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

A Report to the Upper Columbia Salmon Recovery Board from the Upper Columbia Regional Technical Team.

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Past members of the RTT contributed substantially to this and previous drafts of the RTT Biological Strategy. Former members include Bob Bugert, Jerry Marco, Brian Cates, Ken MacDonald, Shane Bickford, John Monahan, Rick Woodsmith, and Joe Foster.

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Introduction

The Upper Columbia Salmon Recovery Board (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 at-risk species through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia Region. To meet its mission, the UCSRB wishes to ensure that actions to protect and restore salmonid habitat in the region are based on sound scientific principles.

The UCSRB requested that a Regional Technical Team (RTT) be formed to accomplish the following functions: 1) recommend region-wide approaches to protect and restore salmonid habitat, 2) develop and evaluate salmonid recovery projects within the Upper Columbia Region as appropriate, and 3) develop and guide salmonid recovery monitoring plans as appropriate. The RTT may adopt other functions if members consider it appropriate, as described in the RTT General Product Review Policy (RTT 2007).

An important function of the RTT is to review the technical merits of projects to be submitted by project sponsors in the Upper Columbia Region for funding by the Washington State Salmon Recovery Funding Board (or other funding sources). The RTT has established and revised a scientific foundation for this process, with the premise that it will allow for the identification of projects that will best contribute to the recovery of salmonids listed under the Endangered Species Act (ESA).

Purpose and Scope

This document outlines a 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), which includes actions for bull trout and other habitat restoration activities. This document should serve as a technical foundation to set regional priorities for habitat protection and restoration, based on available information and the professional judgment of fisheries biologists familiar with the region. This report is an update to initial documents provided to the UCSRB (RTT 2000, 2002a, 2003). The RTT has revised the previous draft (RTT 2003) to accomplish four objectives:

1) Address the Viable Salmonid Population (VSP) characteristics consistent with the Recovery Plan and technical guidance from the Interior Columbia Technical Recovery Team (ICTRT).
2) Update the technical appendices with new information regarding restoration strategies and priorities.
3) Provide revised technical scoring criteria for habitat restoration, protection and assessment projects submitted for funding through various sources.
4) Update the critical uncertainties section.

In the future, updates may be provided as new information becomes available. Recommendations contained herein may be used by decision-makers to more effectively allocate resources to

contribute to the recovery of salmonids listed under the federal Endangered Species Act (ESA) and other species of concern. This strategy identifies the key biological considerations in protecting and restoring habitat, yet does not provide recommendations on the means to accomplish these issues. Project sponsors are encouraged to use this strategy to identify the locations and types of projects that would provide a high likelihood of biological benefit to native salmonids by improving abundance, productivity, spatial structure, or diversity.

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

The Upper Columbia Region (Figure 1) is comprised of the mainstem Columbia River and its tributaries upstream of Rock Island Dam to the tailrace of Chief Joseph Dam. Within this region there are seven Water Resource Inventory Areas (WRIAs): Moses Coulee (44), Wenatchee (45), Entiat (46), Chelan (47), Methow (48), Okanogan (49), and Foster Creek (50), and the northernmost tip of Alkali-Squilchuck (40). These WRIAs are referred to as "subbasins" in this document, and are composed of "watersheds" (Hydraulic Unit Code 5). This Upper Columbia Region description is consistent with the Evolutionarily Significant Unit (ESU) boundary for the extant major population group (MPG) for spring Chinook, 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) that is excluded from the Upper Columbia Region as it is currently defined (ICTRT 2007)(Table 1). For technical and biological purposes, this report will consider actions and recommendations for areas and watersheds downstream of Rock Island Dam. However, we realize that there are political and jurisdictional issues regarding implementation of actions outside the Upper Columbia Region that are not the purview of the UCSRB.

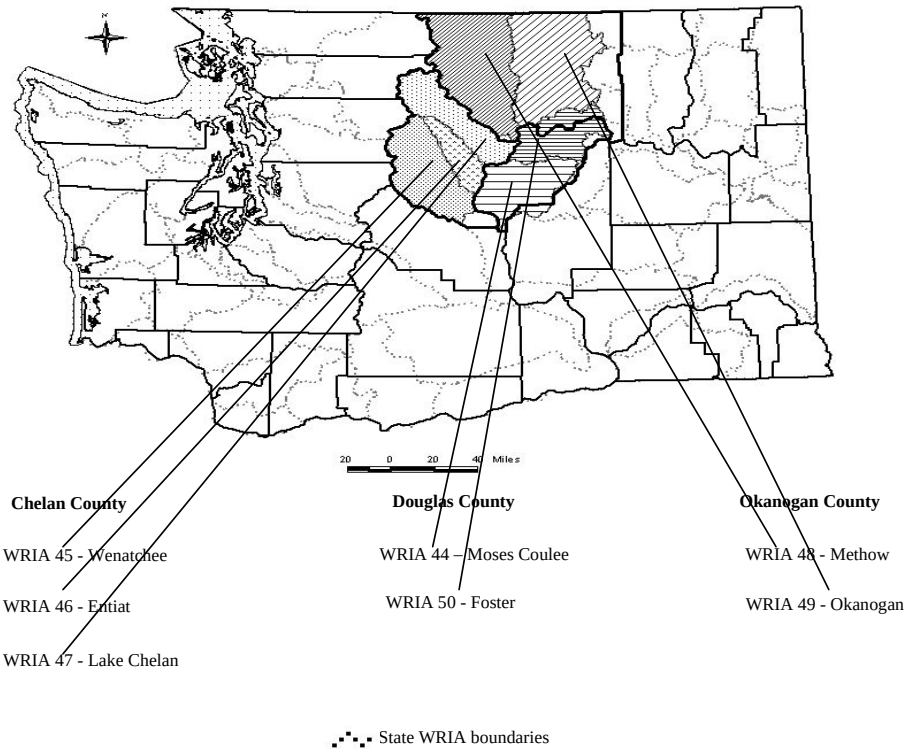

Figure 1. Map of Washington State with locations of the Water Resource Inventory Areas within the Upper Columbia region.

Table 1. Hierarchical organization for the Upper Columbia spring Chinook ESU and steelhead DPS. Status was determined in the Recovery Plan based on Viable Salmonid Population guidelines from the ICTRT. Major (MaSA) and minor (MiSA) spawning areas were determined by the ICTRT using a model of intrinsic potential habitat (ICTRT 2007). See Figure 2 for general overview of ESU/DPS hierarchy.

ESU / DPS	Major Population Group	Independent Population	Status	Population Size Category	MaSA (MiSA)
Upper Columbia Steelhead DPS	East Cascades	Wenatchee	High Risk	Intermediate	7 (8)
		Entiat	High Risk	Basic	1 (1)
		Methow	High Risk	Intermediate	5 (5)
		Okanogan	High Risk	Basic	2 (6)
		Crab Creek	Unknown	Basic	?
	Spokane River	Not defined	Extinct	Not defined	Not defined
	Kettle/Colville/Sanpoil	Not defined	Extinct	Not defined	Not defined
Upper Columbia Spring Chinook ESU	East Cascades	Wenatchee	High Risk	Very Large	5 (4)
		Entiat	High Risk	Basic	1 (0)
		Methow	High Risk	Very Large	4 (1)
		Okanogan	Extinct	Basic	?
	Spokane River	Not defined	Extinct	Not defined	Not defined
	Kettle/Colville/Sanpoil	Not defined	Extinct	Not defined	Not defined

[a] Appendix A contains major and minor spawning area maps for spring Chinook and steelhead and Significant Subwatershed maps for sockeye salmon, summer Chinook salmon, bull trout, and cutthroat.

Scientific Foundation

Threatened, endangered and unlisted salmonids are found in most, but not all watersheds in the Upper Columbia Region. Originally, the RTT biological strategy (RTT 2003) adapted the work of MacDonald et al. (1996), who identified Significant Subwatersheds (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 recent Viable Salmonid Population (VSP) criteria for listed species and adopted by the Recovery Plan (McElhany et al. 2000; UCSRB 2006; ICTRT 2007). It is the goal of the RTT to incorporate both concepts into this strategy because viability criteria have not been defined for all species of concern.

Significant Subwatershed Framework

Based on the framework established by MacDonald et al. (1996), the RTT considered a subwatershed to be significant if any one of the following criteria were met:

1. The subwatershed was identified as a stronghold for the species in the Interior Columbia Basin Assessment (ICBEMP 1997).
2. The subwatershed provides the primary spawning and/or rearing habitat within the watershed.
3. The subwatershed represents the only known occupied habitat within a watershed and is fairly isolated from populations in other watersheds, and thus is significant from a distribution standpoint.
4. The subwatershed contributes toward the genetic integrity of a species. One of the problems facing many native fish populations is genetic introgression. Relatively pure populations, which may be very important to the evolutionary legacy of a species, may be limited. Recently genetic information has become available for some populations in the Upper Columbia Region. Populations judged to be "pure," "essentially pure," or "good" based upon genetic analysis were considered to be significant.
5. The subwatershed is known or strongly suspected to support a stable, strong population of a species.

The application of these criteria resulted in identification of watersheds that do not necessarily fit 5th level HUC designations.

Viable Salmonid Population Framework

The Recovery Plan adopted the Viable Salmonid Population (VSP) concept proposed by McElhany et al. (2000) and the ICTRT (2007) and the following is a brief overview of the main concepts from those documents. Achieving VSP for listed species is the overriding objective for the implementation of this biological strategy for the habitat; although the RTT recognizes that population viability is not likely to be achieved without sufficient survival outside the tributary habitats. There are several levels of hierarchy in the viable salmonid population concept. The first and basic level is the ESU/DPS) at which listing and delisting occurs under the ESA. In order to determine if an ESU was viable the ICTRT followed the population level viability guidelines provided in McElhany et al. (2000). Therefore, the extinction risk of the ESU/DPS is determined based on the status of its component populations. Additionally, groups of independent populations share genetic, geographic (hydrographic), and habitat characteristics

within an ESU and these groups were designated as major population groupings (MPGs) (ICTRT 2005) (Figure 2). The MPG represents an additional level in the hierarchy between the population and ESU (ICTRT 2007). The VSP principles provided a basis for assessing long-term extinction risk for independent populations based on four parameters: abundance, productivity, spatial structure and diversity. The ICTRT then developed specific and measurable criteria for each of the four VSP parameters that described the characteristics of a population that would be at relatively low risk of extinction. In order to quantify several of the metrics associated with spatial structure the ICTRT developed the concept of major (MaSA) and minor (MiSA) spawning areas. These subunits within a population were generally consistent with subwatersheds but often grouped subwatersheds together depending on the configuration and quantity of moderate to high rated intrinsic potential habitat.

VSP guidance suggests evaluation of extinction risk for abundance and productivity together using a viability curve (McElhany et al. 2000; ICTRT 2007). This method does not set a single target for each parameter. Rather, it establishes that there are combinations of abundance and productivity that yield similar extinction risks. The ICTRT established the following objective for abundance and productivity:

> "*Intrinsic productivity and natural origin abundance should be high enough that 1) declines to critically low levels would be unlikely assuming recent historical patterns of environmental variability; 2) compensatory processes provide resilience to the effects of short term perturbations; and 3) subpopulation structure is maintained (e.g., multiple spawning tributaries, spawning patches, life history patterns).*"

ESU/DPS specific viability curves were generated and "viability" was defined as an extinction risk less than 5% over a 100-year timeframe (ICTRT 2007). Additional minimum abundance thresholds were established to ensure genetic integrity (particularly for small sized populations) and sufficient demographics and sub-population structure (particularly for large populations).

The ICTRT also combined spatial structure and diversity parameters based on their interdependence, but established two main goals for that these parameters were striving to achieve:

> "*Goals are the biological or ecological objectives that spatial structure and diversity criteria are intended to achieve. We have identified two primary goals:*
>
> 1. *Maintaining natural rates and levels of spatially-mediated processes. This goal serves to minimize the likelihood that populations will be lost due to local catastrophe, to maintain natural rates of recolonization within the population and between populations, and to maintain other population functions that depend on the spatial arrangement of the population.*
> 2. *Maintaining natural patterns of variation. This goal serves to ensure that populations can withstand environmental variation in the short and long terms.*"

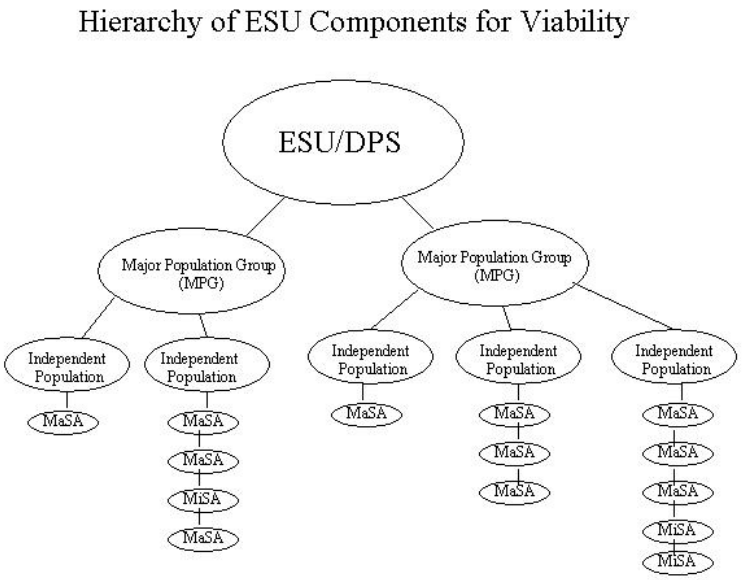

Figure 2. Overview diagram of the hierarchy for the components of ESU/DPS viability.

To achieve these goals, several measurable metrics were established that evaluated:

1) The number and spatial arrangement of MaSAs
2) Genetic and phenotypic variation and the persistence of major life history strategies
3) Spawner composition (source and magnitude of hatchery fish on the spawning grounds)
4) Distribution across diverse geographic areas (based on ecoregions within each population boundary)
5) Selectivity of anthropogenic activities

The RTT biological strategy strives to provide guidance on the habitat actions that are expected to contribute to improved status for the VSP parameters. Species response to those actions may be limited by factors other than habitat conditions. For example, increasing spawning gravels or quality pools for adult holding represent actions that would theoretically increase abundance. Likewise, improving the quality and quantity of summer and winter rearing habitat should increase productivity by improving egg to smolt survival. However, those benefits may not be realized (or measurable) if survival outside the tributaries decreases during the same time period. Additionally, spawner composition comprised of high proportions of hatchery fish on the spawning grounds has been identified as a high risk factor for diversity throughout the Upper Columbia (SRP 2006). Improvements to the habitat will not directly effect spawner composition so that metric will have to be addressed in other venues.

