout Creek.

Assessment Unit: Chumstick Creek

Species: Steelhead and coho.

Assessment Unit Description: Chumstick Creek (RM: 0-12.4).

Current fish use status: MaSA for steelhead. Spawning and rearing habitat for steelhead and coho. Potential rearing area for spring Chinook salmon.

Secondary and tertiary sub-watersheds: Eagle, Little Chumstick, Sunitsch, and Freund Canyon creeks.

Factors Affecting Habitat Conditions:

- Private land development and high road density affects sediment delivery.
- Channel migration affected by state highway, the railroad, multiple water crossing structures, and private land development.
- Water temperature levels are elevated based on reduced riparian and instream flow.
- Dam at RM 10 prevents passage into the upper basin.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Riparian Condition (Riparian Condition)
3. Sediment Conditions (Increased Sediment Quantity)
4. Water Quality (Temperature)
5. Habitat Quantity (Anthropogenic Barriers)
6. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

Level of Certainty/Data gaps

- Consistent yearly water quality monitoring provides certainty on temperature.
- The extent of the effect of private and public roads on stream channel function and sediment delivery is not fully assessed, but of concern.
- The potential for impacts from unscreened water diversions is not known. An inventory and assessment are needed.
- The cumulative effects of surface water diversions and groundwater withdrawal from wells on low flows is not known, but of concern.
- Most of the anthropogenic barriers in the lower mainstem Chumstick Creek have been addressed. Habitat upstream of Little Chumstick confluence (approximate location of last fixed barrier) appears to have biological potential, but may not be feasible because of social issues.
- Based on current knowledge, barriers in the tributaries of Chumstick Creek are not a biological priority.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Water right purchase and lease
    - Water banking
    - Conversion of small pumps to wells
    - Improve irrigation efficiencies

2. Riparian Condition (Riparian Condition)

    - Re-establish native vegetation where appropriate from Little Chumstick Creek to the confluence with the Wenatchee River;
    - Install livestock control fencing where appropriate throughout the assessment unit.

3. Sediment Conditions (Increased Sediment Quantity)

    - Implement sediment control program on USFS lands
    - Reduce road densities in tributaries and upper reaches of the assessment unit

4. Water Quality (Temperature)

    - Actions under riparian condition, side channel and wetland connection should address this ecological concern.

5. Habitat Quantity (Anthropogenic Barriers)

    - Determine whether opportunities arise on barriers upstream of the Little Chumstick confluence, and provide passage.

6. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

    - Reconnect side channels throughout the assessment unit; sites yet to be comprehensively identified.

Assessment Unit: Peshastin Creek

Species: Spring Chinook, steelhead and bull trout.

Assessment Unit Description: Peshastin Creek (RM: 0-16.3).

Current fish use status: MiSA for spring Chinook and MaSA for steelhead. Spawning and rearing habitat for steelhead, spring Chinook (limited), coho salmon (limited), and bull trout.

Secondary and tertiary sub-watersheds: Ingalls (RM 9.8-0), Etienne, Mill, Ruby, Shaser, Tronsen, Scotty, and Kings creeks.

Factors Affecting Habitat Conditions:

- Channel migration, riparian habitat, floodplain function, stream sinuosity, and gravel recruitment are severely impacted by state highway.
- Low instream flows in lower Peshastin Creek impede upstream migration, reduce rearing habitat, and likely contribute to elevated water temperature.
- Loss of riparian habitat resulting from land development and state highway reduces quantity and quality of spawning and rearing habitat.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Channel Structure and Form (Instream Structural Complexity)
3. Water Quality (Temperature)
4. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
5. Habitat Quantity (Anthropogenic Barriers)
6. Riparian Condition (Riparian Condition)

Level of Certainty/Data gaps

- Cumulative effects of current gold mining in tributaries on sediment delivery, water quality, and channel conditions are not fully understood, but are of concern.
- Cumulative effects of past timber harvest (and road density) in tributaries on sediment delivery and water quality are not fully understood, but are of concern.
- There is uncertainty on the status of Ingalls Creek bull trout, although some have been tracked into spawning areas in Etienne Creek.
- The following recommendations were formed under the assumption that the primary cause of the habitat degradation (State highway 97) could not be significantly altered to allow for natural processes to occur.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Design and implement pumping from Wenatchee River to reduce irrigation water withdrawals from Peshastin Creek.
    - Water right purchase and lease
    - Water banking
    - Improve irrigation efficiencies

2. Channel Structure and Form (Instream Structural Complexity)

    - Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity where feasible.

3. Water Quality (Temperature)

    - Actions under riparian condition, side channel and wetland connection should address this ecological concern.

4. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

    - Develop side-channel habitat from the confluence with the Wenatchee River to Ingalls Creek (see RA for additional details; Inter-fluve 2010).

5. Habitat Quantity (Anthropogenic Barriers)

    - Culvert replacement in Mill Creek (in progress as of 2012), Ruby, Shaser and Scotty creeks.

6. Riparian Condition

    - Re-establish native vegetation where appropriate (see RA for additional details; Inter-fluve 2010).

Assessment Unit: Mission Creek

Species: Spring Chinook and steelhead.

Assessment Unit Description: Mission Creek (RM: 0-16.3).

Current fish use status: MiSA for steelhead. Spawning and rearing habitat for steelhead and coho salmon. Potential rearing area for spring Chinook salmon.

Secondary and tertiary sub-watersheds: Brender, Yaksum, Sand, and East Fork creeks.

Factors Affecting Habitat Conditions:

- Low or non-existent flows with associated high instream temperatures in lower Mission Creek disrupt distribution and abundance of native species, particularly in summer.
- Channelization of lower Mission, Brender and Yaksum creeks.
- Degraded water quality and loss of riparian habitat, road construction, urban/residential and agricultural development, especially in the floodplains, grazing, and soil compaction have changed channel function.
- There are several culverts throughout the watershed that are passage barriers when flows are available.
- Loss of channel sinuosity and floodplain function in the Mission Creek watershed.
- Chronic road failure on East Fork Mission Creek results in increased sediment delivery.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
3. Sediment Conditions (Increased Sediment Quantity)
4. Channel Structure and Form (Instream Structural Complexity)
5. Riparian Condition (Riparian Condition)
6. Habitat Quantity (Anthropogenic Barriers)
7. Water Quality (Temperature)
8. Channel structure and form (Bed and Channel Form)

Level of Certainty/Data gaps

- Watershed surveys by USFS and Chelan Conservation District provide high level of certainty of watershed conditions and causal mechanisms.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

- Water right purchase and lease
- Water banking
- Conversion of small pumps to wells
- Improve irrigation efficiencies

2. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)

    - From the confluence with the Wenatchee River to USFS boundary

3. Sediment Conditions (Increased Sediment Quantity)

    - Assess and reduce road interference with channel function and sediment load.

4. Channel Structure and Form (Instream Structural Complexity)

    - Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity where feasible.

5. Riparian Condition (Riparian Condition)

    - Re-establish native vegetation where appropriate.

6. Habitat Quantity (Anthropogenic Barriers)

    - Assess and fix any passage barriers in lower Mission Creek mainstem

7. Water Quality (Temperature)

    - Actions under riparian condition, side channel and wetland connection should address this ecological concern.

8. Channel structure and form (Bed and Channel Form)

    - Determine and implement where city of Cashmere levees, bank hardening and incision all along the orchards can be modified or removed to improve bed and channel form.

Appendix E.2: Entiat River Basin Assessment and Strategy

Spring Chinook and Steelhead Population Structure

The Entiat River spring Chinook salmon and steelhead populations (Figures E3 and E4) are part of the UCR spring Chinook ESU and steelhead DPS, respectively. Important spawning and rearing areas occur throughout the basin. Bull trout, cutthroat trout, and lamprey[12] all inhabit the Entiat Basin and important habitat for these species is in need of protection and restoration to varying degrees.

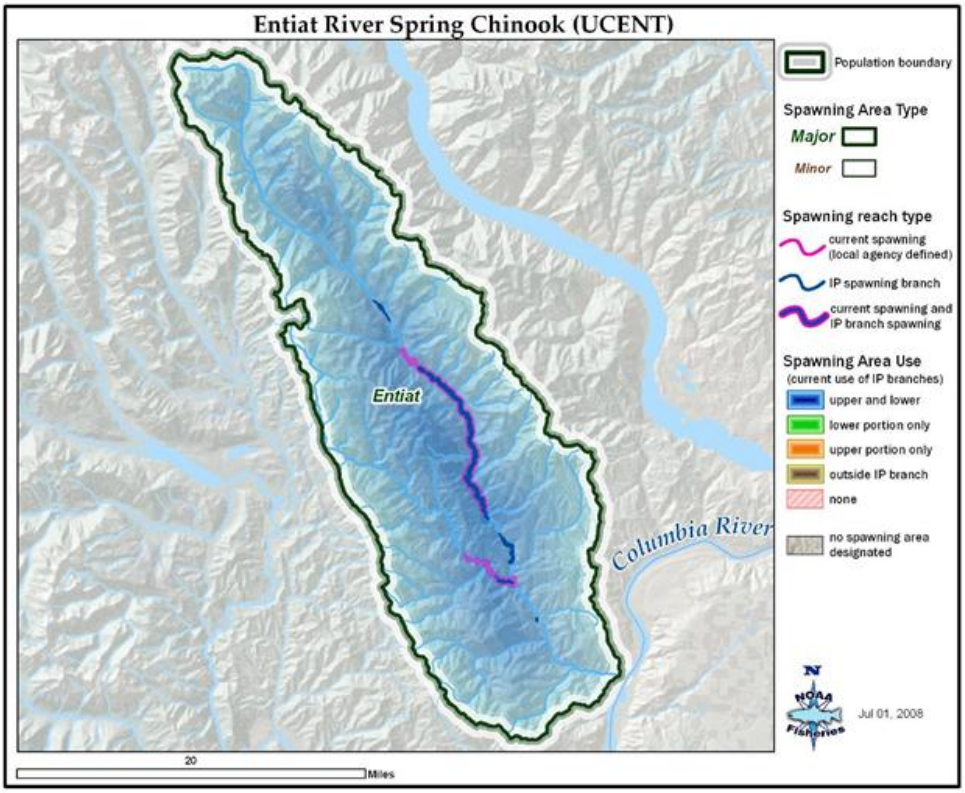

Figure E3. Entiat River spring Chinook salmon population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 3.1.2-5 from ICTRT 2008).

[12] The distribution of lamprey is uncertain.

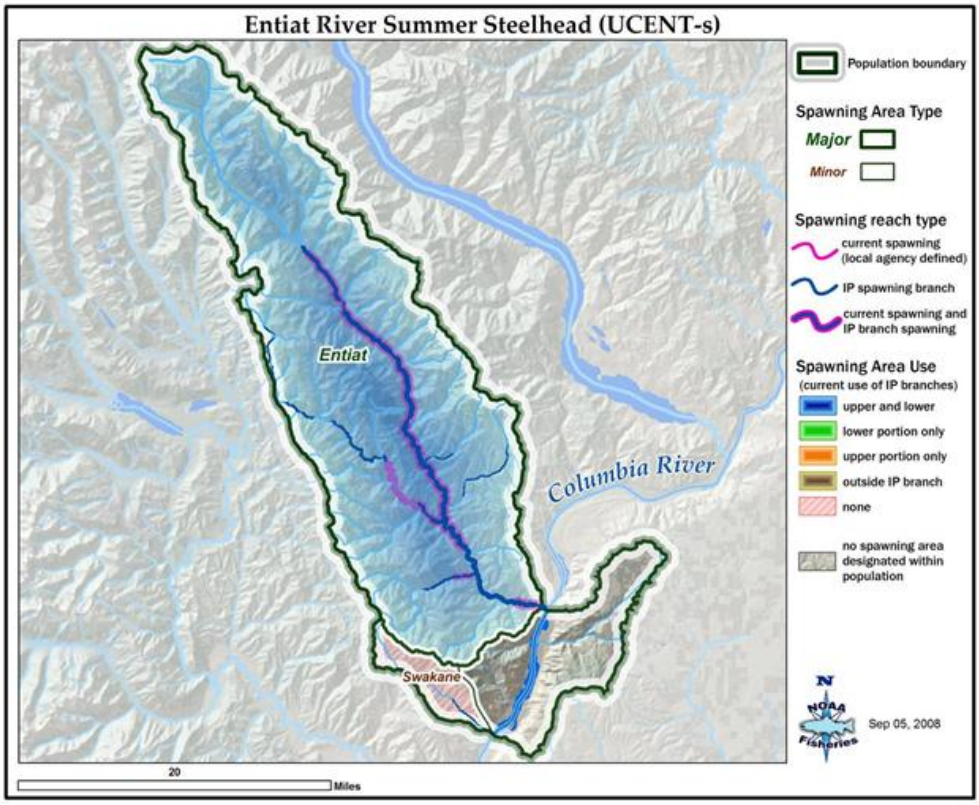

Figure E4. Entiat River steelhead population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 4.1.2-5 from ICTRT 2008).

Priority areas

Based on Table E1 above, the priorities for areas for restoration and protection actions are summarized in Table E%:

Table E5. Assessment unit priority for restoration and protection actions in the Entiat River basin.

Restoration		**Protection**	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Middle Entiat (Stillwater)	1	Stillwater	1
Lower Entiat	2	Lower Entiat	2
Upper-Middle Entiat	3	Upper-Middle Entiat	2
Mad River	4	Mad River	2

What follows is a detailed summary and assessment for each assessment unit in the Entiat River basin.

Assessment Unit: Upper-Middle Entiat

Species: Spring Chinook salmon, steelhead, bull trout, cutthroat trout.

Assessment Unit Description: Mainstem Entiat River (RM: 26-36)

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring and summer Chinook salmon, steelhead, and bull trout.

Secondary and tertiary sub-watersheds: Roaring, Stormy, and Mud creeks.

Factors Affecting Habitat Conditions:

- Poor large woody debris recruitment and retention potential
- Levees and rip-rapped banks
- Entiat River Road
- Forest management practices and road densities in the upper watersheds leading to reduced LW recruitment and increased sediment input.
- Historic channel straightening for flood control
- Reduced riparian condition and few mature trees decreasing the input of key wood pieces that would form persistent log jams.
- Decades of depressed salmon returns resulting in reduction in marine-derived nutrients

Ecological Concerns and (subcategories) in priority order:

1. Channel structure and form (Instream structural complexity)
2. Food (Altered Primary Productivity and Food Competition)

Level of Certainty/Data gaps

- Likely reduced primary and secondary productivity because of reduced marine-derived nutrients.

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Instream structural complexity)

    - Install large wood and ELJs that are consistent with the geomorphic potential based on the reach assessment (BOR 2009a; BOR 2009b).

2. Food (altered primary productivity and food-competition)

    - See discussion under *Universal Ecological Concerns and Actions*.

Assessment Unit: Middle Entiat

Species: Spring Chinook salmon, steelhead, bull trout, cutthroat trout.

Assessment Unit Description: Mainstem Entiat River (Stillwaters; from Entiat Falls to Potato Moraine; RM: 16-26)

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring and summer Chinook salmon, steelhead, and bull trout.

Secondary and tertiary sub-watersheds: Roaring, Stormy, and Mud creeks.

Factors Affecting Habitat Conditions:

- Poor large woody debris recruitment and retention potential
- Levees and rip-rapped banks
- Entiat River Road
- Undersized bridges
- Forest management practices and road densities in the upper watersheds leading to reduced LW recruitment and increased sediment input.
- Historic channel straightening for flood control
- Reduced riparian condition and few mature trees decreasing the input of key wood pieces that would form persistent log jams.
- Decades of depressed salmon returns resulting in reduction in marine-derived nutrients

Ecological Concerns and (subcategories) in priority order:

1. Channel structure and form (Bed and Channel Form)
2. Peripheral and transitional habitats (Side channel, Wetland, and Floodplain Condition)
3. Channel structure and form (Instream Structural Complexity)
4. Riparian condition (Riparian condition)
5. Food (Altered Primary Productivity)
6. Sediment conditions (Increased Sediment Quantity)
7. Injury and mortality (Mechanical Injury)
8. Habitat quantity (Anthropogenic Barriers)
9. Water quantity (Decreased Water Quantity)
10. Water quality (Temperature, Turbidity, pH)

Level of Certainty/Data gaps

- Reach assessment has been completed in most areas, providing a high confidence in assessment.
- There is a high level of concern about the effects of land development on this reach. There is consensus among RTT members on the need to protect stream channel function.

