

## Appendix H

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

**Discussion Draft (22 May 2003)**

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

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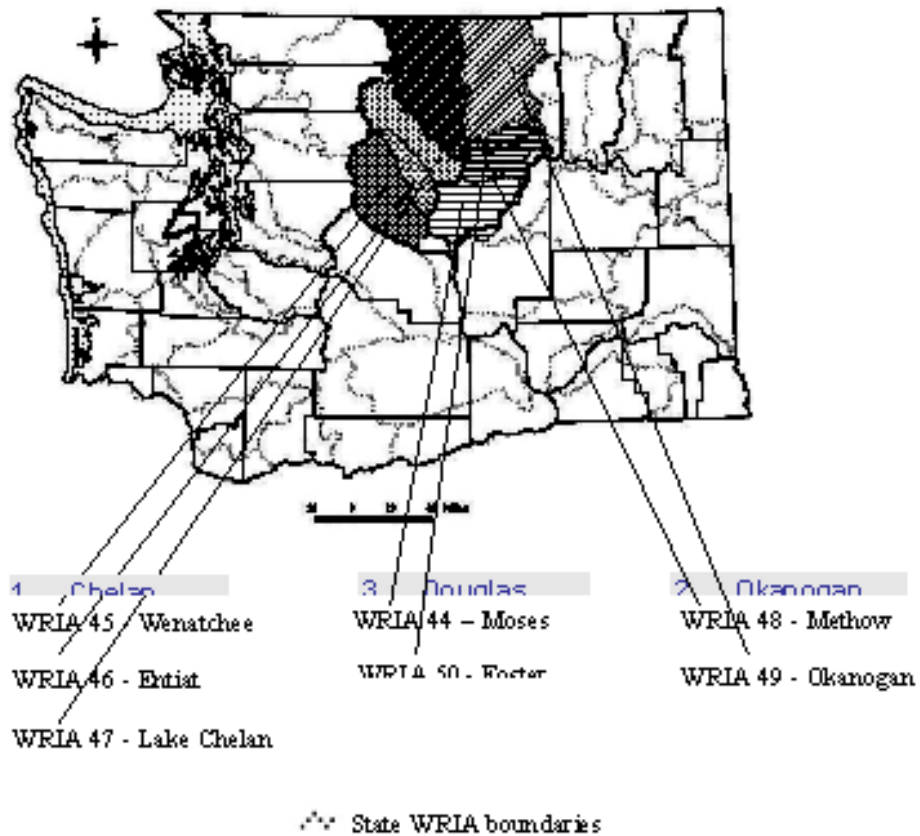
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## A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region

### Introduction

#### *Purpose*

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 a technical foundation to set regional priorities for habitat protection and restoration, based on available information and the professional judgement of fisheries biologists familiar with the region. This report was developed by a Regional Technical Team (RTT), which was established by the Upper Columbia Salmon Recovery Board (UCSRB). This report is an update to initial documents provided to the UCSRB (RTT 2000, 2002a). Further 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). This strategy identifies the key biological considerations in protecting and restoring habitat, yet does not provide recommendations on the means to accomplish these issues, as they generally entail important policy considerations on natural



Note: This figure is incomplete and will be fixed in the next version.

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resource management. Project sponsors are encouraged to use this strategy to identify the locations and types of projects that would provide a high likelihood of benefit to salmonids, yet should work closely with the UCSRB in identifying appropriate means to implement the projects.

The UCSRB is a partnership among Chelan, Douglas, and Okanogan counties, the Yakama Nation, and Colville Confederated Tribes in cooperation with local, state, and federal partners. The mission of the UCSRB is to restore viable and sustainable populations of salmon, steelhead, and other at-risk species through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia Region. To better meet its mission, the UCSRB wishes to ensure that actions taken to protect and restore salmonid habitat in the region are based on sound scientific principles. The UCSRB may use these principles to develop strategies that address the needs of salmon in an economically viable manner.

One 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 (SRFB). The UCSRB directed the RTT to establish a scientific framework for this process, with the premise that it will enable them to identify projects that will best contribute to the recovery of salmonids listed under the ESA. This report is a technical guide to help the Lead Entities, Citizens' Committees, and project sponsors to develop and identify habitat protection and restoration projects.

### *Scope*

The species included in this overview include chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), steelhead (*O. mykiss*), westslope cutthroat trout (*O. clarki*) and bull trout (*Salvelinus confluentus*), although other species will benefit from the recommended priorities in this report. 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 report provides specific recommendations for each of the 31 watersheds (and the mainstem Columbia River) in the region.

The RTT considers this report to be iterative. New and more refined biological priorities could be developed when key policy directives are made, or when new biological data are gathered. The priorities suggested in this report are consistent with the 2000 and 2002 reports released by the RTT.

### *Relation to Other Assessments*

This document complements the Habitat Limiting Factors Analyses (HLFA) conducted by the Washington Conservation Commission. It uses the information in the completed HLFA reports for the Wenatchee, Entiat, Foster Creek/Moses Coulee, Methow and Okanogan WRIs to establish a common framework throughout the region, rather than on an individual WRIA basis. As this strategy develops, it will incorporate findings of individual WRIs under the state's Watershed Planning Act (RCW 90.82). This strategy considers the biological priorities set in the Spirit of the Salmon Recovery Plan by the Columbia River Intertribal Fish Commission and the Tributary Assessment of the Mid-Columbia Mainstem Conservation Plan, and is intended to complement the Subbasin Summaries under the Northwest Power and Conservation Council's Provincial Rolling Review. The integration of tribal, local, state, and federal watershed planning and salmon recovery efforts into this strategy illustrates the coordinated and comprehensive approach of the Upper Columbia Salmon Recovery Board.

### *Priorities in Species Distribution*

Threatened, endangered and unlisted salmonids are found in most, but not all watersheds in the Upper Columbia Region. In order to help guide protection and restoration programs, the RTT 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. Based on the framework established by MacDonald et al. (1996), we considered a subwatershed to be significant if any one of the following criteria was met:

- The subwatershed was identified as a stronghold for the species in the Interior Columbia Basin Assessment (ICBEMP 1997).
- The subwatershed provides the primary spawning and/or rearing habitat within the watershed.
- 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.
- 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.

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- The subwatershed is known or strongly suspected to support a stable, strong population of a species.

Appendix A contains maps of RTT identified Significant Subwatersheds for sockeye salmon, spring chinook salmon, summer chinook salmon, steelhead, and bull trout. Additional Significant Subwatersheds may be identified, or some Significant Subwatersheds may be determined not to be significant, based upon the above criteria, as more information becomes available.

The designation of Significant Subwatershed does not necessarily depict the total distribution or life history stages of salmonids in the Upper Columbia region. Appendix B contains the known distribution of salmonids in the region. However, the status of some salmonid species is not fully known, particularly for those that drain directly into the Columbia River. In an effort to better capture current, known salmonid distributions, the Washington Conservation Commission (WCC) completed GIS coverages for salmonid fish distribution the Upper Columbia region (except Lake Chelan). The coverages were developed by incorporating existing local, state, and federal electronic data and professional knowledge to update the data into 1:24,000 scale coverages. The GIS salmonid fish distribution coverages are available from the WCC office in Olympia, Washington. Available WCC salmonid fish distribution GIS coverages are as follows:

- WRIAs 44 and 50 (Moses Coulee and Foster Creek watersheds), including the mainstem Columbia River from one mile downstream of the Moses Coulee confluence (RM 447.9) upstream to Grand Coulee Dam (RM 596.6) - summer chinook, spring chinook, steelhead, sockeye, bull trout, and coho.
- WRIA 45 (Wenatchee Subbasin), including portions of WRIA 40 (Squilchuck, Stemilt and Colockum creeks) - summer chinook, spring chinook, steelhead, sockeye, and bull trout.
- WRIA 46 (Entiat Subbasin) – summer chinook, spring chinook, steelhead, and sockeye.
- WRIA 48 (Methow Subbasin) - summer chinook, spring chinook, steelhead, and bull trout.
- WRIA 49 (Okanogan Subbasin, U.S. portion only) - summer chinook, spring chinook, steelhead and sockeye.