Understanding Ecological Processes

Many restoration projects fail because natural processes operating at different spatial and temporal scales and how human activities affect these processes are not well understood or considered. Implementation of successful restoration projects requires an understanding of these natural processes and the factors that control them (Frissell and Nawa 1992; Roni et al. 2002). Because these factors and processes operate at different spatial and temporal scales, restoration ecologists need to view the river holistically as a continuous "riverscape" (Fausch et al. 2002). The idea 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 the long term.

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 controls (Leopold et al. 1992; Montgomery and Bolton 2003). These factors operate over large areas, are stable over 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. These factors include processes such as stream flows, temperature, sediment input, and channel migration. Factors operating at both the geographic and watershed scales help to define flow

(water and sediment) characteristics, which in turn help 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 processes that form suitable habitat conditions at the habitat/reach scale (Opperman et al. 2005)(Figure 3). 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. Likewise, 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 different spatial and temporal scales, most habitat-enhancement techniques tend to be relatively short lived if the underlying process that has been disrupted is not corrected (Fausch et al. 2002).

In summary, successful restoration requires a holistic approach that considers processes operating at different spatial and temporal scales. A watershed or ecosystem assessment of current and historical conditions and disrupted processes is necessary to identify restoration opportunities that are consistent with reestablishing the natural processes and functions that create habitat (Roni et al. 2002). It is also essential to determine what restoration actions to implement first 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.

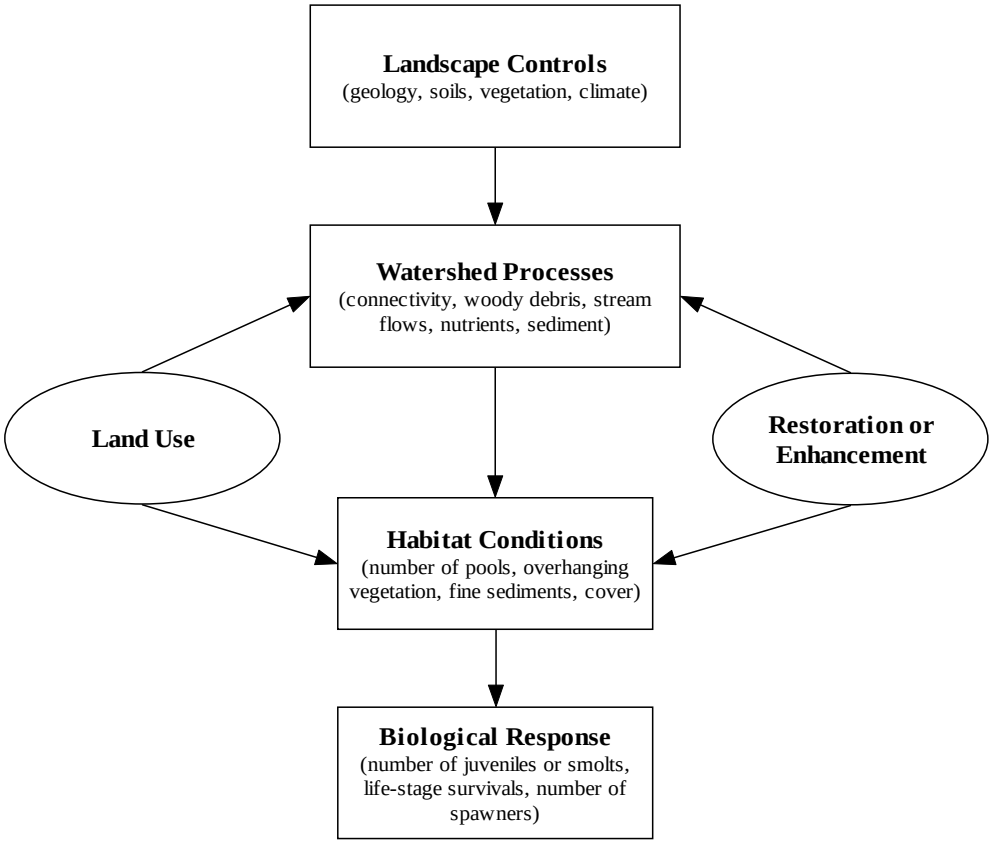

Figure 3. Simple model showing linkages between landscape controls and watershed processes, and how land use and restoration or enhancement can influence habitat and biota (modified from Roni 2005).

Priorities in Habitat Activities

Habitat Protection Overview

The highest priority for protecting biological productivity should be to allow unrestricted stream channel migration, complexity, and flood plain function. The principal means to meet this objective is to protect riparian habitat in Category 1 and 2 subwatersheds (see descriptions below). Predetermined riparian protection measures (i.e., buffer strip widths) for each site may not be biologically effective. Riparian function depends on site-specific considerations including channel type, floodplain character, presence of wetlands or off-channel features, and the potential for channel migration. Obviously, some areas have more acute needs, because they may be within significant spawning or rearing areas, or may be at risk to future habitat degradation.

Protection of existing stream flows in virtually all subbasins in the Upper Columbia Region is important to maintaining biological productivity. Currently, the primary means to protect existing flows are regulatory in nature. Additionally, some Upper Columbia streams need increased flows to address chronic sources of mortality to salmonids; inadequate flows may be natural or human-caused. 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 Upper Columbia subbasins; this strongly reduces the productivity and expression of diverse life histories in the region. The means to increase flows are discussed in the section on habitat restoration.

Habitat Restoration Overview

The highest priority for increasing biological productivity is to restore the complexity of the stream channel and floodplain. The RTT recommends a range of strategies for habitat restoration in the Upper Columbia Region, based on a fundamental emphasis of promoting 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. List of needed habitat restoration strategies for various locations in the Upper Columbia recovery region.

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

The RTT recommends that structural manipulation of the stream channel (such as boulder or log placements) not be used unless; (1) they are designed at the reach level or context, (2) those factors that are causing the habitat degradation cannot be corrected, and (3) the area is critical for achieving a viable population. Actions that rectify the effects of improper land use practices can have more benefits to biological productivity in the long run, may be economically more efficient, and be more permanent than measures that mechanically alter the stream channel. Attempts to restore habitat are likely to fail if structures are placed in the stream channel without addressing those activities that are causing habitat degradation.

In some isolated situations, restoration projects may be accomplished with both short-term and long-term objectives. For example, LWD may be secured to stabilize erosive banks, allowing interim stream bank protection and salmonid habitat, while passive restoration and revegetation will ensure proper functioning riparian conditions for the long term. The RTT recognizes these projects are biologically effective when the initiation of the short-term strategy has been integrated with the long-term strategy. Each active restoration project should be reviewed on a case-by-case basis.

Priorities Across Varied Landscapes

The consensus of the RTT is that protection and restoration should focus first on maintaining the best remaining examples of biological integrity, connectivity, and diversity. This strategy will contribute to the improvement in abundance, productivity, spatial structure, and diversity over the long term. Improvements to abundance and productivity are needed for all populations in the ESU (SRP 2006). Additionally, genetic diversity of steelhead and spring Chinook needs to be improved to achieve viability. Spatial structure requirements are generally being met; however, significant improvements can still be made for specific populations (SRP 2006). The RTT also recognizes that there can be an interaction between VSP parameters such that low abundance might cause a population to not meet spatial structure requirements (e.g. suitable but unoccupied habitat). Likewise, degraded genetic diversity and loss of local adaptation might decrease productivity and therefore hinder a population's ability to take advantage of habitat improvements.

To provide a framework to set priorities consistent with this strategy, the RTT classified each watershed (HUC-5 level) in the Upper Columbia Region into categories, based on the functionality of the aquatic ecosystems in those watersheds, and the capability of the ecosystem to protect against ecological catastrophe for endemic populations. The RTT also designated the mainstem Columbia River as a separate category (Category 5) because of its unique features. The RTT adapted the classification system used by Quigley and Arbelbide (1997) for this report. In general, Category 1 watersheds should receive priority allocation of financial and management resources. Subsequent allocation of resources should be given to Categories 2 and 3, in that order, once refuge habitats (Category 1) for the target species are protected and secure. This does not mean that specific actions should not occur in Category 2 and 3 watersheds until all activities in Category 1 watersheds are completed. Any project within those watersheds that increase the range, life history diversity, or age cohorts of one or more species should contribute to the overall strategy of making them more robust to disturbances within and outside the region. As salmon recovery progresses, founder populations from core areas would colonize many

watersheds that are suitable, yet unoccupied. Restoration of Category 4 watersheds should be considered in the regional recovery planning process, but immediate actions there would not be a priority.

Category 1: (*Protection/Restoration*)
These watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems (Table 3). In general, they comprise large, often continuous blocks of high-quality habitat and subwatersheds supporting multiple fish populations. Connectivity among subwatersheds and through the mainstem river corridor is good, and two or more species of federally listed fish are known to occur. Exotic species may be present but are not dominant. Protecting the functioning ecosystems in these watersheds is a priority although restoration in some areas is also needed.

Category 2: (*Restoration/Protection*)
These watersheds support important aquatic resources, and are strongholds for one or more listed fish species (Appendix A). Compared to Category 1 watersheds, Category 2 watersheds have a higher level of fragmentation resulting from habitat disturbance or loss (Table 3). These watersheds have a substantial number of subwatersheds where native populations have been lost or are at risk for a variety of reasons. Connectivity among subwatersheds may still exist or could be restored within the watershed so that it is possible to maintain or rehabilitate life history patterns and dispersal. Restoring and protecting ecosystem functions and connectivity within these watersheds are priorities.

Category 3: *(Restoration)*
These areas may still contain subwatersheds that support salmonids but they have experienced substantial degradation and are strongly fragmented by habitat loss, most notably through loss of connectivity with historically occupied habitat. The priority for funding in these watersheds should be to rectify the primary factor that is causing the habitat degradation.

Category 4: (*Major restoration or minor fish use*)
These watersheds contain both functional and non-functional habitats that historically supported one or more federally listed species (Table 3). Exotic species may now be dominant in one or more subwatersheds; native species are typically not present in sustainable numbers. The priority for funding in these watersheds should be to rectify the primary factor that is causing the habitat degradation or other limiting factors.

Category 5:
The Upper Columbia River is a migration and movement corridor for anadromous and inland species, and has documented spawning, rearing, and overwinter habitat for several species (Table 3). Hydroelectric dams primarily affect habitat quality and use in the mainstem, but shoreline management also influences salmonid habitat use. Protection of shoreline areas should be a priority. Restoration should be considered, if it can be shown to cause sustainable and reasonable improvements to productivity of salmonids in the Upper Columbia Region.

Table 3. Comparison of key indicators for watershed categories used to identify priority actions for protection and restoration of salmonid habitat in the Upper Columbia Region. The mainstem Columbia River is a separate category, and is treated separately in this analysis.

Category	Significant subwatersheds	Principle actions	Habitat fragmentation	Exotic species	Listed species
1	Yes	Protection	Low	Low	Two or more
2	Yes	Protection/ Restoration	Medium	Medium	One or more
3	Possible	Restoration	High	High	Possible
4	No	Restoration	High	High	Possible
5	No	Restoration	Low	High	Two or more

Objectives by Subbasin and Watershed

The following narratives for each subbasin (HUC-4) provide objectives for protection and restoration of habitats that are designed to remedy limiting factors for corresponding independent populations, as identified in Appendix G (Habitat Matrices) of the Recovery Plan (UCSRB 2006). The tables in Appendix C provide greater detail; i.e. they outline the status of each watershed (HUC-5), classify them by the above categories, identify Significant Subwatersheds (HUC-6) and major spawning areas, and recommend prioritized actions for habitat protection and restoration. These prioritized actions are based on "Possible Actions" from the Implementation Schedule (Appendix I in the Recovery Plan) that were assessed for biological benefit by applying the RTT Project Rating Criteria (Appendix D).

The Wenatchee Subbasin *(WRIA 45)*

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, yet is facing the greatest risk of habitat loss and degradation. State highways, railroads, and housing development have substantially diminished the overall function of the stream channel and floodplain. This has impaired stream complexity, wood and gravel recruitment, floodwater retention, late summer flows, and water quality.

The highest priority within the Wenatchee Subbasin should be the protection of habitat that supports salmonid communities so that the populations are robust to environmental disturbances, can increase in abundance, and expand their range to adjacent watersheds. Priority (Category 1) watersheds within the Wenatchee Subbasin include the White River, Chiwawa River, and the upper and middle mainstem Wenatchee River (including Lake Wenatchee, Table 2). Additional priorities are to increase the functionality of Category 2 watersheds such as Nason, Peshastin, and Icicle Creeks, and the Lower Wenatchee River. In the Wenatchee, these watersheds have the highest potential to increase abundance and productivity through restoration efforts.

The Entiat Subbasin *(WRIA 46)*

The Entiat River has been affected by upland management activities throughout the subbasin and construction of flood control dikes in the lower mainstem. Upland erosion is a chronic problem in the Entiat Watershed. Reduced stream channel complexity is the primary limitation to productivity of salmonids on the lower 20-km of the mainstem Entiat River (downstream of the terminal moraine; Category 2). Stream sinuosity is low, with very few point bars for gravel accumulation. Instream habitat diversity is also low, with few pools, glides, pocket waters or LWD accumulations. As a result, there are few resting and rearing areas for both adult and juvenile salmon in the lower mainstem Entiat River. Efforts to improve stream sinuosity and channel forming processes in the lower reach should be continued.

Based on the Entiat Watershed Plan (2004) and the Recovery Plan, the most feasible means to restore habitat in the lower Entiat River is with structure placement as an immediate

improvement, and floodplain restoration as the long-term solution. This short term/long term approach is the most pragmatic restoration practice available for the lower Entiat River. Initially, managers should actively enhance the lower Entiat River by increasing stream habitat complexity and encouraging thalweg development and deposition of spawning gravels. The long-term approach should be to restore riparian and floodplain habitat in the lower Entiat River. Such measures would also be feasible in the lower Mad River (a Category 2 subwatershed). The lower Entiat River is one of the few areas in the Upper Columbia Region where active manipulation of the stream channel is appropriate, and should only be done with a strategy in place to restore floodplain function on a permanent basis.

The most pressing needs on the lower Entiat River are to enhance the lack of instream complexity and riparian cover, yet there are other factors that adversely affect salmonids. Instream flows have also been identified as a limiting factor for salmonid production in the lower Entiat River (Recovery Plan, Appendix G). This is due to the natural characteristics of the watershed, upland slope condition, irrigation water withdrawals, and stream channel modifications in the lower Entiat River. Projects that increase late summer flows in the lower Entiat River should be a subbasin priority.

The Methow Subbasin *(WRIA 48)*

The Methow River has a high proportion of pristine habitat in the upper portions of major tributaries that should be protected. The middle and lower mainstem and lower portions of major tributaries 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 geologic conditions) but is exacerbated by irrigation withdrawals.