- Likely reduced primary and secondary productivity because of reduced marine-derived nutrients.
- Number and effects of unscreened irrigation pumps is uncertain, but not thought to be a major concern.
- Recent Reach Assessments (BOR 2009a; BOR 2009b) have increased the level of certainty concerning the actions recommended below.

Ecological concerns and habitat action recommendations in priority order:

3. Channel structure and form (bed and channel form)

    - Remove levees (Tyee Ranch Levees, Reach 3B berm, Bremmer, others via (BOR 2009a; BOR 2009b)). In general, larger armored levees that block higher quantities of the channel migration zone would be the highest priority for treatment.
    - Undersized bridges: Remove bridges known to impair or reduce habitat or habitat potential. See (BOR 2009a; BOR 2009b) for additional detail and locations.
    - Bank armoring: Priority areas would be those that are most limiting to channel migration and reduction in sinuosity. See (BOR 2009a; BOR 2009b) for additional detail and locations.

4. Peripheral and transitional habitats (sidechannel, wetland, and floodplain condition)

    - Treating the list of features for bed and channel form will generally address the disconnected side channel and wetlands and degraded floodplain condition. In some cases, partial treatment of the feature may result in a hydraulic connection without addressing bed and channel form. These partial treatments are lower priority but may still have some biological benefits; however, there will likely be degradation in effectiveness over time requiring maintenance or adaptive management.

5. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs that are consistent with the geomorphic potential based on the reach assessment (BOR 2009a; BOR 2009b).

6. Riparian condition (Riparian Condition)

    - Plant native riparian vegetation and restore the riparian buffer and LW recruitment potential. In general, riparian restoration will be most effective when coordinated with other projects and in areas where river processes are at high functioning levels. Priority level of stand-alone projects depends on the quantity and location. The Entiat River Watershed Riparian Areas Prioritization Project (GeoEngineers 2007) offers a useful guide for areas that are likely to be a priority.

7. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

8. Sediment conditions (Increased Sediment Quantity)

    - See discussion under *Universal Ecological Concerns and Actions*.

9. Injury and mortality (Mechanical Injury)

    - Conduct an inventory and assessment of irrigation pumps;
    - Screen irrigation pumps and intake structures that are not compliant.

10. Habitat quantity (Anthropogenic Barriers)

    - Replace two Stormy Creek culverts that present fish passage problems and associated small diversion on private land.

11. Water quantity (Decreased Water Quantity)

    - Reduce the quantity of flow diverted from the river through:
        - On farm irrigation efficiency
        - Surface/ground water conversions
        - Water right acquisition

12. Water Quality (Temperature, pH, and Turbidity)

    - Washington DOE identified temperature, pH, and suspended solids as occasionally exceeding the standards. We do not recommend taking any actions to directly affect these attributes. Floodplain and riparian condition treatments will have secondary benefits for these attributes. In the future, climate change effects on temperature could have greater effects on fish and may warrant specific actions; however, floodplain, side channel, and wetland restoration should help ameliorate climate change effects.

Assessment Unit: Lower Entiat

Species: Spring and summer Chinook salmon, steelhead, bull trout, cutthroat trout

Assessment Unit Description: Entiat River mainstem (From Moraine to the Confluence with the Columbia River; RM 0-16).

Current fish use status: MaSA for spring Chinook and steelhead. Migration corridor for spring Chinook salmon, steelhead and bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for steelhead and summer Chinook salmon. Limited rearing area for juvenile spring Chinook salmon and bull trout.

Secondary and tertiary sub-watersheds: Roaring Creek.

Factors Affecting Habitat Conditions:

- Levees and rip-rapped banks
- Entiat River Road
- Undersized bridges
- Forest management practices and road densities in the upper watersheds leading to reduced LW recruitment and increased sediment input.
- Historic channel straightening for flood control
- Historic removal of LW from the channel
- Reduced riparian condition and few mature trees decreasing shading, cover and the input of key wood pieces that would form persistent log jams.
- Decades of depressed salmon returns resulting in reduction in marine-derived nutrients
- Irrigation water withdrawals
- Unscreened or inadequately screened irrigation pumps and intakes

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and transitional habitats (sidechannel, wetland, and floodplain condition)
2. Channel structure and form (instream structural complexity)
3. Channel structure and form (bed and channel form)
4. Riparian condition (Riparian Condition)
5. Injury and mortality (mechanical injury)
6. Sediment conditions (increased sediment quantity)
7. Food (altered primary productivity and food competition)
8. Water quantity (decreased water quantity)

Level of Certainty/Data gaps:

- Extent of irrigation water withdrawal on instream flows and temperature is uncertain but currently thought to be a relatively small portion of base flow.

- Number and effects of unscreened irrigation pumps is uncertain, but not thought to be a major concern.
- Recent evaluations of this assessment unit (BOR 2012; RTT/BOR 2012) have resulted in strong certainty for the actions suggested below.

Ecological concerns and habitat action recommendations in priority order:

Note that many of the actions suggested below are planned for implementation in 2014 as part of the Entiat IMW implementation schedule.

1. Channel structure and form (bed and channel form)

    - River right (~RM 6.6) riprap near Roaring Ck bridge;
    - River right (~RM 4.1) riprap at Harrison levee.

2. Channel structure and form (Instream structural complexity)

    - ELJs near existing natural features (islands, bedrock, bends);
    - Two islands (~RM 6.3) ELJ placement;
    - River right (~RM 5.3) island ELJ placement;
    - River left (RM 4.0) Harrison Side Channel;
    - River left wood placement for cover (~RM 3.1) downstream of fire station;
    - River right (~RM 0.8) wood placement in side channel right bank;
    - Generally ELJ placement at head of any side channel;
    - Generally wood placement for cover anywhere socially acceptable.

3. Peripheral and transitional habitats (Side Channel and Wetland Conditions)

    - Lower Entiat river left side channel (~RM 6.2 culverts) reconnection;
    - H-D (~RM 5.0) side channel reconnection;
    - River Right (~RM 5.6) floodplain reconnection;
    - River Right (~RM 4.45) side channel enhancement. Harrison side channel adaptive mgmt. (~RM 4.0);
    - River right floodplain and side channel (~RM 2.4) development;
    - River right (~RM 1.9) side channel development;
    - River right (~RM 0.8) side channel development in backwater zone.

4. Riparian condition (riparian condition)

    - Increase riparian area in conjunction with other actions; refer to The Entiat River Watershed Riparian Areas Prioritization Project (GeoEngineers 2007) as a guide for areas that are likely to be a priority.

5. Injury and mortality (mechanical injury)

- Conduct an inventory and assessment of irrigation pumps;
- Screen irrigation pumps and intake structures that are not compliant.

6. Sediment conditions (increased sediment quantity)

    - Reduce artificially high rates of fine sediment input and restore other upland watershed processes such as runoff patterns and LWD recruitment)
    - Treat, relocate, or remove roads: decommission 14 miles of National Forest Roads (this objective was from the recovery plan and may not be adequate to achieve the biological objectives).

7. Food (altered primary productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

8. Water quantity (decreased water quantity)

    - Reduce the quantity of flow diverted from the river through:
        - On farm irrigation efficiency
        - Surface/ground water conversions
        - Water right acquisition

Assessment Unit: Mad River

Species: Spring Chinook salmon, steelhead, bull trout, cutthroat trout.

Assessment Unit Description: From confluence with the Entiat River upstream to end of anadromy for steelhead and spring Chinook salmon, and further upstream for bull trout.

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for steelhead and bull trout and rearing habitat for spring Chinook salmon.

Secondary and tertiary sub-watersheds: Tillicum Creek.

Factors Affecting Habitat Conditions:

- Historical sheep grazing and timber harvest practices have increased upland erosion and sediment delivery to the stream, and has affected snow melt runoff and resultant stream flow.
- Mad River Road constricts channel on mainstem from Pine Flat Campground downstream to the confluence with the Entiat River.
- Undersized culvert in Tillicum Creek potentially restricts steelhead distribution and disrupts the recruitment of sediment and LW.
- Decades of depressed salmon returns resulting in reduction in marine derived-nutrients

Ecological Concerns and (subcategories) in priority order:

1. Channel structure and form (bed and channel form)
2. Sediment conditions (increased sediment quantity)
3. Riparian condition (riparian condition and LW recruitment)
4. Food (altered primary productivity and food competition)
5. Habitat quantity (anthropogenic barriers)

Level of Certainty/Data gaps

- Mad River is considered a stronghold for bull trout. Radio-telemetry data from Chelan PUD bull trout studies indicate that numerous bull trout either overwinter in the Mad River or do not migrate downstream from the Mad River into the Columbia River until late winter. Others do migrate into the Columbia River soon after spawning in the Mad River.
- Steelhead redds have been observed as far up as Ninemile Camp and a few surveys have been conducted up to Cougar Creek.
- Steelhead redds have been observed within about 1 mile of the culvert barrier on Tillicum Ck road.
- Likely reduced primary and secondary productivity because of reduced marine-derived nutrients.

Ecological concerns and habitat action recommendations in priority order:

1. Channel structure and form (bed and channel form)

    - Modify or relocate the county road in the lower 4 miles

2. Sediment conditions (increased sediment quantity)

    - Reduce artificially high rates of sediment input and restore other upland watershed processes such as runoff patterns and LWD recruitment
    - Improve county road maintenance along lower Mad River road
    - Treat, relocate, or remove roads: Four miles NF road decommissioning, 12 miles heavy maintenance reconstruction, estimate 40 miles decommission/heavy maintenance / reconstruction in Tillicum watershed (these objectives were from the recovery plan and may not be adequate to achieve the biological objectives).

3. Riparian Condition (riparian condition)

    - Plant native riparian vegetation and restore the riparian buffer and LWD recruitment potential. In general, riparian restoration will be most effective when coordinated with other projects and in areas where river processes are at high functioning levels. Priority level of stand-alone projects depends on the quantity and location. The Entiat River Watershed Riparian Areas Prioritization Project (GeoEngineers 2007) offers a useful guide for areas that are likely to be a priority.

4. Food (altered primary productivity and food competition)

    - See discussion under *Universal Ecological Concerns and Actions*.

5. Habitat quantity (anthropogenic barriers)

    - Replace undersize culvert in Tillicum Ck.

Appendix E.3: Methow River Basin Assessment and Strategy

Spring Chinook and Steelhead Population Structure

The Methow River spring Chinook salmon and steelhead populations (Figures E5 and E6) are part of the UCR spring Chinook ESU and steelhead DPS, respectively. Important spawning and rearing areas occur throughout the basin. Bull trout, cutthroat trout, and Pacific lamprey[13] all inhabit the Methow Basin and important habitat exists and is in need of restoration to varying degrees for these other important species of concern.

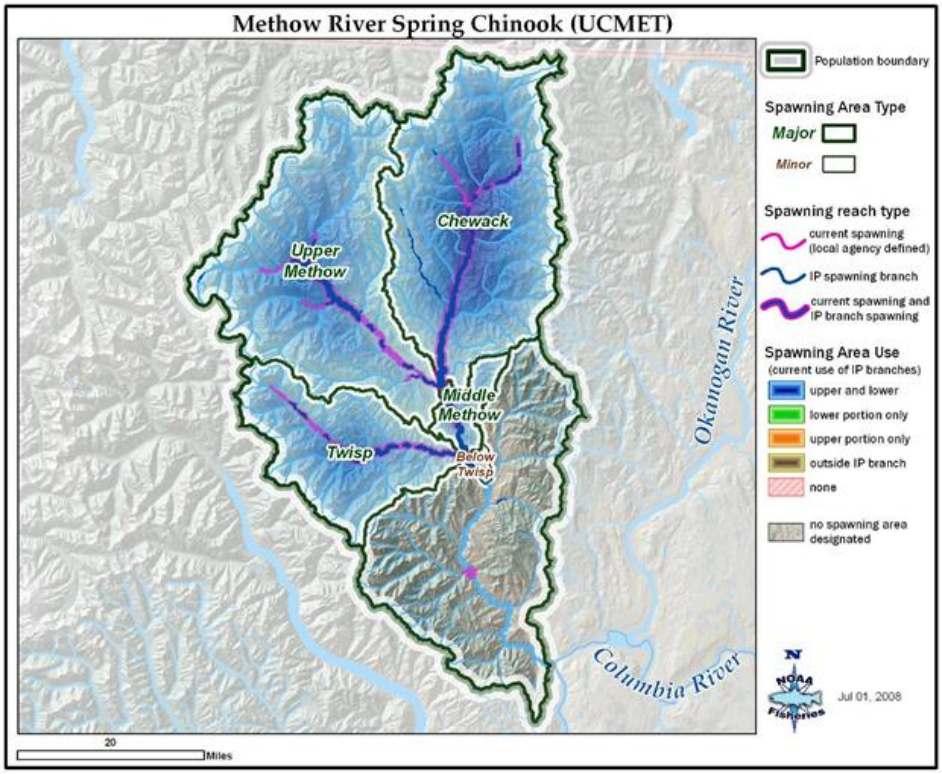

Figure E5. Methow River spring Chinook salmon population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 3.1.2-5 from ICTRT 2008).

[13] The distribution of lamprey is uncertain.

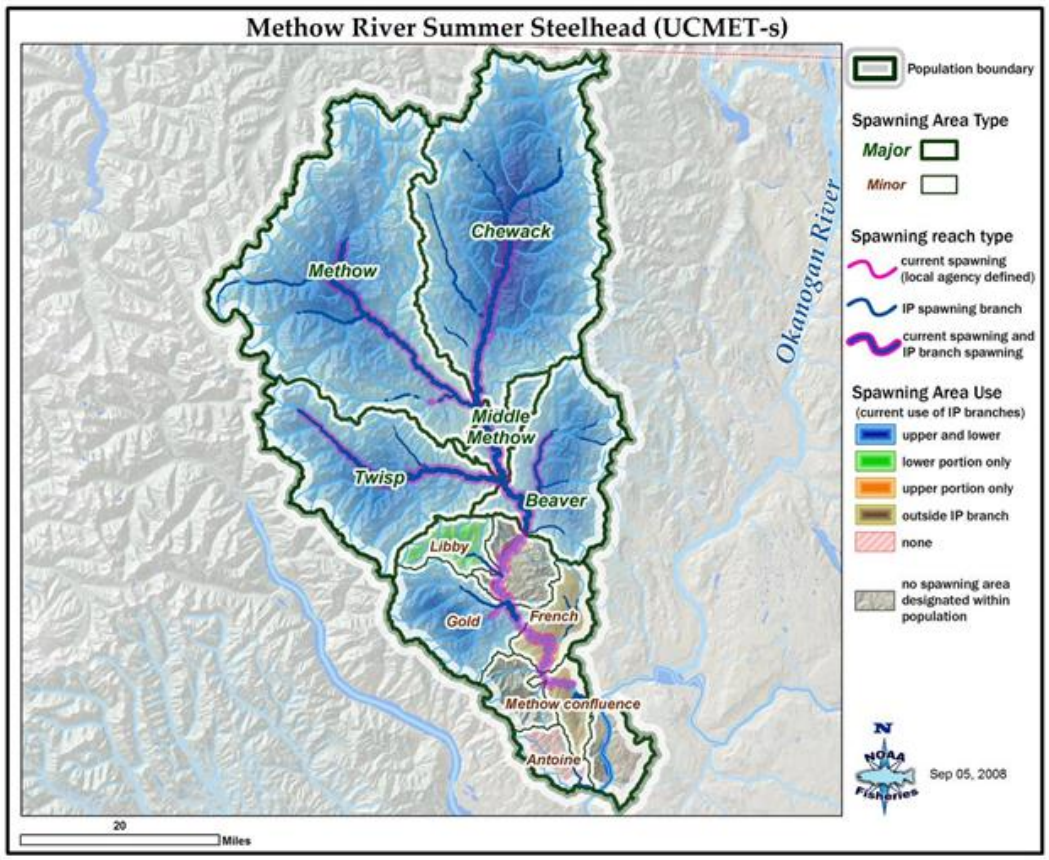

Figure E6. Methow River steelhead population current spawning distribution and spawning areas designations (minor and major; IP is intrinsic potential (see above); Figure 4.1.2-5 from ICTRT 2008).

