SALMON, STEELHEAD AND BULL TROUT HABITAT LIMITING FACTORS

WATER RESOURCE INVENTORY AREA 48

WASHINGTON STATE

CONSERVATION COMMISSION

FINAL REPORT

Carmen Andonaegui

7/18/00

ACKNOWLEDGMENTS

The following individuals served on the "2496 Methow Habitat Limiting Factors Technical Advisory Group". These persons dedicated many long hours to the development and review of the report in the face of constant demands on their professional time. Their dedication is very much appreciated.

Name	Representing
Jennifer Molesworth	US Forest Service
Jeanette Smith	Pacific Watershed Institute
Lynda Hofmann	Washington Department of Fish and Wildlife
Heather Bartlett	Washington Department of Fish and Wildlife
Connie Iten	Washington Department of Fish and Wildlife
Joel Hubble	Yakama Nation
Ray Latham	Washington Department of Ecology
Chris Fisher	Colville Confederated Tribes
Jim McGee	Douglas County Public Utility District
Kate Terrell	US Fish and Wildlife Service

In addition, many individuals were called upon to provide input and assistance during the development of the report. These persons included:

Name	**Representing**
Mel Bennet	US Forest Service
Hal Beecher	Washington Department of Fish and Wildlife
Peter Morrison	Pacific Biodiversity Institute
Chuck Peven	Chelan County Public Utility District
Shane Bickford	Douglas County Public Utility District
Dave Hopkins	US Forest Service
Janet Wilson	US Forest Service
Bill Baer	US Forest Service
Sandra Noble	US Fish and Wildlife Service
Dana Visalli	Methow Biodiversity Project
John Monahan	Washington Department of Ecology
Bob Anderson	Golder Associates
Pat Olson	Pacific Biodiversity Institute
Rick Klinge	Douglas County Public Utilities District
Bob Bugert	Governor's Salmon Recovery Office
Will Keller	Natural Resource Conservation Service
Lee Carlson	Yakama Nation
Dale Bambrick	National Marine Fisheries Service
Tracy Lloyd	Washington Department of Fish and Wildlife
John Easterbrooks	Washington Department of Fish and Wildlife
Bob Steele	Washington Department of Fish and Wildlife

Connie Iten of the Washington Department of Fish and Wildlife deserves special consideration for her assistance in the actual writing and editing of the report. She brought with her a renewed energy to the process that I personally found invigorating. Finally, the behind the scenes efforts of my supervisor, Ed Manary, the rest of the Washington Conservation Commission staff, and Ron McFarlane (GIS project technician), Devin Smith and Randy McIntosh of the Northwest Indian Fisheries Commission provided crucial support during the development of the report.

TABLE OF CONTENTS

ACKNOWLEDGMENTS 2

TABLE OF CONTENTS 4

WRIA 48 MAP APPENDIX TABLE OF CONTENTS 6

LIST OF TABLES 7

LIST OF FIGURES 8

EXECUTIVE SUMMARY 9
- GENERAL INFORMATION 9
- FACTORS AFFECTING NATURAL SALMONID PRODUCTION IN THE WATERSHED 11
- THE TECHNICAL ADVISORY GROUP'S RECOMMENDATIONS RANKED IN ORDER OF IMPORTANCE 12
- SUMMARY OF HABITAT CONDITIONS BY SUBWATERSHED 14
- INVENTORY AND ASSESSMENT DATA GAPS FOR THE WATERSHED 16

INTRODUCTION 18
- THE ROLE OF HABITAT IN A HEALTHY POPULATION OF NATURAL SPAWNING SALMON 19

WATERSHED OVERVIEW 22
- CLIMATE AND HYDROLOGY 24
- GEOLOGY AND HYDROGEOMORPHOLOGY 27
- VEGETATION 28

FISH DISTRIBUTION AND STATUS 31
- SUMMARY OF HISTORIC EVENTS 31
- BULL TROUT 35
- COHO SALMON 37
- SOCKEYE 39
- SUMMER CHINOOK 40
- SPRING CHINOOK 41
- SUMMER STEELHEAD 46

HABITAT LIMITING FACTORS BY SUBWATERSHED 50
- INTRODUCTION 50
- CATEGORIES OF HABITAT LIMITING FACTORS USED BY THE WASHINGTON STATE CONSERVATION COMMISSION: 52
- DATA GAPS 65
- RECOMMENDATIONS 69
- UPPER METHOW RIVER SUBWATERSHED 69
  - Mainstem Upper-Methow River (48.0007) 70
  - Goat Creek (48.1364) 78
  - Other Drainages in the Upper Methow River Subwatershed 86
- LOST RIVER SUBWATERSHED 88
- EARLY WINTERS CREEK SUBWATERSHED 91
- CHEWUCH RIVER SUBWATERSHED 95
  - Mainstem Chewuch River (48.0728) 99

Boulder Creek (48.0770) 105
Eightmile Creek (48.0901) 106
Twentymile Creek (48.0977) 107
Other Drainages in the Chewuch River Subwatershed. 109
MIDDLE METHOW RIVER SUBWATERSHED 111
Mainstem middle-Methow River (48.0007) and Alder Creek (48.0296) 112
Bear Creek (48.0708). 116
Beaver Creek Drainage 117
TWISP RIVER SUBWATERSHED 123
Mainstem Twisp River 124
Tributaries to the Twisp River 130
LOWER METHOW RIVER SUBWATERSHED 135
Mainstem Lower-Methow River 137
Libby Creek Drainage 138
Gold Creek Drainage 143
Squaw Creek (48.0043) and Black Canyon Creek (48.0015). 148
ASSESSMENT OF HABITAT LIMITING FACTORS 151
LITERATURE CITED 160
GLOSSARY 171
APPENDIX A – CHINOOK, STEELHEAD/RAINBOW AND BULL TROUT DISTRIBUTION 182
APPENDIX B – SPRING CHINOOK SPAWNING GROUND SURVEY SUMMARIES 203
APPENDIX C - TABLES OF KNOWN FISH PASSAGE BARRIERS IN THE METHOW, WRIA 48 207
APPENDIX D - SALMONID HABITAT CONDITION RATING STANDARDS FOR IDENTIFYING LIMITING FACTORS 224

WRIA 48 MAP APPENDIX TABLE OF CONTENTS

Several maps have been included with this report for your reference. The maps are appended to the report, either as a separate electronic file (for the electronic copy of this report) or separate printed section (for hard copy). The maps are included as a separate electronic file to enable the reader to utilize computer multi-tasking capabilities to simultaneously bring up the map and associated text. Below is a list of maps that are included in the WRIA 48 map appendix/file:

Map Appendix A: Fish Distribution Maps For The Methow Watershed, WRIA 48

A: 1 Spring Chinook Salmon Distribution In The Methow Watershed, WRIA 48........................2

A: 2 Summer Chinook Salmon Distribution In The Methow Watershed, WRIA 48.....................3

A: 3 Steelhead/Rainbow Trout Distribution In The Methow Watershed, WRIA 48 4

A: 4 Bull Trout Distribution In The Methow Watershed, WRIA 48 5

Map Appendix B: Side Channels Of The Methow, Chewuch, And Twisp Rivers

B:1 The Methow River From The Vicinity Of The Lost River Confluence Downstream To Goat Creek 6

B: 2 The Methow River From The Vicinity Of Goat Creek To The Vicinity Of The Big Valley Ranch 7

B: 3 The Chewuch River In The Vicinity Of The Eight Mile Creek Confluence..........................8

B: 4 The Methow River From The Vicinity Of The Riverbend Rv Park Downstream To The Vicinity Of The South End Of The Town Of Twisp & The Twisp River From The Vicinity Of Poorman Creek Downstream To The Confluence..9

B: 5 The Twisp River From The Buttermilk Creek Confluence Upstream To The Vicinity Of The Lime Creek Confluence..10

B: 6 The Lower Methow River From The Vicinity Of Beaver Creek Downstream To Alder Creek..11

Map Appendix C: Fish Passage Barriers Maps For The Methow Watershed

C: 1 Fish Passage Barriers In The Methow Watershed, WRIA 48 12

C: 2 Fish Passage Barriers In The Beaver Creek Drainage Of The Methow Watershed, WRIA 48..13

Map Appendix D: 1 Known Irrigation Ditches, Water Diversions And Fish Screens In The Methow Watershed, WRIA 48 14

LIST OF TABLES

Table 1 Minimum, Maximum and Mean September Flows for Period of Record at USGS Streamflow Gages in the Methow Watershed. 26