The highest priority within the Methow Subbasin should be the protection of habitat that supports the salmonid communities so that the populations are robust to environmental disturbances, can increase in abundance, and expand their range to adjacent watersheds. Priority (Category 1&2) watersheds for protection actions within the Methow Subbasin are the Lost, Twisp, Chewuch, Upper and Middle Methow Rivers, and Early Winters Creek. Additional priorities are to increase the functionality of Category 2 watersheds such as the Twisp, Chewuch, and Mainstem Methow Rivers, including important subwatersheds such as Wolf, Gold, Libby, and Beaver creeks. In the Methow, these watersheds offer the highest potential to increase abundance and productivity through restoration efforts.

The Okanogan Subbasin *(WRIA 49)*

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 (Arterburn et al. 2007). 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, 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: McIntyre Dam on the mainstem Okanogan River in British Columbia, lack of stream flow in lower Salmon Creek (between the Okanogan Irrigation District diversion dam and the confluence with the Okanogan River), and Conconelly 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 have lasting and important increases in salmon and/or steelhead spatial structure, productivity, and abundance and would enable colonization and expansion from core populations.

The immediate strategy should be to restore and protect the remaining steelhead, sockeye, and summer Chinook spawning and rearing habitat. In particular, the summer steelhead spawning and rearing habitat in the two steelhead MaSAs (Salmon and Omak Creek), several other small tributaries known to support spawning and rearing steelhead, as well as summer Chinook spawning habitat located in the lower Similkameen (Category 2) and in the mainstem Okanogan River between Ellisford and Riverside and between Tonasket and Riverside (Category 2) and the remaining sockeye spawning habitat downstream of McIntyre Dam (Category 2).

The Foster Creek and Moses Coulee Subbasins *(WRIAs 50 and 44)*

Relative to other subbasins in the region, the habitats in these streams have limited capability to sustain natural populations of salmonids (Category 4). 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 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 natural populations (Foster Creek and Rock Island Creek). For these streams that support salmonids, assess habitat condition and evaluate barriers to upstream passage, and develop a strategy to increase productivity where appropriate.

Squilchuck and Stemilt (Partial WRIA 40) and other small tributaries of the mainstem Columbia River.

There are many small tributaries that drain directly into the Columbia River between the Entiat River and Crab Creek. Squilchuck, Stemilt, Colockum, Tarpiscan, Trinidad, Quilomene, Skookumchuck, Whiskey Dick, and Johnson creeks have documented juvenile *O. mykiss* distribution in habitat that ranges from several hundred feet to several miles, depending on natural or manmade barriers (Pfeifer et al. 2001; R2 Resource Consultants; 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 (Baldwin 2006; WDFW unpublished data).

The immediate strategy for these Category 4 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.

Integration of Habitat Actions and Hatchery Supplementation Programs

In-basin recovery strategies include both habitat actions and supplementation hatchery programs[1]. The Biological Strategy is designed to guide only habitat actions. The success of planned supplementation programs is inextricably linked to the habitat actions recommended within this strategy. Sufficient levels of functioning habitat (and out of basin survival) must exist to provide adequate spawning area and juvenile survival to provide adequate numbers of natural origin returns (adult) to support hatchery conservation objectives. Specifically, in the absence of sufficient habitat for returning hatchery and natural origin adults and their progeny, the intended integration of hatchery/wild populations may not be possible. Without integration of all sectors, it is unlikely that recovery of Upper Columbia ESUs will occur (UCSRB 2007).

1 A supplementation hatchery program is one that aims to increase the abundance of the natural origin fish and minimize genetic effects by incorporating a relatively large proportion of natural origin spawners in the broodstock and following other best management practices.

In ranking the biological benefits of habitat actions, the RTT did not consider the presence of supplementation programs; however, some habitat actions may enhance the benefits of conservation hatchery programs within tributaries that support such programs. Tributaries containing hatchery programs with conservation objectives can be found in Table 4. Many of the tributaries identified in Table 4 are already considered priorities for habitat actions based on their category and major spawning area designations.

ESU level priorities

In order for the Upper Columbia spring Chinook and steelhead ESU/DPS and bull trout to be eligible for delisting under the ESA the individual populations need to meet viability targets (ICTRT 2007; UCSRB 2006). Most habitat actions; however, will be implemented at the sub-population level (MaSA and MiSA) and may benefit multiple species. Therefore, the RTT used a method of rating the biological benefit of actions that benefit single or multiple species, at the sub-population level, that could be rolled up to determine the priorities across the ESU/DPS. The RTT used the Recovery Plan Implementation Schedule (IS) and the previous draft RTT Biological Strategy as its basis for estimating the biological benefits of strategies and possible actions at the subpopulation level (RTT 2003; UCSRB 2006). All populations in the Upper Columbia ESU/DPS need substantial improvements in one or more VSP parameters. The Recovery Plan has identified that achieving viability in all populations is a priority. Therefore, the actions with the greatest biological benefit at the sub-population level have been identified as the priorities for the ESU.

The RTT recognizes the importance of sequencing actions and most of the actions on the Implementation Schedule will have some benefit to one or more listed species. The RTT developed a system for prioritizing and sequencing actions and strategies based on their biological benefit to multiple listed species. The biological benefit portion of the RTT project ranking criteria was applied to the strategies, actions types and/or possible actions from the IS. The biological benefit scores were prioritized into four tiers based on the project ranking criteria (Appendix D). Tiers were chosen instead of individual scores based on the uncertainty associated with rating actions from the IS. Tiers were determined after the first draft of scoring all of the possible actions, action types, or strategies on the IS from the Recovery Plan. Based on those draft scores, percentiles where calculated and Tier 1 actions were from the 75th-100th percentile, Tier 2 actions were from the 50th-74th percentile, Tier 3 actions were from the 25-49th percentile, and Tier 4 was from the 0-24th percentile (Table 5). As tier 1 and 2 actions are completed the tier 3 and 4 actions will then become the highest priority. This prioritization method is simply a means to sequence, not a method of determining if certain actions should occur. Social and financial constraints can and will affect the sequencing. Appendix C provides the assessment unit specific results of the tier level designation for strategies and action types. The tiers represent a biological benefit prioritization but may not be in sequence based on social, economic, and other non-biological factors. Although project-scoring criteria only provide scores for benefits to listed species, there is an underlying assumption that the actions that benefit listed species will also benefit other unlisted native species. Additional priority actions have been identified for the following species.

Table 4. Locations of supplementation hatchery programs for anadromous salmonids in the Upper Columbia.

Species	Subbasin	Tributary/Location
Spring Chinook	Wenatchee	Chiwawa River
		White River
		Nason Creek[2]
	Methow	Twisp River
		Chewuch River
		Upper Methow River
Steelhead	Wenatchee	Chiwawa River
		Nason Creek
		Upper Wenatchee River
	Methow	Twisp River
		Chewuch River
		Methow River
	Okanogan	Similkameen River
		Omak Creek
		Okanogan River
Summer Chinook	Wenatchee	Lower Wenatchee River
	Methow	Lower Methow River
	Okanogan	Okanogan River
Sockeye	Wenatchee	Lake Wenatchee (White and Little Wenatchee Rivers)
Coho[3]	Wenatchee	Nason Creek
		Wenatchee River

2 A Nason Creek supplementation program is currently planned under the Priest Rapids Settlement Agreement but is not expected to be in operation until 2012

3 Only coho release locations intended to contribute to natural production are included.

Table 5. Tiers and corresponding biological benefit scores and percentiles for determining ESU level priorities.

Tier	Percentile	2007 Biological Benefit Score
1	75-100	70-100
2	50-74	58-69
3	25-49	48-58
4	0-24	0-47

Sockeye Salmon (Lake Wenatchee): Sockeye salmon in the Wenatchee Basin would benefit from habitat actions already identified for listed species that improve and protect habitat along the Wenatchee River migration corridor. These include increasing in-channel complexity (LWD recruitment, and retention), and side-channel and flood plain restoration/protection. Particular attention should be paid to road maintenance activities within Tumwater Canyon and around Tumwater Dam, to ensure that additions or modifications to existing bank protection (rip-rap) do not impede passage into the Tumwater Dam Fish Ladder or create additional hydraulic barriers within the canyon itself.

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; Pieters et al. 2003; Griswold et al. 2003). Studies are needed to determine the trophic status and history of Lake Wenatchee and the White and Little Wenatchee Rivers so that appropriate recommendation can be made regarding nutrient management.

Sockeye Salmon (Okanogan): Sockeye salmon in the United States portion of the Okanogan Basin would benefit from habitat actions already identified for listed species which improve and

protect habitat along the Okanogan River migration corridor. These include increasing in-channel complexity and side-channel and flood plain restoration/protection. High summer water temperatures in the Okanogan River delay migrations for adults and force them to hold in lotic rather than lentic environments thus using up more energy in order to find coldwater refugia and possibly increasing pre spawn mortality. Systemic water temperature management solutions need to be addressed as part of the long-range planning related to water development, storage, and use across the entire Okanogan basin. However, the primary habitats for spawning and rearing of Okanogan River sockeye occurs in Canada.

Currently there is a water flow management model used by water managers in Canada that has successfully reduced the potential for redd scour by balancing flood control with fish habitat requirements. Continued use of this model is important for guiding future decisions regarding sockeye salmon management.

Habitat restoration actions in Canada should be focused on removing barriers to migration such as occurs at McIntyre Dam, Okanogan Falls Dam, and Okanogan Lake Dam. By extending the range of sockeye in the Okanogan River basin you also address the primary limiting factor of a lack of suitable rearing space in Osoyoos Lake during the summer. The Okanogan 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 to protect and restore the mainstem Wenatchee River from the confluence to Lake Wenatchee will have additional benefits for summer Chinook. Specifically, side-channel reconnection in the lower Wenatchee River corridor would be helpful for high-water refugia.

Methow River.—Actions already identified to protect and restore the mainstem Methow River from the confluence with the Columbia River to the Weeman Bridge will have additional benefits for summer Chinook.

Okanogan River.— Actions already identified to protect and restore the mainstem Okanogan and Similkameen Rivers will have additional benefits for summer Chinook. In addition the following items are considered the primary threats to wild summer Chinook in the Okanogan Basin:

1) Changes in systemic high summer water temperature and climate changes have the potential to changing spawning and migration timing.
2) Predation by abundant smallmouth bass is believed to be a major threat based on recent research conducted in the Yakima basin (Fritts and Pearsons 2004).
3) Continued superimposition of redds and commingling of hatchery and wild fish near the confluence with the Similkameen River.
4) High levels of fine sediments resulting from lateral scour, bank instability, and riparian area degradation along the main-stem Okanogan River especially in areas near the

confluence of the Similkameen River, City of Tonasket, Janis Rapids, McAllister Rapids, Shellrock Point, and City of Malott.

All items listed above, are challenges that will require research to provide meaningful solutions to minimize but were not considered in the development of actions identified to address the needs of listed species (summer steelhead).

Cutthroat trout: Actions already identified 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. Continued stewardship of those lands consistent with the Northwest Forest Plan should provide adequate protection. In Lake Chelan, alluvial deposits caused by lake-level management limit access to spawning tributaries for adfluvial cutthroat trout.

Pacific lamprey: Actions already identified to protect and restore the mainstem Wenatchee River from the confluence to Lake Wenatchee will likely have additional benefits for lamprey. Also, actions already identified in the Lower and Middle Mainstem Methow River will likely have additional benefits for lamprey. However, there are numerous information gaps for lamprey that should eventually be funded. The list of information gaps is presented in (Columbia River Basin Technical Work Group 2005).

Coho Salmon: Naturally producing coho salmon in the Wenatchee and Methow basins would benefit from restoring in-stream 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 in-stream 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 the RTT ESU-level priorities for those species.

General Information Needs

The effects of altered fluvial processes on life stage specific survival in many Upper Columbia streams are not fully understood. Stream channels in many areas are constrained by railroads, highways, dikes, and development, causing reduced channel sinuosity, flood attenuation, gravel recruitment, large woody debris recruitment, and 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 USBR for the Middle Methow, Nason Creek, and the Lower Entiat. We understand that additional analysis is likely to occur in Peshastin Creek and Icicle Creek in the coming years.

More information is needed on the water balance and the relation of surface and groundwater in Upper Columbia streams, particularly in the Methow Subbasin. 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.

The Okanogan and Foster Creek subbasins require an inventory and assessment of fish passage barrier and screens, and a prioritization of these passage issues. 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 are now completed (excluding small pump 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. Using the Wenatchee barrier inventory as an example, the RTT developed a draft approach for prioritizing barriers based on biological benefit. Once finalized, it could be used for the other subbasins.

A better understanding of habitat-productivity relations in Upper Columbia streams 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 production surveys, and spawning ground surveys in representative streams would greatly contribute to our knowledge base, and lead to more 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 structure and dispersal patterns of salmonids in the ESU/DPS. The presence, extent, and distribution of steelhead and redband trout in some of these streams has been evaluated and monitored (Pfeifer et al. 2001; Dresser et al. 2003; Baldwin 2006); 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.

Table 6 below identifies specific assessment and research needs within the entire upper Columbia Basin. This information was gleaned from the Biological Strategy (RTT 2003) and the draft recovery plan (UCSRB 2006). Additionally, the Monitoring and Data Management Committee recently completed a data gap prioritization for these and other data gaps. That synthesis was not available for this draft of the *RTT Biological Strategy* but it is available upon request.

Table 6. List of critical uncertainties, areas that are affected, and potential assessments in the Upper Columbia River Basin.

Category		Stream				Recommendation
General	**Critical Uncertainty**	**Wenatchee**	**Entiat**	**Methow**	**Okanogan**	**Comments**
Fluvial Processes	Channel migration; this includes floodplain sinuosity and connectivity.	lower Wen. (done), critical tributaries	lower, middle, and upper Entiat	middle Methow	mainstem	Determine rates of channel migration, appropriate methods for reestablishment of connection, and locations.
	Riparian health	tributaries	mid- to upper main river and tribs.	mid- to upper main river and tribs.	tributaries	Determine where restoration is feasible and will benefit (establish critical areas; not all locations will show benefit)
	In-stream structures	tributaries	main river and tribs.	tributaries	tributaries	Determine which structures have the greatest benefit and also the greatest chance for lasting within appropriate areas.
	Gravel recruitment	main river and tribs.	main river and tribs.	main river and tribs.	main river and tribs.	More information is needed in specific areas on what factors are affecting gravel recruitment.
	LWD recruitment	main river and tribs.	main river and tribs.	main river and tribs.	main river and tribs.	Determine what factors are affecting LWD recruitment and if there are projects that can encourage LWD recruitment in specific areas.
Migration	Barriers to fish migration	Refine and/or prioritize for whole subbasin (if necessary)	Refine and/or prioritize for whole subbasin (if necessary)	Refine and/or prioritize for whole subbasin (if necessary)	Refine and/or prioritize for whole subbasin (if necessary)	Assessment would include culverts, diversions, diversion dams, gradients, and natural blockages. This has been done in many of the subbasins already, but a systemized strategic plan needs to be developed in some subbasins. Need to properly assess the extent of each barrier on fish passage.
Water	Interaction between ground and surface waters	mid- to upper main river and tribs	mid- to upper main river and tribs	mid- to upper main river and tribs	mid- to upper main river and tribs	Critical ground water recharge areas and areas where ground water contributes to surface water need to be identified. The interactions between ground water withdrawal (wells) and surface water flow should be determined, where possible.
	Climate change effects on water supply and timing	Basin-wide	Basin-wide	Basin-wide	Basin-wide	This should also link in with the groundwater-surfacewater interaction studies.
	Water quality	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Factors, such as non-point and point sources of pollution need to be identified (and addressed), but it's affect on fish needs to be determined.
	Water quantity	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	An empirical study should be pursued, using one indicator stream to determine the effects of low water, both natural, and man-induced, have on fish populations.
	Sedimentation	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Refine for whole subbasin (if necessary)	Determine what actions (e.g., road densities, development) negatively affect sedimentation to streams greater than natural occurrences.
Biological	Fish presence/absence		Bull trout in the upper main and Mad rivers			Salmon rearing in small-order tributaries to the Columbia mainstem River is not known. Some of these streams may help spatial structure and productivity of steelhead and possibly other species of interest.