Priority areas

Based on Table E1 above, the priorities for areas for restoration and protection actions are summarized in Table E6:

Table E6. Assessment unit priority for restoration and protection actions in the Methow River basin (note there is no distinction between some assessment units for protection priority).

Restoration		Protection	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Upper Methow River	1	Lower Twisp River	1
Lower Twisp River	2	Middle Methow River	1
Upper-Middle Methow River	3	Upper Methow River	1

Lower Chewuch River	4	Lower Chewuch River	1
Beaver Creek	5	Upper-Middle Methow River	1
Middle Methow River	6	Upper Twisp River	2
Wolf Creek	Not a priority at this time	Upper Chewuch River	2
Gold Creek	Not a priority at this time	Beaver Creek	2
Libby Creek	Not a priority at this time	Wolf Creek	3
Upper Twisp River	Not a priority at this time	Early Winters Creek	3
Upper Chewuch River	Not a priority at this time	Lost River	3
Early Winters Creek	Not a priority at this time	Gold Creek	4
Lost River	Not a priority at this time	Libby Creek	4
Lower Methow River	Not a priority at this time	Lower Methow River	4

In the following, a detailed summary and assessment of each assessment unit is provided for the Methow River Basin.

Assessment Unit: Upper Methow

Species: spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Upper mainstem Methow River Weeman Bridge to Lost River confluence; RM 61-75)

Current fish use status: MaSA for spring Chinook and steelhead, portion of core area for bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for spring Chinook salmon, steelhead, and bull trout

Secondary and tertiary sub-watersheds: West Fork Methow River, Goat, Fawn, Little Boulder creeks.

Factors Affecting Habitat Conditions:

- The mainstem Methow River between RM 59 and 74 naturally goes dry in most years.
- Mainstem upper Methow River have LW levels below USFS standards. Timber harvest and stream cleaning have reduced LW loads and recruitment in Goat Creek.
- Several dikes and rip rapped banks cut off important side channel and wetland habitats.
- Highway 20 at Weeman Bridge is a channel constriction
- Residential construction in flood prone areas has resulted in clearing of riparian habitat, increased channel restriction, and reduced wood recruitment and retention potential.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Channel Structure and Form (Bed and Channel Form)
3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
5. Riparian Condition (Riparian Condition)
6. Food (Altered Primary Production)
7. Sediment Conditions (Increased Sediment Quantity)
8. Species Interactions (Introduced Competitors and Predators)
9. Habitat Quantity, Anthropogenic Barriers

Level of Certainty/Data gaps

- Watershed and stream analyses by USFS and USGS (BOR 2008) provide high level of certainty on habitat conditions. A targeted Reach Assessment is needed.
- The effect of surface water and groundwater withdrawal on the dewatered reach is not fully understood.
- Fish use and survival in/of the dewatered reaches is not fully understood.
- The role of riparian condition and channel morphology on stream flows in this reach is not understood.

- The contribution of tributaries and mainstem bank erosion to sediment levels in the mainstem Methow River is not understood.
- Extent and effect of interactions of bull trout and other fish with brook trout is uncertain.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Improve natural water storage by allowing off-channel connection, floodplain function and beaver recolonization.
    - Increase stream flow through irrigation practice improvements and water leases/purchases.
    - Maintain existing beaver colonization where appropriate.

2. Channel Structure and Form (Bed and Channel Form)

    - Remove levees;
    - Undersized bridges;
    - Bank armoring;
    - Other human features.

3. Peripheral and Transitional Habitats (Side channel and Wetland Habitats)

    - Side channel and Wetland Habitat Conditions, reconnect disconnected side channels or where low wood loading has changed the inundation frequency, and improve hydraulic connection of side channels and wood complexity within the side channels.

4. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.
    - Improve LWD recruitment, allow regeneration and stop removal practices so that wood can recruit naturally.
    - Rehabilitate habitat in Vanderpool reach of Goat Creek.

5. Riparian Condition

    - Restore condition in degraded areas associated with residential development, agricultural practices, or where there are legacy effects from past riparian logging practices.
    - Fence riparian areas and wetlands, maintain existing fences (Vanderpool reach in Goat Creek may need fencing).

6. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

7. Sediment

    - Road management, reduction, and maintenance to restore sediment and LWD recruitment rates within riparian and upland areas, including important sub-watersheds. Work with local USFS to identify specific problem areas.
    - Reduce unnaturally high stream bank erosion due to vegetation clearing in the riparian on mainstem Methow River from Goat Creek to Mazama.

8. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in floodplain ponds and channels.

9. Habitat Quantity, Anthropogenic Barriers

    - Diversion in Goat Creek

Assessment Unit: Upper-Middle Methow

Species: spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Upper – Middle mainstem Methow River (Weeman Bridge to confluence with Chewuch River; RM 51.6 - 61)

Current fish use status: MaSA for spring Chinook and steelhead, portion of core area for bull trout (including local population in Wolf Creek). Foraging and overwintering for bull trout. Spawning and rearing habitat for spring Chinook salmon, steelhead, and bull trout

Secondary and tertiary sub-watersheds: Hancock and Wolf creeks.

Factors Affecting Habitat Conditions:

- Residential construction in flood prone areas has resulted in clearing of riparian habitat, increased channel restriction, and reduced wood recruitment and retention potential.
- Additional detailed information on locations can be found in (Lyon and Maquire 2008; BOR 2011)

Ecological Concerns and (subcategories) in priority order:

1. Channel Structure and Form (Bed and Channel Form)
2. Channel Structure and Form (Instream Structural Complexity)
3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
4. Riparian Condition
5. Habitat Quantity (Anthropogenic Barriers)
6. Food (Altered Primary Production)
7. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- Recent Reach Assessment (Lyon and Maquire 2008; BOR 2011) provide high level of certainty on habitat conditions and proposed actions.
- The effect of surface water and groundwater withdrawal on the dewatered areas is not fully understood.
- The role of riparian condition and channel morphology on stream flows in this reach is not understood.
- Extent and effect of interactions with brook trout is uncertain

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Bed and Channel Form)

- Remove levees
- Undersized bridges
- Bank armoring
- Other human features

2. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.

3. Water Quantity (Reduced Water Quantity)

    - Improve natural water storage by allowing off-channel connection, floodplain function and beaver recolonization.

4. Peripheral and Transitional Habitats (Side Channel and Wetland Habitats)

    - Side channel and Wetland Habitat Conditions, reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels. Create groundwater based backchannel habitat in areas with suitable hydrology and geomorphology.

5. Riparian Condition (see (Lyon and Maquire 2008; BOR 2011) for more information on locations)

    - Restore condition in degraded areas associated with residential development, agricultural practices, or where there are legacy effects from past riparian logging practices.
    - Improve LW recruitment, allow regeneration and stop removal practices so that wood can recruit naturally.
    - Fence riparian areas and wetlands, maintain existing fences.

6. Habitat Quantity, Anthropogenic Barriers

    - Diversion in Stansbury side channel; landowner outreach is needed.
    - Foghorn Dam.
    - Continued maintenance is needed in Wolf Creek at the irrigation diversion (at low flows, weirs on main channel need to have rocks rolled out of the center notch and jump notch to make sure that there is a clear path for large fish to migrate up).
    - Replace head gate at Wolf Creek irrigation diversion.

7. Food (Altered Primary Productivity)

- See discussion under *Universal Ecological Concerns and Actions*.

8. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in floodplain ponds, Hancock springs.

Assessment Unit: Middle Methow

Species: Spring and summer Chinook salmon, steelhead, bull trout, Westslope cutthroat, and coho.

Assessment Unit Description: Mainstem Methow River (Confluence of the Chewuch River to the Confluence of the Twisp River; RM 27.5 – 51.6).

Current fish use status: MaSA for steelhead and summer Chinook. The mainstem Methow River is an important migration corridor for spring Chinook salmon, steelhead and bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for summer (limited spawning for spring) Chinook salmon and steelhead.

Secondary and tertiary sub-watersheds: Alder Creek, Bear Creek, and the Twisp River (*see separate assessment for Twisp River*).

Factors Affecting Habitat Conditions:

- Levees and residential development, rip rap and dikes are affecting riparian, channel migration, wood recruitment, and floodplain condition.
- Channel is naturally confined by erosion-resistant glacial terraces that limit migration and floodplain connection in many locations.
- Long history of clearing the channel of instream structure including woody debris and log jams.
- The Barkley Irrigation District diversion structures do not meet state and federal standards.
- Low flows in late summer (and winter) may affect juvenile survival.
- Structures in tributaries are passage barriers for adult and juvenile salmonids; see (BOR 2010) for detailed locations.

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
2. Channel Structure and Form (Instream Structural Complexity)
3. Channel Structure and Form (Bed and Channel Form)
4. Water Quantity (Decreased Water Quantity)
5. Riparian Condition (Riparian Condition)
6. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- A recent reach assessment by the USBOR (BOR 2010) has increased the certainty of the condition of the habitat and recommendations below.
- The effects of irrigation water withdrawal on stream flows are not fully understood.

- Passage barriers have been inventoried, but not fully assessed.
- Extent and effect of interactions with brook trout is uncertain, although monitoring data from USGS suggests that Barkley ditch/Bear Creek could be problematic.

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Bed and Channel Form)

    - Remove levees (e.g., WDFW floodplain, Twisp Sugardike, see (BOR 2010) for others)
    - Undersized bridges (e.g., Two Bridges in Winthrop area)
    - Bank armoring; see (BOR 2010).
    - Other human impacts (e.g., Barkley push up dam)

2. Peripheral and Transitional Habitats (Side Channel and Wetland Habitat)

    - Side channel and Wetland Habitat Conditions, reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels. Create groundwater based backchannel habitat in areas with suitable hydrology and geomorphology.

3. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.

4. Water Quantity (Decreased Water Quantity)

    - Improve natural water storage by allowing off-channel connection, floodplain function and beaver recolonization (for additional detail on location, please see (BOR 2010)).
    - Increase stream flow through irrigation practice improvements and water leases/purchases (for additional detail on location, please see (BOR 2010)).

5. Riparian Condition (Riparian Conditions)

    - Restore condition in degraded areas associated with residential development, agricultural practices, or where there are legacy effects from past riparian logging practices (for additional detail on location, please see (BOR 2010)).
    - Improve LW recruitment, allow regeneration and stop removal practices so that wood can recruit naturally.

- Fence riparian areas and wetlands, maintain existing fences (for additional detail on location, please see (BOR 2010)).

6. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in floodplain ponds and Bear Creek.

Assessment Unit: Lower Methow

Species: Spring and summer Chinook salmon, steelhead, bull trout, Westslope cutthroat, and coho.

Assessment Unit Description: Lower Methow River mainstem (from the confluence with the Columbia River to the Twisp River; RM 0-27.5).

Current fish use status: MiSA for steelhead. The mainstem Methow River is an important migration corridor for spring and summer Chinook salmon, steelhead and bull trout. Foraging and overwintering for bull trout. Spawning and rearing habitat for spring and summer Chinook salmon, steelhead, and bull trout.

Secondary and tertiary sub-watersheds: Beaver, Texas, McFarland, French, Squaw, Black Canyon, Libby, and Gold creeks *(See separate assessment unit summary for Beaver, Gold and Libby Creeks)*.

Factors Affecting Habitat Conditions:

- Rip rap along Highway 153 effects channel migration and riparian condition;
- Several small floodplain areas are cut off by levees or berms;
- Riparian areas are degraded due to residential and agricultural development;

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
2. Channel Structure and Form (Bed and Channel Form)
3. Channel Structure and Form (Instream Structural Complexity)
4. Riparian Condition

Level of Certainty/Data gaps

- Habitat in the mainstem lower Methow River and lower reaches of its tributaries has not been surveyed. Some recommendations are based on professional judgment. Habitat in upper reaches of the tributaries has been assessed by USFS.
- Recent assessment of lower Libby Creek (Inter-fluve 2012).
- Spawning of salmonids in the mainstem is regularly surveyed for summer Chinook and steelhead, providing a higher level of certainty.
- Need for rearing surveys.
- Bull trout use of lower Methow not well documented (other than incidentally caught during steelhead season).

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)

    - Floodplain conditions- address human features that affect floodplain conditions, primarily the highway and several push up levees.

2. Channel Structure and Form (Bed and Channel Form)

3. Riparian Condition (Riparian Condition)

    - Plant riparian vegetation to restore adequate riparian buffer along unused agricultural areas
    - Increase LW recruitment and retention

Assessment Unit: Early Winters Creek

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Early Winters Creek, RM 0 - ?

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, steelhead, and local population (possibly including resident population) bull trout.

Secondary and tertiary sub-watersheds: Pine, Cedar, Cutthroat, Varden, Silver Star, and Pekin creeks.

Factors Affecting Habitat Conditions:

Early Winters Creek is generally in very good condition with the exception of some relatively minor effects in the lower mile.

- Channel constriction by state highway in the lower 1 mile reduces natural flood plain function, reduces the number of side channels, and increases water velocities and resultant scour.
- Highway 20 bridge at river mile 0.75 is too small and adjacent trail bridge is too low. In combination they are causing scour and incision, downstream bank erosion, and disconnection from the floodplain.
- Riparian areas (~ 40 acres) have been degraded at campgrounds, resulting in loss of cover and woody debris recruitment.
- Fine sediment and chemical runoff from highway may impact water quality, although effects are probably limited due to winter road closure.
- Irrigation diversion at river mile 1 affects habitat condition and fish passage at the intake canal (screen complex is problematic; contact USFS for additional details).
- Decades of depressed salmon returns resulting in reduction in marine derived nutrients.
- Effects of stocking lakes with trout species that emigrate downstream into anadromous areas that may lead to competition, inbreeding, and other effects.

Ecological Concerns and (subcategories) in priority order:

1. Sediment (Increased Sediment Quantity)
2. Water Quantity (Decreased Water Quantity)
3. Riparian Condition (Riparian Condition)
4. Channel Structure and Form (Bed and Channel Form)
5. Food (Altered Primary Productivity)
6. Habitat Quantity (Anthropogenic Barriers)

Level of Certainty/Data gaps

- Recent (2009) field assessment of stream channel function provided strong indication of high water velocities and resultant bedload, channel scour, and riparian degradation in lower Early Winters Creek.
- Bull trout use of upper Early Winters Creek not well documented.

Ecological concerns and habitat action recommendations in priority order:

1. Sediment Conditions (Increased Sediment Quantity)

    - Road Maintenance (improve drainage on existing forest roads in watershed)
    - Sandy Butte Road Reconstruction
    - Highway 20:
        - Move Early Winters Campground (lower site) away from the creek and stabilize eroding bank

2. Water Quantity (Decreased Water Quantity)

    - Increase on-farm irrigation efficiency
    - Increase surface/ground water conversions
    - Investigate water right acquisition

3. Riparian Condition (Riparian Condition)

    - Restore riparian condition in degraded areas around campgrounds and roads.
    - Improve LWD recruitment and retention.

4. Channel Structure and Form (Bed and Channel Form)

    - Bed and Channel Form- address human features that affect channel form and function, primarily Highway 20 channel restrictions, and MVSTA trail, and USFS campground effects.

5. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

6. Habitat Quantity (Anthropogenic Barriers)

    - Replace culvert on Pine Creek at Highway 20

Assessment Unit: Lost River

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Lost River RM: 0-11.4

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, steelhead, and local population of bull trout (two distinct groups in upper and lower with break at Monument Creek confluence).

Secondary and tertiary sub-watersheds: Eureka, Monument, Drake, Ptarmigan, and Diamond creeks.