Table 2 Known salmonid occurrence in the Methow watershed, WRIA 48........ 32

Table 3 Adult spring chinook counted passing Wells Dam, 1977-1999........ 45

Table 4 Known salmonid species use in the Upper Methow River Subwatershed........ 71

Table 5 Known salmonid species use in the Chewuch River Subwatershed........ 99

Table 6 Known salmonid species use in the Middle Methow River Subwatershed........ 112

Table 7 Known salmonid species use in the Twisp River Subwatershed........ 125

Table 8 Known salmonid species use in the Lower Methow River Subwatershed. 137

Table 9 Assessment of habitat conditions limiting salmonid performance in WRIA 48........ 153

LIST OF FIGURES

Figure 1 Location of WRIA 48 in Washington State 23
Figure 2 Daily Values of Runoff Volume in Cubic Feet per Square Mile 25
Figure 3 Map of subwatersheds in WRIA 48 51
Figure 4 Salmon Carcass Distribution in the Methow, WRIA 48 64
Figure 5 Chewuch Subwatershed Landownership Map (provided by the USFS, Okanogan National Forest, Methow Valley Ranger District) 97
Figure 6 Large woody debris (LWD) removal in the Chewuch River in 1963 (before) 100
Figure 7 Large woody debris (LWD) removal in the Chewuch River in 1963 (after). 100

EXECUTIVE SUMMARY

General Information

The Methow River Water Resource Inventory Area (WRIA) 48 is located in north central Washington State. A tributary of the Columbia River, it is bordered on the west by the Cascade mountains, on the north by Canada, on the east by Buckhorn Mountains and the Okanogan River drainage, and on the south by the Columbia River and the Sawtooth Ridge. Draining nearly 1,890 square miles (1,208,746 acres), the Methow River flows southward for more than 80 miles through western Okanogan County before emptying into the Columbia River near the town of Pateros.

Upper Columbia River summer steelhead, including the Methow River run, were listed under the Endangered Species Act (ESA) as “endangered” on August 18, 1997. Upper Columbia River spring-run chinook salmon, including the Methow River run, were listed under the ESA as “endangered” on March 24, 1999. Bull trout in the Methow River were listed under the ESA as "threatened” on June 10, 1998. All of these ESA listed species inhabit the Methow watershed and have experienced a severe decline in adult numbers. Although not an ESA listed species, summer-run chinook which spawn and rear in the Methow River, declined dramatically between 1967 and 1991 (WDFW 1993). Based on a short-term severe decline and a long-term negative trend in escapement summer-run chinook are identified as "depressed" by the Washington Department of Fish and Wildlife (WDFW 1993) in the Salmon and Steelhead Stock Inventory report (SASSI).

In the late1800’s, overfishing on the lower Columbia River severely depleted salmon runs to upper Columbia River tributaries (Chapman 1986). Later, a hydroelectric dam across the Methow River at Pateros blocked all fish passage between 1915 and 1929. By the time the dam was removed, the Methow River run of coho was extinct, spring and summer chinook runs, as well as steelhead were severely depressed. In 1939, a massive hatchery program was launched to offset the loss of access and mitigate for impacts created by the soon to be completed Grand Coulee Dam. Despite ongoing hatchery programs, resource managers have not been able to reestablish the salmon and steelhead populations to self-sustaining levels. Failure can be attributed to a number of factors including, passage problems and mortality associated with nine hydroelectric facilities on the mainstem Columbia River, unfavorable ocean conditions, harvest pressures, and degradation of ecological processes and habitat within the Methow watershed (WDFW et al. 1990; Peven, 1992; Caldwell and Catterson 1992; WDFW 1993; Williams et al. 1996).

The Salmon, Steelhead and Bull Trout Habitat Limiting Factors Report for the Methow Watershed focuses on habitat conditions in the Methow watershed as they affect the ability of the habitat to sustain naturally-producing salmonid populations. It provides a snapshot in time based on the data and published material available during the development of this report and the professional knowledge of the Technical Advisory Group (TAG). Although revisions to the report are not currently funded, the Washington

State Conservation Commission (WCC) will be requesting funding in the 2001 - 2003 budget for a continuation in funding to allow for this need.

Data in the literature on habitat conditions in the watershed are extremely limited regarding private lands. The quality of available information for public lands, which comprise about 94% of the watershed (Rock Island Hydroelectric Facility et al. 1998), is highly variable. Conclusions within the literature often lack adequate supporting data and in some cases are contradictory. Data collection and studies in the Methow watershed generally focus only on subwatersheds or portions of subwatersheds thereby not supporting a watershed-level, ecosystem-based approach to salmonid management. Thus, the TAG relied heavily on its combined professional knowledge to assess the extent to which habitat conditions are affecting salmonid productivity in the Methow watershed and their relative importance in limiting the productivity of naturally-producing salmonid populations watershed-wide. Knowledge of habitat-forming processes and general salmonid habitat needs provide the basis for drawing conclusions in this report.

In the short-term, structural manipulations of the stream channel (ie. barbs, LWD placements, rock/log toes, weirs, bioengineered bank stabilization) designed to treat symptoms of habitat degradation should be implemented with caution until a long-term salmonid habitat protection and restoration strategy can be developed. A long-term strategy should maintain a watershed-wide, ecosystem-based approach and define a course of action to correct those factors that are causing the habitat degradation. Section 070 of the Salmon Recovery Act (RCW 75.46, also known as HB2496), directs the Lead Entity Citizen's Committee to develop this strategy. As per this legislation, the Colville Confederated Tribes and Okanogan County, co-Lead Entities for Okanogan County, have convened this Citizen's Committee. Components of the strategy for "prioritizing and implementing salmon restoration activities… in a logical sequential manner that produces habitat capable of sustaining healthy populations of salmon" are to include project monitoring, project evaluation, and adaptive management strategies. Integrated into the context of a long-term strategy, short-term structural channel manipulations can then be more biologically effective. All structural improvement projects should be designed so the placement is appropriate for the hydro-geomorphological characteristics of the reach.

Habitat projects aimed at securing critical habitats and rehabilitating impacted habitats should be accomplished concurrently with improved habitat protection measures. Hydraulic Code permitting standards, shoreline management regulations, floodplain ordinances, critical area ordinances, and comprehensive plans should be reviewed, amended and strictly enforced to insure adequate protection of existing habitat. Implementation of adequate habitat protection regulations will help to maintain and enhance those naturally occurring habitat functions currently existing in the watershed. Focus should be removed from treating the effects of habitat degradation (ie. reduced pool quality and quantity, habitat, cobble embeddedness, reduced levels of LWD, high instream temperatures, and accelerated bank instability) with short-lived, engineered treatments (ie. stabilizing banks, anchoring woody debris, planting vegetation and installing barbs) to diagnosis and treatment of the causes of habitat degradation.

Factors Affecting Natural Salmonid Production in the Watershed

Currently production of self-sustaining anadromous salmonids are limited by the reduced numbers of returning wild adults to the Methow watershed. The Methow River is a journey of 424 river miles from the mouth of the Columbia River and requires navigating through nine hydroelectric facilities once as smolts and again as adults. Coincident with unfavorable ocean conditions and harvest impacts, the out-of-basin impacts can significantly affect the ability of the Methow watershed to support self-sustaining anadromous salmonids. Regarding bull trout populations, little information exists concerning the impact of hydroelectric development in the Upper Columbia River system on fluvial bull trout forms but there is speculation that the conversion of the free-flowing upper Columbia River to a series of reservoir impoundments has had a negative effect on upper Columbia River fluvial bull trout populations (Brown1992). Maintaining self-sustaining populations of stream-resident and adfluvial forms of bull trout however, are dependent on providing properly functioning habitat and access to that habitat in sufficient quantities within the watershed.

Natural environmental conditions also can limit natural production of salmonids in the Methow watershed. Extreme winter conditions, the result of latitude, elevation and the influence of the Cascade mountain range on marine and arctic air masses, combine to create extreme winter conditions which contribute to reduced fish growth and activity (Mullan et al. 1992). In years when moisture availability is limited by climatic conditions, instream flows become severely reduced resulting in dewatered reaches, winter icing, and higher summertime water temperatures. Depending on the severity of the climatic conditions, the duration and extent of low instream flows and dewatered reaches can expand. These conditions restrict salmonid access to habitat, dewater redds, and strand juveniles, resulting in direct mortality to salmonids. Catastrophic disturbances are also a natural component of this ecosystem and limit salmonid production. Landslides, floods and fire create a disturbance regime that cleanses, builds and replenishes the aquatic environment. While these events reduce habitat availability or function in one stream reach, they improve habitat conditions in another stream reach by recruiting spawning gravels and LWD while flushing sediment.