	Fish response to habitat restoration	mainstem and tribs	mainstem and tribs	mainstem and tribs	mainstem and tribs	More information is needed to determine the effectiveness of habitat restoration projects on fish productivity.
	Effects of non-indigenous predators on species of interest	mainstem and tribs	mainstem and tribs	mainstem and tribs	mainstem and tribs	Assess abundance and consumption rates of non-native fish that feed on species of interest. This is especially important in the mainstem Columbia River.
	Nutrient enhancement	upper tributaries	upper and middle Entiat, Mad River	upper tributaries	Salmon and Omak Creek	An assessment is needed to determine the location and magnitude for potential nutrient enhancement projects. Within current and historic range, consistent within individual stream capacity and recovery objectives.

Specific Research Needs (from the UC recovery plan)

The proposed Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan identifies research needs (monitoring objectives) for the four sectors (harvest, habitat, hydro, and hatcheries) affecting salmon, steelhead, and bull trout viability (UCSRB 2006). Below is a list of habitat research needs identified in the Recovery Plan.

- Monitor the effectiveness of each "class" of habitat action implemented in the Upper Columbia Basin on listed species and community structure.
- Accurately monitor trends in abundance, productivity (including smolts/redd), spatial structure, and diversity at the population and subpopulation scale.
- Assess stream flows (within the natural hydrologic regime and existing water rights) suitable for spawning, rearing, and migration (based on current research and modeling).
- Implement current monitoring protocols and continue to develop standardized monitoring methods.
- Examine relationships between habitat and biological parameters at coarse (landscape) and fine (stream segment) scales.
- Update, revise, and refine watershed and salmonid performance assessment tools (e.g., Ecosystem Diagnosis and Treatment analysis) to adaptively manage the implementation and prioritization strategy.
- Examine the effects of non-native species on listed species.
- Assess abundance and consumption rates of non-native fish that feed on listed species.
- Conduct channel migration studies within each subbasin to identify priority locations for protection and restoration.
- Examine fluvial geomorphic processes within each subbasin to assess how these processes affect habitat creation and loss.
- Inventory and assess fish passage barriers and screens within each subbasin.
- Conduct hydrologic assessments to better understand water balance and surface/groundwater relations within the subbasins.

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Appendix A.

Table A1. Watershed categories, significant subwatersheds, Major (MaSA) and Minor (MiSA) spawning areas, and core areas for spring Chinook salmon, summer Chinook salmon, sockeye salmon, steelhead, and bull trout in the Upper Columbia Region. X- indicates that the watershed is part of a spawning area and x+ indicates that there are multiple spawning areas within the watershed.

				Spr Chinook		Steelhead		Bull Trout
Subbasin	Watershed	Category	Significant Subwatersheds	MaSA	MiSA	MaSA	MiSA	Core Area
Wenatchee	Mainstem Upper Wen	1	3	x		x[e]		x
	Mainstem Middle Wen	1	1					
	Mainstem Lower Wen	2	1					
	White River	1	5	x			x-[f]	x
	Little Wenatchee River	1	5	x			x-[f]	x
	Lake Wenatchee	1	a					
	Nason Creek	2	3	x		x		x
	Chiwawa River	1	6	x		x		x
	Icicle Creek	2	4		x	x[g]		x
	Chumstick Creek	3	0		x	x		
	Peshastin Creek	2	3		x	x		x
	Mission Creek	3	3		x		x	
Entiat	Mainstem Upper Entiat	1	2					
	Mainstem Middle Entiat	1	2	x-[c]		x-[c]		x
	Mainstem Lower Entiat	2	0	x-[c]		x-[c]		x
	Mad River	1	3	x-[c]		x-[c]		x
Methow	Mainstem Upper Methow	2	6	x-[d]		x-[d]		x
	Mainstem Middle Methow	2	0	x		x		x
	Mainstem Lower Methow	2	0				x+	x
	Early Winters Creek	1	1	x-[d]		x-[d]		x
	Lost River	1	2	x-[d]		x-[d]		x
	Chewuch River	2	3	x		x		x
	Twisp River	2	4	x		x		x
Okanogan	Mainstem Upper Okanogan	2	a				x+	
	Mainstem Lower Okanogan	2	3				x+	
	Similkameen River	3	1				x[h]	
	Bonaparte Creek	4	0				x	
	Omak Creek	2	0			x		
	Salmon Creek	3	0			x		
Mainstem Small Tributaries	Foster Creek	4	0					
	Chelan River/Beebe Spring	4	0					
	Swakane	4	0				x[i]	
	Squilchuck	4	0				x[j]	

	Stemilt	4	0	
	Rock Creek		0	
	Moses Coulee	4	0	
	Colockum	4	b	x[j]
	Tarpiscan	4	b	
	Trinidad	4	b	k
	Tekison	4	b	x[j]
	Quilomene/Brushy	4	b	x[j]
	Skookumchuck	4	b	x[j]
	Whiskey Dick	4	b	
	Johnson Creek	4	b	x[j]
Crab Creek	Crab Creek	3	b	
Columbia	Mainstem Columbia	5	a	

a) The criteria for designation of significance does not apply to Lake Wenatchee, Upper Okanogan, and mainstem Columbia River, yet each contain important habitats.

b) A formal significant subwatershed analysis has not been conducted in these watersheds.

c) The Lower Entiat, Middle Entiat, and Mad River combine to form MaSAs for both spring Chinook and steelhead.

d) The Upper Methow mainstem and all tributaries upstream of the confluence with the Chewuch combine to form MaSAs for both spring Chinook and steelhead.

e) Beaver and Chiwaukum Creeks were included within the Upper Wenatchee Mainstem MaSA.

f) The White and Little Wenatchee Rivers combine to form a MaSA for steelhead.

g) Icicle Creek was considered a major spawning area with the assumption that steelhead did and could get past the boulder field at RM 5.

h) The ICTRT did not designate the Similkameen as a minor spawning area, but the recovery plan did.

i) Swakane Creek was included within the Entiat population boundaries.

j) The small streams downstream of the Wenatchee River were included with the Wenatchee River population

k) Although not large enough to form a MiSA, Trinidad Creek is known to support steelhead spawning

Appendix B. Maps of known distribution and MSAs of spring Chinook salmon, summer Chinook salmon, sockeye salmon, steelhead, and bull trout in the Upper Columbia Region.

Not currently available for this document. Refer to subbasin plans (http://www.nwcouncil.org/), the Recovery Plan (http://ucsrb.com/plan.asp), or salmonscape (http://wdfw.wa.gov/mapping/salmonscape/).

Appendix C.

The subwatershed level assessment and strategy summarized in this appendix are intended to be a quick and simple overview of each assessment unit with particular utility for project sponsors. The recommendations are a combination of the previous draft of the RTT biological strategy (2003) combined with the current draft implementation schedule of the recovery plan (UCSRB 2006). The strategies were prioritized into tiers based on potential biological benefit as described in the "ESU Level Priorities" section of this document.

Appendix Tables C.1: Wenatchee River Subbasin

MAINSTEM UPPER WENATCHEE RIVER (LAKE WENATCHEE TO TUMWATER CANYON) ASSESSMENT AND STRATEGY	
Species: Sockeye salmon, spring and summer Chinook salmon, steelhead, bull trout.	Drainage area:
STATUS: Category 1, Major spawning area for both steelhead and spring Chinook, core area for bull trout. • Important passage corridor for many species • Important spawning habitat for spring and summer Chinook salmon and steelhead • The mainstem from Lake Wenatchee to the Chiwawa River confluence is designated as a Key Watershed in the Northwest Forest Plan (NWFP). • Important overwinter rearing habitat for spring Chinook • Critical rearing area (Lake Wenatchee) for sockeye salmon	
SIGNIFICANT SUBWATERSHEDS: Upper Wenatchee, Chiwaukum Creek	
FACTORS AFFECTING HABITAT CONDITION: ▪ The state highway, railroad, and private land development affect woody debris 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. ▪ Fecal coliform and water temperatures are slightly elevated.	

LEVEL OF CERTAINTY / DATA GAPS:

- Extensive field surveys and analysis of aerial photographs provide strong evidence of impacts to the riparian corridor and stream channel function. Recent LIDAR survey should provide additional valuable information for identifying specific opportunities.
- There is a high level of concern about impacts of and potential increase of development in this assessment unit, which leads to a strong consensus among RTT members on the priority of this watershed in the region.
- The need and magnitude of adding nutrients is not well understood and this assessment unit should be part of an ESU wide plan to determine where, how, and how much nutrient supplementation is required.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect remaining floodplain and riparian habitat

In-channel complexity

- Restore habitat diversity by enhancing large woody debris recruitment, retention, and complexity.

Tier 3

Restore channel migration and riparian condition

- River Road modification and relocation
- Improve fish access to oxbows and historical side channels that have been cut off from main channel.

Tier 4

Restore passage

- Beaver Creek subwatershed (Six culverts currently identified as potential barriers)

- Initiate public information efforts to discourage harassment of spawning salmonids (particularly spring and summer Chinook salmon).

MAINSTEM MIDDLE WENATCHEE (TUMWATER CANYON) ASSESSMENT AND STRATEGY

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

STATUS: Category 1

- Important passage corridor for all migratory salmonids.
- Important spawning habitat for summer Chinook salmon and steelhead.
- Important rearing for steelhead and spring Chinook.
- Tumwater Dam provides an important collection and assessment facility for managing the upper river sub-populations.

SIGNIFICANT SUBWATERSHEDS:

Tumwater Canyon

FACTORS AFFECTING HABITAT CONDITION:

- The state highway negatively affects gravel, LWD recruitment, and possibly water quality.

LEVEL OF CERTAINTY / DATA GAPS:

- Little is known about the physical and chemical effects of highway maintenance to the riparian zone, water quality, and juvenile salmonids.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect remaining floodplain and riparian habitat.

MAINSTEM LOWER WENATCHEE RIVER (TUMWATER TO MOUTH) ASSESSMENT AND STRATEGY

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

STATUS: Category 2

- Important passage corridor for many species.
- Spawning and rearing habitat for summer Chinook salmon and steelhead.

SIGNIFICANT SUBWATERSHEDS:

Lower Wenatchee

FACTORS AFFECTING HABITAT CONDITION:

- Land development, state highway and railroad affect channel migration, woody debris recruitment, and gravel recruitment.
- Riparian habitat and off-channel habitat have been significantly lost or degraded in this reach.
- Late summer instream flows are often critically low throughout this reach.
- Floodplain function has been impaired by development, causing extremes in the peaks and nadir of the hydrograph.
- Stream temperatures often exceed standards, contributed to by riparian habitat loss, reduced floodplain function, and low instream flows.
- There is a high level of concern about impacts of land development on this stream reach, which leads to a strong consensus among RTT members on the priority of this watershed in the region.

LEVEL OF CERTAINTY / DATA GAPS:

- Field and aerial surveys give strong indication of channel constriction and riparian habitat loss. Historical photos indicate loss of floodplains.
- The relation of fish habitat and instream flow in this reach was studied in 1980s; this assessment needs to be refined.
- The relative extent to which irrigation withdrawal and riparian loss affect water temperature is not known.
- A relatively high proportion of subyearling spring Chinook are known to migrate from the tributaries (Chiwawa, Nason, etc.) in the fall and overwinter in the Upper Wenatchee mainstem and Tumwater Canyon (WDFW unpublished data). It is uncertain to what extent the Lower Wenatchee River downstream of Tumwater Canyon was a historically important winter rearing area for spring Chinook.
- Assess groundwater surface water interaction.
- Assess the effects of temperature in the Lower Wenatchee through the TMDL process.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing riparian habitat and channel migration floodplain function.

Side channel reconnection and floodplain restoration

- Above Sleepy Hollow bridge
- Near monitor
- At Cashmere
- CMZ site 11
- Others yet to be identified

Tier 3

Riparian restoration

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

Tier 4

Water quantity restoration

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

MISSION CREEK WATERSHED ASSESSMENT ANDSTRATEGY	
Species: Spring Chinook salmon, steelhead.	Drainage area: 59,609 acres
STATUS: Category 3, minor spawning area for spring Chinook and steelhead (based on intrinsic potential). Currently, no known spring Chinook spawning occurs in the Mission Creek watershed.	
SIGNIFICANT SUBWATERSHEDS: Sand Creek, Devils Gulch, Lower Mission	
FACTORS AFFECTING HABITAT CONDITION: ▪ 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.	
LEVEL OF CERTAINTY / DATA GAPS: ▪ Watershed surveys by USFS and Chelan Conservation District provide high level of certainty of watershed conditions and causal mechanisms.	

HABITAT ACTION RECOMMENDATIONS:
Tier 1 and 2 (none identified)
Tier 3
Increase stream flow

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

In-channel complexity

- Install pool forming in-channel structures

Tier 4
Side channel restoration

- From mouth to USFS boundary

Road management

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

Fish passage

- Multiple culverts in the E. Fork and Little Camas creeks.
- Assess and fix any passage barriers in lower Mission Creek mainstem

Riparian restoration

- Japanese knotweed removal.
- Opportunistically between Cashmere and the USFS boundary.
- Implement IRIS program

Most projects should be delayed until flow and water quality are addressed.

PESHASTIN CREEK WATERSHED ASSESSMENT AND STRATEGY	
Species: Spring Chinook salmon, steelhead, bull trout.	Drainage area: 78,780 acres

STATUS: Category 2, Major spawning area for steelhead and minor spawning area for spring Chinook, bull trout core area.

- Very little evidence of natural origin spring Chinook spawning. Most of the recent spring Chinook spawning activity has been from placement of unlisted hatchery fish from the LNFH.