Factors Affecting Habitat Conditions:

The Lost River is generally in very good condition with the exception of some relatively minor effects in the lower mile.

- A dike on the Methow River at the confluence of the lower Lost River constrains floodplain function.
- Residential construction on the alluvial fan may lead to a constrained channel in the future.
- Large woody debris levels in the lower Lost River (downstream from Lost River Road Bridge) are currently low, due to removal for flood control. However, the potential for recruitment of woody debris is at natural levels.
- County Road Bridge is undersized.
- The Lost River Airport runway butts up against the Lost River on the south side, requiring mature trees to be cut down that reduces wood recruitment and shade for about 180 feet along the river.

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitats (Floodplain Condition)
2. Channel Structure and Form (Bed and Channel Form)
3. Riparian Condition (Riparian Conditions)
4. Food (Altered Primary Productivity)

Level of Certainty/Data gaps

- Watershed surveys by USFS provide high level of certainty.
- Impact of recreation harvest fishery on bull trout is not well understood; also poaching of adfluvial bull trout in Cougar Lake and fluvial bull trout in Monument Creek are not well documented.

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitat (Floodplain Condition)

    - Sugar dike

2. Channel Structure and Form (Bed and Channel Form)

    - Remove (total or partial) dike at the Methow Confluence (may be necessary to acquire property in floodplain).
    - Residential construction on the alluvial fan may lead to a constrained channel in the future.
    - Fix (possibly replace) undersized county road bridge

3. Riparian Condition (Riparian Condition)

    - Restore condition in degraded areas associated with residential development.
    - LW recruitment, allow regeneration and stop removal practices so that wood can recruit naturally in the lower mile.

4. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

Assessment Unit: Wolf Creek

Species: Steelhead, spring Chinook, and bull trout.

Assessment Unit Description: Wolf Creek

Current fish use status: Steelhead and bull trout.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

-

Ecological Concerns and (subcategories) in priority order:

1. Injury and Mortality (Mechanical Injury)
2. Riparian Condition (Riparian Condition)
3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
5. Water Quantity (Decreased Water Quantity)

Level of Certainty/Data gaps

-

Ecological concerns and habitat action recommendations in priority order:

1. Injury and Mortality (Mechanical Injury)
    - Wolf Creek Irrigation Diversion
2. Riparian Condition (Riparian Condition)
3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
5. Water Quantity (Decreased Water Quantity)

Assessment Unit: Upper Chewuch River

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Chewuch River RM: 20-35

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, steelhead, and two local populations of bull trout (Lake Creek and upper Chewuch).

Secondary and tertiary sub-watersheds: Thirtymile, Andrews, and Lake creeks

Factors Affecting Habitat Conditions:

- Channel clearing and LW removal reduced channel complexity in the Chewuch River.
- Skid roads in riparian areas increase dispersed recreation use impacts to the stream.
- Livestock grazing has impacts on riparian areas in tributaries.
- High densities of brook trout in some tributaries.
- Much of the watershed (~3/4) has burned since 2001.

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Riparian Condition (Riparian Condition)
3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
4. Channel Structure and Form (Bed and Channel Form)

Level of Certainty/Data gaps

- Field habitat analyses were conducted a number of years ago on public lands, allowing a relatively high confidence in assessment.
- Extent and effect of interactions of bull trout/native fish with brook trout is uncertain
- Impact of recreational fishery on bull trout in Black Lake is not well known

Ecological concerns and habitat action recommendations in priority order:

1. Sediment (Increased Sediment Quantity)

    - Road management, reduction, and maintenance to restore sediment and LWD recruitment rates within riparian and upland areas (contact USFS for additional detail).

2. Riparian Condition (Riparian Condition)

- Restore condition in degraded areas associated with residential development or where there are legacy effects from past riparian logging practices/stream clearing.
- Improve LW recruitment, allow regeneration.
- Fence riparian areas and wetlands, maintain existing fences.

3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)

    - Reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels.

4. Channel Structure and Form, Instream Structural Complexity

    - Install large wood and ELJs in geomorphically appropriate locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.

Assessment Unit: Lower Chewuch River

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit Description: Chewuch River RM: 0 – 20)

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon and steelhead. Migration corridor for bull trout.

Secondary and tertiary sub-watersheds: Twentymile, Falls, Eightmile, Cub, and Boulder creeks.

Factors Affecting Habitat Conditions:

- Channel clearing and LWD removal reduced channel complexity in the Chewuch River, and upstream too.
- Road placement and bank hardening have isolated sections of the main channel from its floodplain and side channels in a few places from the mouth to Eightmile Creek.
- Skid roads in riparian areas increase dispersed recreation use impacts to the stream.
- Low flows in late summer (through winter) reduce quantity of rearing habitat in the lower Chewuch River.
- Livestock grazing has impacts on riparian areas in tributaries and mainstem.
- Certain areas with high road densities within the lower Chewuch assessment unit have highly erosive soils and create sediment and bank erosion problems when they fail (see USFS MRA (2011) for additional details).
- Road constriction at river mile 1.7 on Eightmile Creek creates a partial barrier for steelhead, bull trout and spring Chinook salmon (Inter-fluve 2010a).
- High densities of brook trout in some tributaries like Boulder, Eightmile, and Cub creeks.
- Much of the assessment unit (~3/4) has burned since 2001.
- Road across Twentymile Creek alluvial fan is an identified issue for steelhead.

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
3. Channel Structure and Form (Instream Structural Complexity)
4. Riparian Condition (Riparian Condition)
5. Water Quantity (Decreased Water Quantity)
6. Food (Altered Primary Productivity)
7. Species Interactions (Introduced Competitors and Predators)
8. Habitat Quantity (Anthropogenic Barriers)

Level of Certainty/Data gaps

- Recent Reach Assessment (Inter-fluve 2010a) has been conducted on both private and public lands, allowing a high confidence in the recommendations below.
- The relation of instream flows and fish habitat in the lower Chewuch River are not fully understood, yet some studies provide a strong level of inference.
- Bull trout use of the Chewuch is not fully understood.
- Extent and effect of interactions between bull trout and other native fish with brook trout is well understood.

Ecological concerns and habitat action recommendations in priority order:

1. Sediment (Increased Sediment Quantity)

    - Road management, reduction, and maintenance to restore sediment and LWD recruitment rates within riparian and upland areas. See (USFS MRA) for additional details and locations.

2. Peripheral and Transitional Habitats (Side-channel and Wetland Habitats)

    - Reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels. See (Inter-fluve 2010a) for additional detail on locations.

3. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs in geomorphically appropriate locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site. See (Inter-fluve 2010a) for additional detail on locations.

4. Riparian Condition (Riparian Condition)

    - Restore condition in degraded areas associated with residential development or where there are legacy effects from past riparian logging practices. See (Inter-fluve 2010a) for additional detail on locations.
    - Improve LWD recruitment, allow regeneration and stop removal practices so that wood can recruit naturally. See (Inter-fluve 2010a) for additional detail on locations.
    - Fence riparian areas and wetlands, maintain existing fences (see reach assessment). See (Inter-fluve 2010a) for additional detail on locations.
    - Fix Twentymile Creek alluvial fan road.

5. Water Quantity (Decreased Water Quantity)

- Improve natural water storage by allowing off-channel connection, floodplain function and beaver recolonization. See (Inter-fluve 2010a) for additional detail on locations for off-channel connection and floodplain function and USFS for areas of beaver recolonization.
- Increase stream flow through irrigation practice improvements and water leases/purchases.

6. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

7. Species interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in Eightmile Creek, and other high density areas of brook trout.

8. Habitat Quantity (Anthropogenic Barriers)

    - Improve fish passage in Eightmile Creek at the USFS road pinch point (this action may not be effective until or unless the brook trout population is reduced; see USFS MRA for additional details).

Assessment Unit: Upper Twisp

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit: Upper Twisp River (RM 14-31)

Current fish use status: MaSA for spring Chinook and steelhead. Spawning and rearing habitat for spring Chinook salmon, steelhead, and local population of bull trout.

Secondary and tertiary sub-watersheds: North, South, Reynolds creeks.

Factors Affecting Habitat Conditions:

- Campground effects on riparian in several locations.
- Channel clearing and LWD removal reduced channel complexity.
- Road placement and bank hardening have isolated sections of the main channel from its floodplain and side channels in a few places.
- Skid roads in riparian areas increase dispersed recreation use impacts to the stream.
- High densities of brook trout in some tributaries.

Ecological Concerns and (subcategories) in priority order:

1. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
2. Channel Structure and Form (Instream Structural Complexity)
3. Channel Structure and Form (Bed and Channel Form)
4. Riparian Condition (Riparian Condition)
5. Food (Altered Primary Production)
6. Sediment (Increased Sediment Quantity)
7. Species Interactions (introduced competitors and predators)

Level of Certainty/Data gaps

- Field habitat analyses have been conducted on public lands, allowing a high confidence in assessment.
- Extent and effect of interactions between bull trout and other native species with brook trout is not well understood.

Ecological concerns and habitat action recommendations in priority order:

1. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)

    - Reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels.

2. Channel Structure and Form (Instream Structural Complexity)

    - Install large wood and ELJs in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.

3. Channel Structure and Form (Bed and Channel Form)

    - Remove levees
    - Undersized bridges
    - Bank armoring,
    - Other human features (be specific)

4. Riparian Condition (Riparian Condition)

    - Restore condition in degraded areas associated with residential development or where there are legacy effects from past riparian logging practices.
    - Improve LWD recruitment, allow regeneration.
    - Fence riparian areas and wetlands, maintain existing fences.
    - Implement respect the river program (North Creek/Gilbert area, Reynolds Creek, Roads End, South Creek, Mystery, Poplar Flat, and War and other dispersed areas).

5. Food (Altered Primary Productivity)

    - See discussion under *Universal Ecological Concerns and Actions*.

6. Sediment (Increased Sediment Quantity)

    - Road management, reduction, and maintenance to restore sediment and LW recruitment rates within riparian and upland areas.

7. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in high density areas.

Assessment Unit: Lower Twisp

Species: Spring Chinook salmon, steelhead, bull trout, Westslope cutthroat trout.

Assessment Unit: Lower Twisp River (RM 0-14)

Current fish use status: MaSA for spring Chinook and steelhead. Foraging and overwintering for bull trout. Spawning and rearing habitat for spring Chinook salmon, steelhead, and rearing and migration (not spawning) for bull trout.

Secondary and tertiary sub-watersheds: Buttermilk, Little Bridge, and Poorman creeks.

Factors Affecting Habitat Conditions:

- Low instream flows and high water temperatures in the lower Twisp River affect several species at several life history stages (The lower Twisp River is listed on the Washington State 303(d) list for inadequate instream flow and for temperature exceedance).
- The Twisp River (from Buttermilk Creek to the mouth) has been cut off from its floodplain and side channels through dikes and riprap in places, resulting in a simplified channel; see (Inter-fluve 2010b) for additional details.
- In the lower Twisp River (RM 0.0 – 16.5) LWD levels and recruitment potential are well below geomorphic potential (Inter-fluve 2010b).
- The MVID West Canal diversion on the Twisp River at RM 3.9 is a river cobble levee dam that must be pushed up each year, disturbing salmonid rearing and spawning habitat.
- Development of riparian and floodplain areas has impaired channel migration, riparian condition and floodplain function (Inter-fluve 2010b).
- Residential development has impacted riparian in many locations.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Water Quality (Temperature)
3. Channel Structure and Form (Bed and Channel Form)
4. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)
5. Channel Structure and Form (Instream Structural Complexity)
6. Riparian Condition (Riparian Condition)
7. Sediment (Increased Sediment Quantity)
8. Food (Altered Primary Productivity)
9. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- Extent and effect of interactions between bull trout and other native species with brook trout is not well understood.

- A recent (Inter-fluve 2010b) reach assessment for the Lower Twisp has increased the level of certainty of the RTT's recommendations below.
- Need consistent bull trout redd surveys in all tributaries.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Improve natural water storage by allowing off-channel connection, floodplain function and beaver recolonization (see Inter-fluve (2010b) for specific locations).
    - Increase stream flow through irrigation practice improvements and water leases/purchases (see Inter-fluve (2010b) for specific locations).
    - Little Bridge Creek diversion may impact bull trout migration, spawning, and rearing.

2. Channel Structure and Form (Bed and Channel Form)

    - Remove levees (see Inter-fluve (2010b) for specific locations).
    - Undersized bridges (see Inter-fluve (2010b) for specific locations).
    - Bank armoring (see Inter-fluve (2010b) for specific locations).

3. Peripheral and Transitional Habitats (Side channel and Wetland Habitat Conditions)

    - Side channel and Wetland Habitat Conditions, reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels (see Inter-fluve (2010b) for specific locations).

4. Channel Structure and Form (Instream Structural Complexity) *(below Buttermilk Creek)*

    - Install large wood and ELJs in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site (see Inter-fluve (2010b) for specific locations).

5. Riparian Condition (Riparian Condition)

    - Restore condition in degraded areas associated with residential development or where there are legacy effects from past riparian logging practices (see Inter-fluve (2010b) for specific locations).
    - Fence riparian areas and wetlands, maintain existing fences (see Inter-fluve (2010b) for specific locations).

6. Food (Altered Primary Productivity)

- See discussion under *Universal Ecological Concerns and Actions*.

7. Sediment (Increased Sediment Quantity)

    - Road management, reduction, and maintenance to restore sediment and LWD recruitment rates within riparian and upland areas. Contact USFS for additional information.

8. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout in Buttermilk and Little Bridge Creek.

Assessment Unit: Beaver Creek

Species: Steelhead, spring Chinook (rearing only), and bull trout.

Assessment Unit Description: Beaver Creek (RM 0 – 10)

Current fish use status: MaSA for steelhead, some juvenile rearing for spring Chinook and bull trout.

Secondary and tertiary sub-watersheds: Frazier, Lightning, Blue Buck, and South Fork Beaver creeks.

Factors Affecting Habitat Conditions:

- Roads, Residential development, and agriculture are affecting riparian and floodplain condition.
- High Road density in upper watersheds
- Low flows in late summer (and winter) may affect juvenile survival and passage,
- Although the vast majority of passage problems have been fixed in the anadromous portion of Beaver Creek, the effectiveness of the diversion structures is likely to degrade over time or in response to high flow events, causing a potential ongoing maintenance problem.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Channel Structure and Form (Bed and Channel Form)
3. Habitat Quantity (Anthropogenic Barriers)
4. Riparian Restoration (Riparian Condition)
5. Sediment (Increased Sediment Quantity)
6. Injury and Mortality (Mechanical Injury)
7. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- No reach assessment and habitat survey have not been completed on the lower privately owned areas.
- Extent and effect of interactions between bull trout and other native species with brook trout is not well understood.
- Bull trout use of Buck Creek is unknown.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

- Increase stream flow through irrigation practice improvements and water leases/purchases; contact Trout Unlimited for additional information.

2. Channel Structure and Form (Bed and Channel Form)

    - Address roads and dikes

3. Habitat Quantity (Anthropogenic Barriers)

    - Remove or modify instream diversion structures to maintain effective fish passage at the Beatty diversion.
    - Replace Stokes Ranch culvert (~ RM 3.0).

4. Riparian Condition (Riparian Condition)

    - Plant riparian vegetation to restore adequate riparian buffer
    - Increase LWD recruitment and retention
    - Livestock exclusion fencing in riparian areas HOW, WHERE?
    - Implement Respect the River Program (20 acres on USFS, 40 acres on WDFW)

5. Sediment (Increased Sediment Quantity)

    - Road management, reduction, and maintenance to restore sediment and LW recruitment rates within riparian and upland areas; in particular, around WDFW and USFS campgrounds.

6. Injury and Mortality (Mechanical Injury)

    - Replace or properly modify diversion screens to meet fish passage standards.

7. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout.

Assessment Unit: Gold Creek

Species: steelhead, bull trout.

Assessment Unit Description: Gold Creek (RM 0 – 5.5)

Current fish use status: MiSA for steelhead, spawning and rearing for bull trout.

Secondary and tertiary sub-watersheds: North Fork, South Fork, Crater, and Foggy Dew creeks.