In some portions of the watershed, human alterations to the environment are exacerbating naturally limiting conditions by reducing habitat quality and quantity thereby reducing a species' chances of successfully completing its life cycle. These alterations have primarily occurred in the lower gradient, lower reaches of subwatersheds and include road building and placement, conversion of riparian habitat to agriculture and residential development, water diversions, and diking. However, in Cub, Boulder, Eightmile and Falls creeks (all in the Chewuch River subwatershed), and in the Goat, Beaver, Libby and Gold creek drainages, impacts also extend into the upper reaches of the drainages. These impacts are mostly the result of past timber harvest operations, road building and placement, and grazing.

Providing that habitat rehabilitation and protection of aquatic systems continues on federally owned land within the watershed as per current standards and guidelines

(PACFISH; USDA Forest Service and USDI Bureau of Land Management 1995), it is the professional opinion of the TAG that habitat conditions in the upper portions of the Methow watershed are sufficiently intact to support self-sustaining populations of salmonids given the following: 1) no further reduction in habitat quality and quantity in the watershed; 2) removal of artificial fish passage barriers and installation of approved screening devices on water diversions; 3) rehabilitation of stream functions in the lower reaches of certain tributaries and portions of the mainstem; 4) instream flows sufficient so as not to impede adult fish passage and salmonid rearing; 5) and adequate out-of-basin survival rates are achieved to maintain basin populations.

The Technical Advisory Group's Recommendations Ranked in Order of Importance

1. **Protection of properly functioning habitat**. The TAG identified protection of properly functioning habitat as the most critical action necessary to insure sustainability of naturally-producing, anadromous salmonids in the Methow watershed, given adequate returns of adult spawners. Floodplains and riparian habitat along the upper Methow River from the Lost River confluence, inclusive, downstream to the town of Winthrop was identified by the TAG as habitat in the most immediate need of protection. Protecting functional floodplains and riparian habitat located in the lower 15 miles of the Twisp River and along the middle mainstem Methow River was identified as a high priority second to the upper Methow River habitat. Although enough professional knowledge exists to identify habitat that qualifies for immediate protection, given the lack of information on non-federal lands, a study is needed to define current floodplains, habitat conditions, and fish usage in the Methow watershed in terms of channel form and process. This would allow for the development of a coordinated, watershed-level approach to habitat protection that would address issues of maintaining habitat connectivity and habitat-forming processes.

2. **Restoration of fish passage and screening of water diversions**. Concurrent with habitat protection, restoring fish passage at critical fish passage barriers and meeting NMFS Juvenile Fish Screen Criteria for water diversions was identified by the TAG as a critical action needed to promote sustainability of naturally-producing, anadromous salmonids in the Methow watershed. To implement a watershed-wide strategy of fish passage restoration in a logical and sequential manner, a single data set of inventoried fish passage barriers with the quantity and quality of habitat upstream of the barriers is needed. In regards to fish screen needs, Greg Knott of the Okanogan National Forest, Methow Valley Ranger District (U.S. Forest Service, pers. comm., April 2000) has stated that all water diversions on USFS land have been identified and are screened as per federal standards. The Forest Service maintains the locations of all water diversions in a Geographic Information Services (GIS) coverage with an associated database. The WDFW Salmonid Screening, Habitat Enhancement and Restoration (SSHEAR) Division also maintains a database of water diversions and screen conditions for which they have an installation or maintenance agreement. For the purpose of this report, a map of known water diversions and fish screens in

the Methow watershed was created by combining these two data sets (Map Appendix D). There is still a need to review this data to reconcile any inconsistencies between the data sets. A field inventory of unidentified water diversions and screen conditions will then be needed to fill in gaps in knowledge.

3. **Restoration of stream functions in the lower 15 miles of the Twisp River**. Next to habitat protection, fish barrier removal and screening issues, rehabilitating the stream functions in the lower 15 miles of the Twisp River was identified by the TAG as a critical action needed to insure sustainability of naturally-producing, anadromous salmonids in the Methow watershed. Based on spring chinook spawning ground survey results from 1987 – 1999 (Appendix B, **Table B- 1**), 25% of spring chinook redds were found in the Twisp River. Prior to human alterations, the natural characteristics of the lower Twisp River landscape (its geomorphological characteristics) would have provided much in the way of associated beaver/wetland complexes, riparian forests with a cottonwood gallery component, and active side channels. These habitats are highly productive habitats for salmonids, benefiting not only spring chinook salmon but rainbow/steelhead and bull trout populations as well. Lower Gold Creek and lower Lost River are other reaches in the Methow watershed where rehabilitation would benefit chinook, rainbow/steelhead and bull trout species although to a much lesser extent. Rehabilitation of stream functions in the lower reaches of Wolf Creek, the Chewuch River and Early Winters Creek also would benefit salmon, rainbow/steelhead and bull trout. There are active restoration plans in place for both the Chewuch and Early Winters, and a Habitat Conservation Plan is currently being negotiated for the Wolf Creek drainage. Projects proposed for these areas should take into consideration on-going efforts and strategies.

4. **Research, analyze and assess the relationship between stream flows and water use in the watershed.** Dewatering in portions of the upper Methow River between Robinson Creek (RM 74.6) and the Weeman Bridge (RM 59.7) have been documented as far back as 1898 (Gorman 1899) and are considered a naturally occurring condition. In the lower reaches of some tributaries to the Methow River, dewatering and/or low flows have been documented below water diversions or where considerable human alterations have occurred in the drainage (Wolf Creek, Goat Creek, Beaver Creek, Libby Creek, Gold Creek, and Black Canyon Creek). The extent to which environmental conditions or human influences contributes or causes low flows or dewatering in a given reach requires further data collection and analysis. Data needs that would improve the understanding of the hydrologic functions and conditions in the Methow basin include: 1) a groundwater and surface water interactions study that analyses the patterns and speed of movement of groundwater (especially relative to irrigation return flows; BPA 1997, page 35), identifies critical groundwater recharge areas, and identifies where groundwater contributes to surfacewater ; and 2) a study of the correlation between properly functioning habitat and fish species use as affected by the various hydrologic processes and functions. In 1999, Okanogan County received start-up funding from a Centennial Clean Water Grant to initiate a hydrologic study in the Methow basin. In May 2000, the budget

signed by Washington Governor Gary Locke provided $500,000 to Okanogan County to fund a comprehensive hydrologic study in the Methow watershed. These funds will be available to the County beginning July 2000.

5. **<u>Development and implementation of water conservation practices</u>**. Given the natural variation in stream flows in the Methow watershed, the TAG identified developing and implementing water conservation practices for all uses watershed-wide as a critical action necessary to insure sustainability of naturally-producing, anadromous salmonids in the Methow watershed. Decreased stream flows from July until May are a natural condition in the watershed, a function of environmental influences, and therefore highly variable within a year and between years. Instream flows can be negatively influenced by human-induced changes in the watershed, potentially altering the timing and magnitude of peak and base flows. The lowest flows in the Methow watershed usually occur naturally during the winter months (January – April) when snowpacks do not thaw, precipitation falls only as snow, and some stream reaches freeze up entirely (winter icing). The Chewuch and Twisp River subwatersheds are examples of areas in the watershed where winter icing conditions can negatively affect salmonid productivity. Low flows and lack of riparian vegetation can contribute to this condition. During periods of low snowpack and drought, low flow conditions can also extend into the summer and fall months. Natural low flow conditions can be exacerbated by the diversion of instream flows for irrigation and domestic use during July, August, and especially September. A decrease in the water storage capacity of the drainage and a change in runoff patterns can also affect instream flows in the Methow watershed.

Summary of Habitat Conditions by Subwatershed

Presented below is a summary of habitat conditions by subwatershed that have been identified by the TAG in the development of the report. A more detailed discussion of habitat conditions in each subwatershed can be found in the "Habitat Limiting Factors by Subwatershed" chapter of this document.

<u>Upper Methow River Subwatershed</u> (156,160 acres). The most significant human-induced impacts in this subwatershed occur along the mainstem Methow River from the Lost River confluence downstream to the town of Winthrop. The portions of the subwatershed above the valley floor are in a properly functioning condition with the exception of the lower two-thirds of the Goat Creek drainage. The alluvial fans of every major tributary to the Methow River in this reach have been diked and channelized to some extent (Lost River, Early Winters Creek, Goat Creek, Wolf Creek). Large woody debris levels are inadequate throughout this section of the river although from the headwaters downstream to Goat Creek (RM 64.0) large woody debris levels have been improving and are reaching an "adequate" amount. Accelerated bank destabilization is occurring where riparian lands have been converted to residential and agricultural use. Dewatering of portions of the mainstem Methow River from Robinson Creek downstream to the Weeman bridge naturally occur during low water years. The extent to which the loss of fish production from dewatering in this subwatershed is offset by successful production in other areas of the Methow watershed may be dependent on maintaining accessibility to quality spawning and rearing habitat in the rest of the watershed.