SIGNIFICANT SUBWATERSHEDS:

Upper Peshastin, Lower Peshastin, Ingalls Creek

FACTORS AFFECTING HABITAT CONDITION:

- 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.

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 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.
- 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.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing riparian habitat and channel migration floodplain function.

In-channel complexity

- Install 20-30 pool forming in-stream structures and LWD from Ingalls Creek to mouth.

Stream flow

- Water right purchase and lease
- Water banking
- Improve irrigation efficiencies

Side-channel reconnection

- Ingalls Creek to river mile 1

Tier 4

Provide improved fish passage

- Culvert replacements in Mill, Ruby, and Scotty Creeks. (*primary benefit to steelhead only, more information is needed on Mill Creek to determine the extent of potential rearing habitat and flow regime*)

Side-channel reconnection

- Develop side-channel habitat (from CMZ, RM 0-1).

Riparian restoration

- Throughout the assessment unit and in conjunction with side channel reconnection; sites yet to be comprehensively identified.(the implementation schedule only called for an evaluation, but the RTT recognized the need for riparian restoration in conjunction with flow, pool formation, and side-channel connection actions).

Most projects should be delayed until increased flow and pool formation are addressed.

ICICLE CREEK WATERSHED ASSESSMENT AND STRATEGY

Species: Steelhead, bull trout, cutthroat trout, redband trout, spring Chinook	Drainage area: 136,960 acres

STATUS: Category 2, minor spawning area for spring Chinook and major spawning area for steelhead (assuming that steelhead did and can get past the boulder field). Core area for bull trout.

- Relatively good habitat above the hatchery.
- Resident fish are present and of concern.
- Designated as Key Watershed in Northwest Forest Plan.

SIGNIFICANT SUBWATERSHEDS:

Upper Icicle Creek, Jack Creek, French Creek, Headwaters Icicle Creek.

FACTORS AFFECTING HABITAT CONDITION:

- Land development downstream of Leavenworth Hatchery has affected stream channel migration, recruitment of large woody debris, and off channel habitat.
- There are barriers to migration on Icicle Creek at Leavenworth Hatchery and possibly in the boulder field near Snow Creek
- Water withdrawals in Icicle Creek (primarily between Rat Creek and the hatchery) likely contribute to low flows and high summer temperatures in lower Icicle Creek.
- The Icicle Road upstream of Chatter Creek at places may confine the stream channel and affect floodplain function.
- The 1994 Rat Creek fire caused increased sedimentation and water temperature in the middle and lower Icicle drainage.

LEVEL OF CERTAINTY / DATA GAPS:

- Field and aerial reconnaissance of lower Icicle Creek provide strong certainty of need for stream channel protection and restoration.
- 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.
- The role of surface and well-water withdrawals on instream flows and habitat use is uncertain.

HABITAT ACTION RECOMMENDATIONS:
Tier 1 (none identified)

Tier 2
Passage

- Provide improved fish passage at the LNFH headgate and Dam 5.
- Improve fish passage at LNFH/Cascade Orchards, Icicle Irrigation District and City of Leavenworth intakes.

Channel reconnection

- Reconnect the original channel to Icicle Creek above the headgate and Dam 5

Reduce sedimentation

- Stream bank restoration from the LNFH to mouth
- Remove USFS road at Trout Creek

Increase stream flow

- Improved hatchery intake, provide 20 cfs pump back
- Water right purchase and lease
- Water banking
- Conversion of small pumps to wells
- Improve irrigation efficiencies

Tier 3
Protect existing riparian habitat and channel migration floodplain function.

- Acquire conservation easements: where appropriate from hatchery to mouth

Screen diversions

- Icicle/Leavenworth & LNFH-Cascade screens

Tier 4
Riparian restoration

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

CHUMSTICK CREEK WATERSHED ASSESSMENT AND STRATEGY

Species: Steelhead.	Drainage area: 47,000 acres

STATUS: Category 3, Major spawning area for steelhead and minor spawning area for spring Chinook (based on intrinsic potential). Currently, no known spring Chinook spawning occurs in the Chumstick Creek watershed.

- Likely, it was very important coho salmon habitat, although few records exist.

SIGNIFICANT SUBWATERSHEDS:

None

FACTORS AFFECTING HABITAT CONDITION:

- 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.
- Fecal coliform and water temperature levels are elevated, mostly a result of livestock and improper septic tanks.
- Passage is impeded at the North Road and numerous smaller culverts upstream.
- Riparian habitat has been degraded or lost from Little Chumstick Creek to mouth.

LEVEL OF CERTAINTY / DATA GAPS:

- This watershed is only partially accessible to steelhead at this time, yet it is unknown whether it is accessible to other species.
- Barrier survey needs to be conducted in Eagle Creek.
- Field inventory and assessment of passage barriers enable a high level of certainty regarding habitat degradation.
- Consistent yearly water quality monitoring provides certainty on fecal coliform and 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.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Restore passage

- Provide unobstructed passage under North Road

Water Quantity

- Increase stream flow

Tier 2

Restore passage

- Replace culverts in Chumstick Creek (at least 12 identified by USFWS between Eagle and Little Chumstick creeks).

Sediment reduction

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

Riparian restoration

- Re-establish native vegetation where appropriate from Little Chumstick Creek to mouth (includes control of noxious weeds such as reed canary grass)
- Install livestock control fencing where appropriate throughout the assessment unit

Tier 3

Side channel reconnection

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

CHIWAWA RIVER WATERSHED ASSESSMENT AND STRATEGY	
Species: Spring Chinook salmon, steelhead, migratory bull trout, and cutthroat trout.	Drainage area: 117,000 acres

STATUS: Category 1, Major spawning area for spring Chinook and steelhead, bull trout core area.

- Designated as Key Watershed in Northwest Forest Plan.
- Critical spawning and rearing habitat for multiple species.

SIGNIFICANT SUBWATERSHEDS:

Headwaters Chiwawa, Upper Chiwawa, Middle Chiwawa, Lower Chiwawa, Rock Creek, Chikamin Creek

FACTORS AFFECTING HABITAT CONDITION:

- 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 on the lower Chiwawa River. Loss of riparian vegetation in these reaches may influence water temperatures and hiding cover.
- Water withdrawals in the lower Chiwawa River may affect rearing habitat in low flow years.

LEVEL OF CERTAINTY / DATA GAPS:

- The effect of water withdrawals on lower Chiwawa River salmonid habitat is not known.
- There is concern over the potential impacts of development in Chikamin Creek on salmonid productivity and water temperatures.
- The need and magnitude of adding nutrients is not well understood and this assessment unit should be part of an ESU wide plan to determine where, how, and how much nutrient supplementation is required.

HABITAT ACTION RECOMMENDATIONS:

Tier 1
Protect existing riparian habitat and channel migration floodplain function.

- Acquire conservation easements in the lower 4 miles of the Chiwawa River

Tier 2
Increase nutrients

- Add nutrients using hatchery carcasses and/or carcass analogs within the current and historic range of anadromy consistent with individual stream capacity and recovery objectives.

Tier 3
Restore fish passage

- Replace culverts at Clear, Minnow, Alder and Deep creeks.

Exotic species control

- Brook trout eradication at Minnow and Schaefer lakes.

Tier 4
Riparian restoration

- Management of recreational areas to reduce impacts to riparian areas in NF campsites in the middle/upper watershed

Floodplain restoration

- Restore floodplain at Chikamin Flat.

NASON CREEK WATERSHED ASSESSMENT AND STRATEGY

Species: Spring Chinook salmon, steelhead, bull trout, and cutthroat trout.	Drainage area: 69,000 acres

STATUS: Category 2, Major spawning area for spring Chinook and steelhead, bull trout core area.

SIGNIFICANT SUBWATERSHEDS:
Headwaters Nason, Upper Nason, Lower Nason

FACTORS AFFECTING HABITAT CONDITION:

- The state highway, railroad, and private land development affect woody debris recruitment, channel migration, and gravel recruitment.
- Lower Nason Creek is on the state 303(d) list for water temperature.

LEVEL OF CERTAINTY / DATA GAPS:

- Extensive field surveys and analysis of aerial photographs provide strong evidence of impacts to stream channel function. There is some uncertainty about the most appropriate means to restore floodplain function, given the existing constraints. Recent LIDAR survey should provide additional valuable information for identifying specific opportunities.
- There is some uncertainty of the extent to which oxbows are disconnected, and what efforts should be done to provide access to Nason Creek.
- The cumulative effects of timber harvest, development, and road densities on stream channel function and sediment delivery are not fully known, but of concern.
- The need and magnitude of adding nutrients are not well understood and this assessment unit should be part of an ESU-wide plan to determine where, how, and how much nutrient supplementation is required.

HABITAT ACTION RECOMMENDATIONS:

Tier 1
Protect existing riparian habitat and channel migration floodplain function.

Floodplain restoration

- Increase LWD complexes from Whitepine Creek to mouth
- Reconnect side channels and off-channel habitat, where appropriate, from Whitepine Creek to mouth.

Tier 2

Riparian Restoration

- Focus riparian plantings in floodplain areas, residential developments, and side-channel reconnections from Whitepine Creek to the mouth (certain locations would be at high risk of failure due to channel restriction so individual project scores might vary widely).

Increase nutrients

- Add nutrients using hatchery carcasses and/or carcass analogs within the current and historic range of anadromy consistent with individual stream capacity and recovery objectives.

Provide improved fish passage

- Coulter/Roaring Creek railroad crossing, Mill Creek, lower reaches of Gill and Roaring creeks.

Deleted: ¶

WHITE RIVER WATERSHED ASSESSMENT AND STRATEGY

Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat trout, bull trout.	Drainage area: 99,956 acres

STATUS: Category 1, major spawning area for spring Chinook, part of a major spawning area for steelhead (forms a MaSA when combined with the Little Wenatchee) and a core area for bull trout

- Designated as Key Watershed in Northwest Forest Plan.
- Critical spawning and rearing habitat for many species.

SIGNIFICANT SUBWATERSHEDS:

Headwaters White, Upper White, Lower White, Napeequa Creek, Panther Creek

FACTORS AFFECTING HABITAT CONDITION:

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

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.
- The need and magnitude of adding nutrients is not well understood and this assessment unit should be part of an ESU-wide plan to determine where, how, and how much nutrient supplementation is required.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing riparian habitat and channel migration floodplain function.

- Acquire conservation acquisition/easements in the lower mainstem White River

Floodplain restoration

- Restore wetland complexes that connect to stream channel.

Riparian restoration

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

Tier 2

Increase nutrients

- 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.

LITTLE WENATCHEE WATERSHED ASSESSMENT AND STRATEGY

Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat trout, bull trout.	Drainage area: 75,329 acres

STATUS: Category 1, major spawning area for spring Chinook, part of a major spawning area for steelhead (forms a MaSA when combined with the White River) and a core area for bull trout.

- Designated as Key Watershed in Northwest Forest Plan.
- Critical spawning and rearing habitat for many species.
- Bull trout numbers above the waterfalls are extremely low.

SIGNIFICANT SUBWATERSHEDS:

Headwaters Little Wenatchee, Upper Little Wenatchee, Lower Little Wenatchee, Rainy Creek, Lake Creek

FACTORS AFFECTING HABITAT CONDITION:

- Past riparian harvest and log drives below the waterfalls may have affected stream channel morphometry and function.
- Habitat above the waterfalls is intact and relatively pristine, need to protect and maintain stream channel and floodplain integrity.
- The lower Little Wenatchee is on the state 303(d) list for water temperature.

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.
- Some uncertainty exists on effects of logging and road management on stream channel function, water temperature, flow, and possible input of large woody debris.
- The need and magnitude of adding nutrients is not well understood and this assessment unit should be part of an ESU wide plan to determine where, how, and how much nutrient supplementation is required.
- Strategies assume that the Little Wenatchee is currently well protected and at very low risk of development. Should this change protection would be a Tier 1 priority.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing intact and functioning habitats

Tier 2

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.

Floodplain restoration

- Restore stream channel and riparian vegetation function at dispersed recreation sites below Little Wenatchee Falls

Reduce sedimentation

- NF road maintenance and actions
- Decommission roads

Tier 3

Riparian restoration

- Plant native vegetation

LAKE WENATCHEE ASSESSMENT AND STRATEGY	
Species: Sockeye salmon, spring Chinook salmon, steelhead, cutthroat trout, bull trout.	Drainage area:

STATUS: Category 1.

- Necessary adult holding and juvenile rearing area for sockeye salmon and bull trout.

SIGNIFICANT SUBWATERSHEDS:

Not applicable.

FACTORS AFFECTING HABITAT CONDITION:

- Shoreline development. Bulkheads change dynamics of near shore wave action, affecting invertebrate production, gravel deposition, and habitat use.

LEVEL OF CERTAINTY / DATA GAPS:

- Quantified field analyses have not been conducted, yet reviews of aerial photographs in combination with field reviews have allowed strong inferences on habitat needs.
- Trophic status of the lake needs to be determined for both current and historic.

RECOMMENDATION:

- Protect remaining near shore habitat, and develop a means to reduce impacts of bulkheads.

Appendix C.2: Entiat River Subbasin

LOWER ENTIAT (FROM MORAINE DOWNSTREAM TO MOUTH) ASSESSMENT AND STRATEGY	
Species: Spring and summer Chinook salmon, steelhead, bull trout, cutthroat trout	Drainage area:
STATUS: Category 2 Migration corridor for spring Chinook salmon, steelhead and bull trout. Spawning and rearing habitat for steelhead and summer Chinook salmon. Limited rearing area for juvenile spring Chinook and bull trout.	
SIGNIFICANT SUBWATERSHEDS: None	
FACTORS AFFECTING HABITAT CONDITION: ▪ Loss of channel complexity and lateral migration ▪ Loss of riparian habitats and floodplain connectivity ▪ Loss of gravel recruitment ▪ Sediment delivery from Potato Creek and Mud Creek	
LEVEL OF CERTAINTY/ DATA GAPS: ▪ Extent of irrigation water withdrawal on instream flows and temperature is not known. ▪ Extent of riparian cover and channel shape on anchor ice formation is not known.	

HABITAT ACTION RECOMMENDATIONS :

Tier 1

Protect existing intact and functioning habitats

Water Quantity/Low Flow

- Knapp-Wham and Hanan Detwiller Irrigation Consolidation

Habitat Diversity

- Instream/LWD pool forming structures
- Floodplain and side channel reconnection
- Decommission 14 miles of National Forest Roads

Tier 2

Nutrient Restoration

- Hatchery carcass out planting and/or use of nutrient analogs

Water Quantity/Low Flow

- On farm irrigation efficiency
- Surface/ground water conversions

Habitat Diversity

- Riparian Restoration

Obstructions

- Screen and/or upgrade existing screens on pumps/diversion intakes

MIDDLE MAINSTEM ENTIAT (STILLWATERS) FROM ENTIAT FALLS TO POTATO MORAINE ASSESSMENT AND STRATEGY

Species: Critical habitat for spring Chinook salmon, steelhead, bull trout, cutthroat trout.	Drainage area:

STATUS: Category 1

- Designated as Key Watershed in Northwest Forest Plan

SIGNIFICANT SUBWATERSHEDS:
Upper Mid-Entiat, Lower Mid-Entiat

LEVEL OF CERTAINTY/DATA GAPS:
Field habitat analysis has been completed on most areas, providing a high confidence in assessment.