In spring 2003, WDFW updated their salmonid fish distribution database, StreamNet, with associated GIS coverages, and incorporates the WCC salmonid distribution information. The updated 1:24,000 WDFW StreamNet fish distribution coverages will be available from the WDFW offices in Olympia, Washington.

## **Priorities in Habitat Activities**

### ***Habitat Protection***

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. 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 population areas, or may be at risk to habitat degradation, and should be given greater emphasis. These efforts will likely occur throughout the subbasins where properly functioning habitat remains.

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 full effects of upland habitat degradation on peak flows in the Upper Columbia Region are not understood and should be assessed. The means to increase flows are discussed in the section on habitat restoration.

### ***Habitat Restoration***

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 measures would include, but not be limited to:

- provide fish access to disconnected stream sections or oxbows,
- remove dikes (or similar structures) that prevent stream channel migration,

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- change the points of origin for problematic water withdrawals to less sensitive site(s),
- screen water intakes to prevent impingement or stranding of juvenile fish,
- manipulate stream flows at critical periods through various means,
- provide alternative sources of irrigation and domestic water to mitigate impacts of problematic surface water diversions,
- remove passage barriers,
- use mechanical means to encourage natural development of riparian areas,
- implement upland management practices that reduce sediment delivery to streams, and
- use engineering techniques to increase complexity of permanently altered habitats.

We strongly recommend 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 and (2) those factors that are causing the habitat degradation cannot be corrected within a reasonable time. Remedial measures to rectify the effects of improper land use practices can have more benefits to biological productivity, may be economically more efficient, and be more permanent than measures that require active management of the stream channel. The simple alteration of physical features in the stream channel does not necessarily restore biological productivity when improper riparian or upland management practices continue to exert their effects on the aquatic ecosystem. 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. For example, some short-term habitat benefits might be achieved by adding large woody debris (LWD) to streams, but the benefits can only be temporary from an ecological perspective unless riparian management practices ensure the long-term recruitment of LWD from the riparian zone.

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 streambank protection and salmonid habitat, while passive restoration and revegetation will ensure proper functioning riparian conditions for the long term. We feel 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

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allow the populations to stabilize in abundance and productivity over the long term. It may be likely however, that current core populations have inadequate diversity and spatial distribution to ensure population resiliency.

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 four 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. We also designated the mainstem Columbia River as separate (Category 5) because of its unique features. We 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 however, 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 would 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:**

These watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems (Table 1). In general, they comprise large, often continuous blocks of high-quality habitat and subwatersheds supporting multiple populations. Connectivity among subwatersheds and through the mainstem river corridor is good, and more than two 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.

### **Category 2:**

These watersheds support important aquatic resources, often with subwatersheds classified as strongholds (Appendix A), for one or more populations throughout. The most important difference between Category 1 and Category 2 is an increased level of fragmentation that has resulted from habitat disturbance or loss (Table 1). These watersheds have a substantial number of subwatersheds where native populations have been lost or are at risk for a variety of reasons. At least one federally listed fish species can be found within the watershed. 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 ecosystem functions and connectivity within these watersheds are priorities.



**Category 3:**

These watersheds may still contain subwatersheds that support salmonids (Table 1). In general, however, these watersheds have experienced substantial degradation and are strongly fragmented by extensive habitat loss, most notably through loss of connectivity with the mainstem corridor. At this time, there are limited opportunities for restoring full expression of life histories for multiple populations found within the watershed. The priority for funding in these watersheds should be to rectify the primary factor that is causing the habitat degradation.

**Category 4:**

These watersheds contain both functional and non-functional habitats that historically supported populations of one or more federally listed species (Table 1). Exotic species may now be dominant in one or more subwatersheds; native species are typically not present in sustainable numbers.

**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 1). Hydroelectric dams primarily effect 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 1** 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.

	Significant	Principle	Habitat	Exotic	Listed
Category	subwatersheds	actions	fragmentation	species	species
1	Yes	Protection	Low	Low	Two or more

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2	Yes	Protection/ restoration	Medium	Medium	One or more
3	Possible	Restoration	High	High	Possible
4	No	Restoration	High	High	Possible

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### **Interim Objectives by Subbasin and Watershed**

The following narratives for each subbasin (HUC-4) provide interim (five-year) objectives for protection and restoration of salmonid habitats. In these assessments, we identify priorities within and across the subbasins. The tables in Appendix B provide greater detail: they outline the status of each watershed (HUC-5), classify them by the above categories, identify Significant Subwatersheds (HUC-6), recommend priority approaches, and lay the foundation for a region-wide effectiveness monitoring program (discussed in Section 7).

#### ***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 desynchronization and retention, late summer flows, and water quality.

There are core populations of sockeye salmon, steelhead, bull trout and both spring and summer chinook salmon in the upper Wenatchee Subbasin that are relatively strong, when compared to other populations in the Columbia Basin. The highest regional priority should be the protection of this salmonid community. The immediate strategy should be to protect the watersheds that contain these core populations so that they are robust to normal environmental disturbances, and then to expand their range to adjacent watersheds. Priority (Category 1) watersheds within the Wenatchee Subbasin are White River, Chiwawa River, and the upper and middle mainstem Wenatchee River (including Lake Wenatchee, Table 2). These watersheds are well connected and support a diverse assemblage of native species. Efforts should be made to connect Category 1 and 2 watersheds (Nason Creek, Middle Mainstem Wenatchee River, and Icicle Creek) to these

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strongholds, which would enable a fuller expression of life history strategies and increase population resilience.

Recent research indicates that the mainstem Wenatchee River provides important habitat for many life stages of spring and summer chinook salmon, steelhead, and bull trout. The mainstem at this time is most vulnerable to riparian and instream habitat degradation. All remaining intact areas on the mainstem should be protected, and flood plain function should be restored, particularly from the Mission Creek confluence downstream to the Columbia River confluence. This could primarily be done with passive restoration. Since this reach has the highest discharge in the subbasin, the extent of riparian vegetation needed to restore flood plain function would be larger than the tributaries. Benefits of this action would be numerous to anadromous and inland salmonids, as well as a myriad of wildlife species.

### *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. To encourage properly functioning and stable habitats in the subbasin, four actions should be approached simultaneously:

1. protect core subwatersheds in the upper subbasin and upper Mad River (Category 1 watersheds),
2. continue restoration of highly erosive upland areas in Fox, McCree, Brenegan, Preston, and Mud creeks, Crum Canyon, and the mainstem Entiat between Fox and Stormy creeks (Category 1 and 2 subwatersheds),
3. restore habitat diversity and channel function in the lower Entiat River (a Category 2 watershed), and
4. increase late summer instream flows in the lower Entiat and lower Mad rivers (Category 2 watersheds).

Upland erosion is a severe chronic problem in the Entiat Watershed, yet substantial restoration efforts are underway in the Wenatchee National Forest to address this problem. Erosion on private lands contributes little to the overall problem of sediment delivery to the stream.

Low 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,

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there are very few resting areas for both adult and juvenile salmon through this important migration corridor. Efforts to improve stream sinuosity and channel forming processes in the lower reach should be considered.

Based on the work of NRCS, we believe the most feasible means to restore habitat in the lower Entiat River is primarily in 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 restore the lower Entiat River to increase stream habitat complexity, encourage 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).

A multi disciplinary team of fishery biologists, hydrologists, and fluvial geomorphologists should provide specific recommendations on the types of structures that would work best, based upon channel configuration. Active restoration projects should be reviewed on a case-by-case basis. We caution that these approaches to increase productivity are short-term, and will likely require maintenance. The lower Entiat River is one of the few watersheds 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 the lack of instream complexity and riparian cover, yet there are other factors that adversely affect salmonids. It is our opinion that instream flows limit salmonid production in the lower Entiat River, but not to the chronic and severe extent seen in other subbasins of the Upper Columbia Region. This is partly a result of the natural characteristics of the watershed, upland slope condition, irrigation water withdrawals, and stream channel modifications in 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 habitats, relative to other subbasins in the region. However, late summer and winter instream flow conditions often reduce migration, spawning, and rearing habitat for stream-type chinook salmon. This problem is partly natural (a result of watershed-specific weather and geologic conditions) but is exacerbated by irrigation, particularly at the points of surface water withdrawals. The immediate strategy to protect and restore the Methow Subbasin has two factors:

1. Protect riparian habitats in the mainstem Methow River and in the lower reaches of some of the key tributaries: Lost River, Early Winters Creek, Gold Creek, Libby Creek, Wolf Creek, Chewuch River,

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and Twisp River, (Category 1 and 2 watersheds). Protection of riparian and floodplain habitats should benefit instream flow conditions.