Factors Affecting Habitat Conditions:

- Culverts, roads, and irrigation diversion structures impede salmonid passage.
- Roads on contribute to sedimentation and riparian degradation, and loss of floodplain and channel function.

Ecological Concerns and (subcategories) in priority order:

1. Channel Structure and Form (Bed and Channel Form)
2. Habitat Quantity (Anthropogenic Barriers)
3. Peripheral and Transitional Habitats (Floodplain Conditions)
4. Riparian Restoration (Riparian Conditions)
5. Sediment (Increased Sediment Quantity)
6. Water Quantity (Decreased Water Quantity)
7. Injury and Mortality (Mechanical injury)
8. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- Extent and effect of interactions with bull trout and other native species with brook trout is not well understood.
- An assessment of habitat and passage needs for bull trout is needed.

Ecological concerns and habitat action recommendations in priority order:

1. Channel Structure and Form (Bed and Channel Form)

    - Fix USFS roads and dikes in lower Gold Creek.

2. Habitat Quantity (Anthropogenic Barriers)

    - Correct fish barriers on USFS in Gold Creek and its tributaries.

3. Peripheral and Transitional Habitats (Floodplain Condition)

    - Fix USFS roads and dikes in lower Gold Creek

4. Riparian Condition (Riparian Condition)

5. Water Quantity (Decreased Water Quantity)

    - Increase stream flow through irrigation practice improvements and water leases/purchases.

6. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout

Assessment Unit: Libby Creek

Species: steelhead and bull trout.

Assessment Unit Description: Libby Creek (RM 0 – 7.4)

Current fish use status: MiSA for steelhead. Steelhead spawning has been documented in the lower four kilometers. Limited bull trout use likely.

Secondary and tertiary sub-watersheds: North Fork Libby Creek, South Fork Libby Creek

Factors Affecting Habitat Conditions:

- Roads and agricultural development contribute to sedimentation and riparian degradation, and loss of floodplain and channel function.
- Low instream flows in Libby Creek likely impact salmonid distribution and abundance (Inter-fluve 2012).

Ecological Concerns and (subcategories) in priority order:

1. Channel Structure and Form (Bed and Channel Form)
2. Riparian Condition (Riparian Condition)
3. Water Quantity (Decreased Water Quantity)
4. Species Interactions (Introduced Competitors and Predators)

Level of Certainty/Data gaps

- Recent assessment increase the confidence RTT has with recommendations below (Inter-fluve 2012)
- Extent and effect of interactions with brook trout is uncertain.
- Bull trout use unknown.

Ecological concerns and habitat action recommendations in priority order:

For detailed locations and potential actions, see (Inter-fluve 2012).

1. Channel Structure and Form (Bed and Channel Form)

    - Address USFS roads and dikes in lower Libby Creek.

2. Riparian Condition (Riparian Condition)

    - Plant riparian vegetation to restore adequate riparian buffer Increase LWD recruitment and retention.

- Livestock exclusion fencing.

3. Water Quantity (Reduced Water Quantity)

    - Increase stream flow through irrigation practice improvements and water leases/purchases.

4. Species Interactions (Introduced Competitors and Predators)

    - Reduce or eliminate brook trout.

Appendix E4. Okanogan River Basin Assessment and Strategy

Steelhead Population Structure

The Okanogan River steelhead population (Figure E7) is part of the UCR steelhead DPS. Important spawning and rearing areas occur sporadically throughout the basin. Pacific lamprey also are believed to inhabit the Okanogan Basin, but their distribution is uncertain.

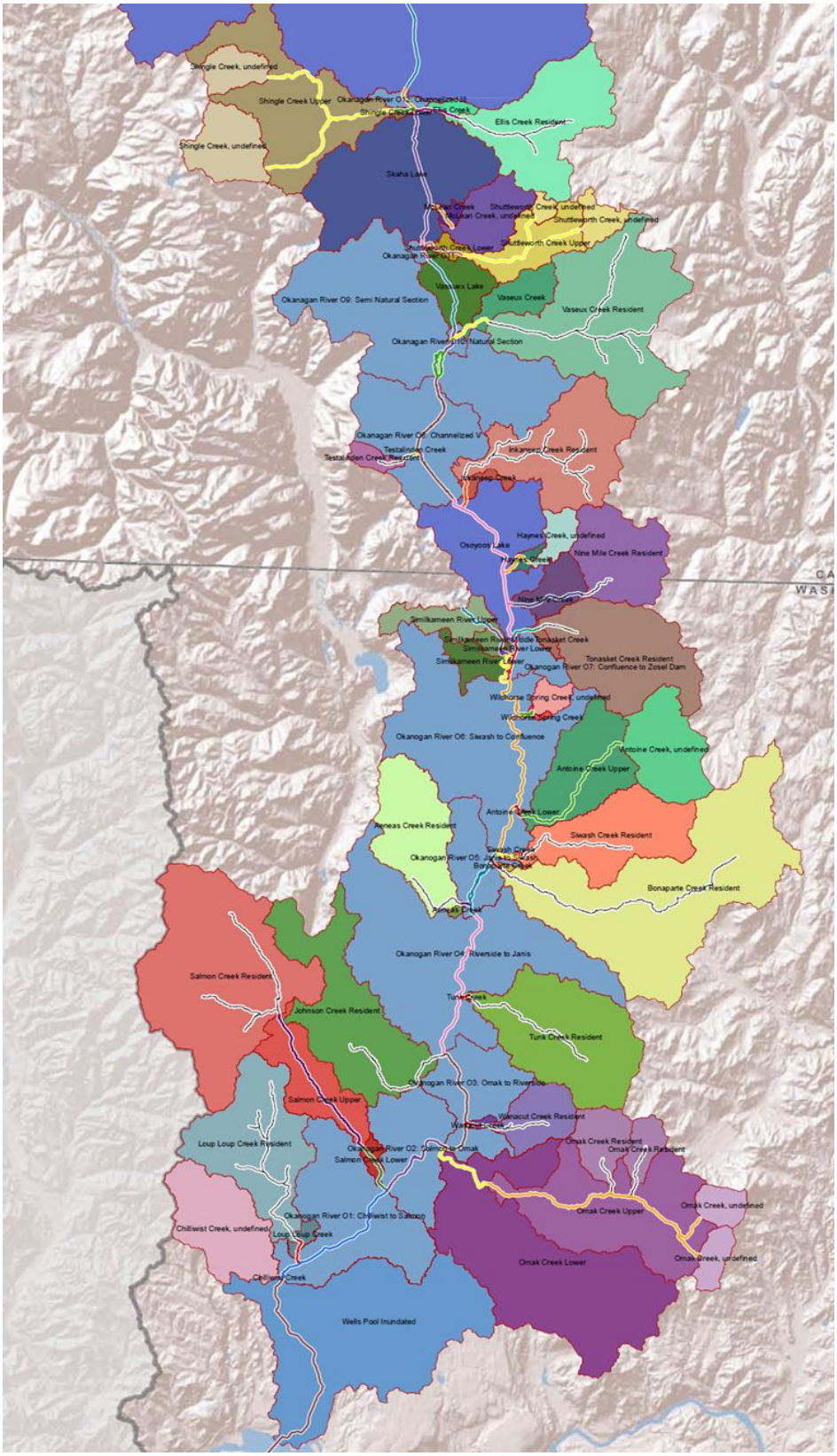

Figure E7. Okanogan River Subbasin Assessment Units.

Priority areas

Based on Table E1 above, the priorities for areas for restoration and protection actions are summarized in Table E7:

Table E7. Assessment unit priority for restoration and protection actions in the Okanogan River basin (note there is no distinction between some assessment units for protection priority).

Restoration		Protection	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Upper Salmon Creek	1	Lower Omak Creek	1
Loup Loup Creek	2	Upper Salmon Creek	1
Okanogan River 01	3	Okanogan River 07	2
Upper Omak Creek	4	Similkameen Middle	2
Okanogan River 04	5	Loup Loup Creek	2
Upper Antoine Creek	6	Nine Mile Creek	2
Lower Salmon Creek	7	Upper Omak Creek	2
Okanogan River 05	8	Okanogan River 05	2
Okanogan River 02	9	Okanogan River 02	3
Nine Mile Creek	10	Bonaparte Creek	3
Similkameen Lower	11	Lower Antoine Creek	3
Johnson Creek	12	Johnson Creek	3
Lower Antoine Creek	13	Tunk Creek	3
Okanogan River 03	14	Okanogan River 04	3
Similkameen Middle	15	Tonasket Creek	3
Lower Omak Creek	16	Upper Antoine Creek	3
Okanogan River 06	17	Lower Salmon Creek	3

Restoration		Protection	
Assessment Unit	**Priority**	**Assessment Unit**	**Priority**
Inundated Okanogan	18	Similkameen Lower	3
Okanogan River 07	19	Similkameen Upper	3
Bonaparte Creek	20	Okanogan River 03	4
Tunk Creek	21	Okanogan River 01	4
Aeneas Creek	22	Okanogan River 06	4
Chiliwist Creek	23	Inundated Okanogan	4
Similkameen Upper	24	Wild Horse Spring Creek	4
Siwash Creek	25	Aeneas Creek	4
Tonasket Creek	26	Chiliwist Creek	4
Wild Horse Spring Creek	27	Wanacut Creek	4
Wanacut Creek	28	Siwash Creek	4

In the following, a detailed summary and assessment of each assessment unit is provided for the Okanogan River Basin.

All mainstem assessment units

For the mainstem Okanogan River assessment units in the US portion of the basin, many of the ecological concerns and general action types are the same or very similar. In Table E8, the ecological concerns and action types are summarized instead of repeating them for each mainstem assessment unit. However, where unique actions are suggested, they remain within the specific assessment unit.

Table E8. Summary of US portion of mainstem Okanogan River assessment unit ecological concerns and action types.

Ecological Concern	Action Type
Water Quality (Temperature)	➢ Develop cold water refugia sites along main stem Okanogan River, ➢ Investigate options for reconnecting groundwater input, cold water tributaries, ➢ Alter upstream water management to reduce temperatures in Okanogan River. Other novel approaches to reduce water temp during summer months.

Ecological Concern	Action Type
Water Quantity (Altered Flow Timing)	➢ Expand Fish Water Management Tool to include other species (i.e. summer steelhead and Chinook) and expand the area to include river below Zosel Dam
Sediment Conditions (Increased Sediment Quantity)	➢ Minimize potential overland run-off (e.g., no till farming) ➢ Bioengineering for bank stabilization ➢ Increase streamside management zone (increase buffer widths) ➢ Protect or re-vegetate incised riverbanks where feasible
Channel Structure and Form (Bed and Channel Form)	➢ Reduce bank hardening and allow channel migration, where feasible.
Channel Structure and Form (Instream Structural Complexity)	➢ Add or increase retention of LW.
Food (Altered Prey Species Composition and Diversity)	➢ Actions for sediment reduction should apply to this EC too
Injury and Mortality (Predation)	➢ Reduce predator densities (e.g., predator reduction program, revise fishing regulations)
Injury and Mortality (Mechanical Injury)	➢ Bring irrigation intakes into compliance with NMFS criteria
Species Interaction (Competition)	➢ Continue to monitor the potential effects of the hatchery programs and modify management were feasible.
Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)	➢ Activate floodplain or relic channels where feasible

Assessment Unit: Wells Pool (inundated)

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From the confluence with the Columbia River to Chiliwist Creek (RM 0-15.1)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from upstream land management practices, inundation and lack of floodplain exchange.
- Hydrological influence from Wells reservoir
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Altered Flow Timing)
2. Sediment Conditions (Increased Sediment Quantity)
3. Water Quality (Temperature)
4. Injury and Mortality (Predation)
5. Channel Structure and Form (Bed and Channel Form)
6. Channel Structure and Form (Instream Structural Complexity)
7. Food (Altered Prey Species Composition and Diversity)
8. Injury and Mortality (Mechanical Injury)
9. Species Interaction (Competition)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

See Table E8. In addition:

1. Water Quantity (Altered Flow Timing)
    - Due to the influence of Wells Dam, no actions identified at this time.
2. Sediment Conditions (Increased Sediment Quantity)
    - Due to the influence of Wells Dam, no actions identified at this time.
3. Channel Structure and Form (Bed and Channel Form)
    - Due to the influence of Wells Dam, no actions identified at this time.
4. Channel Structure and Form (Instream Structural Complexity)
    - Due to the influence of Wells Dam, no actions identified at this time.
5. Food (Altered Prey Species Composition and Diversity)
    - Due to the influence of Wells Dam, no actions identified at this time.
6. Injury and Mortality (Predation)
7. Water Quality (Temperature)
8. Injury and Mortality (Mechanical Injury)
9. Species Interaction (Competition)

Assessment Unit: Okanogan River 01

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Chiliwist Creek to Salmon Creek (RM 15.1-25.75)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Chiliwist and Loup Loup Creek (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from upstream sources and land management practices and lack of floodplain interaction
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources
- Channel is artificially confined by levees and dykes to protect agricultural interests or property from flooding

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Water Quality (Temperature)
3. Channel Structure and Form (Bed and Channel Form)
4. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
5. Injury and Mortality (Predation)
6. Channel Structure and Form (Instream Structural Complexity)
7. Injury and Mortality (Mechanical Injury)
8. Food (altered Prey Species Composition and Diversity)
9. Species Interaction (Competition)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Water Quality (Temperature)
    - Create ground water feed off-channel habitats
3. Channel Structure and Form (Bed and Channel Form)
4. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
    - Reconnect side-channel at Conservancy Island
5. Injury and Mortality (Predation)
6. Channel Structure and Form (Instream Structural Complexity)
    - Install pilings to rack wood at heads of islands and mid-channel; bars
7. Injury and Mortality (Mechanical Injury)
    - Install pump screen
8. Food (Altered Prey Species Composition and Diversity)
9. Species Interaction (Competition)

Assessment Unit: Okanogan River 02

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Salmon Creek to Omak Creek (RM 25.72-31.5)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Salmon Creek (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from roads and lack of floodplain interaction
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources
- Channel is artificially confined by levees and dykes to protect agricultural interests or property from flooding.