Lost River Subwatershed (107,538 acres). Human impacts in this subwatershed are restricted to the alluvial fan in the lower mile of the Lost River. Nearly 95% of the subwatershed lies within the Pasayten Wilderness. Within the channel migration zone of the first river mile, construction of roads, dikes and buildings associated with home developments have confined the channel, reducing pool quality and quantity and eliminating side channel habitat. Some riparian habitat in the lower mile has been converted to residential development and pasture land. Large woody debris has been removed from the lower mile of the river for flood control and firewood gathering, although recruitment potential is good from the upper reaches of the watershed.

Early Winters Subwatershed (51,547 acres)**.** Although Highway 20 runs parallel to Early Winters Creek up to the headwaters, human impacts in this subwatershed are primarily restricted to the lower 2 miles of Early Winters Creek, including its alluvial fan. Habitat conditions elsewhere in the subwatershed are in a relatively undisturbed or properly functioning condition. The lower ½ mile has been riprapped and diked to keep the channel in a stable location to accommodate Highway 20, the Early Winters Campground development, and to protect private property. Confinement of the floodplain in this reach concentrates high flows resulting in channel incision and entrenchment. High water velocities then scour the channel, destabilizing banks and flushing out spawning gravels. Levels of LWD in the first two miles are low and pool quality and quantity is poor. Severe low flows persist in the lower 1.4 miles of the creek where there are also two water diversions.

Chewuch River Subwatershed (335,000 acres). Downstream of RM 25.0, human land-use impacts within the tributaries and along the mainstem of the lower 25 miles of the Chewuch River limit salmonid productivity in this subwatershed. The upper 50% of the subwatershed is in a properly functioning condition. Chronic and catastrophic sediment delivery to streams (correlated to highly erodible soils exacerbated by impacts from high road densities, road placements, and grazing) and reduced levels of LWD (a result of stream cleanouts and a loss of mature riparian LWD recruitment material) are driving habitat degradation in the lower half of the Chewuch subwatershed. This condition is compounded by; 1) channelization in the alluvial fans at Farewell, Lake, Twentymile, and Boulder creeks, 2) removal of large trees in the riparian zone along the lower 25 miles of the Chewuch River and lower Lake Creek, 3) a decrease in beaver activity over historic times, and 4) low flows in the lower 8 miles of the Chewuch River. There are also three water diversions in lower Chewuch River (RM 9.0, RM 8.1 and RM 0.9) and two water diversions in Eightmile Creek (both at RM 0.25) which enters the Chewuch River at RM 8.0.

Middle Methow River Subwatershed (162,834 acres). Diking, the conversion of riparian areas to agriculture and residential uses, and large woody debris removal along the mainstem Methow River are the most significant human impacts in this subwatershed. As a result, there has been a loss of side channel access and habitat complexity. Additionally, numerous man-made fish passage barriers and unscreened water diversions have been identified in the Beaver Creek drainage, which is included in this subwatershed. A fish passage barrier and screen inventory conducted in 1998 by WDFW (Gower and Espie 1999) identified 78 man-made fish passage barriers (includes both partial and full barriers) and 26 unscreened water diversions (includes both pump and gravity diversions).

Twisp River Subwatershed (157,114 acres). The capability of the lower 15 miles of the Twisp River to provide productive salmonid habitat has been substantially reduced (TAG 2000). This is the result of reduced LWD levels, road placement, dike placement, bank hardening, and conversion of riparian areas to agriculture and residential uses. In addition, from RM 4.0 to the mouth, the reduction of instream flows resulting from water diversions further reduces the quantity of rearing habitat and access to rearing habitat.

Lower Methow River Subwatershed (235,553 acres). There has been no survey or data collection on habitat conditions for the segment of the Methow River that falls within this subwatershed (RM 0.0 - 27.0). Very little of this reach has been visited by TAG participants. Because of the lack of knowledge on habitat conditions, the TAG did not feel qualified to assess the condition of habitat factors for this reach of the Methow River. The Libby Creek and Gold Creek drainages are included in the subwatershed and have more information available for assessment needs. Both drainages have been heavily managed for timber harvesting and livestock grazing and are heavily used areas for recreation in the Methow Valley Ranger District. Roads placement and high road densities are having a major affect on aquatic habitat in both drainages where roads parallel every major stream. Throughout most of both drainages, LWD levels, pool habitat, and sediment delivery are poor to fair. In addition, the lower 2.9 miles of Libby Creek have been channelized and portions of the banks along the lower 3.5 miles of Gold Creek have been riprapped. In years when water diversions exceed base flows during August and September, lower Libby Creek dewaters. Portions of the lower 3 miles of Gold Creek also dewater during dry years.

Inventory and Assessment Data Gaps for the Watershed

Following are the overriding watershed-level inventory and assessment data gaps for the Methow watershed. Obtaining this information will increase the ability of the public and technical staff to make natural resource management decisions at the watershed-level with a higher degree of confidence in the outcomes or results. These data gaps and subwatershed-level data gaps are discussed in more detail in the "Habitat Limiting Factors by Subwatershed" section of this document.

- An assessment of the extent salmonid productivity is being limited by habitat conditions (human-induced or natural), correlated to species and life stage, and provided on a stream reach basis. This would allow for the development of a long-term coordinated, watershed-level strategy to protect and restore salmonid habitat.

This can be accomplished using existing data and professional knowledge and can be fine-tuned as more data collection and analysis is completed.

- A watershed-wide fish passage barrier and screen safety inventory and assessment to include both private and public lands. This should incorporate existing state, federal and local data and GIS into a single, accessible database and GIS coverage.

- A study is needed to define current floodplains in the Methow watershed in terms of channel form and process. This would contribute to the development of a habitat protection and restoration strategy that would address issues of maintaining habitat connectivity and habitat-forming processes.

- A watershed wide inventory and assessment of riparian habitat and conditions including change over time. This should be developed at a 1:24,000 map scale. It should incorporate existing federal and non-profit data, along with data acquired from an inventory of non-federal lands, into a single, accessible GIS coverage.

- A hydrologic assessment to evaluate groundwater and surface water interactions, identify critical ground water recharge areas, and locations where groundwater contributes to surfacewater. A measure of the affect this interaction has on moderating high summertime and low wintertime surface water conditions should be included.

INTRODUCTION

This report was written pursuant to Engrossed Substitute House Bill (ESHB) 2496 as codified in RCW 75.46, the Salmon Recovery Act, a key piece of the 1998 Legislature's salmon recovery effort. It represents a compilation of information regarding known habitat conditions in the Methow watershed, also know as WRIA 48.

Engrossed Substitute House Bill (ESHB) in part:

- directs the Conservation Commission in consultation with local government and the tribes to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group (section 090, subsection 1, RCW 75.46);

- directs the technical advisory group to identify limiting factors for salmonids to respond to the limiting factors relating to habitat pursuant to section 070 subsection 2 of this act (section 090, subsection 3, RCW 75.46);

- defines limiting factors as "conditions that limit the ability of habitat to fully sustain populations of salmon." (section 010, subsection 5, RCW 75.46);

- defines salmon as "all members of the family Salmonidae which are capable of self-sustaining, natural production." (section 010, subsection 7, RCW 75.46).

The overall goal of the Conservation Commission's limiting factors project is to identify habitat factors limiting production of salmonids in the State. In waters shared by salmon, steelhead and bull trout we will include all three. It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis. The hatchery, hydro and harvest segments of identifying limiting factors are being dealt with in other forums.

Beginning in July 1999, a technical advisory group (TAG) consisting of persons with technical/professional knowledge of the Methow watershed was convened. During monthly meetings scheduled through December 1999, input was solicited from TAG participants regarding existing data, published reports, and professional knowledge of habitat conditions in the watershed. The information was then assembled into draft chapters of the report and widely circulated for review and comments. The TAG was then reconvened in January 2000 and met on a weekly basis through April 2000 for the purpose of providing a more thorough review and edit of the draft chapters of the report. Their input, thus incorporated, was used to produce the final document.