2. Increase late summer and winter instream flows in these streams.

Both of these factors will serve to stabilize and improve winter and late summer flows, and should be considered a regional priority. Within the Methow Subbasin, three other factors are of secondary, yet still critical importance, and should be addressed as subbasin priorities:

1. passage barriers created by irrigation diversion dams (primarily push up dams) and road culverts should be corrected,
2. improper irrigation screens should be modified to meet current standards, or points of diversions changed to minimize impacts to salmonids, and
3. dikes and hardened banks should be corrected to allow less restricted stream channel migration.

### *The Okanogan Subbasin (WRIA 49)*

The Okanogan/Similkameen is the largest and most complex subbasin in the region, and has a relatively high proportion of land in private ownership. Poor water quality and low late summer instream flows strongly limit the survival, distribution, and productivity of both anadromous and inland salmonids. More than half of the subbasin is within British Columbia and many of the causes for water pollution begin there, making an acute need for a coordinated transboundary process. There is an effort underway to convene all tribal, local, state, provincial, and federal governments to begin a comprehensive water planning and management process in the subbasin.

Water temperatures often exceed lethal tolerance levels for salmonids in United States portion of the Okanogan Subbasin. This exceedence is partly a result of natural phenomena (low gradient and solar radiation on the upstream lakes), but is exacerbated by sedimentation and summer low flows caused by dam operations, irrigation, and highly erosive uplands. High water temperatures and low flows in summer and fall effectively exclude juvenile salmon from rearing in most tributaries of the basin.

In addition to the thermal barrier on the mainstem Okanogan River, there are three structural barriers to upstream migration in the Okanogan Subbasin: (1) Enloe Dam on the Similkameen River (There is debate within the region whether anadromous salmonids historically passed the natural waterfalls that existed prior to construction of the dam on the lower Similkameen River.),

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(2) McIntyre Dam on the mainstem Okanogan River in British Columbia, and (3) low flows on Salmon Creek caused by the Okanogan Irrigation District diversion dam. Each of these substantially reduces the distribution and abundance of anadromous salmonids. Correction of these barriers would have lasting and important increases in salmon productivity, and would enable colonization and expansion from core populations.

Sedimentation is a major water quality concern in the Okanogan Subbasin. Naturally erosive soils coupled with improper land use management have resulted in accelerated sediment delivery to the stream system. The effects of sedimentation include channel widening, loss of pool habitat, shallower, broader channels, elevated water temperatures, and substrate embeddedness. Soil erosion is most severe in the Similkameen watershed, but is also a concern in Bonaparte, Antoine, and Omak creeks. Overall, the Similkameen, Bonaparte, and the Okanogan mainstem itself contribute the most sediment to the Okanogan River.

The immediate strategy should be to protect the remaining sockeye and summer chinook spawning and rearing habitat that remains within this watershed. In particular, the summer chinook spawning habitat located in the lower Similkameen (Category 2) and in the mainstem Okanogan River between Ellisford and Riverside (Category 2) and the remaining sockeye spawning habitat that remains downstream of McIntyre Dam (Category 2). Strategies should also be explored to reconnect smaller tributary streams with the mainstem Okanogan River. Many of the smaller tributaries once provided thermal refuge for summer and fall migrating adults and for rearing of stream-type juvenile salmonids. These actions would allow recolonization of summer chinook, sockeye and summer steelhead into historical areas. Any effort to establish a normative hydrograph, decrease the width: depth ratio, increase riparian coverage, and decrease sediment input will improve water quality, quantity and would provide for improved upstream migration and over-summer rearing conditions. Late-summer instream flows of tributary streams should be increased.

### *The Foster Creek/Moses Coulee Subbasin (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 Creek and Rock Island Creek. Steelhead have spawned in high escapement years 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.

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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.

### *North Alkali/Squilchuck (Partial WRIA 40)*

Colockum, Stemilt, and Squilchuck creeks support small numbers of spring chinook salmon and steelhead, yet little is known about their abundance and productivity. We speculate that passage barriers and intermittent stream flows limit the distribution of anadromous salmonids, and likely isolate populations of inland trout. The immediate strategy for these Category 4 streams would be twofold: 1) Increase late summer instream flows, if it can be shown to contribute to sustainable habitat conditions, and 2) Develop and implement an approach to correct passage barriers, if it can be shown that sufficient flows will be available for sustainable spawning and rearing in the newly accessible habitats.

Both these actions require a fundamental information base on habitat conditions and the current (and potential) distribution of anadromous and resident salmonids. These data should be collected before any restoration projects begin. A survey should be done on the population and genetic structure of inland trout, as it is likely that fragmented populations of redband trout (*O. mykiss gairdneri*) may persist in these streams.

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**Table 2** Categories of watersheds (HUC-5 level) and number of Significant Subwatersheds (HUC-6 level) within those watersheds in the Upper Columbia Salmon Recovery Region. Definitions of watershed categories and Significant Subwatersheds are provided in text.

Subbasin	Watershed	Category	Significant subwatersheds
Wenatchee	Mainstem Upper Wenatchee	1	2
	Mainstem Middle Wenatchee	1	2
	Mainstem Lower Wenatchee	2	1
	White River	1	5
	Little Wenatchee River	1	5
	Lake Wenatchee	1	-- <sup>a</sup>
	Nason Creek	2	3
	Chiwawa River	1	6
	Icicle Creek	2	4
	Chumstick Creek	3	0
	Peshastin Creek	2	3
Entiat	Mission Creek	3	3
	Mainstem Upper Entiat	1	2
	Mainstem Lower Entiat	2	0

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

<sup>b</sup> There is insufficient information to designate the significance of Colockum Creek.



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	Mad River	1	3
Methow	Mainstem Upper Methow	2	6
	Mainstem Middle Methow	2	0
	Mainstem Lower Methow	2	0
	Early Winters Creek	1	1
	Lost River	1	2
	Chewuch River	2	3
	Twisp River	2	4
Okanogan	Mainstem Upper Okanogan	2	--
	Mainstem Lower Okanogan	2	3
	Similkameen River	3	1
	Bonaparte Creek	4	0
	Omak Creek	2	0
	Salmon Creek	3	0
Foster	Foster Creek	4	0
Moses Coulee	Moses Coulee	4	0
Squilchuck	Squilchuck	4	0
	Stemilt	4	0
	Colockum	4	--b
Columbia	Mainstem Columbia	5	--

### **Information Needs**

The RTT is concerned that some active restoration projects in the Upper Columbia Region may be undertaken without a solid understanding of the geomorphic and hydrologic processes in the watersheds. This may result in projects that are not biologically effective—or potentially counter-productive. We recommend that the following assessments be undertaken to improve our understanding of salmonid habitat and productivity. All assessments should address the levels of certainty within one or more watersheds (Appendix C) and should lead to projects or management decisions within a reasonable time frame. We have not assigned priorities to these information needs.

Fluvial processes in many Upper Columbia streams are not fully understood, particularly in the lower Wenatchee, middle Methow, and lower Entiat rivers. Stream channels in these reaches 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 migration rates, means to restore floodplain function, and the appropriate types and locations of restoration.

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. 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 in the Wenatchee, Entiat, and Methow subbasins, yet full assessments of these structures may be required to correct the barriers in a systematic and strategic order. We recommend that the UCSRB develop a comprehensive strategy to address barriers in the region using the information garnered from the completed surveys.

An 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. Upstream/downstream salmonid migrant trapping, parr production surveys, and spawning ground surveys in selected index streams (such as the Chiwawa River) would greatly contribute

to our knowledge base, and lead to more appropriate resource allocation decisions. Indicator streams should be established.