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
3. Sediment Conditions (Increased Sediment Quantity)
4. Peripheral and Transitional Habitats (Floodplain Condition)
5. Channel Structure and Form (Bed and Channel Form)
6. Injury and Mortality (Predation)
7. Injury and Mortality (Mechanical Injury)
8. Channel Structure and Form (Instream Structural Complexity)
9. Food (Altered Prey Species Composition and Diversity)
10. Species Interaction (Competition)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quality (Temperature)
    - Create ground water feed off-channel habitats
2. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
3. Sediment Conditions (Increased Sediment Quantity)
4. Peripheral and Transitional Habitats (Floodplain Condition)
5. Channel Structure and Form (Bed and Channel Form)
6. Injury and Mortality (Predation)
7. Injury and Mortality (Mechanical Injury)
    - Install fish screens
8. Channel Structure and Form (Instream Structural Complexity)
    - Install pilings to rack wood at heads of islands and mid-channel; bars
9. Food (Altered Prey Species Composition and Diversity)
10. Species Interaction (Competition)

Assessment Unit: Okanogan River 03

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Omak Creek to Riverside (RM 31.5- 41.1)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Wanacut, Johnson, and Omak Creeks (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from roads
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources
- Channel is artificially confined by levees and dykes to protect agricultural interests or property from flooding.
- New hatchery acclimation release sites

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Water Quality (Temperature)
3. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
5. Species Interaction (Competition)
6. Channel Structure and Form (Bed and Channel Form)
7. Injury and Mortality (Predation)
8. Injury and Mortality (Mechanical Injury)
9. Food (Altered Prey Species Composition and Diversity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Sediment Conditions (Increased Sediment Quantity)

2. Water Quality (Temperature)
    - Create ground water feed off-channel habitats
3. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
    - Install pilings to rack wood at heads of islands, side channels and mid channel bars.
5. Species Interaction (Competition)
6. Channel Structure and Form (Bed and Channel Form)
7. Injury and Mortality (Predation)
8. Injury and Mortality (Mechanical Injury)
    - Install pump screens
9. Food (Altered Prey Species Composition and Diversity)

Assessment Unit: Okanogan River 04

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Riverside to Janis Bridge (RM 41.1 - 52.6)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Tunk Creek (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from roads
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources
- Artificially confined

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
3. Sediment Conditions (Increased Sediment Quantity)
4. Peripheral and Transitional Habitats (Floodplain Condition)
5. Injury and Mortality (Mechanical Injury)
6. Channel Structure and Form (Instream Structural Complexity)
7. Injury and Mortality (Predation)
8. Channel Structure and Form (Bed and Channel Form)
9. Species Interaction (Competition)
10. Food (Altered Prey Species Composition and Diversity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quality (Temperature)

    - Create ground water feed off-channel habitats

2. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)

    - Reconnect side Channel at Peterson.
    - Reconnect Wilson side channels

3. Sediment Conditions (Increased Sediment Quantity)

4. Peripheral and Transitional Habitats (Floodplain Condition)

5. Injury and Mortality (Mechanical Injury)

    - Install fish screens

6. Channel Structure and Form (Instream Structural Complexity)

    - Install piling to rack wood at heads of islands. Side channels, and mid-channel bars

7. Injury and Mortality (Predation)

8. Channel Structure and Form (Bed and Channel Form)

    - Purchase property where dykes exist to allow for future removal and reconnection of the historic floodplain

9. Species Interaction (Competition)

10. Food (Altered Prey Species Composition and Diversity)

Assessment Unit: Okanogan River 05

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Janis Bridge to Siwash Creek (RM 52.6 – 57.3)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Aeneas and Bonaparte creeks (see separate assessment unit summaries for both).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from roads
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Sediment Conditions (Increased Sediment Quantity)
3. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
5. Injury and Mortality (Predation)
6. Injury and Mortality (Mechanical Injury)
7. Channel Structure and Form (Bed and Channel Form)
8. Species Interaction (Competition)
9. Food (Altered Prey Species Composition and Diversity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quality (Temperature)
    - Create ground water feed off-channel habitats
2. Sediment Conditions (Increased Sediment Quantity)
3. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
4. Channel Structure and Form (Instream Structural Complexity)
    - Install pilings to rack wood at heads of islands, side channels, and mid-channel bars.
5. Injury and Mortality (Predation)
6. Injury and Mortality (Mechanical Injury)
    - Install fish screens
7. Channel Structure and Form (Bed and Channel Form)
    - Purchase property where dykes exist to allow for future removal and reconnection of the historic floodplain
8. Species Interaction (Competition)
9. Food (Altered Prey Species Composition and Diversity)

Assessment Unit: Okanogan River 06

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From Siwash Creek to confluence with Similkameen (RM 57.3-74.3)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Wildhorse spring Creek, Whitestone Creek, Siwash Creek, and Antonie Creek (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone primarily extensive livestock impacts
- Excess sediment from destabilized banks and roads
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Riparian Condition
3. Channel Structure and Form (Instream Structural Complexity)
4. Channel Structure and Form (Bed and Channel Form)
5. Water Quality (Temperature)
6. Peripheral and Transitional Habitats (Floodplain Condition)
7. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
8. Injury and Mortality (Predation)
9. Injury and Mortality (Mechanical Injury)
10. Species Interaction (Competition)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Sediment Conditions (Increased Sediment Quantity)

    - Stabilize banks
    - Increase floodplain interaction

2. Riparian Condition

    - Remove livestock
    - Re-slope banks but armor toe
    - Replant native vegetation

3. Channel Structure and Form (Instream Structural Complexity)

    - Install pilings to rack wood at heads of islands, side channels, and mid-channel bars

4. Channel Structure and Form (Bed and Channel Form)

    - Purchase property where dykes exist to allow for future removal and reconnection of the historic floodplain

5. Water Quality (Temperature)

    - Create ground water feed off-channel habitats

6. Peripheral and Transitional Habitats (Floodplain Condition)

7. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)

    - Reconnect relic side channels

8. Injury and Mortality (Predation)

9. Injury and Mortality (Mechanical Injury)

    - Install fish screens

10. Species Interaction (Competition)

Assessment Unit: Okanogan River 07

Species: Steelhead, summer Chinook salmon and sockeye.

Assessment Unit Description: From confluence with Similkameen to Zozel Dam (RM 74.3 - 78.9)

Current fish use status: Migration corridor for all species, possible rearing at certain times of the year. Summer Chinook and steelhead spawning.

Secondary and tertiary sub-watersheds: Ninemile Creek, Tonasket Creek, Similkameen River (see separate assessment unit summary).

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from roads
- Introduction of non-native competitors and predators
- Irrigation intake impingement or entrainment
- Increase solar input; impoundments in Canada, and reduction of cool water inputs from tributary sources
- Artificially confined by highway and rail roads
- Altered flows from water management in Canada
- Hatchery acclimation and stocking location

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Altered Flow Timing)
2. Water Quality (Temperature)
3. Peripheral and Transitional Habitats (Floodplain Condition)
4. Injury and Mortality (Predation)
5. Species Interaction (Competition)
6. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Land protection to protect high density spawning habitat
    - Purchase property along stream
2. Flow alteration
    - Expand fish water management tool to include summers Chinook and steelhead along with the OK river below Zosel Dam.
3. Water Quality (Temperature)
    - Pipe hypolimnion to lake outlet
4. Peripheral and Transitional Habitats (Floodplain Condition)
5. Injury and Mortality (Predation)
6. Species Interaction (Competition)
    - Relocate summer steelhead and Chinook stocking locations
7. Channel Structure and Form (Instream Structural Complexity)

Assessment Unit: Lower Similkameen River

Species: Steelhead, summer Chinook salmon and some sockeye.

Assessment Unit Description: From confluence with Okanogan River to Cross Channel (RM 0-3.7)
Current fish use status: Summer Chinook and steelhead spawning and rearing in all but warmest months.

Secondary and tertiary sub-watersheds: none.

Factors Affecting Habitat Conditions:

- Agricultural development within riparian zone
- Excess sediment from destabilized banks and roads
- Introduction of non-native competitors and predators
- Hatchery stocking and acclimation

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Sediment Conditions (Increased Sediment Quantity)
3. Injury and Mortality (Predation)
4. Species Interaction (Competition)
5. Injury and Mortality (Pathogens)
6. Riparian Condition
7. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

Please see Table E8.

1. Water Quality (Temperature)

    - Create groundwater feed off channel habitats

2. Sediment Conditions (Increased Sediment Quantity)

- Bank stability projects

3. Injury and Mortality (Predation)
4. Species Interaction (Competition)
    - Move hatchery release locations
5. Injury and Mortality (Pathogens)
    - Follow BMPs for Similkameen acclimation site
6. Channel Structure and Form (Instream Structural Complexity)
    - Install pilings at heads of islands, mid channel bars and side channels.

Assessment Unit: Middle Similkameen River

Species: Steelhead, summer Chinook salmon and some sockeye.

Assessment Unit Description: From Cross Channel to Canyon (RM 3.7-6.6)

Current fish use status: Summer Chinook and steelhead (and limited sockeye) spawning and rearing.

Secondary and tertiary sub-watersheds: none.

Factors Affecting Habitat Conditions:

- Development within riparian zone
- Excess sediment from roads
- Introduction of non-native competitors and predators
- Hatchery acclimation and stocking location
- Angler harassment and poaching

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Sediment Conditions (Increased Sediment Quantity)
3. Injury and Mortality (Predation)
4. Species Interaction (Competition)
5. Injury and Mortality (Pathogens)
6. Water Quality (Gas Saturation)
7. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)
8. Riparian Condition
9. Injury and Mortality (Harassment/Poaching)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Protection of productive spawning habitats

2. Water Quality (Temperature)

    - Create groundwater feed off-channel refugia

3. Sediment Conditions (Decreased Sediment Quantity)

    - Use gravel augmentation to restore lost natural recruitment due to Enloe Dam

4. Injury and Mortality (Predation)

5. Species Interaction (Competition)

    - Relocate stocking and acclimation activities

6. Injury and Mortality (Pathogens)

    - Probably related to either high densities of Chinook salmon spawners or releases of steelhead; implement BMPs for adult management and/or release of fish

7. Water Quality (Gas Saturation)

    - Investigate and determine if this EC warrants action.

8. Peripheral and Transitional Habitats (Side-channel and Wetland Conditions)

    - Reconnection of side channels on Klein property

9. Injury and Mortality (Harassment/Poaching)

    - Increase enforcement and outreach efforts

Assessment Unit: Upper Similkameen River

Species: Steelhead, summer Chinook salmon and some sockeye.

Assessment Unit Description: From Canyon to Enloe Dam (RM 6.6-8.9)

Current fish use status: Summer Chinook and steelhead (and limited sockeye) spawning.

Secondary and tertiary sub-watersheds: none.

Factors Affecting Habitat Conditions:

- Naturally confined bedrock canyon
- Recreational gold dredging
- Angling Harassment and poaching
- Gravel recruitment lost due to sink at Enloe Dam
- High TDG due to enloe spillway
- Hatchery stocking and acclimation

Ecological Concerns and (subcategories) in priority order:

1. Water Quality (Temperature)
2. Sediment Conditions (Increased Sediment Quantity)
3. Water Quality (Gas Saturation)
4. Injury and Mortality (Predation)
5. Species Interaction (Competition)
6. Injury and Mortality (Harassment/Poaching)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quality (Temperature)

2. Sediment Conditions (Decreased Sediment Quantity)

3. Water Quality (Gas Saturation)

- Investigate and determine if this EC warrants action.

4. Injury and Mortality (Predation)
5. Species Interaction (Competition)
    - Move stocking and acclimation sites
6. Injury and Mortality (Harassment/Poaching)
    - Increase enforcement and outreach efforts

Assessment Unit: Chiliwist Creek

Species: Steelhead

Assessment Unit Description: Chiliwist Creek from confluence with Okanogan River to (RM 0.3)

Current fish use status: Rearing area for steelhead juveniles.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

Will not be large enough benefit to get adults in; never was a large stream
Limited access due to private ownership

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Habitat Quantity (Natural and Anthropogenic Barrier)
3. Sediment Conditions (Increased Sediment Quantity)
4. Riparian Condition

Level of Certainty/Data gaps

Low – need additional information on private lands

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Determine if you can change source point of water withdrawal (to wells)

2. Habitat Quantity (Anthropogenic Barrier)

    - Barrier at mouth precludes access by most juvenile but appears to be a natural condition
    - 2-culverts represent potential passage barriers to juvenile fish attempting to move upstream

3. Sediment Conditions (Increased Sediment Quantity)

    - Riparian habitat is almost completely missing from lower 0.3 miles of stream on private property due to livestock.

4. Riparian Condition

   - Riparian habitat is almost completely missing from lower 0.3 miles of stream on private property due to livestock.

Assessment Unit: Loup Loup Creek

Species: Steelhead

Assessment Unit Description: Loup Loup Creek from confluence with the Okanogan River to Loup Loup Creek diversion (RM 0 – 1.4).

Current fish use status: MiSA for steelhead. Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Diversion during non-irrigation season (Oct.-April) reduces potential rearing
- Limited habitat complexity in lower 1 mile
- Riparian has been removed, affecting instream complexity
- Streambed is heavily armored from past water management practices in the lower 1 mile.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment condition (decreased sediment quality and quantity)
3. Channel Structure and Form (Instream Structural Complexity)
4. Riparian Condition

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Continue to work with irrigation user group to change POD to Okanogan River

2. Sediment Conditions (decreased Sediment Quantity and quality)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

3. Channel Structure and Form (Instream Structural Complexity)

- Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

4. Riparian Condition

    - Plant trees and protect from livestock to jump start riparian recolonization

Assessment Unit: Lower Salmon Creek

Species: Steelhead

Assessment Unit Description: Salmon Creek from confluence with Okanogan River to OID diversion (RM 0 – 4.5).

Current fish use status: Migration corridor for steelhead with limited steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None.

Factors Affecting Habitat Conditions:

- Historic water diversion
- Development within the riparian corridor
- Artificial confinement through town of Okanogan

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Water Quantity (Altered Flow Timing
3. Food (Altered Prey Species Competition and Diversity)
4. Channel Structure and Form (Bed and Channel Form)
5. Sediment Conditions (Decreased Sediment Quantity and Quality)
6. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Some has been addressed through collaboration with CCT
    - Develop better water management to include considerations for fish needs

2. Water Quantity (Altered Flow Timing)

- Develop better water management to include considerations for fish needs (year-round flow improvements would increase fish production (over winter survival and production in the lower three miles)

3. Food (Altered Prey Species Competition and Diversity)

4. Channel Structure and Form (Bed and Channel Form)

5. Sediment Conditions (Decreased Sediment Quantity)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

6. Channel Structure and Form (Instream Structural Complexity)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

Assessment Unit: Upper Salmon Creek

Species: Steelhead

Assessment Unit Description: Salmon Creek from OID to Conconully Dam (RM 4.5 -17.6)

Current fish use status: MaSA for steelhead. Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Reduced winter flow
- Non-native species present
- Bank instability (increases sediment)

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Water Quantity (Altered Flow Timing)
3. Sediment Conditions (Increased Sediment Quantity)
4. Channel Structure and Form (Instream Structural Complexity)
5. Channel Structure and Form (Bed and Channel Form)
6. Riparian Condition
7. Species Interactions (Competition)
8. Injury and Mortality (Harassment/Poaching)
9. Injury and Mortality (Predation)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Protect this high quality habitat

2. Water Quantity (Decreased Water Quantity)

    - Supplement winter flows through releases from Conconully Reservoir.

3. Water Quantity (Altered Flow Timing)

4. Sediment Conditions (Increased Sediment Quantity)

    - Address unstable banks

5. Channel Structure and Form (Instream Structural Complexity)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

6. Channel Structure and Form (Bed and Channel Form)

7. Species Interactions (Competition)

    - Reduce non-native competitors (EBT)
    - Reduce rainbow trout introductions into Lake Concunully
    - Instead of "rainbow trout," plant non-migrating steelhead instead into lake

Assessment Unit: Lower Omak Creek

Species: Steelhead

Assessment Unit Description: Omak Creek from the confluence with the Okanogan River to Mission Falls (RM 0 – 5.6)

Current fish use status: MaSA for steelhead. Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Most of the factors affecting this reach are from effects upstream
- Development along the creek
- Fish management activities

Ecological Concerns and (subcategories) in priority order:

1. Sediment Conditions (Increased Sediment Quantity)
2. Water Quantity (Decreased Water Quantity)
3. Water Quality (Temperature)
4. Injury and Mortality (Harassment/Poaching)

Level of Certainty/Data gaps

- Omak Creek Watershed assessment (1995)
- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

Please see actions from upper Omak AU.

1. Protect this high quality habitat

2. Sediment Conditions (Increased Sediment Quantity)

3. Water Quantity (Decreased Water Quantity)

- Supplement flows from ground water during winter months

4. Water Quality (Temperature)

    - Supplement flows from ground water sources during summer months.

5. Injury and Mortality (Harassment/Poaching)

    - Increased enforcement
    - Reduce trap avoidance

Assessment Unit: Upper Omak Creek

Species: Steelhead

Assessment Unit Description: Upstream of Mission Falls (RM 5.6 -26.6)

Current fish use status: Currently not accessible to anadromous fish at such time as passage is restored at Mission Falls this area would represent an MaSA for steelhead with both spawning and rearing.

Secondary and tertiary sub-watersheds: Stapaloop, Swimptkin, Trail creeks

Factors Affecting Habitat Conditions:

- High percent fine sediment
- Railroad construction enhanced natural barrier (Mission Falls)
- Other culverts under HWY 155 represent barriers to additional habitat
- Introduction of non-native species
- Floodplain disconnected (Desautel Community)

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Anthropogenic Barrier)
2. Sediment Conditions (Increased Sediment Quantity)
3. Channel Structure and Form (Instream Structural Complexity)
4. Species Interactions (Competition)

Level of Certainty/Data gaps

- Omak Creek Watershed assessment (1995)
- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Habitat Quantity (Anthropogenic Barrier)

    - Remove debris at Mission Falls
    - Install instream structures to create step pool sequence
    - Replace HWY 155 culvert at Stapaloop Creek

2. Sediment Conditions (Increased Sediment Quantity)

    - Removing and replace undersize culverts (plugged, and then overtopped and loss of road fill)
    - Decommission roads
    - BMPs for livestock management (e.g., hard crossing, exclusions, etc.)