- The status of bull trout in the upper Entiat is not well understood. However, recent studies indicate that Entiat fluvial bull trout over winter in the Entiat Pool of the Columbia River.
- There is a high level of concern about the impact of land development on this reach. There is a strong consensus among RTT members on the need to protect stream channel function.

... [1]

HABITAT ACTION RECOMMENDATIONS:

Tier 1
Protect existing intact and functioning habitats

Habitat Diversity

- LWD pool forming structures
- Floodplain and side channel Reconnection
- Heavy maintenance and reconstruction on 30 miles of National Forest roads

Tier 2

Nutrient Restoration

- Hatchery carcass out planting and/or use of nutrient analogs

Water Quantity/Low Flow

- On farm irrigation efficiency
- Surface/ground water conversions

Habitat Diversity

- Riparian Restoration

Tier 4

Obstructions

- Replace 2 Stormy Creek culverts that present fish passage problems (open up 1-1.5 miles of habitat) and associated small diversion on private land.

UPPER MAINSTEM ENTIAT ABOVE ENTIAT FALLS ASSESSMENT AND STRATEGY

Species: cutthroat trout	Drainage area:
STATUS: Category 1	
SIGNIFICANT SUBWATERSHEDS: None	
FACTORS AFFECTING HABITAT CONDITION: ▪ Surface erosion and sediment delivery. ▪ Impacts from roads on the National Forest	
LEVEL OF CERTAINTY/DATA GAPS: ▪ The status of bull trout in the upper Entiat is not well understood. ▪ Introduction of brook trout remains a concern for species interaction.	
HABITAT ACTION RECOMMENDATIONS: **Tier 1** Protect existing intact and functioning habitats **Tier 3** Ecological Interaction • Evaluate presence/absence of bull trout above Entiat Falls • Evaluate and implement a brook trout eradication program	

MAD RIVER WATERSHED ASSESSMENT AND STRATEGY

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

STATUS: Category 1

- Designated as Key Watershed in Northwest Forest Plan

SIGNIFICANT SUBWATERSHEDS:

Upper Mad River, Middle Mad River, Lower Mad River

FACTORS AFFECTING HABITAT CONDITION:

- Historical sheep grazing and timber harvest practices have increased upland erosion and sediment delivery to the stream, and has impacted snow melt runoff and resultant stream flow.
- Road constricts channel on mainstem from Pine Flat campground downstream to mouth.
- Anchor ice formations associated with loss of riparian cover and changes in channel.

LEVEL OF CERTAINTY/DATA GAPS:

- Field habitat analysis has been completed on most areas, providing a high confidence in assessment.
- Mad River is considered a stronghold for bull trout. Recent studies indicate that the Mad River fluvial bull trout over winter in the Entiat Pool of the mainstem Columbia River.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing intact and functioning habitats

Habitat Diversity

- Install rock gravel catchers to promote gravel recruitment

Tier 2

Habitat Diversity (Road Management)

- 4 miles NF road decommissioning
- 12 miles heavy maintenance reconstruction
- Estimate 40 miles decommission/heavy maintenance / reconstruction in Tillicum watershed
- Improve County road maintenance along lower Mad River road
- Install rock gravel catchers to promote gravel recruitment

Appendix C.3: Methow River Subbasin

EARLY WINTERS CREEK ASSESSMENT AND STRATEGY	
Species: Spring Chinook salmon, steelhead, bull trout, westslope cutthroat trout.	Drainage area: 51,925 acres

STATUS: Category 1

- Designated as a Key Watershed in Northwest Forest Plan

SIGNIFICANT SUBWATERSHEDS:

Early Winters Creek

FACTORS AFFECTING HABITAT CONDITION:

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 and downstream bank erosion.
- 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 at the intake canal.

LEVEL OF CERTAINTY / DATA GAPS:

- Previous (1994) 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.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing intact and functioning habitats

Road Maintenance (sediment reduction and floodplain connectivity benefits)

- Sandy Butte Road Reconstruction
- Highway 20

Tier 2

Water Quantity Restoration

- Encourage water use efficiency
- Move to ground water conversion (wells) (NRCS conversion)

Floodplain Restoration

- Relocate road and campsite to allow river migration
- Rebuilding Bridges (Hwy 20 and MVSTA trail)
- Implement Respect the River program
- LWD Restoration
- Establish flood channel - management plan

Tier 4

Culvert Replacement

- Pine Creek / Highway 20

LOST RIVER ASSESSMENT AND STRATEGY

Species: Spring Chinook salmon, steelhead, bull trout, westslope cutthroat trout.	Drainage area: 107,400 acres

STATUS: Category 1

- Designated as a tier 1 Key Watershed in Northwest Forest Plan.

SIGNIFICANT SUBWATERSHEDS:
Upper Lost River, Lost River

FACTORS AFFECTING HABITAT CONDITION: The Lost River is generally in very good condition with the exception of some relatively minor effects in the lower mile or two.

- 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 are currently low, due to removal for flood control and firewood. However, the potential for recruitment of woody debris is at natural levels.
- County Road bridge is too small

LEVEL OF CERTAINTY / DATA GAPS:

- Watershed surveys by USFS provide high level of certainty.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing intact and functioning habitats

Tier 2

Floodplain Restoration

- Develop and implement a flood hazard protection plan that is compatible with natural channel maintaining processes and flood plain function.
- Allow for woody debris recruitment.

Other (not yet rated for tier level)
Cougar Lake- phantom fishing gear mess at the mouth in the log jam

CHEWUCH RIVER ASSESSMENT AND STRATEGY

Species: Spring Chinook salmon, steelhead, bull trout, westslope cutthroat trout.	Drainage area: 340,000 acres

STATUS: Category 2

- Designated as a Key Watershed in NWFP.

SIGNIFICANT SUBWATERSHEDS:

Lake Creek, Lower Chewuch River, Eightmile Creek

FACTORS AFFECTING HABITAT CONDITION:

- Channel clearing and LWD removal reduced channel complexity in the Chewuch River from RM 0 to 20.
- 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 Boulder Creek.
- Skid roads in riparian areas upstream of Boulder Creek 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.
- High water temperatures in the lower river may at times cause a migration barrier.
- Livestock grazing may have potential impacts on riparian areas in tributaries.
- High road densities along the mainstem Chewuch and in Cub, Eightmile, and Boulder creeks combined with highly erosive soils create sediment and bank erosion problems.
- Road constriction at river mile 1.7 on Eightmile Creek creates a probable barrier for steelhead, bull trout and spring Chinook.
- High densities of brook trout in some tributaries.
- Much of the watershed (~3/4) has burned since 2001.

LEVEL OF CERTAINTY / DATA GAPS:

- Field habitat analyses have been conducted on both private and public lands, allowing a high confidence in assessment.
- 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.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing intact and functioning habitats (particularly in the lower 9 miles of the mainstem)

Water Quantity Restoration

- Improve natural water storage by allowing offchannel connection, floodplain function and beaver recolonization
- Increase stream flow through irrigation practice improvements and water leases/purchases

Habitat Diversity

- Restore habitat-forming processes and channel complexity of the Chewuch River from RM 0 to 28.
- LWD restoration and recruitment
- Side-channel reconnection

Sediment

- Transportation planning, road reconstruction, road maintenance, undersized culvert replacement
- Reduce road densities

Tier 2

Riparian Restoration

- Fence riparian areas and wetlands; maintain existing fences

Ecological Interaction

- Reduce or eliminate brook trout
- Add nutrients using hatchery carcasses and/or carcass analogs

Tier 3

Obstructions

- Improve fish passage at Eight Mile Creek

Tier 4

Riparian Restoration

- Continue Respect the River and expand to Eightmile

TWISP RIVER ASSESSMENT AND STRATEGY	
Species: Spring Chinook salmon, steelhead, bull trout, westslope cutthroat trout.	Drainage area: 157,000 acres

STATUS: Category 2, Major spawning area for spring Chinook and steelhead and a core area for bull trout.

- Designated as a key watershed in NWFP.

SIGNIFICANT SUBWATERSHEDS:

Middle Twisp, Lower Twisp, North Creek, Buttermilk Creek, Little Bridge Creek

FACTORS AFFECTING HABITAT CONDITION:

- Low instream flows and high water temperatures in the lower Twisp River affect several species at several life history stages.
- 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 highly simplified channel.
- In the lower Twisp River (RM 0.0 – 16.5) LWD levels and recruitment potential are well below amounts expected.
- 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.
- The lower Twisp River is listed on the Washington State 303(d) list for inadequate instream flow and for temperature exceedence.
- Development of riparian and floodplain areas from river mile 0-17.
- The road in Little Bridge Creek affects stream channel function.

LEVEL OF CERTAINTY / DATA GAPS:

- Field habitat analyses have been conducted on public lands, allowing a 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.
- Some uncertainty exists on relation of instream flows and fish habitat.
- Increasing recreational demand in key salmonid production areas in the Upper Twisp River is a concern.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect remaining floodplain and riparian habitat.

Water Quantity (Lower Twisp)

- Reduce water withdrawals and lease/purchase water rights.

Floodplain Restoration

- Remove or modify levees and dike were appropriate
- Replace undersized culverts to restore alluvial fan function and delivery of LWD and gravel to Twisp River.
- Side channel reconnection and restoration
- Reestablish beaver populations (some additional benefits to water quantity and winter temperatures).

Sediment

- Road maintenance, road reconstruction, heavy maintenance and obliteration where appropriate

Riparian Restoration

- Fence wetlands and riparian areas on USFS to allow recovery from livestock grazing and beaver recolonization.
- Increase LWD recruitment and retention in the lower 11 miles of Twisp River.

Tier 2

Ecological Interaction

- Add nutrients using hatchery carcasses and/or carcass analogs

Tier 3

Obstructions

- Improve passage (*any mainstem Twisp passage impediments would be Tier 1*)
- Replace any culverts that impede anadromous fish passage (tributaries)

Riparian Restoration

- Manage recreation site impacts to floodplain (North Creek/Gilbert area, Reynolds Creek)

Ecological Interaction

- Reduce or eliminate brook trout

UPPER MAINSTEM METHOW (HEADWATERS TO CHEWUCH CONFLUENCE) ASSESSMENT AND STRATEGY

Species: spring Chinook salmon, steelhead, bull trout, westslope cutthroat trout.	Drainage area: 322,385 acres

STATUS: Category 2; Major spawning area for spring Chinook and steelhead, core area for bull trout.

SIGNIFICANT SUBWATERSHEDS:
Upper Methow, Mainstem West Fork Methow, Upper Goat Creek, Lower Goat Creek, Little Boulder Creek, Hancock Creek, Wolf Creek

TRIBUTATIES WITHIN THIS REACH: Brush Creek, Trout Creek, Rattlesnake Creek, Robinson Creek, Gate Creek, Goat Creek, Little Boulder Creek, Fawn Creek, Hancock Creek, Little Falls Creek, and Wolf Creek.

FACTORS AFFECTING HABITAT CONDITION:

- The mainstem Methow River between RM 59 and 74 goes dry in low flow years.
- All reaches of the mainstem upper Methow River have LWD levels below USFS standards. Timber harvest and stream cleaning have reduced LWD recruitment in Goat Creek.
- Several small dikes and rip rapped banks cut off important side channel 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.

LEVEL OF CERTAINTY / DATA GAPS:

- Watershed and stream analyses by USFS and USGS provide high level of certainty on habitat conditions. The effect of surface water and groundwater withdrawal on the dewatered reach 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.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect remaining floodplain and riparian habitat.

Water Quantity Restoration **(*Tier 2 in Goat Creek*)**

- Restore drained wetlands
- See floodplain restoration
- Increase stream flows

Floodplain Restoration *(in combination with side channel connection, riparian restoration, and LWD recruitment/retention).*

- Restore natural channel form and function (*remove constrictions and constraints within the channel migration zone*)

Habitat Diversity

Goat Creek strategies are combined and rated as Tier 1. If each strategy is implemented individually then they will have a lower biological benefit.

- Reactivate historic channel to split flow on alluvial fan and improve function
- Add LWD complexes to channel to match natural wood loads in functioning reaches of Goat Creek
- Riparian Restoration, 2-3 miles replanting and restoration
- LWD enhancement
- Re-establish alluvial fan function - bridge reconstruction

Tier 2

Ecological Interaction

- Add nutrients using hatchery carcasses and/or carcass analogs

Sediment

- Reduce stream bank erosion on mainstem Methow River from Goat Creek to Mazama.
- Roads analysis and reconstruction / obliterations on USFS lands in Upper Goat Creek
- Other tributaries that supply unnatural levels of sediment to the mainstem spawning reaches

Riparian Restoration

- Wolf and Hancock Creeks
- LWD restoration

Tier 3

Habitat Diversity

- Instream structures in Hancock Creek
- Off-channel livestock water facility in Hancock Creek

Obstructions

- Diversion in Goat Creek

MIDDLE MAINSTEM METHOW RIVER (CHEWUCH RIVER CONFLUENCE TO TEXAS CREEK CONFLUENCE) ASSESSMENT AND STRATEGY	
Species: Spring and summer Chinook salmon, steelhead, bull trout.	**Drainage area:** 15,600 acres
STATUS: Category 2, major spawning area for steelhead and spring Chinook (based on historic intrinsic potential) ▪ The mainstem Methow River is an important migration corridor for spring Chinook salmon, steelhead and bull trout. Spawning and rearing habitat for summer Chinook salmon and steelhead.	
SIGNIFICANT SUBWATERSHEDS:	
TRIBUTARIES WITHIN THIS REACH: Alder Creek, Bear Creek, Beaver Creek and Benson Creek (see separate assessment and strategy summary for Beaver Creek)	

Tier 4

Riparian Restoration

- Manage dispersed recreation use in riparian areas throughout the watershed.

FACTORS AFFECTING HABITAT CONDITION:

- Residential development is affecting riparian and floodplain condition.
- The Methow Valley 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.
- The mainstem Methow is on the state 303(d) list for temperatures.
- Rip Rap has caused channel constriction and cutoff sidechannel habitat.
- Barkley diversion is a river cobble push-up dam in the mainstem Methow.

LEVEL OF CERTAINTY / DATA GAPS:

- Habitat in the Middle Mainstem 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.
- The effects of irrigation water withdrawal on stream flows are not fully understood.
- Passage barriers have been inventoried, but not fully assessed.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect functioning floodplain, riparian habitat, and side channels in the middle Methow River.