The extent of salmonid rearing in small-order tributaries to the Columbia River is not known. Many streams (such as Douglas, Sand, Rock Island, Colockum, Stemilt, and Squilchuck creeks) may be rearing or overwinter refuges when flows are present, which could be important to the population structure and dispersal patterns of salmonids in the region. The presence of redband trout in these streams should be determined.

### **Implementation and Effectiveness Monitoring**

All projects undertaken to protect and restore salmonid habitat in the Upper Columbia Region must be monitored for implementation. However, not all projects should be monitored for effectiveness. A series of standardized indicators of habitat condition (with data quality guidelines) should be set for selected watersheds within each subbasin. Collection of indicator data for these watersheds should be coordinated at the regional level and based on state and federal guidelines. The RTT will submit a companion document in late 2003 to set the foundation for an effectiveness monitoring strategy for the Upper Columbia Region. This report will build upon our previous outline (RTT 2002b) and will be consistent with standards and guidelines established through the State Comprehensive Monitoring Strategy.

## Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

### REFERENCES

- ICBEMP 1997. Interior Columbia Basin Ecosystem Management Project. Available from U.S. Forest Service, Walla Walla, Washington.
- MacDonald, K., Noble, S., Haskins J. 1996. An assessment of aquatic resources on the Wenatchee National Forest. Available from the Supervisor's Office, Wenatchee/ Okanogan National Forest, Wenatchee, Washington.
- Quigley, T. M., and S. J. Arbelbide, tech. Editors. 1997. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. Volume 3. Gen. Tech. Rep., PNW-GTR-405. Portland, Oregon.
- RTT 2000. Priority considerations for protection and restoration of salmonid habitat in the Upper Columbia Region. Available from the Upper Columbia Salmon Recovery Board, Chelan, Washington.
- RTT 2002a. A biological strategy to protect and restore salmonid habitat in the Upper Columbia Region. Available from the Upper Columbia Salmon Recovery Board, Chelan, Washington.
- RTT 2002b. An outline to assess salmonid productivity and habitat in the Upper Columbia Evolutionarily Significant Unit. Available from the Upper Columbia Salmon Recovery Board, Chelan, Washington.
- SSRS 1999. Statewide Strategy to Recover Salmon: Extinction is Not an Option. Available from Governor's Salmon Recovery Office, Olympia, Washington.

**APPENDIX**

**Appendix A.** Maps of Significant Subwatersheds for spring chinook salmon, summer chinook salmon, sockeye salmon, steelhead, and bull trout in the Upper Columbia Region. These maps are based on the most current information and will be continuously updated.

**Appendix B.** Maps of known distribution of spring chinook salmon, summer chinook salmon, sockeye salmon, steelhead, and bull trout in the Upper Columbia Region. These maps are based on the most current information and will be continuously updated.

**Appendix C.** Population and habitat status of each watershed and recommended priority approaches for protection and restoration of habitat.

**Appendix C.1: Wenatchee River Subbasin**

<p><b>MAINSTEM UPPER WENATCHEE RIVER (LAKE WENATCHEE TO TUMWATER CANYON) ASSESSMENT AND INTERIM STRATEGY</b></p>	
<p><u>Native species:</u> Sockeye salmon, spring and summer chinook salmon, steelhead, bull trout.</p>	<p><u>Drainage area:</u></p>
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Important passage corridor for many species.</li> <li>▪ Important spawning habitat for summer chinook salmon and steelhead.</li> <li>▪ The mainstem from Lake Wenatchee to the Chiwawa River confluence is designated as a Key Watershed in the Northwest Forest Plan (NWFP).</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Wenatchee, Lake Wenatchee</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ The state highway, railroad, and private land development affect woody debris recruitment, channel migration, and gravel recruitment.</li> <li>▪ The state highway cut off a large oxbow near Nason Creek confluence.</li> <li>▪ Historical log drives and resultant loss of wood recruitment has reduced channel complexity.</li> <li>▪ Fecal coliform and water temperatures are slightly elevated.</li> </ul>	

**LEVEL OF CERTAINTY:**

- 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.
- There is some uncertainty of the extent to which oxbows are disconnected, and what efforts should be done to provide access to the mainstem.
- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect remaining floodplain and riparian habitat.
2. Restore channel migration to resemble historical function.
3. If restoration is not possible, improve fish access to oxbows and historical side channels that have been cut off from main channel.
4. Initiate public information efforts to discourage harassment of spawning summer chinook salmon.
5. Reduce nonpoint pollution from septic tanks and livestock.
6. Initiate public information efforts to encourage protection of riparian habitat.

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<p><b>MAINSTEM MIDDLE WENATCHEE (TUMWATER CANYON) ASSESSMENT AND INTERIM STRATEGY</b></p>	
<p><u>Native species:</u> Sockeye salmon, spring and summer chinook salmon, steelhead, bull trout.</p>	<p><u>Drainage area:</u></p>
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Important passage corridor. Important spawning habitat for summer chinook salmon and steelhead.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Tumwater Canyon, Chiwaukum Creek</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Coarse sedimentation impacts from fire.</li> <li>▪ The state highway negatively affects gravel and LWD recruitment.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Recent USFWS bull trout surveys provide higher level of certainty.</li> </ul>	



**RECOMMENDATIONS (IN PRIORITY):**

1. Protect existing riparian habitat
2. Address passage barriers at Skinney Creek near mouth

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<b>MAINSTEM LOWER WENATCHEE RIVER (TUMWATER TO MOUTH)</b>	
<b>ASSESSMENT AND INTERIM STRATEGY</b>	
<u>Native species:</u> Sockeye salmon, spring and summer chinook salmon, steelhead, bull trout.	<u>Drainage area:</u>
<b>STATUS:</b> Category 2	
<ul style="list-style-type: none"><li>▪ Important passage corridor for many species.</li><li>▪ Spawning and rearing habitat for summer chinook salmon and steelhead.</li></ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b>	
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, which is contributed to by riparian habitat loss 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:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect existing riparian habitat and channel migration floodplain function.
2. Restore channel migration to normative function.
3. If restoration is not possible, improve fish access to oxbows and historical side channels
4. Increase late summer flows.

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MISSION CREEK WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead.	<u>Drainage area:</u> 59,609 acres
<b>STATUS:</b> Category 3	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  Sand Creek, Devils Gulch, Lower Mission	
<b>FACTORS AFFECTING HABITAT CONDITION:</b> <ul style="list-style-type: none"> <li>▪ Low or non-existent flows with associated high instream temperatures in lower Mission Creek disrupt distribution and abundance of native species, particularly in summer.</li> <li>▪ Channelization of lower Mission, Brender and Yaksum creeks.</li> <li>▪ 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.</li> <li>▪ There are several culverts throughout the watershed that are passage barriers when flows are available.</li> <li>▪ Loss of channel sinuosity and floodplain function in the Mission Creek watershed.</li> </ul>	

**LEVEL OF CERTAINTY:**

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

**RECOMMENDATIONS (IN PRIORITY):**

1. Increase stream flow.
2. Reduce nonpoint pollution from septic tanks and livestock.
3. Restore channel sinuosity and floodplain function upstream of Yaksum Creek confluence.
4. Other projects should be delayed until flow and water quality are addressed.

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PESHASTIN CREEK WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 78,780 acres
<p><b>STATUS:</b> Category 2</p> <ul style="list-style-type: none"> <li>▪ Important steelhead spawning and rearing habitat, both in the mainstem and subwatersheds.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Peshastin, Lower Peshastin, Ingalls Creek</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Channel migration, riparian habitat, floodplain function, stream sinuosity, and gravel recruitment are severely impacted by state highway.</li> <li>▪ Low instream flows in lower Peshastin Creek impede upstream migration, reduce rearing habitat, and likely contribute to elevated water temperature.</li> <li>▪ Loss of riparian habitat resulting from land development and state highway reduces quantity and quality of spawning and rearing habitat.</li> <li>▪ .</li> </ul>	

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Increase stream sinuosity and floodplain function from Ingalls Creek to mouth.
2. Restore flow from Camas Creek to mouth.
3. Other projects should be delayed until stream sinuosity and flows are addressed.