3. Channel Structure and Form (Instream Structural Complexity)

    a. LW structures

4. Species Interactions (Competition)

    - Remove EBT

Assessment Unit: Wanacut Creek

Species: Steelhead

Assessment Unit Description: Wanacut Creek from the confluence with the Okanogan River to RM 1.3.

Current fish use status: Steelhead rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Limited flow
- Anthropogenic instream complexity

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment Conditions (Increased Sediment Quantity)
3. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Increase use of ground water
    - Replace split culvert under eastside river road

2. Sediment Conditions (Increased Sediment Quantity)

    - BMP for livestock management (e.g., exclusion)
    - Purchase key properties and manage for sediment reduction

3. Channel Structure and Form (Instream Structural Complexity)

   - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

Assessment Unit: Johnson Creek

Species: Steelhead

Assessment Unit Description: Johnson Creek from the confluence with the Okanogan River (RM 0 – 7.5)

Current fish use status: Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Several anthropogenic barriers between Ok River and HWY 97
- Multiple water users withdrawal straight from creek
- High sediment loads and lack of good gravels
- High natural confinement due to steep gradient in lower 1 mile

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Habitat Quantity (Anthropogenic Barrier)
3. Sediment Conditions (Increased Sediment Quantity)
4. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

Only discovered steelhead spawning in 2012 but lots of potential needs to be assessed

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Evaluate water use within watershed, particularly surface withdrawals and consider alternative water sources

2. Habitat Quantity (Anthropogenic Barrier)

    - Replace culverts with bottomless, or bridges

3. Sediment Conditions (Increased Sediment Quantity)

    - BMPs for livestock
    - Develop sediment traps

4. Channel Structure and Form (Instream Structural Complexity)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

Assessment Unit: Tunk Creek

Species: Steelhead

Assessment Unit Description: Tunk Creek from confluence with Okanogan River to Tunk Falls (RM 0 – 0.75)

Current fish use status: Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Dewatered reach, possibly due to groundwater withdrawal

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment Conditions (Increased Sediment Quantity)
3. Peripheral and Transitional Habitats (Floodplain Condition)
4. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)
    - Change location of well (in progress)
2. Sediment Conditions (Increased Sediment Quantity)
    - Reduce road densities in upper drainage
    - Assess and prioritize all culverts in the watershed
3. Peripheral and Transitional Habitats (Floodplain Condition)
    - Improve floodplain connectivity

4. Channel Structure and Form (Instream Structural Complexity)

    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

Assessment Unit: Aeneas Creek

Species: Steelhead

Assessment Unit Description: Aeneas Creek from the confluence with the Okanogan River to RM 0.75 (falls)

Current fish use status: Cutthroat, potential steelhead rearing

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Access; remnant beaver dams, perched culvert
- Artificially confined and straightened

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Anthropogenic Barrier)
2. Sediment Conditions (Decreased Sediment Quantity)
3. Riparian Condition
4. Food (Altered Prey Species Competition and Diversity)

Level of Certainty/Data gaps

- Unclear why fish are not using this stream (have done pen test with fish and they survived)
- General observations

Ecological concerns and habitat action recommendations in priority order:

Actions are uncertain at this time until it can be determined why fish are not using stream.

1. Habitat Quantity (Anthropogenic Barrier)

    - 15-17 barriers exist between mouth and HWY 7 (mostly old log jams or beaver dams enforced with calcium carbonate)
    - Perched culvert at HWY 7 is complete passage barrier

2. Sediment Conditions (Decreased Sediment Quantity)

    - Gravel augmentation

3. Riparian Condition

4. Food (Altered Prey Species Competition and Diversity)

Assessment Unit: Bonaparte Creek

Species: Steelhead

Assessment Unit Description: Bonaparte Creek from the confluence with the Okanogan River to falls (RM 0- 0.99).

Current fish use status: Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds:

Factors Affecting Habitat Conditions:

- Natural waterfall about 1 mile from Okanogan River
- Over-allocated water withdrawals
- High percent of fine sediment
- Artificially confined due to roads and development in town of Tonasket.

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment Conditions (Increased Sediment Quantity)
3. Riparian Condition
4. Peripheral and Transitional Habitats (Floodplain Condition)
5. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Change POD to Okanogan River where feasible
    - Change irrigation practices

2. Sediment Conditions (Increased Sediment Quantity)

    - Retard sediment transport from highway
    - Stabilize fill-slope vegetation

3. Riparian Condition

4. Peripheral and Transitional Habitats (Floodplain Condition)

5. Channel Structure and Form (Instream Structural Complexity)
    - Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

Assessment Unit: Siwash Creek

Species: Steelhead

Assessment Unit Description: Siwash Creek from the confluence with the Okanogan River to RM 1.8.

Current fish use status: None currently, Steelhead rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Over-allocation of water

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment Conditions (Increased Sediment Quantity)
3. Riparian Condition
4. Habitat Quantity (Barriers)
5. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

CCT hired consulting firm to investigate hydrology and found irrigation efficiencies could be improved.

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)
    - Conduct assessment to see if year round flows are possible
    - If year round flow is feasible, Change water delivery system
    - If year round flow is feasible, Change POD to groundwater
    - Purchase sufficient water rights to make year round flows feasible.
2. Sediment Conditions (Increased Sediment Quantity)
    - Only implement actions after year round flows are reestablished
3. Riparian Condition
4. Habitat Quantity (Barriers)
    - Provide passage to all habitat containing year round flows

- Install instream structure to facilitate fish passage over approximately six foot rock chute

5. Channel Structure and Form (Instream Structural Complexity)

    - Address complexity only after year round flows are restored

Assessment Unit: Lower Antoine Creek

Species: Steelhead

Assessment Unit Description: Antoine Creek from confluence with the Okanogan River to Rock Chute (RM 0 - 0.89)

Current fish use status: Steelhead rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Most of the factors affecting this reach are from effects upstream.
- Highly embedded substrate from past water management
- Large delta at mouth
- Artificially confined and straightened

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Channel Structure and Form (Instream Structural Complexity)
3. Sediment Conditions (Decreased Sediment Quantity)
4. Channel Structure and Form (Bed and Channel Form)
5. Riparian Condition
6. Barrier at mouth (only accessible when Okanogan River above 5,000CFS)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

See actions described in Upper Antoine Creek AU.

1. Water Quantity (Decreased Water Quantity)
    - Add water in spring (April) from reservoir to avoid uncontrolled spill in June
2. Channel Structure and Form (Instream Structural Complexity

- Install instream structures to create pool habitat, modify velocity in localized reaches, develop down-welling sites, and potentially recruit spawning-sized gravel.

3. Sediment Conditions (Decreased Sediment Quantity)

    - Restore flushing flows to restart natural gravel recruitment

4. Channel Structure and Form (Bed and Channel Form)

5. Riparian Condition

6. Remove barriers

Assessment Unit: Upper Antoine Creek

Species: Steelhead

Assessment Unit Description: Antoine Creek from the Rock Chute to Fancher Dam (RM0.89 - 11.9)

Current fish use status: Once access to habitat is possible Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Old concrete diversion (water)
- Small reservoir for irrigation

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Anthropogenic Barrier)
2. Water Quantity (Decreased Water Quantity)

Level of Certainty/Data gaps

Very low - needs to be assessed

Ecological concerns and habitat action recommendations in priority order:

1. Habitat Quantity (Anthropogenic Barrier)

    - Modify irrigation diversion (in progress)
    - Conduct watershed assessment

2. Water Quantity (Decreased Water Quantity)

    - Buy land and restore natural processes (breach dam)
    - Purchase 600-1000 acre feet of water right from reservoir, and release for adult access to stream
    - Purchase some of land and some of water

Assessment Unit: Wild Horse Spring Creek

Species: Steelhead

Assessment Unit Description: Wild Horse Spring Creek from the confluence with the Okanogan River to barrier (RM 0 – 0.68)

Current fish use status: This stream has been functioning as sink. Steelhead are attracted to this stream in the spring with several spawning annually but by mid-summer most of the juveniles are dead due to lack of perennial flows. A barrier to adult fish or operation of an adult trap for hatchery activities should be considered.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Natural low flow
- Banks have been trampled by livestock and development
- Natural pool habitat is limiting

Ecological Concerns and (subcategories) in priority order:

1. Habitat Quantity (Anthropogenic Barrier)
2. Sediment Conditions (Increased Sediment Quantity)
3. Water Quantity (Decreased Water Quantity)

Level of Certainty/Data gaps

- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

Because natural water flow is so low, it does not make sense to address other ECs.

1. Habitat Quantity (Anthropogenic Barrier)
    - Install barrier or trap to keep adults from spawning in this habitat.
2. Sediment Conditions (Increased Sediment Quantity)
    - Restrict livestock access to creek

3. Water Quantity (Decreased Water Quantity)

Assessment Unit: Tonasket Creek

Species: Steelhead

Assessment Unit Description: Tonasket Creek from the confluence with the Okanogan River to Tonasket Falls (RM 0 – 2.17)

Current fish use status: Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Subsurface flow (natural) near confluence with Okanogan River
- Upstream of this reach is a "perennial" reach where conditions are good for spawning and rearing
- Artificially confined and straightened

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Sediment Conditions (Increased Sediment Quantity)
3. Peripheral and Transitional Habitats (Floodplain Connection)
4. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- CCT hired consulting firm to investigate hydrology to establish a perennial connection with the Okanogan River, and it is not feasible

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Studies have shown that there is insufficient water to provide year round flow once discharge reaches the floodplain (Reference the study??). Therefore, pursuing increases in water quantity do not make sense at this time.
    - There may not be enough water to obtain to reduce effect of subsurface flow

2. Sediment Conditions (Increased Sediment Quantity)Retard sediment transport from highway

    - Stabilize fill-slope vegetation

3. Peripheral and Transitional Habitats (Floodplain Connection)

4. Channel Structure and Form (Instream Structural Complexity)

Assessment Unit: Nine Mile Creek

Species: Steelhead

Assessment Unit Description: Nine Mile Creek from the confluence with the Okanogan River to falls (RM 0 – 5.22)

Current fish use status: Steelhead spawning and rearing.

Secondary and tertiary sub-watersheds: None

Factors Affecting Habitat Conditions:

- Intermittent section between second culvert and cottonwood gallery. Headwaters are in Canada, where there are 4 small reservoirs; none of these reservoirs are licensed and will most likely be deconstructed, which should increase water quantity
- Culverts
- Bank instability
- Lower 1 mile of this stream has been diked and straightened

Ecological Concerns and (subcategories) in priority order:

1. Water Quantity (Decreased Water Quantity)
2. Habitat Quantity (Anthropogenic Barrier)
3. Sediment Conditions (Increased Sediment Quantity)
4. Peripheral and Transitional Habitats (Floodplain Connection)
5. Channel Structure and Form (Bed and Channel Form)
6. Channel Structure and Form (Instream Structural Complexity)

Level of Certainty/Data gaps

- Okanogan watershed quality management plan (1998); sediment yield,
- Okanogan Subbasin Plan (2004)
- Upper Columbia Salmon Recovery Plan 2008
- General observations (e.g., predators, water temperature)
- OBMEP

Ecological concerns and habitat action recommendations in priority order:

1. Water Quantity (Decreased Water Quantity)

    - Current project to change POD to groundwater
    - Remove upper watershed reservoirs (go get-em' Mounties!)

2. Habitat Quantity (Anthropogenic Barrier)
    - Replace culverts with bottomless, or bridges
3. Sediment Conditions (Increased Sediment Quantity)
    - BMPs for livestock
4. Peripheral and Transitional Habitats (Floodplain Connection)
5. Channel Structure and Form (Bed and Channel Form)
6. Channel Structure and Form (Instream Structural Complexity)

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Appendix F. Data Gap Identification and Prioritization

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X	X	X			Inadequate steelhead monitoring in the Wenatchee, Entiat, Methow, and Okanogan to evaluate VSP parameters. Steelhead data needed includes sex ratio, origin, and age so that VSP parameters can be monitored at the population scale.		X		S&T	Appendix P Review	**1**	PIT tag detection arrays are now well developed in the Wenatchee, Entiat, Methow and Okanogan basin. However, arrays are prone to gaps in data due to flows, maintenance etc. Data and reports are becoming available (CPUD, DCPUD, and BPA). However comparisons of results to previous methods of estimating productivity have not yet occurred. Additional questions relating spatial distribution, in particular the extent that steelhead use small streams previously overlooked may still be in question.
X					Determine relative performance (survival and productivity) and reproductive success of hatchery and naturally produced fish in the wild.	X	X		Research	UCSRP	**1**	Wenatchee River spring Chinook RRS study is nearing completion, the last year of brood (adult) sampling will occur 2013 with sampling of progeny (juvenile and adult) through 2017 or 2018. Annual progress reports are currently available but a comprehensive report will not be available until the completion of the study (2018). The Wenatchee steelhead RRS study is expected to be completed in 2014, while the Twisp River multi-generation steelhead RRS study is ongoing and expected to be completed until 2025. While the RTT does not expect that RRS studies must be completed for every population/hatchery program the transferability of results should consider differing hatchery management strategies.
X	X	X	X	X	Currently no plans for analysis of genetic data for naturally produced spring Chinook in the Entiat River.	X			S&T	New	**1**	Collection of genetic samples is ongoing. The USFWS is currently seeking funding for analysis of samples.

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
	X				Determine the effects of exotic species and predatory native species on (recovery of) salmon and trout and the feasibility to eradicate or control their numbers	X	X	X	Research	UCSRP	**1**	No new activity/information; Data Gap 110 was combined with this data gap. DG110 was moved to 'not rated' and removed from the ranking.
		X			A reference condition for genetic variation for steelhead and spring Chinook is needed so that we can determine what the goal is and how to track progress	X	X		S&T	Appendix P Review	**1**	*No new activity/information*
X					Estimate precision and accuracy of redd counts wherever these counts are used to estimate spawning escapement.	X	X		S&T	RPA workgroup	**1**	Observer efficiency studies for estimating the precision of redd counts is ongoing in the Wenatchee and Methow river basins for both spring Chinook and Steelhead (WDFW). Revised spawning ground survey protocols and along with new spawning escapement estimates will be forthcoming after the conclusion of the studies. The Wenatchee steelhead observer efficiency study concludes this year (2012). The Methow steelhead observer efficiency study will continue through 2014. Similarly spring Chinook observer efficiency studies will continue through 2014.
			X		Assess the genetic and/or demographic contribution of resident redband rainbow trout to UCR anadromous steelhead		X		S&T Research	New	**1**	*No new activity/information*

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
		X			Assess the occurrence of resident bull trout populations and their interactions with migrant (fluvial and ad-fluvial) populations			X	S&T	UCSRP	1	Radio telemetry work is nearing completion. PIT tag data is also currently providing information and work is ongoing. Results are expected through the PIT tagging program. Current work focuses on migratory fish, better understanding of where resident fish occur and how they are included with the fluvial and ad-fluvial component is needed.
			X		Determine the effects of brook trout and bull trout interactions			X	Research	UCSRP	1	*No new activity/information*
X	X	X	X	X	The adult passage conditions at the boulder field near Snow Creek are not certain. The recovery plan assumed that steelhead and bull trout could get past the boulder field but spring Chinook could not.		X	X	S&T	Revised Biological Strategy	1	The Icicle Creek Boulder Field Passage Analysis is currently underway. TU/USFWS is assessing the hydrology of the boulder field and will provide a fish passage analysis. USFWS has a proposal to assess passage using PIT tag arrays.
X	X	X	X	X	Mechanistic link between habitat creation, restoration and fish use and productivity is unknown.	X	X	X	Effectiveness	UCSRP & Revised Biological Strategy	1	Work remains in progress in the Methow 'IMW' and in the Entiat (ISEMP IMW). Comprehensive results are still forthcoming.
X	X	X	X	X	Spring Chinook and steelhead redd surveys and spawning escapement expansion estimates are invalidated. Need to validate number of fish per redd and redds per female.	X	X		S&T	Appendix P Review	1	Data and methodologies for estimating spring Chinook spawner escapement based on redd counts is published and peer reviewed in the NAJFM (Murdoch et al., 2010. estimating the spawning escapement of hatchery and natural origin spring Chinook salmon using redd counts and carcass data. NAJFM 30:2, 361-375). Similarly reports have also been peer reviewed and published on the number or redds constructed per female spring Chinook (Murdoch et al. 2009. The number of redds constructed per female spring Chinook salmon in the Wenatchee

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
												River Basin. NAJFM 29:2, 441-446) . This may no longer be a data gap for spring Chinook. New methodology for to estimate steelhead spawning escapement is forthcoming (WDFW) and will likely include both a PIT tag based estimate and redd based estimates.
X					Assess if hatchery programs increase the incidence of predation on naturally produced fish	X	X	X	Research	UCSRP	**1**	A comprehensive NTTOC modeling effort (using PCD-Risk and a Delphi approach) as part of the M&E programs for the DCPUD, CCPUD, and GCPUD HCP Hatchery Compensation Programs is currently underway. This is a regional effort with involvement from YN, USFWS, and WDFW. This modeling approach considers direct predation by hatchery fish but may not include increased indirect predation as a result of a hatchery program. USFWS and NOAA are currently investigating mechanisms of residualism WNFH steelhead in the Methow. Currently the Chief Joseph Hatchery Programs are not considered.