Floodplain and Side Channel Restoration

- Restore access by the mainstem channel to floodplains and side channels disconnected by dikes.

Obstructions

- Correct and maintain the MVID and Barkley diversions.

Tier 2

Large Woody Debris Restoration

- Increase recruitment and retention of LWD within the mainstem Methow River.

Tier 3

Ecological Interaction

- Reduce or eliminate brook trout

LOWER METHOW (TEXAS CREEK CONFLUENCE TO MOUTH) ASSESSMENT AND STRATEGY

Species: Summer and spring Chinook salmon, steelhead, bull trout.	Drainage area: 200,000 acres

STATUS: Category 2; Gold, Libby, and French Creeks were classified as minor spawning areas (based on intrinsic potential, not current known spawning)

- The mainstem Methow River is an important migration corridor for spring Chinook salmon, steelhead and bull trout. Spawning and rearing habitat for summer Chinook salmon and steelhead.

SIGNIFICANT SUBWATERSHEDS:
Libby Creek, Gold Creek

IMPORTANT TRIBUTARIES: Texas Creek, McFarland Creek, French Creek, Squaw Creek and Black Canyon Creek.

FACTORS AFFECTING HABITAT CONDITION:

- Culverts, roads, and irrigation diversion structures impede salmonid passage on several tributaries.
- Roads on several tributaries contribute to sedimentation and riparian degradation, and loss of floodplain and channel function.
- Low instream flows in Libby and Gold creeks likely impact salmonid distribution and abundance.

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.
- Spawning and rearing of salmonids in the mainstem are regularly surveyed, providing a higher level of certainty.
- Spawning in Lower Methow tributaries is infrequently surveyed, leading to uncertainty regarding the extent of steelhead use.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect remaining floodplain and riparian habitat (mainstem Methow river, Gold, Libby, and any other creeks with anadromous fish access).

Obstructions

- Correct fish barriers on USFS in Gold Creek
- Replace or properly modify diversion screens to meet fish passage standards.

Tier 2

Water Quantity

- Restore flows where feasible (mainstem Methow River, Gold Creek, Libby Creek)
- In upstream areas, reestablish natural off channel storage capacity areas by reconnecting side channels, wetlands, and beaver ponds.

Tier 3

Floodplain Restoration

- Lower portions of Gold and Libby creeks
- Dike removal and side channel reconnection where appropriate (mainstem Methow, Gold Creek)

Sediment

- Road management in Gold and Libby creeks

Tier 4

Riparian Restoration

- Revegetation of riparian areas along unused agricultural areas (mainstem and tributaries)

Obstructions

- Provide unobstructed access to anadromous fish in smaller tributary streams

Sediment

- Road management in smaller tributary watersheds

Ecological Interaction

- Reduce or eliminate brook trout *(Gold and Libby Creeks)*

Riparian Restoration

- Implement Respect the River Program (Foggy Dew, North Fork Gold, Crater creeks)

BEAVER CREEK ASSESSMENT AND STRATEGY	
Species: steelhead and bull trout.	**Drainage area:** 15,600 acres
STATUS: Category 2; Major spawning area for steelhead, some juvenile rearing potential for spring Chinook and currently some bull trout recolonization.	
SIGNIFICANT SUBWATERSHEDS: none	
TRIBUTARIES WITHIN THIS REACH: Frazier Creek, Lightning Creek, South Fork Beaver Creek	
FACTORS AFFECTING HABITAT CONDITION: ▪ 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, though the vast majority of passage problems have been fixed.	
LEVEL OF CERTAINTY / DATA GAPS: ▪ Habitat surveys have not been completed on the lower privately owned areas.	

HABITAT ACTION RECOMMENDATIONS:
Tier 1

In-stream Flow
- Improve in-stream flow from the month of Blue Buck Creek to the confluence with the Methow.
- Water rights purchase and lease.

Sediment Reduction
- Road maintenance (Transportation planning in Beaver creek watershed: reconstruction, heavy maintenance, and replace undersized culverts in Lightning Cr.)

Tier 3

Riparian Restoration
- Livestock exclusion fence maintenance on NF
- Restore natural water storage areas through beaver reintroductions

Obstruction

- Culvert replacement for fish passage on USFS

Ecological Interaction
- Reduce or eliminate brook trout

Tier 4

Riparian Restoration
- Implement Respect the River Program (20 acres on USFS, 40 acres on WDFW)
- enforcement of NF firewood cutting regulations

Appendix C.4: Okanogan River Subbasin

UPPER CANADIAN MAINSTEM OKANOGAN (MCINTYRE DAM TO VERTICAL DROP STRUCTURE 12) ASSESSMENT AND STRATEGY	
Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 2, Major spawning area for sockeye, minor spawning area for summer steelhead and summer Chinook.

- This reach is the primary spawning habitat for the largest sockeye salmon population remaining in the Columbia River basin.
- Summer steelhead are know to spawn in the main-stem Okanagan River and Vasuex Creek but the magnitude and distribution is still uncertain.
- Summer/fall Chinook are known to spawn in this reach but the magnitude and distribution are unknown. This stock is under review for listing under SARA (the Canadian version of ESA)

SIGNIFICANT SUBWATERSHEDS:

- Vaseux Creek

FACTORS AFFECTING HABITAT CONDITION:

- McIntyre Dam is the current terminus to anadromous fish in the Okanogan River subbasin
- Urbanization of region is affecting water quality and quantity and is accelerating the eutrophication of Osoyoos Lake.
- Irrigation withdrawals are largely unscreened.
- Intermittent surface water flows restrict fall spawner use of Vasuex Creek and the movements of juvenile salmonids during the summer and fall.

LEVEL OF CERTAINTY / DATA GAPS:

- Annual ONA surveys indicate level and areas of sockeye salmon use.
- Water quantity parameters documented through OBMEP and federal government efforts.
- In-stream and riparian habitats have been quantified but priority areas have not been established.
- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables including summer steelhead spawner location and enumeration plus relative parr abundance
- Video monitoring at Zosel dam provide broad scale data on spawner abundance for all anadromous fish
- The summer steelhead and summer/fall spawning distribution uncertainties need to be addressed
- Causes and solutions to intermittent flows at the lower end of McIntyre Creek should be investigated.
- Assess sediment inflows to develop a sediment budget for this portion of the subbasin

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Protect existing riparian habitat

Obstructions

- Removal of / or passage through McIntyre Dam (Current terminus for all anadromous fish in the Okanogan River subbasin

Floodplain Restoration

- Restore riparian habitat and channel migration floodplain function.
- Dike setback from vertical drop structure 12 upstream.

Tier 3

In-stream Flow

- Address intermittent flow issues in the lower reaches of Vasuex Creek.

Obstructions

- Improve screening compliance for all water withdrawal wherever approximate throughout this assessment unit.

LOWER CANADIAN MAINSTEM OKANOGAN (VERTICAL DROP STRUCTURE 12 TO U.S. / CANADA BOARDER) ASSESSMENT AND STRATEGY.

Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 2

- Spawner abundance suggests that Inkameep Creek should be considered a minor spawning area but information related to spawning distribution is still uncertain.

SIGNIFICANT SUBWATERSHEDS:

- Inkaneep Creek

FACTORS AFFECTING HABITAT CONDITION:

- Late summer water temperatures exceed salmonid tolerance levels, both in the river and in Lake Osoyoos. The North Basin of Lake Osoyoos provides the only thermal refuge for adult sockeye.
- Turbidity, suspended sediment, and nutrient loading exacerbate water temperature and water quality exceedences, and effect spawning and rearing habitat.
- The stream corridor has been modified, disconnecting floodplain from the stream channel, and reducing riparian habitat.
- Vertical Drop Structures in stream channel affect bedload movement and channel forming processes.
- Urbanization of region is affecting water quality and quantity and is accelerating the eutrophication of Osoyoos Lake.

LEVEL OF CERTAINTY /DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables including summer steelhead spawner location and enumeration plus relative parr abundance
- A picket weir was place on Inkameep Creek in 2006.
- Water quantity parameters documented through OBMEP and federal government efforts.
- Instream and riparian habitats have not been quantified; priority areas have not been established.
- Radio telemetry studies verify effects of dam operations and water temperatures on upstream migration behavior of sockeye, summer Chinook and steelhead.
- Video monitoring at Zosel dam provide broad scale data on spawner abundance for all anadromous fish
- Assess sediment inflows to develop a sediment budget for this portion of the subbasin

HABITAT ACTION RECOMMENDATIONS:

Tier 1
Protect and restore existing riparian habitat and channel migration floodplain function.

Floodplain/Side Channel Restoration

- Dike setback from vertical drop structure 12 downstream to Osoyoos Lake.
- Reconnect historical side channel habitats along the reach from vertical drop structure 12 downstream to Osoyoos Lake.

Tier 3
Obstructions

- Improve screening compliance for all water withdrawal wherever approximate throughout this assessment unit.

Tier 4
Riparian Restoration (primarily in the Inkaneep Creek subwatershed)

- Implement best range management practices.
- Revegetate stream banks using native species.

UPPER UNITED STATES MAINSTEM OKANOGAN (U.S. / CANADA BOARDER TO SIMILKAMEEN CONFLUENCE) ASSESSMENT AND STRATEGY.	
Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 2

- Important migration corridor for sockeye salmon and steelhead.
- Spawning and rearing habitat for summer Chinook salmon.
- Minor spawning area for summer steelhead.

SIGNIFICANT SUBWATERSHEDS:

- Nine Mile Creek (See small tributary assessment)
- Tonasket Creek (See small tributary assessment)

FACTORS AFFECTING HABITAT CONDITION:

- Managed water releases at Zosel Dam have the potential to scour/desiccate redds.
- Late summer water temperatures exceed salmonid tolerance levels, both in the river and in Lake Osoyoos. Turbidity, suspended sediment, and nutrient loading exacerbate water temperature and water quality threshold violations, and effect spawning and rearing habitat.
- The stream corridor has been modified, disconnecting floodplain from the stream channel, and reducing riparian habitat.
- Low flows during the summer and fall restrict fall spawners to main-stem spawning areas and juvenile steelhead use to limited rearing habitat in the tributaries.
- Disconnected or reduced flows in tributaries have altered sediment recruitment structure and function.
- An abundance of smallmouth bass likely impacts juvenile salmon survival especially juvenile summer Chinook.
- Poorly screened irrigation pumps represent an unquantified hazard to juvenile salmon and out-migrating smolts especially naturally produced summer Chinook.

LEVEL OF CERTAINTY / DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Annual steelhead redd surveys.
- Water quantity parameters documented through OBMEP and federal government efforts.
- Annual summer/fall Chinook redd and carcass surveys.
- Zosel dam video counting data verify effects of dam operations and water temperatures on upstream migration behavior of sockeye, summer Chinook and steelhead plus provides broad scale data on spawner abundance for all anadromous fish passing above Zosel Dam.
- Develop a fish water management tool to help manage water releases from Zosel Dam to enhance spawning, incubation and rearing of summer steelhead and summer/fall Chinook.
- Develop pit-tagging technology at Zosel Dam to improve understanding of habitat use by anadromous fish.
- Knowledge about habitat and fish use above river kilometer 1.3 on Nine Mile Creek remains a data gap.
- Conduct predator index studies to determine amount and extent of smallmouth bass and northern pike minnow predation on salmon and steelhead.
- Annual passage maintenance at tributary mouths and on small tributaries.

HABITAT ACTION RECOMMENDATIONS:

Tier 1 and Teir 2 (none identified)

Tier 3

Protect existing spawning areas, mature riparian areas, and side channel habitats throughout this assessment area

In-Stream Flows

- Increase discharge through irrigation efficiencies, groundwater conversions, and water banking especially in the tributaries.

Tier 4

Obstructions

- Increase surface water flows
- Reduce surface diversions
- Screen irrigation pumps
- Improve culvert passage

Riparian Restoration

- Implement best range management practices.
- Revegetate stream banks using native species.

Habitat Diversity

- Installation of large woody debris
- Creation of in-stream structures

UPPER MIDDLE UNITED STATES MAINSTEM OKANOGAN RIVER (SIMILKAMEEN CONFLUENCE TO BONAPARTE CREEK) ASSESSMENT AND STRATEGY.

Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 3

- Important migration corridor for sockeye, Chinook salmon and steelhead.
- Important rearing habitat for summer Chinook salmon.

SIGNIFICANT SUBWATERSHEDS:

- Wildhorse Spring Creek
- Antoine Creek
- Siwash Creek (See small tributary assessment)

FACTORS AFFECTING HABITAT CONDITION:

- Late summer water temperatures exceed salmonid tolerance levels along main-stem habitats. Turbidity, suspended sediment, and nutrient loading exacerbate water temperature and water quality threshold violations, and effect spawning and rearing habitat.
- The stream corridor has been modified, disconnecting floodplain from the stream channel, and reducing riparian habitat.
- Low flows during the summer and fall restrict fall spawners to main-stem spawning areas and juvenile steelhead use to limited rearing habitat in the tributaries.
- Highly erosive soils and widespread livestock use make river banks highly unstable
- Low gradients make this reach ideal for deposition of fine sediments.
- Disconnected or reduced flows in tributaries have altered sediment recruitment structure and function.
- An abundance of smallmouth bass likely impacts juvenile salmon survival especially juvenile summer Chinook.
- Poorly screened irrigation pumps represent an unquantified hazard to juvenile salmon and out-migrating smolts especially naturally produced summer Chinook.

LEVEL OF CERTAINTY /DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Water quantity parameters documented through OBMEP and federal government efforts.
- In-stream and riparian habitats have been quantified and the main-stem reaches are not considered suitable for salmonid spawning
- Priority areas do exist for rearing of summer Chinook and adult holding habitats for sockeye and summer Chinook.
- Conduct predator index studies to determine amount and extent of smallmouth bass and northern pike minnow predation on salmon and steelhead.
- Expand knowledge of the use of Wildhorse Spring Creek by summer steelhead.
- Annual passage maintenance at tributary mouths and on small tributaries.

HABITAT ACTION RECOMMENDATIONS:

Tier 1 and Teir 2 (none identified)

Tier 3

In-Stream Flows

- Increase discharge through irrigation efficiencies, groundwater conversions, and water banking especially in the tributaries.

Protect existing spawning areas, mature riparian areas, and side channel habitats in tributaries associated with this assessment area.

Tier 4

Obstructions

- Increase surface water flows
- Reduce surface diversions
- Screen irrigation pumps
- Improve culvert passage

Riparian Restoration and Sediment Reduction

- Implement best range management practices.
- Reslope banks
- Revegetate stream banks using native species.

Habitat Diversity

- Installation of large woody debris
- Creation of in-stream structures

Floodplain Restoration

- Reconnect side-channels
- Reconnect floodplains

LOWER MIDDLE UNITED STATES MAINSTEM OKANOGAN RIVER (SIWASH CREEK TO SALMON CREEK) ASSESSMENT AND STRATEGY.

Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 2

- Important migration corridor for sockeye, Chinook salmon and steelhead.
- Important spawning and rearing habitat for summer Chinook salmon.
- Minor spawning area for summer steelhead

SIGNIFICANT SUBWATERSHEDS:

- Bonaparte Creek
- Aeneas Creek
- Tunk Creek
- Johnson Creek
- Wanacut Creek
- Omak Creek (has its own assessment unit)

FACTORS AFFECTING HABITAT CONDITION:

- Late summer water temperatures exceed salmonid tolerance levels in main-stem habitats. Turbidity, suspended sediment, and nutrient loading exacerbate water temperature and water quality threshold violations, and effect spawning and rearing habitat.
- The stream corridor has been modified, disconnecting floodplain from the stream channel, and reducing riparian habitat.
- Low flows during the summer and fall restrict fall spawners to main-stem spawning areas and juvenile steelhead use to limited rearing habitat in the tributaries.
- Development along the river threatens floodplain and riparian habitat.
- Braided areas and gradient drops define priority spawning areas for both summer steelhead and Chinook salmon (i.e. below Bonaparte Creek, near Janis Bridge, Janis Rapids, McAlister Rapids, and near Shellrock Point)
- Disconnected or reduced flows in tributaries have altered sediment recruitment structure and function.
- An abundance of smallmouth bass likely impacts juvenile salmon survival especially juvenile summer Chinook.
- Poorly screened irrigation pumps represent an unquantified hazard to juvenile salmon and out-migrating smolts especially naturally produced summer Chinook.

LEVEL OF CERTAINTY / DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Water quantity parameters documented through OBMEP, State, and federal government efforts.
- In-stream and riparian habitats have been quantified and the main-stem reaches with braided areas and gradient drops define priority spawning areas for both summer steelhead and Chinook salmon (i.e. below Bonaparte Creek, near Janis Bridge, Janis Rapids, McAlister Rapids, and near Shellrock Point)
- Priority areas also exist for rearing of summer Chinook and adult holding habitats for sockeye and summer Chinook near cold water tributary inflows.
- Conduct predator index studies to determine amount and extent of smallmouth bass and northern pike minnow predation on salmon and steelhead.
- Annual redd survey for summer steelhead conducted in main-stem and tributary habitats.
- Annual redd and carcass surveys for summer Chinook conducted in this reach.
- Annual passage maintenance at tributary mouths and on small tributaries.

HABITAT ACTION RECOMMENDATIONS:

Tier 1 (none identified)

Tier 2

Protect existing coldwater tributary inputs and spawning areas associated with this assessment area.

Habitat Diversity

- Improve habitat diversity and complexity.

Tier 3

In-Stream Flows

- Increase discharge through irrigation efficiencies, groundwater conversions, and water banking.

Riparian Restoration

- Protect and enhance existing mature riparian areas, and floodplain function associated with this assessment area.

Obstructions

- Increase surface water flows
- Reduce surface diversions
- Screen irrigation pumps
- Improve culvert passage

Tier 4

Sediment

- Implement best range management practices.
- Reslope banks
- Revegetate stream banks using native species.
- Decommission Roads (Bonaparte Creek-subwatershed)
- Develop sediment catch basins (Bonaparte Creek-subwatershed)

LOWER UNITED STATES OKANOGAN RIVER (SALMON CREEK TO WELLS POOL) ASSESSMENT AND STRATEGY.

Species: Sockeye salmon, summer/fall Chinook salmon, steelhead.	Drainage area:

STATUS: Category 3

- Important migration corridor for sockeye, Chinook salmon and steelhead.
- Important spawning and rearing habitat for summer/Fall Chinook salmon.

SIGNIFICANT SUBWATERSHEDS:

- Salmon Creek (has its own assessment unit)
- Loup Loup Creek (has its own assessment unit)
- Chiliwist Creek

FACTORS AFFECTING HABITAT CONDITION:

- Late summer water temperatures exceed salmonid tolerance levels in main-stem habitats. Turbidity, suspended sediment, and nutrient loading exacerbate water temperature and water quality threshold violations, and effect spawning and rearing habitat.
- The stream corridor has been modified, disconnecting floodplain from the stream channel, and reducing riparian habitat.
- Low flows during the summer and fall restrict fall spawners to main-stem spawning areas and juvenile steelhead use to limited rearing habitat in the tributaries.
- Development along the river threatens floodplain and riparian habitat.
- Extensive riparian habitat loss and degradation throughout the main stem Okanogan River, causing very high width:depth ratios, low woody debris levels, sedimentation, and embedded spawning gravels.
- Disconnected or reduced flows in tributaries have altered sediment recruitment structure and function.
- An abundance of smallmouth bass likely impacts juvenile salmon survival especially juvenile summer Chinook.
- Poorly screened irrigation pumps represent an unquantified hazard to juvenile salmon and out-migrating smolts especially naturally produced summer Chinook.

LEVEL OF CERTAINTY / DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Water quantity parameters documented through OBMEP, and federal government efforts.
- In-stream and riparian habitats have been quantified along the main-stem reaches, poor spawning habitat is limited to braided areas with a gradient drop and is often associated this tributary inflows that produce a gravel bar a short distance downstream of the confluence.
- Conduct predator index studies to determine amount and extent of smallmouth bass and northern pike minnow predation on salmon and steelhead.
- Annual redd survey for summer steelhead conducted in main-stem and tributary habitats.
- Annual redd and carcass surveys for summer Chinook conducted in this reach.
- Annual passage maintenance at tributary mouths and on small tributaries.

HABITAT ACTION RECOMMENDATIONS:
Tier 1 or Tier 2 (none identified)

Tier 3

In-Stream Flow
- Increase discharge through irrigation efficiencies, groundwater conversions, and water banking.

Riparian Restoration
- Protect and enhance riparian habitats
- Improve bank stability

Tier 4

Obstructions
- Screen all irrigation pumps
- Increase surface water flows

SIMILKAMEEN RIVER ASSESSMENT AND STRATEGY	
Species: Summer Chinook salmon, steelhead, and sockeye salmon.	Drainage area: 228,536

STATUS: Category 2

- Highly used summer Chinook salmon spawning and rearing downstream of Enloe Dam (at RK 14), which is a barrier to migration.
- Minor spawning area for Summer Steelhead
- Major coldwater refugia and adult holding area for migrating summer Chinook and sockeye salmon

SIGNIFICANT SUBWATERSHEDS:

- Several tributaries exist in both the United States and Canada, however, all are above Enloe Dam which current blocks upstream passage for all fish so they are not listed here.

FACTORS AFFECTING HABITAT CONDITION:

- Grazing, mining, irrigation, and road building have caused extensive upland erosion and floodplain degradation, which has deteriorated several water quality parameters and both riparian and in-stream habitat.
- Enloe Dam blocks upstream migration of summer Chinook salmon, summer steelhead and sockeye salmon.
- An abundance of smallmouth bass likely impacts juvenile salmon survival especially juvenile summer Chinook.

LEVEL OF CERTAINTY / DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Water quantity parameters documented through State and federal government.
- In-stream and riparian habitats have been quantified along the main-stem reaches, priority high quality spawning areas are mostly located downstream of the town of Oroville , WA.
- Annual redd survey for summer steelhead conducted in main-stem and tributary habitats.
- Annual redd and carcass surveys for summer Chinook conducted in this reach.
- Sedimentation impacts from most significant sources are well documented.
- There is uncertainty over historical distribution of anadromous salmonids in this watershed.
- Total dissolved gas level are unknown but believed to be higher than established standards

HABITAT ACTION RECOMMENDATIONS:
Tier 1 and Tier 2 (none identified)

Tier 3
Protect existing spawning and riparian areas

Habitat Diversity
- Increase channel complexity by reconnecting off-channel and side-channel habitats
- Gravel supplementation

Tier 4
Riparian Restoration
- Livestock exclusion
- Revegetate stream banks using native species where possible

OMAK CREEK ASSESSMENT AND STRATEGY

Species: Summer steelhead and Spring Chinook.	Drainage area: 90,691 acres

STATUS: Category 2
- Major spawning area for summer steelhead
- Spring Chinook have been reintroduced but no natural spawning has been documented to date.

SIGNIFICANT SUBWATERSHEDS:
Stapaloop Creek is the largest tributary to Omak Creek but is located above Mission Falls. Because passage has yet to be documented above Mission Falls, Stapaloop Creek was not considered as part of this assessment unit.

FACTORS AFFECTING HABITAT CONDITION:
- Poor upslope condition in rangeland and forested areas contribute to sedimentation, water quality and quantity concerns.
- Loss of riparian habitat and floodplain due to increased channel incision.
- Passage currently limits fish to below Mission Falls

LEVEL OF CERTAINTY / DATA GAPS:
- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- Water quantity parameters documented through State government.
- In-stream and riparian habitats have been quantified along the main-stem reaches, priority high quality spawning areas are mostly located downstream of Mission Falls.
- Annual redd survey for summer steelhead conducted throughout watershed.
- Permanent weir capable of trapping all adult fish entering this watershed.
- Pit-tag and screw trap data collected annually to monitor smolt out-migrations.
- Parental origin study is being conducted to determine contribution of wild, hatchery, and reconditioned kelt steelhead.
- Range and forest conditions assessed through federal and tribal surveys.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

Obstructions

- Ensure fish passage at Mission Falls by modifying or extending existing fish passage structures and installing additional structures needed to ensure passage under a broad range of discharges.

Tier 2

Sediment

- Decommission roads
- Repair or replace road culverts that are undersized or at risk of washing out.

Tier 3

Riparian and Floodplain Restoration

- Remove livestock and implement best management practices throughout the watershed
- Develop springs and watering point away from the stream
- Stabilize banks using native vegetation wherever possible
- Increase habitat diversity using large woody debris and in-stream structures

Tier 4

Obstruction

- Replace culverts above Mission Falls that impede fish passage after passage at falls has been documented.

SALMON CREEK ASSESSMENT AND STRATEGY

Species: Summer steelhead and historical Spring Chinook and bull trout habitat.	Drainage area: 98,625 acres

STATUS: Category 3,
However, with long-term water lease that provides passage above the OID diversion it would become a category 2

- Intrinsic potential to be major spawning area for summer steelhead and minor spawning area for spring Chinook once water releases provide passage in the lower 4.3 kilometers.

SIGNIFICANT SUBWATERSHEDS:

The West, South, and North forks of Salmon Creek along with Pelican Creek are all located above Conconully Dam which has no provisions for fish passage. Therefore, these subwatershed were not considered as part of this assessment.

FACTORS AFFECTING HABITAT CONDITION:

- Dewatered reach downstream of OID irrigation diversion dam prevents upstream migration to entire watershed, and all life histories in lower reach.
- Conconully Dam operations have substantially modified stream channel morphology and function.
- Lack of year round flows in the lower 9.6 kilometers have resulted in a complete lack of riparian habitat in many areas resulting in poor channel stability, lack of habitat diversity, and water quality issues.
- Some reaches upstream of OID diversion dam have high width: depth ratios, and lack streambank vegetation and woody debris.

LEVEL OF CERTAINTY / DATA GAPS:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in resident fish population densities, water quality, and physical habitat variables.
- Water quantity parameters are not publicly available although data collection infrastructure exists above the OID diversion and at Conconelly Dam.
- In-stream and riparian habitats have been quantified above the OID diversion Dam and above Conconully Dam but no priority habitats have been identified.
- To document returning anadromous fish pit-tag and video counting equipment could be installed at the OID diversion dam. This would provide highly accurate adult spawner counts and smolt enumerations.
- Annual redd and snorkel surveys would help to identify priority spawning and rearing areas.
- Detailed habitat information will need to be collected once priority spawning and rearing areas are identified.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

In-Stream Flow

- Ensure summer steelhead adults and smolts have sufficient water to migrate through the lower 9.6 kilometers of Salmon Creek, Annually.
- Sign MOA with OID for long-term minimum flow release.
- Establish a water bank for addition flow that improves passage or extends the passage window.
- Work with irrigators to conserve water to extend flow for reestablishment of groundwater and riparian structure and function.
- Utilize Watercress Springs to improve hydrolic connectivity in the lower 4.4 kilometers of Salmon Creek.

Tier 2 and Tier 3 (none identified)

Tier 4

Obstructions

- Create a properly functioning channel that passes high flow while retaining migratory habitat during low flow.

Riparian and Floodplain Restoration

- Implement best range management practices throughout the watershed
- Develop springs and watering point away from the stream
- Stabilize banks using native vegetation wherever possible
- Increase habitat diversity using large woody debris and in-stream structures

LOUP LOUP CREEK ASSESSMENT AND STRATEGY	
Species: Summer steelhead and historical bull trout	Drainage area: 9,081 acres

STATUS: Category 3

- Summer steelhead has been documented but is limited to wet years when water flows during the spring.
- Has the potential to become a minor spawning area for summer steelhead if flows were consistently provided

SIGNIFICANT SUBWATERSHEDS:

Little Loup Loup Creek is located above Loup Loup Falls (RKM 4.8) which is the terminus for anadromous fish so it was not included in this assessment.

FACTORS AFFECTING HABITAT CONDITION:

- Dewatered reach downstream of irrigation diversion prevents upstream migration to entire watershed, and all life histories in lower reach.
- Perched culverts impede passage to most fish above river kilometer 0.1.
- Water claims are over allocated in this watershed.
- Poor upslope condition in rangeland and forested areas contribute to sedimentation, water quality and quantity concerns.
- Riparian habitat and floodplain connections have been lost due to lack of flow for much of the year.
- Habitat diversity is low due to the lack of large woody debris and a natural hydrograph.

LEVEL OF CERTAINTY:

- The OBMEP has established monitoring sites in this reach to monitoring the long-term status and trends in water quality, physical habitat and biological variables.
- No water quantity parameters are currently documented and no infrastructure exists.
- In-stream and riparian habitats have not been quantified along below Loup Loup Falls, and no priority habitats have been designated due to lack of use by anadromous fish.
- Annual redd survey for summer steelhead conducted throughout watershed.
- Detailed habitat information will need to be collected once priority spawning and rearing areas are identified.

HABITAT ACTION RECOMMENDATIONS:

Tier 1

In-Stream Flow

- Convert surface water diversions to ground water or Okanogan River sources.
- Increasing irrigation efficiencies
- Establish long-term flow agreements to provide passage flows for adult steelhead, out-migration smolts, and rearing habitat.
- Establish a water bank

Obstructions

- Replace or remove culverts that impede fish passage
- Modify roads as needed if culverts are removed
- Ensure passage at all irrigation withdrawal structures

Tier 2 (none indicated)

Tier 3

Channel Complexity and Habitat Diversity

- Install large woody debris and in-stream structures
- Implement best range management practices throughout the watershed
- Develop springs and watering point away from the stream

Tier 4 (none indicated)

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