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ICICLE CREEK WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead, bull trout, cutthroat trout, redband trout	<u>Drainage area:</u> 136,960 acres
<b>STATUS:</b> Category 2 <ul style="list-style-type: none"><li>▪ Relatively good habitat</li><li>▪ Inland fish are present and of concern.</li><li>▪ Designated as Key Watershed in Northwest Forest Plan.</li></ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b> 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:**

- Field and aerial reconnaissance of lower Icicle Creek provide strong certainty of need for stream channel protection and restoration.
- The adult passage conditions at boulder field near Snow Creek is not known.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect remaining floodplain and riparian habitat downstream of Chatter Creek. Emphasis should be placed on habitat downstream of Leavenworth Hatchery.
2. Rectify human-made passage barriers.
3. Restore flow conditions on Icicle Creek downstream of Rat Creek.
4. Investigate the role of surface and well water withdrawals on instream flows and habitat use. Develop strategies with water users to reduce effects, if any.
5. Initiate public information efforts to discourage harassment of spawning salmonids.
6. Manage recreation areas to reduce impacts to riparian cover.

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CHUMSTICK CREEK WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead.	<u>Drainage area:</u> 47,000 acres
<p><b>STATUS:</b> Category 3</p> <ul style="list-style-type: none"> <li>▪ Chumstick Creek was historical steelhead habitat.</li> <li>▪ Likely, it was very important coho salmon habitat, although few records exist.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>None</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Private land development and high road density affects sediment delivery.</li> <li>▪ Channel migration affected by state highway, the railroad, multiple water crossing structures, and private land development.</li> <li>▪ Fecal coliform and water temperature levels are elevated, mostly a result of livestock and improper septic tanks.</li> <li>▪ Passage is impeded at the North Road and numerous smaller culverts upstream.</li> <li>▪ Riparian habitat has been degraded or lost from Little Chumstick Creek to mouth.</li> </ul>	

**LEVEL OF CERTAINTY:**

- This watershed is only accessible to steelhead at this time, yet it is unknown whether it is accessible to other species.
- The loss of riparian vegetation in Chumstick Creek is readily observable, yet cumulative effects on instream habitat, channel function, and water quality are not quantified.
- Constraint of the stream channel by human-made structures is readily observable; the means to address these effects are not established.
- 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 required.
- The cumulative effects of surface water diversions and ground water withdrawal from wells on low flows is not known, but of concern.

## Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

### RECOMMENDATIONS (IN PRIORITY):

1. Restore passage for anadromous and inland fish. This should be done in a comprehensive, coordinated strategy, rather than a piecemeal approach.
2. Protect remaining floodplain and riparian habitat
3. Increase stream flow.
4. Restore riparian habitat, primarily from Eagle Creek to Suntisch Canyon.
5. Reduce road densities.
6. Restore stream channel migration.
7. Reduce nonpoint pollution from septic tanks and livestock.
8. Reduce fine sediment input from roads and some land management activities.

### CHIWAHA RIVER WATERSHED ASSESSMENT AND INTERIM STRATEGY

Native species: Spring chinook salmon, steelhead, and migratory bull trout.

Drainage area: 117,000 acres

#### **STATUS:** Category 1

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

<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Headwaters Chiwawa, Upper Chiwawa, Middle Chiwawa, Lower Chiwawa, Rock Creek, Chikamin Creek</p>
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"><li>▪ 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.</li><li>▪ 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.</li><li>▪ Water withdrawals in the lower Chiwawa River may affect rearing habitat in low flow years.</li></ul>
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"><li>▪ The effect of water withdrawals on lower Chiwawa River salmonid habitat is not known.</li><li>▪ There is concern over the potential impacts of development in Chikamin Creek on salmonid productivity and water temperatures.</li></ul>
<p><b>RECOMMENDATIONS (IN PRIORITY):</b></p> <ol style="list-style-type: none"><li>1. Protect remaining floodplain and riparian habitat, particularly around Chikamin Flats.</li><li>2. Investigate the role of surface and well water withdrawals on instream flows and habitat use. Develop strategies with water users to reduce effects, if any.</li><li>3. Initiate public information efforts to discourage harassment of spawning spring chinook salmon and bull trout.</li><li>4. Manage recreation areas to reduce or avoid impacts to riparian habitats.</li></ol>

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NASON CREEK WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 69,000 acres
<b>STATUS:</b> Category 2	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  Headwaters Nason, Upper Nason, Lower Nason	
<b>FACTORS AFFECTING HABITAT CONDITION:</b> <ul style="list-style-type: none"><li>▪ The state highway, railroad, and private land development affect woody debris recruitment, channel migration, and gravel recruitment.</li><li>▪ Lower Nason Creek is on the state 303(d) list for water temperature.</li></ul>	



**LEVEL OF CERTAINTY:**

- 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. The recently funded channel migration study should assist in this assessment.
- 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 is not fully known, but of concern.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect remaining floodplain and riparian habitat.
2. Restore channel migration to historical function.
3. If restoration is not possible, improve fish access to oxbows and historical side channels.
4. Initiate public information efforts to discourage harassment of spawning salmonids.

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WHITE RIVER WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Sockeye salmon, spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 99,956 acres
<p><b>STATUS:</b> Category 1.</p> <ul style="list-style-type: none"> <li>▪ Designated as Key Watershed in Northwest Forest Plan.</li> <li>▪ Critical spawning and rearing habitat for many species.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Headwaters White, Upper White, Lower White, Napeequa Creek, Panther Creek</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Past riparian harvest and log drives have altered woody debris accumulations and channel morphometry.</li> <li>▪ Habitat is intact and contiguous, but development pressures place a critical need to protect and maintain stream channel and floodplain integrity</li> </ul>	

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect stream channel, riparian and floodplain function: focus on Panther Creek downstream to mouth.
2. Restore wetland complexes that connect to stream channel
3. Protect shorelines along Lake Wenatchee near White River mouth
4. Initiate public information efforts to discourage harassment of spawning spring chinook, sockeye salmon, and bull trout.
5. Manage recreation areas to reduce impacts to riparian cover.

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LITTLE WENATCHEE WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Sockeye salmon, spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 75,329 acres
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Designated as Key Watershed in Northwest Forest Plan.</li> <li>▪ Critical spawning and rearing habitat for many species.</li> <li>▪ Bull trout numbers above the waterfalls are extremely low.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Headwaters Little Wenatchee, Upper Little Wenatchee, Lower Little Wenatchee, Rainy Creek, Lake Creek</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Past riparian harvest and log drives below the waterfalls may have affected stream channel morphometry and function.</li> <li>▪ Habitat above the waterfalls is intact and relatively pristine: essentially need to protect and maintain stream channel and floodplain integrity.</li> <li>▪ The lower Little Wenatchee is on the state 303(d) list for water temperature.</li> </ul>	

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect stream channel, riparian and floodplain function: focus on Little Wenatchee River falls downstream to mouth.
2. Address road impacts in the drainage, emphasis on Rainy Creek and Little Wenatchee between Hidden Creek and Fir Creek.
3. Restore wetland complexes that connect to stream channel.
4. Manage recreation areas to reduce impacts to riparian cover.
5. Initiate public information efforts to discourage harassment of spawning salmonids.

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LAKE WENATCHEE ASSESSMENT AND INTERIM STRATEGY	
<p><u>Native species:</u> Sockeye salmon, spring chinook salmon, steelhead, bull trout.</p>	<p><u>Drainage area:</u></p>
<p><b>STATUS:</b> Category 1.</p>	
<ul style="list-style-type: none"> <li>▪ Necessary adult holding and juvenile rearing area for sockeye salmon and bull trout.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p>	
<p>Not applicable.</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p>	
<ul style="list-style-type: none"> <li>▪ Shoreline development. Bulkheads change dynamics of near shore wave action, affecting invertebrate production, gravel deposition, and habitat use.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p>	
<ul style="list-style-type: none"> <li>▪ Quantified field analyses have not been conducted, yet reviews of aerial photographs in combination with field reviews have allowed strong inferences on habitat needs.</li> </ul>	

**RECOMMENDATION:**

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

**Appendix C.2: Entiat River Subbasin**

<b>MAINSTEM ENTIAT FROM ENTIAT FALLS TO POTATO MORAINES ASSESSMENT AND INTERIM STRATEGY</b>	
<u>Native species:</u> Critical habitat for spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u>
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Designated as Key Watershed in Northwest Forest Plan</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Mid-Entiat, Lower Mid-Entiat</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Surface erosion and sediment delivery hazard is high.</li> <li>▪ Fluvial processes are now good within this reach, but they are at risk from development pressure in bottomlands.</li> <li>▪ Past stream clean-outs and salvage logging activities after major fire events have affected stream channel complexity.</li> </ul>	



**LEVEL OF CERTAINTY:**

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.
- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect fluvial processes and floodplain function from the falls to the moraine.
2. Continue road closure and reforestation in highly erosive uplands, particularly Fox, McCree, Brenegan, Preston, and Mud creeks, and the mainstem Entiat between Fox and Stormy creeks.
3. Initiate public information efforts to discourage harassment of spawning salmonids.