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X					Assess if hatchery programs increase the incidence of disease on naturally produced fish	X	X	X	Research	UCSRP	1	A comprehensive NTTOC modeling effort (using PCD-Risk and a Delphi approach) as part of the M&E programs for the DCPUD, CCPUD, and GCPUD HCP Hatchery Compensation Programs is currently underway. This is a regional effort with involvement from YN, USFWS, and WDFW .This modeling approach considers disease transmission however there are no current plans to directly measure rates of disease transmission from hatchery to wild fish. Funding is needed to implement an exisiting research proposal from PNW Research Station/USFS to address this. The USFWS wild fish surveys are currently measuring the frequency of disease in natural populations in Icicle Creek, Entiat River, and the Methow River.
X					A reference condition for the phenotypic variation metric for both steelhead and spring Chinook is needed	X	X		S&T	Appendix P Review	1	Phenotypic data collection is ongoing but the information gap (goal or target conditions) still exists.
		X			Assess the interactions between hatchery and naturally produced fish: a) Competition and behavioral anomalies	X	X	X	Research	UCSRP &Regional Objective in HCP Hatchery M&E Plans	1	In progress, modeling and dephi approach to assess cumulative effects of multiple hatchery programs on NTTOC, uncertain field data/studies will be proposed at end of the modeling excessive.
			X		Understand the need and magnitude of adding nutrients as part of an ESU wide plan to determine where, how, and how much nutrient supplementation is required	X	X	X	Research	Revised Biological Strategy	1	CCFEG is currently implementing a water quality /nutrient evaluation in the Wenatchee basin. YN nutrient studies in the Twisp River are ongoing. DFO Salmon in Regional Ecosystems Program group continues research nutrient 'flux' in ecosystems and its influence on the sustainability of salmon populations.

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
			X		Examine migratory characteristics and reproductive success of bull trout Define population level productivity for bull trout (assume core-population are at the sub-basin level).			X	S&T	UCSRP	**2**	Radio-telemetry studies are nearly complete and data from PIT tagging efforts is ongoing. No new activity/information regarding life history specific productivity/survival or reproductive success. Reproductive success is not a priority concern because there is no artificial production but productivity of bull trout is an important data gap. Rated for lack of knowledge regarding bull trout productivity
	X				Study the effectiveness of actions to reduce water temperature.		X		Effectiveness	New	**2**	The Methow Basin Water quality and restoration program has both riparian and water quality monitoring to assess the effectiveness of riparian plantings on water temperatures. Due to TMDLs for water temperatures this data gap was expanded from the Okanogan to include the Wenatchee and Methow. This data gap includes data gap 107 (moved to not a data gap). Additional modeling and assessment may be necessary in the Okanogan due the extent of the temperatures and upstream sources.
X	X	X	X	X	Examine the feasibility and effectiveness of steelhead kelt reconditioning		X		Research and Effectiveness	UCSRP	**2**	Kelt reconditioning and evaluation of efficacy (including a RRS study) is ongoing in Omak Creek. YN is in the early phases of implementing a reconditioning program in the Methow basin. Within the Methow basin, opportunities exist to answer critical uncertainties regarding kelt reconditioning due to the existing instream PIT arrays and ongoing steelhead RRS study in the Twisp River.
			X		Examine water balance and surface/groundwater relations	X	X	X	Research	UCSRP & BS	**2**	*No new activity/information*

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X	X	X	X	X	Assess the effectiveness and feasibility of using fish transfers and artificial propagation in bull trout recovery			X	Research	UCSRP	2	*No new activity/information*
X	X	X	X	X	Some uncertainty exists on relation of instream flows and fish habitat	X	X	X	Effectiveness	Revised Biological Strategy	2	*The Chewuch is now a pilot basin for NWFW flow accounting framework.*
			X		Some uncertainty exists on relation of instream flows and fish habitat	X	X	X	Effectiveness	Revised Biological Strategy	2	*No new activity/information*
X	X	X	X	X	Increase understanding of estuarine ecology of Upper Columbia stocks	X	X		Research	UCSRP	2	Estuarine data collection is ongoing. However it is unlikely that the results will be stock specific.
X	X	X	X	X	Increase genetic research to identify genotypic variations in habitat use	X	X	X	Research	UCSRP	2	Entiat IMW may inpart address this gap. Genetic variation within the river is being evaluated. USFWS is analyzing genetic samples.
		X			Extent of straying between populations for natural origin fish.	X	X		S&T	New	2	Knowledge of stray rates for natural populations will help managers develop appropriate targets or limits for hatchery programs, and to better understand the connectivity between populations. Would also apply to summer Chinook and sockeye.
X					Harvest status and trend monitoring in the upper Columbia is not funded; limited information from the lower Columbia	X	X	X	Effectiveness	Appendix P Review	2	Harvest data for bull trout in the Lost River remains a data gap.
X					Assess the interactions between hatchery and naturally produced fish: c) predation	X	X	X	Research	UCSRP &Regional Objective in HCP Hatchery M&E Plans	2	A comprehensive NTTOC modeling effort (using PCD-Risk and a Delphi approach) as part M&E programs hatchery compensation programs associated with DCPUD, CCPUD, and GCPUD is currently underway. This modeling approach considers direct predation by hatchery fish but no empirical studies are currently

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
												planned.
X	X	X	X	X	Level and effect of poaching in the upper Columbia is unknown.	X	X	X	Effectiveness	Appendix P Review	**2**	Poaching rates continue to be an issue. Enforcement rates may be inconsistent. Counts of citations are available but not expandable. Needs to be addressed for all species. This is a problem Columbia River Basin wide.
X					Describe genetic makeup of bull trout in the Upper Columbia Basin			X	Research	UCSRP	**2**	Samples have been analyzed and the USFWS now has a working genetic baseline. Sample size in small and collection to augment baseline is ongoing.
	X				Study the effects of climate change on the water temperature of the Okanogan, Methow, Entiat, and Wenatchee Rivers and ways to mitigate for increased water temps	X	X	X	Research	New	**2**	USGS recently initiated a climate change modeling exercise for the Methow Basin - a decision support model that directly models flow and could be adapted to include temperature. Effects of climate change on water temp and its impact on both anadromous and resident salmon in the Canadian Okanagan is an active topic of research under the sponsorship of both federal and provincial government initiatives. DFO has a new multiyear (2012-2016) program of climate change research in which Okanagan work will be featured.
X	X	X	X	X	Trophic status of the lake needs to be determined for both current and historic.	X	X	X	Research	Revised Biological Strategy	**3**	Water Quality Engineers completed a water quality study in Lake Wenatchee however it did not include multiple trophic levels. CRITFC is currently funding seasonal acoustic surveys for pelagic fish biomass, zooplankton, phytoplankton, and water chemistry. Under this funding, the DFO, ONA, and the Yakama Nation are looking at seasonal to

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
												annual variations water clarity, temperature, nutrients, zooplankton and pelagic fish production in Lake Wenatchee over the next few years. Survey and analytical methods are identical to similar work underway in Skaha and Osoyoos Lake providing a three-lake comparison of current factors limiting production. Historic conditions are unknown - Paleocore analysis is recommended to gain insight on how the lake may have changed through time.
X	X	X	X	X	Extent of irrigation water withdrawal on instream flows and temperatures is not known	X	X	X	Research	Revised Biological Strategy	**3**	*No new activity/information*
X	X	X	X	X	Determine population characteristics of Little Wenatchee bull trout (spawn distribution, spawner abundance etc)			x	S&T	New	**3**	No information/work underway
X	X	X	X	X	Uncertainty on the status of Ingalls Creek Bull Trout			X	S&T	Revised Biological Strategy	**3**	Knowledge of bull trout use in Ingalls Creek and Peshastin Creek is minimal. Radio telemetry and PIT tags provide some migration information (Peshastin Creek and Etienne Creek) but juvenile use is not well known.
X	X	X	X	X	Not all steelhead minor spawning areas are index areas. Small tributaries between the Wenatchee and Crab Creek are not currently included in the ISEMP sampling universe. Other populations may have areas in need of sampling as well.		X		S&T	Appendix P Review	**3**	*No new activity/information*

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X	X	X	X	X	Investigate physical and chemical effects of highway maintenance to the riparian zone, water quality and juvenile salmonids	X	X	X	Research	Revised Biological Strategy	**3**	This remains a data gap. Toxicology studies for affects of de-icer on fish are unknown and the effects of the de-icer on the riparian vegetation remain of concern, not only in Tumwater Canyon but anywhere de-icer is used along the riparian Corridor.
X	X	X	X	X	Effects of irrigation water withdrawal on stream flows are not fully understood	X	X	X	Research	Revised Biological Strategy	**3**	*No new activity/information*
		X			Test assumptions and sensitivity of EDT model runs	X	X		Research	UCSRP	**3**	Status unchanged. - Ongoing under Entiat IMW and Methow Reach based effectives - some data being collected but time is needed before results can be produced.
		X			Assess the presence of bull trout in Lake Chelan an Okanogan sub basin and upstream of Entiat Falls in the Entiat sub basin			X	S&T	UCSRP	**3**	A historical perspective on bull trout in Lake Chelan was reported by the USFWS (Nelson 2012). Limited sampling upstream of Entiat Falls has occurred however a probability of occurrence sampling is still needed. Year-round video monitoring on the fish ladders at Zosel Dam and season video sites on Salmon Creek, Ninemile Creek and Antoine Creek may provide some additional information in the Okanogan.
X	X	X	X	X	Develop better methods to estimate harvest of naturally produced fish and indirect harvest mortalities in freshwater and ocean fisheries	X	X	X	S&T	UCSRP	**3**	Intent is to estimate harvest on natural origin fish (spring Chinook and steelhead) in the ocean, current estimates are inferred from harvest on hatchery fish. May need to increase samples sizes (tagged) for natural origin fish.
X	X	X	X	X	Extent of redd superimposition by hatchery summer Chinook on spring Chinook	X			Research	New	**3**	This data gap is of particular concern in the Entiat where ENFH has transitioned to a summer chinook program. Research in the Entiat is ongoing but may be an issue in other basins. If this were limited to just the Entiat we may have rated it higher for use of information.

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X	X	X	X	X	Assess sediment inflows to develop a sediment budget for this portion of the sub basin		X		Research	Revised Biological Strategy	**3**	No new activity/ information.
X	X	X	X	X	Increase understanding of linkages between physical and biological processes so mangers can predict changes in survival and productivity in response to selected recovery actions	X	X	X	Effectiveness	UCSRP	**3**	Status unchanged. - Ongoing under Entiat IMW and Methow 'IMW' - some data being collected but time is needed before results can be produced.
			X		Summer steelhead and summer/fall spawning distribution uncertainties need to be addressed.		X		S&T	Revised Biological Strategy	**3**	*No new activity/information*
X	X	X	X	X	Assess the effects of hydroelectric operations on juvenile and subadult bull trout survival.			X	Research	UCSRP	**3**	Sample size remain an issue however additional PIT tagged bull trout will provide some information on hydrosystem movement.
X	X	X	X	X	Status of bull trout in the upper Entiat is not well understood			X	S&T	Revised Biological Strategy	**3**	Knowledge of bull trout distribution has increased through telemetry and PIT tags but early life history use of upper Entiat remains unknown.
X	X	X	X	X	No water quality parameter are currently documented and no infrastructure exists		X		Effectiveness	Revised Biological Strategy	**3**	Water Quality data has been collected since eth beginning of OBMEP in 2005 but water quantity data is lacking. CCT is working to install a real-time USGS gauge in October 2012 as under a BPA/USGS cost-share.
X	X	X	X	X	Assess sediment inflows to develop a sediment budget for this portion of the sub basin		X		Research	Revised Biological Strategy	**4**	*No new activity/information*
X	X	X	X	X	Effect of surface water and groundwater withdrawal on the dewatered reach is not fully understood.	X	X	X	Research	Revised Biological Strategy	**4**	*No new activity/information*

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
X					Cumulative effects of current gold mining in tributaries on sediment delivery, water quality, and channel conditions are not fully understood	X	X	X	Research	Revised Biological Strategy	4	No new activity /information however it is now a requirement that the USFS consult on any mining activities that occur in streams with ESA listed species.
X	X	X	X	X	Impacts from unscreened water diversions is not known. An inventory and assessment are needed	X	X	X	S&T	Revised Biological Strategy	4	*No new activity/information*
X	X	X	X	X	Cumulative effects of past timber harvest in tributaries on sediment delivery and water quality are not fully understood but are of concern	X	X	X	Research	Revised Biological Strategy	4	*No new activity/information*
X	X	X	X	X	Evaluate if passage through hydroelectric projects affects reproductive success of listed fish species	X	X	X	Research	UCSRP	4	*No new activity/information*
X	X	X	X	X	Determine the interactions of shad on Upper Columbia stocks in the lower Columbia River	X	X		Research	UCSRP	4	*No new activity/information*
X	X	X	X	X	TDG levels are unknown but believed to be higher than established standards		X		Effectiveness	Revised Biological Strategy	4	*No new activity/information*
X	X	X	X	X	Contribution of tributaries and main stem bank erosion to sediment levels in the main stem Methow River is not understood	X	X	X	Research	Revised Biological Strategy	4	2012 is the second year of McNeil Core sediment monitoring in the Methow.
X	X	X	X	X	Knowledge about habitat and fish use above Rkm 1.3 on Nine Mile Creek remains a data gap		X		Effectiveness	Revised Biological Strategy	4	Seasonal video at nine-mile creek may provide some information regarding steelhead use upstream of Rkm 1.3.

Basin Where Gap Occurs [a]					Description	Species Affected [b]			Cat. of RME [c]	Where Gap Was Identified (Source)	Tier	MaDMC Notes (August 2012)
W	E	M	O	MC		SCS	SH	BT				
	X				extent of the effect of private and public roads on stream channel function and sediment delivery is not known	X	X	X	Research	Revised Biological Strategy	4	*No new activity/information*
X	X	X	X	X	Habitat in the lower main stem Methow River and lower reaches of its tributaries has not been surveyed. Some recommendations are based on professional judgment.	X	X	X	Research	Revised Biological Strategy	4	Data gap 82 (now moved to 'not rated) is really a subset of this one (83). No new activity/information
X	X	X	X	X	Extent of riparian cover and channel shape on anchor ice formation is not known	X	X	X	Effectiveness	Revised Biological Strategy	4	The Reach Assessment addresses conditions in which anchor ice forms but is not so specific as to address channel form and riparian vegetation effects on anchor ice.