Given the data and professional knowledge available during the development of this report, habitat conditions were identified and assessed with a heavy reliance on professional knowledge. The information regarding habitat conditions is presented in the "Habitat Limiting Factors by Subwatershed" chapter of the report. The assessment of the habitat conditions, rated as "Good", "Fair" or "Poor" (Table 9), was based on the criteria outlined in Appendix D, titled "Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors in the Methow Watershed" and is presented in the "Assessment" chapter of the report. An assessment of the extent to which the habitat conditions, by reach, may be limiting natural salmonid production in the Methow watershed, correlated to species and life stage, was not accomplished within the time frame of this project. This assessment is still needed to develop a coordinated, watershed-level strategy to protect and restore salmonid habitat. It can be accomplished using existing data and professional knowledge and can be fine-tuned as more data collection and analysis is completed. Data gaps are discussed in more detail in the "Habitat Limiting Factors by Subwatershed: chapter of this report.

The Role of Habitat in a Healthy Population of Natural Spawning Salmon

Washington State anadromous salmonid populations have evolved in their specific habitats during the last 10,000 years (Miller 1965). Water chemistry, flow, and the physical attributes unique to each stream have helped shape the characteristics of each salmonid population. These unique physical attributes resulted in a wide variety of distinct salmonid stocks for each salmonid species throughout the State. Stocks are population units within a species that do not extensively interbreed because returning adults rely on a stream's unique chemical and physical characteristics to guide them to their natal grounds to spawn. This maintains the separation of stocks during reproduction, thus preserving the distinctiveness of each stock.

Salmonid habitat includes physical, chemical and biological components. These components include water quality, water quantity or flows, nutrients, stream and river physical features, riparian zones, upland terrestrial conditions, and ecosystem interactions as they pertain to habitat. Changes in stream flows can alter water quality by affecting temperatures, decreasing the amount of available dissolved oxygen, and concentrating toxic materials. For example, water quality can be reduced by heavy sediment loads which result in increased channel instability and decreased spawner success. The riparian zone interacts with the stream environment, providing nutrients and a food web base, woody debris for habitat and flow control (channel complexity), filtering runoff prior to surface water entry (water quality), and providing shade to aid in water temperature control.

Salmonids require clean, cool, well-oxygenated water flowing at a natural rate for all stages of freshwater life. Salmonid survival depends upon specific habitat needs for egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, ocean rearing, adult migration to spawning areas, and spawning. Specific needs vary by species and even by stock.

When adults return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to natal grounds. They need pools with vegetative cover and instream structures such as root wads to provide for resting and shelter from predators. Successful spawning and incubation requires sufficient gravel of the right size for the stock (or population), in addition to the constant need of adequate flows and water quality, all in unison at the necessary location. Also, delayed upstream migration can be critical to spawning success. After entering freshwater, salmon have a limited time to migrate and spawn, sometimes as little as 2-3 weeks. Delays result in pre-spawn mortalities, or spawning in suboptimal locations.

The eggs need stable gravel that is not covered with fine sediment. River channel stability is vital at this life history stage. Floods have their greatest impact to salmon populations during incubation, and human activities can exacerbate these impacts. In an undisturbed system, upland vegetation stores water and shades snowpack slowing the rate of water runoff into the stream. A healthy river has sinuousity with large pieces of wood contributed by an intact, mature riparian zone. The uplands and riparian areas both act to slow the speed of water downstream. Natural systems have access to floodplains where wetlands store flood water and later discharge this storage back to the river during lower flows. Erosion or sediment produced in a healthy system provides a constant supply of new gravel for spawning and incubation without increasing overall channel instability. A stable incubation environment is essential for salmon. It is a complex function of nearly all habitat components contained within that river ecosystem.

When the young fry emerge from the gravels, some species of salmonids migrate quickly downstream toward the estuary while other species search for suitable rearing habitat within side channels and sloughs, tributaries, spring-fed "seep" areas, and stream margins. Quiet water margins and off channel areas are vital for early juvenile habitat. The presence of woody debris and overhead cover aid in food and nutrient inputs as well as provide protection from predators. As growth continues, the juvenile salmonids (parr) will move away from the quiet shallow areas into deeper, faster water.

During the winter, salmonids require habitat that will sustain growth and protect them from predators and harsh winter conditions . Habitat use is determined by behavior changes associated with declining temperatures in the fall and winter. Behavior changes vary by species and life stage (Bjornn and Reiser 1991). In a study of seasonal habitat use of juvenile chinook salmon and steelhead in the Wenatchee River (Don Chapman Consultants 1989) juveniles were located along the stream margin in boulder zones from October to March. During the day they hid in interstitial spaces among boulders; at night both species stationed on boulders and sand adjacent to their daytime habitat. When water temperatures dropped below 50° F (10° C), juveniles were not observed in the water column during the daytime, but remained in the substrate. Adult steelhead that overwinter in the upper-Columbia region are thought to generally seek refuge in the mainstem Columbia River. Some adults will also seek refuge in deep pools of the mainstem tributaries to the Columbia River (Chuck Peven, Chelan PUD, pers. comm., 2000) but may return to the Columbia River if instream water temperatures become too harsh (Larry Brown, WDFW, pers. comm., 2000). Bull trout embryos and alevins overwinter in the gravels for more than 200 days (Fraley and Shepard 1989) making their survival closely dependant on relatively stable thermal regimes. Baxter et al. (1999) considered that groundwater-influenced areas within alluvial valley areas in Montana may be important to egg incubation, emergence success, and the survival of juvenile bull trout.

The following spring, smolts begin seaward migration. Flows, food and cover that provides protection from predators are critical. Once again the unique natural flow regime in each river which shaped the population's characteristics through adaptation over the last 10,000 years, plays an important role in the salmonids behavior and survival. In contrast to natural flow regimes, salmonids from the upper-Columbia region must migrate through a river system that has been highly altered by hydroelectric development. Hydropower dams converted the free-flowing Columbia River to a series of reservoirs upstream from the site of Priest Rapids Dam. Subyearling summer chinook salmon produced in upper-Columbia tributaries tend now to spend several weeks in the reservoirs before they arrive at Priest Rapids Dam in August and later. This has substantially increased the mean size of subyearlings at time of passage at Priest Rapids Dam (Chapman et al. 1994a).

Once reaching the estuary, that food-rich environment provides an ideal area for rapid growth. Adequate natural habitat must exist to support the detritus-based food web, such as eelgrass beds, mudflats, and salt marshes. Also, the processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as woody debris and sediment loads.

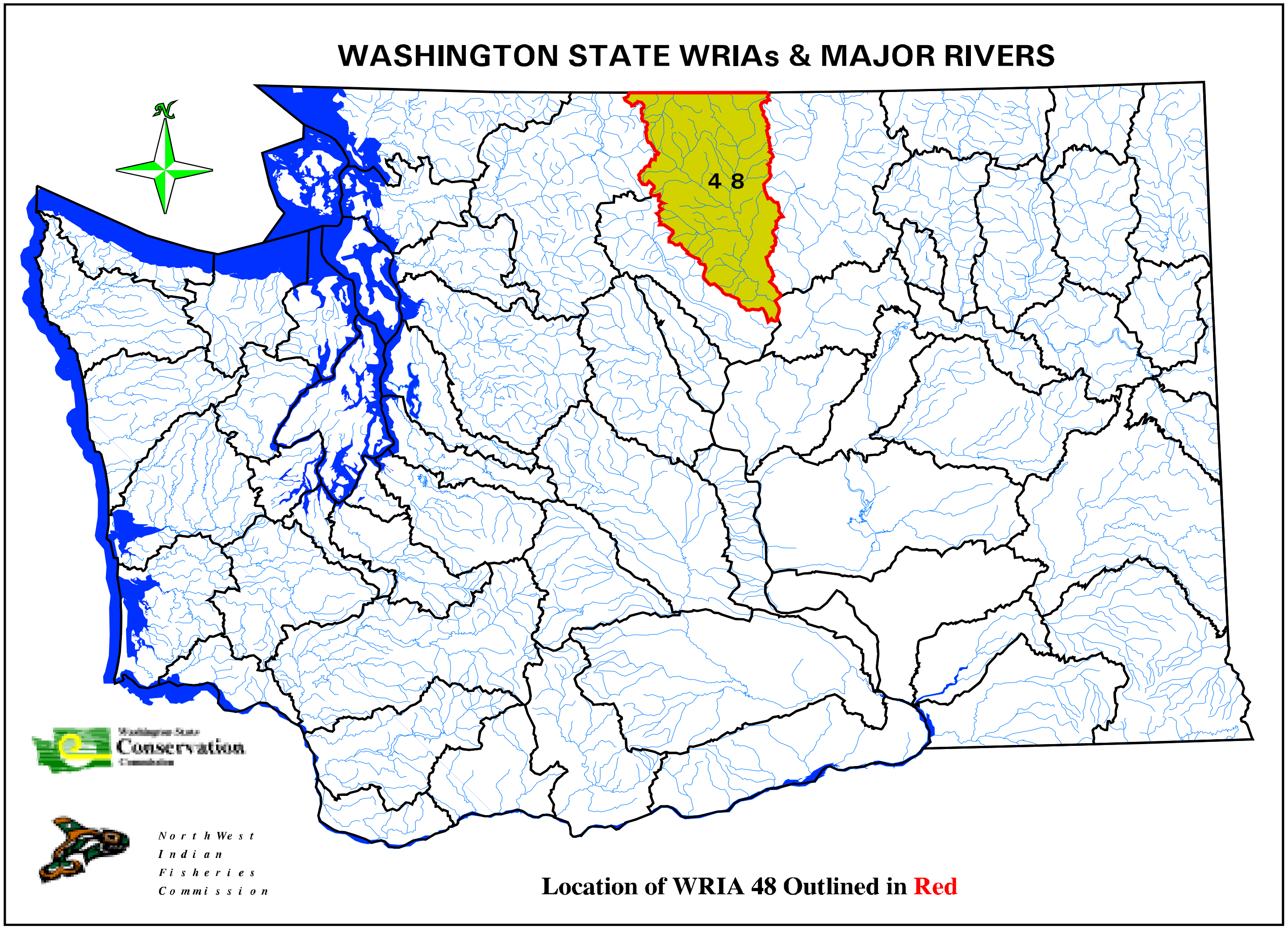
The distribution, seasonal abundance and migratory behavior of salmon and steelhead, exiting the estuary for the nearshore and offshore ocean environment varies considerably (Groot and Margolis 1991; Chapman et al. 1994b; Chapman et al. 1995a). The movements of chinook at sea are more complicated than those of sockeye and pink salmon. Ocean residence for spring chinook is 2-3 years compared to 3-4 years for summer/fall chinook. First-year chinook remain along the continental shelf north to the Gulf of Alaska more than other first-year salmon species (Chapman et al. 1995a). In contrast, distribution of young steelhead differ in time and space from any salmon. Steelhead do not remain along the coastal belt but move directly seaward during their first ocean summer (Chapman et al. 1994b).