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MAD RIVER WATERSHED ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout, cutthroat trout.	<u>Drainage area:</u>
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Designated as Key Watershed in Northwest Forest Plan</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Mad River, Middle Mad River, Lower Mad River</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ 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 streamflow.</li> <li>▪ Road constricts channel on mainstem from Pine Flat campground downstream to mouth.</li> <li>▪ Anchor ice formations associated with loss of riparian cover and changes in channel.</li> </ul>	

**LEVEL OF CERTAINTY:**

- Field habitat analysis has been completed on most areas, providing a high confidence in assessment.
- Mad River is considered a stronghold for bull trout, but their habitat use outside the watershed is not well understood.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect fluvial processes and floodplain function.
2. Continue reforestation in highly erosive uplands.
3. Initiate public information efforts to discourage harassment of bull trout.
4. Reduce impacts from roads in floodplains, and relocate where appropriate. Restore riparian areas in lower Mad River.

<b>LOWER ENTIAT (FROM MORaine DOWNSTREAM TO MOUTH) ASSESSMENT AND INTERIM STRATEGY</b>	
<u>Native species:</u> Spring and summer chinook salmon, steelhead, bull trout.	<u>Drainage area:</u>
<p><b>STATUS:</b> Category 2</p> <ul style="list-style-type: none"> <li>▪ Migration corridor for spring chinook salmon, steelhead and bull trout. Spawning and rearing habitat for steelhead and summer chinook salmon.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>None</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Loss of channel complexity and lateral migration</li> <li>▪ Loss of riparian habitats and floodplain connectivity</li> <li>▪ Loss of gravel recruitment</li> <li>▪ Sediment delivery from Potato Creek and Mud Creek</li> </ul>	

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Restore stream channel complexity and lateral migration.
2. Protect existing riparian and floodplain habitats.
3. Restore degraded riparian habitats.

**Appendix C.3: Methow River Subbasin**

<p>EARLY WINTERS CREEK ASSESSMENT AND INTERIM STRATEGY</p>	
<p><u>Native species:</u> Spring chinook salmon, steelhead, bull trout.</p>	<p><u>Drainage area:</u> 51,925 acres</p>
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Designated as a Key Watershed in Northwest Forest Plan</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Early Winters Creek</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Channel constriction by state highway precludes natural flood plain function, reduces the number of side channels, and increases water velocities and resultant scour.</li> <li>▪ Riparian areas have been degraded at campgrounds, resulting in loss of cover and woody debris recruitment.</li> <li>▪ Fine sediment and chemical runoff from highway may impact water quality.</li> </ul>	

**LEVEL OF CERTAINTY:**

- Field assessment of stream channel function provides strong indication of high water velocities and resultant bedload, channel scour, and riparian degradation in lower Early Winters Creek.
- Low flows are readily measurable, but groundwater/surface water interaction is complex and not fully understood.

**RECOMMENDATIONS (IN PRIORITY):**

1. Restore natural stream channel functions within the alluvial fan.
2. Improve riparian conditions in the lower reach.
3. Manage recreation areas to reduce or avoid impacts to riparian areas.

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

LOST RIVER ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 107,400 acres
<p><b>STATUS:</b> Category 1</p> <ul style="list-style-type: none"> <li>▪ Designated as a Key Watershed in Northwest Forest Plan.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Lost River, Lost River</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ A dike on the Methow River at the confluence of the lower Lost River constrains floodplain function.</li> <li>▪ Residential construction on the alluvial fan may lead to a constrained channel in the future.</li> <li>▪ Large woody debris levels in the lower Lost River are currently low, due to removal for flood control and firewood. The potential for recruitment of woody debris is at natural levels however.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Watershed surveys by USFS provide high level of certainty.</li> </ul>	



**RECOMMENDATIONS (IN PRIORITY):**

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

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

CHEWUCH RIVER ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout, westslope cutthroat trout.	<u>Drainage area:</u> 340,000 acres
<b>STATUS:</b> Category 2 <ul style="list-style-type: none"><li>▪ Designated as a Key Watershed in NWFP.</li></ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  Perrygin Creek, Lake Creek, Lower Chewuch River	

**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 of mainstem Chewuch and tributaries.
- High road densities in Cub, Eightmile, and Boulder creeks combined with highly erosive soils create sediment and bank erosion problems.

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Restore habitat-forming processes and channel complexity of the Chewuch River from RM 0 to 28.
2. Increase LWD recruitment and retention in the mainstem Chewuch River from RM 0 to 30.
3. Increase stream flows on the lower mainstem Chewuch River.
4. Reduce road densities, particularly in highly erosive areas (such as mid-slope areas) and riparian areas.
5. Manage recreation activities in riparian areas; include an educational component.
6. Assess the condition of roads in the Chewuch Watershed and their contribution to sediment delivery to the surface water network.
7. Monitor summer and winter thermal refugia in the lower mainstem Chewuch River. Protect and restore key thermal refuges.
8. Assess grazing effects on riparian areas in upper mainstem Chewuch River, and in Eightmile, Boulder, Falls and Cub creeks on sediment delivery and channel stability.

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

TWISP RIVER ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Spring chinook salmon, steelhead, bull trout, westslope cutthroat trout.	<u>Drainage area:</u> 157,000 acres
<b>STATUS:</b> Category 2 <ul style="list-style-type: none"><li>▪ Designated as a key watershed in NWFP.</li></ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b> Middle Twisp, Lower Twisp, North Creek, Buttermilk Creek	

**FACTORS AFFECTING HABITAT CONDITION:**

- Low instream flows in the lower Twisp River affect several species at several life history stages.
- The Twisp River (from Buttermilk Creek to the mouth) has been diked and riprapped 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 East Canal diversion on the Twisp River at RM 3.9 is a rock 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.
- Beaver activity is very limited in the lower Twisp River where the large cottonwood galleries and low gradients would once have supported beaver colonies.
- The road in Little Bridge Creek affects stream channel function.

**LEVEL OF CERTAINTY:**

- 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Investigate and implement alternatives to improve low flow conditions in the lower Twisp River.
2. Protect and restore access to floodplains, side channels, and riparian areas in the lower 15 miles of the Twisp River.
3. Increase LWD recruitment and retention in the lower 11 miles of Twisp River.
4. Eliminate MVID push up dam on lower Twisp River.
5. Reduce road densities in Lower Bridge Creek and Buttermilk Creek and their effects on hydrology and instream sediment conditions.
6. Gather baseline temperature data throughout the watershed.
7. Provide alternative sites in the upper Twisp River for developed and dispersed recreation.
8. Reestablish a sustainable population of beaver.

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

<p><b>UPPER MAINSTEM METHOW (HEADWATERS TO CHEWUCH CONFLUENCE) ASSESSMENT AND INTERIM STRATEGY</b></p>	
<p><u>Native species:</u> spring chinook salmon, steelhead, bull trout.</p>	<p><u>Drainage area:</u> 322,385 acres</p>
<p><b>STATUS:</b> Category 2</p>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Methow, Mainstem West Fork Methow, Upper Goat Creek, Lower Goat Creek, Little Boulder Creek, Hancock Creek</p>	
<p><b>TRIBUTARIES WITHIN THIS REACH:</b> 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.</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ The mainstem Methow River between RM 59 and 74 goes dry in low flow years.</li> <li>▪ 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.</li> <li>▪ Several small dikes cut off important side channel habitats.</li> </ul> <p>Residential construction in flood prone areas has resulted in clearing of riparian habitat.</p>	



**LEVEL OF CERTAINTY:**

- 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 morphometry 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.
- There is concern about the effect of snowmobiles in the main channel Methow River on habitat and water quality.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect functioning floodplain, riparian habitat, and side channels in the upper Methow River.
2. Protect LWD accumulations in the channel.
3. Protect habitat within this reach that sustains flows through the winter, and stream channel sections where ground water is recharged.
4. Improve late summer and winter instream flows through several means: restore drained wetlands, restore cut off side channels, rehabilitate riparian areas, and remove constrictions and constraints within the channel migration zone.
5. Restore access to habitat blocked by dikes and restore the channel function of the reach upstream of the dikes.
6. Increase recruitment and retention of LWD within the mainstem Methow River.
7. Reduce streambank erosion on mainstem Methow River from Goat Creek to Mazama. Evaluate the location of these eroding sites relative to the channel migration zone.
8. Manage dispersed recreation use in riparian areas throughout the watershed.
9. Develop and implement a snowmobile management plan.

<b>MIDDLE MAINSTEM METHOW RIVER (CHEWUCH RIVER CONFLUENCE TO TEXAS CREEK CONFLUENCE) ASSESSMENT AND INTERIM STRATEGY</b>	
<u>Native species:</u> Spring and summer chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 15,600 acres
<p><u>STATUS:</u> Category 2</p> <ul style="list-style-type: none"> <li>▪ 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.</li> </ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b>	
<b>TRIBUTARIES WITHIN THIS REACH:</b> Alder Creek, Bear Creek, Beaver Creek and Benson Creek	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Residential development is affecting riparian and floodplain condition.</li> <li>▪ The Methow Valley Irrigation District fish screens and diversion structures do not meet state and federal standards.</li> <li>▪ Low flows in late summer and winter may affect juvenile survival.</li> <li>▪ Structures in tributaries are passage barriers for adult and juvenile salmonids.</li> <li>▪ The mainstem Methow is on the state 303(d) list for temperatures.</li> </ul>	

**LEVEL OF CERTAINTY:**

- Habitat in the Middle Mainstem Methow River and lower reaches of its tributaries has not been surveyed. Some recommendations are based on professional judgement. 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect functioning floodplain, riparian habitat, and side channels in the middle Methow River.
2. Restore access by the mainstem channel to floodplains and side channels disconnected by dikes.
3. Correct the MVID screens and diversion.
4. Modify existing bank hardening projects to incorporate design elements to reduce water velocity and increase instream complexity.
5. Increase recruitment and retention of LWD within the mainstem Methow River.

<b>LOWER METHOW (TEXAS CREEK CONFLUENCE TO MOUTH)</b>	
<b>ASSESSMENT AND INTERIM STRATEGY</b>	
<u>Native species:</u> Summer and spring chinook salmon, steelhead, bull trout.	<u>Drainage area:</u> 200,000 acres
<b>STATUS:</b> Category 2	
<ul style="list-style-type: none"> <li>▪ 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.</li> </ul>	
<b>SIGNIFICANT SUBWATERSHEDS:</b>	
None.	
<b>IMPORTANT TRIBUTARIES:</b> Texas Creek, Libby Creek, Gold Creek, McFarland Creek, French Creek, Squaw Creek and Black Canyon Creek.	
<b>FACTORS AFFECTING HABITAT CONDITION:</b>	
<ul style="list-style-type: none"> <li>▪ Culverts, roads, and irrigation diversion structures impede salmonid passage on several tributaries.</li> <li>▪ Roads on several tributaries contribute to sedimentation and riparian degradation.</li> <li>▪ Low instream flows in Libby and Gold creeks likely impact salmonid distribution and abundance.</li> </ul>	

**LEVEL OF CERTAINTY:**

- Habitat in the mainstem lower Methow River and lower reaches of its tributaries has not been surveyed. Some recommendations are based on professional judgement. Habitat in upper reaches of the tributaries has been assessed by USFS.
- Spawning and rearing of salmonids in the mainstem and tributaries are regularly surveyed, providing a higher level of certainty.

**RECOMMENDATIONS (IN PRIORITY):**

1. Develop and implement a plan to correct fish passage barriers on tributaries.
2. Evaluate habitat conditions in the lower mainstem Methow River.
3. Address sedimentation in the drainage by identifying roads for closure, relocation, obliteration, and drainage improvements.
4. Protect and restore riparian habitats in Gold and Libby creeks.
5. Irrigation diversions in Gold and Libby creeks should be assessed and screened according to standards
6. Increase instream flows in Gold Creek.

**Appendix C.4: Okanogan River Subbasin**

<p><b>UPPER MAINSTEM OKANOGAN (MCINTYRE DAM TO SIMILKAMEEN CONFLUENCE) ASSESSMENT AND INTERIM STRATEGY</b></p>	
<p><u>Native species:</u> Sockeye salmon, summer chinook salmon, steelhead.</p>	<p><u>Drainage area:</u></p>
<p><b>STATUS:</b> Category 2</p> <ul style="list-style-type: none"> <li>▪ This reach is the only remaining spawning habitat for sockeye salmon.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Data are not available.</p>	

**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.
- Okanagan Falls Dam and Zosel Dam modify hydrograph, which in some years may affect upstream/downstream migration.
- Urbanization of region is affecting water quality and quantity and is accelerating the eutrophication of Osoyoos Lake.

**LEVEL OF CERTAINTY:**

- Annual surveys indicate level and areas of sockeye salmon use.
- Water quality parameters documented through state and federal studies.
- Instream and riparian habitats have not been quantified; critical 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.

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect habitat and flows from McIntyre Dam downstream to Osoyoos Lake.
2. Manage water releases through Okanagan Falls Dam to prevent redd scour/desiccation.
3. Restore floodplain function in this reach.
4. Develop a normative flow pattern in this reach.
5. Reduce sedimentation and nonpoint pollution in the reach and Lake Osoyoos.



Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

<p><b>MAINSTEM OKANOGAN RIVER (SIMILKAMEEN CONFLUENCE TO MOUTH) ASSESSMENT AND INTERIM STRATEGY</b></p>	
<p><u>Native species:</u> Sockeye salmon, summer chinook salmon, bull trout, cutthroat trout, and steelhead.</p>	<p><u>Drainage area:</u></p>
<p><b>STATUS:</b> Category 2</p> <ul style="list-style-type: none"> <li>▪ Important migration corridor for sockeye salmon and steelhead. Spawning and rearing habitat for summer chinook salmon.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Upper Okanogan River, Middle Okanogan River, Lower Okanogan River, North Fork Salmon Creek.</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Late summer water temperatures exceed salmonid tolerance levels.</li> <li>▪ Turbidity, suspended sediment, and nutrient loading exacerbate water temperature exceedences, and effect spawning and rearing habitat.</li> <li>▪ Extensive riparian habitat loss and degradation throughout the mainstem Okanogan River, causing very high width:depth ratios, low woody debris levels, sedimentation, and embedded spawning gravels.</li> <li>▪ Upstream dams modify hydrograph, which in some years may affect upstream/downstream migration.</li> </ul>	

**LEVEL OF CERTAINTY:**

- Annual surveys indicate level and areas of summer chinook salmon use.
- Water quality parameters documented through state and federal studies.
- Instream and riparian habitats have not been quantified; critical areas have not been established.
- Radio telemetry studies verify effects of dam operations on upstream migration behavior of sockeye, summer chinook and steelhead.

**RECOMMENDATIONS (IN PRIORITY):**

1. Release water from upstream dams at critical periods to aid adult sockeye salmon migration.
2. Increase seasonal flows in small tributary streams to mainstem Okanogan River.
3. Protect and passively restore riparian habitat on the mainstem, with upstream reaches having priority.
4. Implement agricultural practices that reduce sediment delivery to the river.