In addition to the relationships between various salmonid species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years. These interactions represent a delicate balance affected by habitat quality and habitat quantity. This relationship is complicated by the introduction of non-native salmonid species (brook trout), the introduction of salmonid hatchery stocks, planting of hatchery fish, the extirpation of native coho stocks, and potentially the reintroduction of hatchery coho stocks (BPA 1999) in the Methow watershed. Species like salmon, steelhead/rainbow, and bull trout exhibit a variety of life history patterns often as a result of their adaptability to a complex and fluctuating environment. Maintaining access to sufficient quantities of high quality habitat can contribute to supporting multiple life history stages for all species, thereby increasing a population’s resiliency to environmental changes whether natural or human-induced (Lestelle et al. 1996).

WATERSHED OVERVIEW

The mouth of the Methow River is located at River Mile (RM) 524 on the Columbia River in north central Washington State. The Methow watershed (WRIA 48) extends northward from the confluence with the Columbia River, to its headwaters located along the Cascade Crest and the Canadian border (Figure 1). It is bordered to the east by the Okanogan watershed. The Methow River drains roughly a 1,800 square mile catchment (WDFW et al. 1990; Golder Associates 1993; Methow Valley Water Pilot Planning Project Planning Committee 1994; CRITFC 1995), extending approximately 86 river miles from its headwaters to its mouth. Topography within the basin is varied, and ranges from mountainous sub-alpine and alpine terrain along the Cascade Crest to the gently sloping, wide valley found along the middle reaches of the Methow River. Elevation ranges from over 8,500 feet in the headwaters of the basin to approximately 800 feet at the confluence of the Methow and Columbia Rivers.

Figure 1 Location of WRIA 48 in Washington State

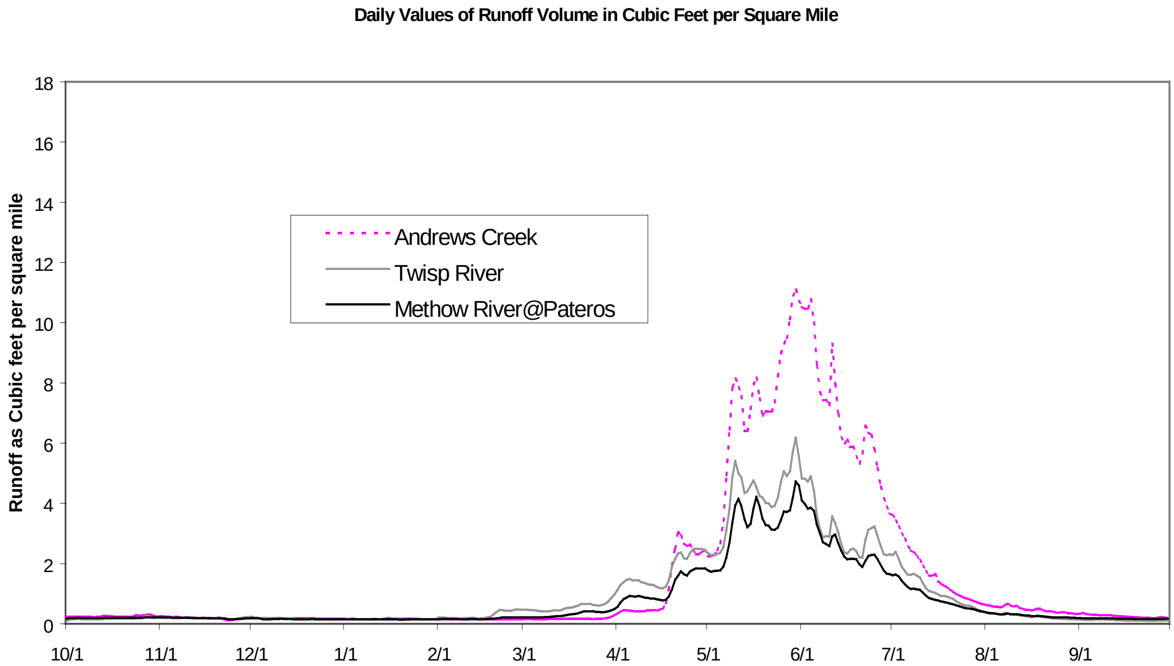


Climate and Hydrology

Elevation, topography and geographic location on the east side of the Cascade Mountains influences the climate of the Methow River Basin. Annual precipitation ranges from over 80 inches along the Cascade Crest to approximately 10 inches near the town of Pateros (Richardson 1976). The temporal distribution of precipitation has a high degree of seasonality, with approximately two-thirds of the precipitation occurring between October and March, mostly in the form of snow. Summers are generally hot and dry with precipitation coming from brief and intense thunderstorms. In fall, precipitation increases and generally peaks in the winter as snowfall occurring between December and February.

Natural characteristics of the Methow watershed, including spatial and temporal variation in precipitation, as well as variation in elevation, aspect, geology, soils and vegetation, affects runoff patterns and water storage in the basin. The seasonal distribution of runoff is influenced by snow storage and melt. The runoff regime in the basin is primarily snowmelt dominated. The maximum volume of streamflow and the highest peak flows occur during spring and early summer (Figure 2). Some peaks in flow occur in November and December. These are generally rain-on-snow events (P. Olson, Pacific Watershed Institute, 2000). Approximately 60 percent of the annual runoff volume, as measured at Pateros, occurs during May and June (Milhous et al 1976; Golder Associates 1993).

Figure 2 Daily Values of Runoff Volume in Cubic Feet per Square Mile.



Streamflow remains relatively high through early June but begins to quickly recede from July through September in response to reduced snowmelt, low summer precipitation, and higher air temperatures. From September to March streamflow is sustained at a relatively constant rate by groundwater, autumn precipitation, and limited snowmelt. Baseflow runoff, in cubic feet per square mile, is nearly the same for all three USGS gage stations even though the watershed characteristics are different (Figure 2). However, some sections of streams in the basin go dry. The extent and duration of this condition is dependent on previous year precipitation and winter snowpack. Thus in very dry years these stream reaches may go dry earlier in the year, stay dry longer, and the dry reaches be more extensive than during wetter years. The timing of the runoff is also governed by watershed elevation. For example, the hydrograph at Andrews Creek gage (elevation: 4300 feet) does not begin to rise until late April, early May. The hydrograph recession begins later than the Twisp River or the Methow at Pateros and a longer snowmelt period sustains Andrews Creek flow longer. The Twisp River hydrograph begins to increase in early March. The gage is at an elevation of 1640 feet.