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

SIMILKAMEEN RIVER ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Summer chinook salmon, steelhead.	<u>Drainage area:</u>
<p><b>STATUS:</b> Category 3</p> <ul style="list-style-type: none"> <li>▪ Highly used summer chinook salmon spawning downstream of Enloe Dam (at RK 14), which is a barrier to migration.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>Similkameen River</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ 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 instream habitat.</li> <li>▪ Enloe Dam blocks upstream migration of summer chinook salmon, although a natural waterfall may have historically blocked migration.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Sedimentation impacts from most significant sources are well documented.</li> <li>▪ There is uncertainty over historical distribution of anadromous salmonids in this watershed.</li> </ul>	

**RECOMMENDATIONS (IN PRIORITY):**

1. Protect riparian and instream habitats from Enloe Dam to the Okanogan confluence.
2. Reduce impacts from roads in floodplains, and relocate where appropriate.
3. Implement agricultural practices that reduce sediment delivery to the river.
4. Increase knowledge base on heat loading processes in this reach.
5. Clean up mine tailings in riparian areas that have connectivity to the river.

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BONAPARTE CREEK ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead.	<u>Drainage area:</u>
<b>STATUS:</b> Category 4	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  None	
<b>FACTORS AFFECTING HABITAT CONDITION:</b> <ul style="list-style-type: none"> <li>▪ Channel cutting and bank erosion, loss of channel sinuosity and riparian habitat.</li> <li>▪ High levels of sheet and rill erosion.</li> </ul>	
<b>LEVEL OF CERTAINTY:</b> <ul style="list-style-type: none"> <li>▪ NRCS studies provide high level of certainty.</li> </ul>	
<b>RECOMMENDATIONS (IN PRIORITY):</b> <ol style="list-style-type: none"> <li>1. Reduce impacts from roads in floodplains, and relocate where appropriate.</li> <li>2. Implement agricultural practices that reduce sediment delivery to the river.</li> </ol>	

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OMAK CREEK ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead.	<u>Drainage area:</u> 90,684 acres
<b>STATUS:</b> Category 2	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  None	
<b>FACTORS AFFECTING HABITAT CONDITION:</b> <ul style="list-style-type: none"> <li>▪ Poor upslope condition in rangeland and forested areas contribute to water quality and quantity concerns.</li> <li>▪ Loss of riparian habitat and floodplain due to increased channel incision.</li> </ul>	
<b>LEVEL OF CERTAINTY:</b> <ul style="list-style-type: none"> <li>▪ Range and forest conditions assessed through federal and tribal surveys.</li> <li>▪ Water quality information derived from periodic sampling.</li> </ul>	

**RECOMMENDATIONS (IN PRIORITY):**

1. Implement forest and agricultural practices that reduce sediment delivery to the river.
2. Increase stream flow.
3. Protect and restore riparian habitat in middle and lower reaches.

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SALMON CREEK ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead, redband trout.	<u>Drainage area:</u> 675,849 acres
<p><b>STATUS:</b> Category 3</p> <ul style="list-style-type: none"> <li>▪ Historical spring chinook salmon and bull trout habitat.</li> </ul>	
<p><b>SIGNIFICANT SUBWATERSHEDS:</b></p> <p>None</p>	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Dewatered reach downstream of irrigation diversion dam prevents upstream migration to entire watershed, and all life histories in lower reach.</li> <li>▪ Dam operations have substantially modified stream channel morphology and function.</li> <li>▪ Some reaches upstream of dam have high width: depth ratios, and lack streambank vegetation and woody debris.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Habitat conditions well documented through joint studies of Colville Tribe and Okanogan Irrigation District.</li> </ul>	



**RECOMMENDATIONS (IN PRIORITY):**

1. Provide suitable instream flows for lower Salmon Creek.
2. Create a stream channel morphology in lower Salmon Creek that is consistent with the historical stable stream type, and raise the water table to support riparian vegetation by developing a small but effective floodplain.
3. Use passive restoration for riparian areas between Conconully Reservoir and diversion dam.

**Appendix C.5: Foster Creek and Moses Coulee Subbasin**

FOSTER CREEK ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead	<u>Drainage area:</u> 213,639 acres
<b>STATUS:</b> Category 4	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Low flows, intermittent flows and seasonal flows.</li> <li>▪ Fish passage barriers likely limit distribution in some streams.</li> <li>▪ Flood events and human activities have altered instream and riparian habitats.</li> <li>▪ Distribution of anadromous fish is affected by natural variations in stream flow and escapement levels.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Distribution of fish is based on professional judgement and intermittent surveys</li> <li>▪ Data on habitat conditions, flow conditions, and fish passage barriers are limited.</li> </ul>	

**RECOMMENDATIONS (IN PRIORITY):**

1. Determine life history of salmonids in Foster Creek.
2. Collect baseline habitat data in Foster Creek.
3. Evaluate surface and groundwater conditions.

Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat

MOSES COULEE ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> Steelhead	<u>Drainage area:</u> 776,222 acres
<b>STATUS:</b> Category 4	
<b>SIGNIFICANT SUBWATERSHEDS:</b>  None	
<b>FACTORS AFFECTING HABITAT CONDITION:</b> <ul style="list-style-type: none"> <li>▪ All streams have low seasonal stream flows.</li> <li>▪ Fish passage barriers limit distribution in some streams.</li> <li>▪ Flood events and human activities have altered instream and riparian habitats.</li> </ul>	
<b>LEVEL OF CERTAINTY:</b> <ul style="list-style-type: none"> <li>▪ Distribution of fish is based on professional judgement and intermittent surveys.</li> <li>▪</li> </ul>	

**RECOMMENDATIONS (IN PRIORITY):**

1. Determine life history of salmonids in, Rock Island Creek.
2. Continue to collect baseline habitat data in Rock Island Creek.
3. Evaluate surface and groundwater conditions in Moses Coulee.

**Appendix C.5: Squilchuck Watershed**

SQUILCHUCK ASSESSMENT AND INTERIM STRATEGY	
<u>Native species:</u> steelhead.	<u>Drainage area:</u>
<b>STATUS:</b> Category 4	
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"> <li>▪ Low stream flows and passage barriers limit distribution and abundance of salmonids.</li> <li>▪ Upstream populations are likely isolated by fragmented habitats in lower reaches.</li> </ul>	
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"> <li>▪ Distribution and status of salmonids in streams are not well known.</li> <li>▪ Low flows and passage barriers are readily apparent, but no formal surveys have been made to assess benefits of restoration practices in these streams.</li> <li>▪ There is likelihood that there are isolated populations of redband trout in these streams.</li> </ul>	
<p><b>RECOMMENDATIONS (IN PRIORITY):</b></p> <ul style="list-style-type: none"> <li>▪ Assess the distribution, abundance, and genetic structure of salmonids in these streams.</li> <li>▪ Identify habitat conditions that limit their productivity, and develop a protection and restoration plan accordingly.</li> </ul>	

**Appendix C.6. Mainstem Columbia River**

MAINSTEM COLUMBIA RIVER ASSESSMENT AND INTERIM STRATEGY
<p><u>Native species:</u> spring, summer, and fall chinook salmon, steelhead, sockeye salmon, coho salmon, bull trout.</p>
<p><b>STATUS:</b> Category 5</p> <ul style="list-style-type: none"><li>▪ Upstream and downstream migration corridor, and a documented spawning habitat in some areas for summer and fall chinook salmon. Likely overwinter habitat for many species and age groups.</li></ul>
<p><b>FACTORS AFFECTING HABITAT CONDITION:</b></p> <ul style="list-style-type: none"><li>▪ Hydroelectric dams inundated habitats and impaired passage conditions.</li><li>▪ Habitat degradation and loss on shorelines from land development and road construction may affect salmonids at some life history stages.</li><li>▪ Stormwater and agricultural runoff contribute to water quality degradation.</li></ul>
<p><b>LEVEL OF CERTAINTY:</b></p> <ul style="list-style-type: none"><li>▪ Hydropower impacts are well studied.</li><li>▪ Impacts to salmonids from Columbia River shoreline management are inferred from studies on smaller-order streams.</li></ul>

**RECOMMENDATIONS (IN PRIORITY):**

1. Hydropower impacts are an obvious concern, but are not addressed in this assessment.
2. Protect any remaining riparian habitat.
3. Evaluate potential for impacts to salmonids from shoreline management: develop recommendations to lessen impacts, as appropriate.