Human water management, including surface and groundwater withdrawals, irrigation return flow, and diversions, can also affect low summer streamflows. For example, record minimum flows most often take place in September and October on the Twisp and Methow rivers (Table 1). Record minimum flows on Andrews Creek most often occur in November and December. Andrews Creek has no water withdrawals and the majority of the watershed is in the Pasayten Wilderness.

Table 1 Minimum, Maximum and Mean September Flows for Period of Record at USGS Streamflow Gages in the Methow Watershed.

USGS Station #	Description	Drainage Area (sq. mi.)	Location of Station (RM)	Mean Sept. Flow for Period of Record (cfs.)	September		Year Recorded (Max/Min)	Period of Record
					Max. for period of record (cfs.)	Min. for period of record (cfs.)		
12447383	Methow R. above Goat Cr.	373	63.8	40.8	179	0	1997/1994	1991-1998
12447390	Andrews Cr. near Mazama	22	3.5	8.6	100	2	1978/1977	1968-1998
12448000	Chewuch R. at Winthrop	525	0.2	78.7	220	25	1997/1994	1992-1998
12448500	Methow R. at Winthrop	1,007	49.8	284.0	570	134	1997/1994	1912-1998
12448998	Twisp R. at Twisp	245	1.6	51.1	154	15	1976/1994	1975-1998
12449500	Methow R. at Twisp	1,301	40.0	310.0	1160	134	1959/1926 & 1929	1919-1998
12449950	Methow R. near Pateros	1,772	6.7	451.0	2070	200	1978/1973	1959-1998

The stream hydrographs provide the basis for understanding hydrologic processes and patterns in a watershed. However, streamflow influence on biologically important processes is not captured by using mean annual or monthly values or by maximum and minimum flows or even by the daily hydrograph. Aquatic habitat conditions are dependent on a number of complex hydrologic processes that affect runoff patterns and hydraulic variables in streams. Hydraulic variables include water velocity, channel width, depth and slope. The influence of hydrologic runoff processes and hydraulic variables may be on much smaller time intervals than daily or larger time-scales. More importantly the variation in these processes and variables, covers many time and space-scales and all influence the well-being of the aquatic community.

In Figure 2 (Daily Values of Runoff Volume in Cubic Feet per Square Mile), the daily average values for Andrews Creek, Twisp River and Methow River at Pateros are normalized by dividing discharge by drainage area. This allows a comparison of runoff among streams of differing sizes and watershed areas. These hydrographs illustrate that the predominant runoff regime is snowmelt driven. They also show that baseflow runoff for all the streams is similar and nearly constant in winter.

Geology and Hydrogeomorphology

The geomorphology and glacial history of the Methow Valley are described in Geomorphology and Glacial Geology of the Methow Drainage Basin (Waitt 1972). Topsoils in the valley consist of sandy loams with permeabilities from 2.0 to 6.0 inches per hour. These are underlain by alluvium and glacial outwash with rapid to very rapid permeability of greater that 6 inches per hour. It is in these layers of unconsolidated sediments that the major groundwater aquifers of the Methow Valley exist, underlain by bedrock. Groundwater occurrence, movement and availability are primarily related to recharge sources and the configuration of depositional sediments. The Methow River and the alluvial aquifer system have a discharge/recharge relationship that varies seasonally, with specific valley position, and in relation to recharge sources (EMCON 1993). Waitt (1972) estimated the sediment thickness in the Methow Valley to be between 500 and 1,200 feet. Geophysical surveys completed as part of the EMCON study indicate a depth to bedrock of 800 to 1,200 feet at mid-valley locations from Weeman Bridge to above Early Winters Creek. Extrapolation of data from these sites, in combination with less extensive drilling and geophysical investigations conducted in the remainder of the Methow Valley area above Winthrop have been used to define subsurface conditions upstream of the Wolf Creek confluence (EMCON 1993). Subsurface conditions downstream of Winthrop have not been investigated.

The geology of the Methow River basin, in concert with the watershed's hydrology (precipitation and runoff patterns) has shaped the physical character of its watercourses. Stream channels respond to changes in stream discharge, sediment loading, and riparian vegetation conditions. Stream habitat quality and abundance are a function of conditions of riparian vegetative assemblages, channel morphology and stream flows, with temporal and spatial influences of natural and human-induced disturbances affecting the condition of these three components.

In the Methow watershed, numerous high-energy watercourses drain steep slopes carrying melted snowpack and stream bed materials. These streams drain into hanging valleys, briefly taking on the characteristics of lower gradient systems before reverting to high-energy streams as they exit the hanging valleys, or they drain into U-shaped valley troughs and valley bottoms with deep deposits of glacial outwash and alluvium. Here these watercourses meander and braid, with the stream meander zone widths defined by the underlying geology of rock and clay outcrops. Patterns of channel flows within these meander zones are further defined by the duration of sustained high flows, water velocities, and the type and quantity of bedload material and large woody debris moved through the system.

The Methow River is the principal hydrologic feature in the valley, bisecting the valley from Lost River to Winthrop. In many areas, particularly above Winthrop, the Methow River displays the characteristics of a braided stream, with interlaced and divergent channels and the development of gravel and boulder bars. The river course migrates within a broader stream meander zone as a result of inadequate stream energy to transport and rearrange bedload materials and large woody debris traveling through the system (EMCON 1993). Alluvial fans, notably at Lost River, Early Winters Creek and Wolf Creek, constrain the river in places. Downstream from Winthrop to below Twisp, the river channel is better confined within the fluvial valley fill sediments. The average slope of the bed in this reach also drops from 23.4 feet/river mile reported between Mazama and Winthrop(Beck and Associates 1973), to 17.0 feet/river mile between Winthrop and Twisp (Okanogan County 1996). From Twisp at RM 39.40, downstream to RM 32.67, where the river bed and valley floor are composed of erodible, unconsolidated alluvial sediments, the river will change its course given flows of certain timing and duration (Okanogan County 1996). Dikes constructed within this reach and above Winthrop, affect water velocities, thereby altering bedload deposition and channel migration patterns. From RM 32.67 down to the town of Carlton and on to the confluence with the Columbia River, the lower Methow River is confined primarily to a channel eroded in bedrock, with discontinuous depositional terraces immediately adjacent to the river (EMCON 1993).

Vegetation

The natural vegetation of the Methow River basin varies in response to temperature, moisture availability, and soil characteristics. Periodic outbreaks of fire, diseases and insect infestations further affect tree species composition and distribution. Climax vegetation zones within the Methow watershed are generally described as follows. These zones are described by the tree species likely to become climax within a specified range of macroclimates or unique site variables.   This usually implies a period of stability, free of disturbance, which allows the more competitive tree species and understory vegetation to become established.

1. On sites with a high water table or seasonal flooding, deciduous riparian communities may develop, or Englemann spruce may be dominant, especially on colder sites;

2. in basin lowlands and valleys, shrub-steppe and steppe plant communities dominate;

3. ponderosa pine occupies lower elevation sites that are moisture limiting to douglas fir;

4. with increasing moisture and elevation, douglas fir assumes dominance;

5. with colder temperatures at higher elevations subalpine fir becomes the dominant species; and

6. at higher elevations that can not support tree growth, subalpine and alpine meadow grass and forb species dominate (USFS 1994).

Undisturbed riparian areas in the Methow Valley have a more reliable source of water than is available in most parts of the basin, and are therefore heavily vegetated with deciduous trees (inlcuding quaking aspen, black cottonwood, alder, willow, maple and hawthorn) and shrubs (including snowberry, rose, and red-osier dogwood). These support a wide variety of herbaceous species, such as yarrow and water hemlock, as well.

Human activities have resulted in a shift in many plant communities' composition from native to aggressive introduced species. In disturbed riparian areas, where livestock graze the major shrubs and herbs, native understory tends to be replaced by exotic grasses and noxious weeds (Okanogan County 1996). Livestock grazing and human land disturbance activities have resulted in a shift in many plant communities' composition from native to aggressive introduced species.

High elevation (especially alpine) riparian sites are distinguished more by understory species and saturated soils than by tree species. Where trees exist, sites are dominated by subalpine fir or Engelmann spruce. The shrub and herb layer is stunted but floristically rich and includes giant horsetail, bunchberry dogwood, Sitka alder, prickly currant and twinflower (Knutson and Naef 1997).

The earliest description of vegetation in the Methow watershed comes from a 1898 survey account by Martin W. Gorman describing the timber resources of the eastern portion of the Washington Forest Reserve (Gorman 1899). This area was east of the summit of the Cascade Range and described as "an oblong tract, 72 miles in length from north to south and averaging about 37.7 miles from east to west, with the western line somewhat sinuous and irregular, owing to the irregular course of the crest line".

Gorman (1899) described four forest zones or belts of vegetation: 1) ponderosa pine, 1100 to 3000 feet; 2) lodge pole pine, 3000 to 5000 feet; 3) subalpine fir, 5000 to 6000 feet; and 4) whitebark pine, 6000 to 7500 feet. The lower elevations between 1,100 to 3,000 feet were described as containing all the merchantable timber to be found in the region, with the dominant tree species being ponderosa pine. Gorman described the zone from 3,000 to 5,200 feet in altitude, as supporting the most dense growth in the region, outside of the moist ravines and canyons. “Owing to its dense growth and the consequent shade afforded by it, this tree (the lodgepole pine) is well adapted for the conservation of the water supply, and large patches of winter snow may be found under its protecting shadows as late as July”. Willows, cottonwoods, alders, hawthorn, maple and dogwood were listed as occurring in the ponderosa pine zone along with many shrub species, presumably growing in moist zones along the valley bottoms. Early Winters Creek was described as “typical” of moist valleys and canyons in the Forest Reserve but Gorman’s account described only those tree species that occurred there that had not yet been listed in the descriptions of zones elsewhere in his report. These species included western red cedar, hemlock sp., Pacific silver fir, and western white pine.

The earliest vegetation maps for entire Methow watershed date back to the early 1920’s and provide some general information on major tree species and tree sizes (Issac 1924). Vegetative conditions for the entire watershed were last developed in 1983 using satellite (Landsat) imagery (USFS 1997). An analysis of vegetative conditions using more current high resolution satellite imagery has not been compiled for the entire watershed nor has an analysis of the change in vegetation composition over time.

FISH DISTRIBUTION AND STATUS

Following a brief summary of historic events as they affected salmonids in the Methow watershed, this chapter provides an overview of the life history, state and federal status, and distribution of bull trout, coho, sockeye, summer chinook, spring chinook, and steelhead/rainbow trout within the Methow watershed.

Summary of Historic Events

The Methow River basin historically supported bull trout, westslope cutthroat trout, rainbow trout, spring chinook, summer chinook, steelhead, and coho. The anadromous runs were decimated by the 1930's (Craig and Suomela 1941, Mullan et al. 1992), because of overfishing in the lower Columbia River fisheries, poor mining practices, grazing, logging, irrigation diversion practices in the watershed, and construction of an impassable hydro-power dam near Pateros on the lower Methow River (Methow RM 6.4) in 1915 (Mullan et al. 1992; Peven 1992; USFS 1995c; BPA et al. 1999). The Pateros dam was removed in 1929.

From the 1930's to present, the development of the Columbia River for hydroelectric power production, hatchery mitigation programs, fishing harvest pressures, degradation of tributary habitats, and the loss of Columbia River estuary rearing areas for juvenile anadromous salmonids have contributed to suppressing naturally producing anadromous salmonid runs in the Methow basin (USFS 1995c). With the construction of the Grand Coulee Dam in 1939, anadromous salmonids were barred from 1,140 miles of potential spawning and rearing habitat in the upper Columbia River drainage (Fish and Havana 1938). Between 1939 and 1943 all adult salmon and steelhead were intercepted at Rock Island Dam for brood stock as part of the Grand Coulee Fish Maintenance Project (GCFMP). The various tributary stocks of each species were mixed in the hatchery program with the resultant young being released throughout the Wenatchee, Entiat, Methow and Okanogan River drainages.

Meanwhile, Columbia River harvests continued to take a heavy toll on returning adults. A harvest rate approaching 85% in the 1930's and 1940's was estimated in the lower Columbia River fisheries (Mullan 1987). Aside from harvest impacts, habitat alterations in the Columbia River estuary were impacting rearing juveniles, and in the Methow watershed logging, water diversions, and grazing impacts were negatively affecting rearing and spawning success. As more hydroelectric facilities on the upper Columbia River became operational, alterations and adjustments to the hatchery supplementation program were made. Still, wild salmon and steelhead returns continued to decline.

By 1971, nine dams were in place on the Columbia River from Bonneville Dam to Wells Dam. In the Methow watershed, timber harvests were in full swing up through the 1980's. Road densities and riparian harvests associated with logging operations continue to be an impact today in regard to fish passage, water runoff patterns, sediment delivery to streams, large woody debris (LWD) recruitment, and stream function. Some irrigation diversions and delivery systems developed at the turn of the century still operate mostly without modifications designed to conserve water or screens designed to avoid and minimize fish impacts. The decline of beaver, the loss of the nutrient input from salmon carcasses, the introduction of Eastern brook trout, flood control, and residential and commercial development also continue to negatively impact habitat conditions.

Table 2 summarizes current known summer chinook, spring chinook, steelhead/rainbow trout, and bull trout distribution in the Methow watershed by stream. More detailed identification of distribution on a reach basis is available using the fish distribution maps (Map Appendix A) and the fish distribution tables (Appendix A).

Table 2 Known salmonid occurrence in the Methow watershed, WRIA 48

STREAM NAME	WRIA INDEX	Spring Chinook	Summer Chinook	Summer Steelhead/ Rainbow	Bull Trout
Methow River	48.0007	X	X	X	X
Black Canyon	48.0015			X	
Gold Creek	48.0104	X		X	X
S. Fork Gold Creek	48.0105	X		X	
Foggy Dew Creek	48.0153			X	
Crater Creek	48.0177				X
N. Fk. Gold Creek	48.0178			X	
Libby Creek	48.0203			X	
N. Fk. Libby Creek	48.0229			X	
S. Fk. Libby Creek	48.0231			X	
Beaver Creek (spring chinook at mouth only)	48.0307	X		X	X
Frazer Creek	48.0366			X	
S. Fk. Beaver Creek	48.0342			X	
Blue Buck Creek	48.0309			X	X
Alder Creek (mouth only)	48.0296	X		X	
Twisp River	48.0374	X		X	X
Poorman Creek	48.0386			X	
Little Bridge Creek	48.0423	X		X	X
Canyon Creek	48.0548			X	

STREAM NAME	WRIA INDEX	Spring Chinook	Summer Chinook	Summer Steelhead/ Rainbow	Bull Trout
Buttermilk Creek	48.0466	X		X	X
E. Fk. Buttermilk Creek	48.0470			X	X
W. Fk. Buttermilk Creek	48.0466			X	X
Eagle Creek	48.0541	X		X	
War Creek	48.0559	X		X	
Reynolds Creek	48.0613	X		X	X
South Creek	48.0641	X		X	X
North Creek	48.0674	X			X
Bear Creek	48.0708	X			
Chewuch River	48.0728	X		X	X
Pearrygin Creek (steelhead at mouth only)	48.0730	X			
Cub Creek (anadromy to RM 0.4 only)	48.0737	X		X	
Boulder Creek (anadromy to RM 1.0 only)	48.0770	X		X	X
Eightmile Creek (anadromy to RM 1.7 only)	48.0901	X		X	
Falls Creek (anadromy to RM 0.2 only)	48.0940	X		X	
Twentymile Creek (anadromy to RM 0.6 only)	48.0977	X		X	X
Lake Creek	48.1020	X		X	X
Andrews Creek (lower reach only)	48.1087	X		X	X
Sheep Creek	48.1110			X	
Thirtymile Creek	48.1136	X		X	
Dog Creek (lower reach only)	48.1139	X			
Wolf Creek	48.1300	X		X	X
N. Fk. Wolf Creek	48.1310				X
Hancock Creek	48.1355			X	
Goat Creek (spring chinook only at mouth)	48.1364	X		X	X
Whiteface Creek (only up to RM 0.25)	48.1370			X	X

STREAM NAME	WRIA INDEX	Spring Chinook	Summer Chinook	Summer Steelhead/ Rainbow	Bull Trout
Little Boulder Creek	48.1400	X		X	
Early Winters Creek	48.1408	X		X	X
Cedar Creek	48.1411			X	X
Huckleberry Creek	48.1412				X
Lost River	48.1592	X		X	X
Eureka Creek (up to barrier falls at RM 0.3)	48.1600	X		X	X
Monument Creek	48.1602				X
Ptarmigan Creek (up to barrier falls at RM 0.5)	48.1700				X
Robinson Creek (up to barrier falls at RM 0.6)	48.1794	X		X	X
Rattlesnake Creek (at mouth only)	48.1842	X		X	X
Trout Creek (at mouth only)	48.1872	X		X	X

Map Appendix A contains four maps showing the distribution of spring chinook, summer chinook, steelhead/rainbow trout, and bull trout. It reflects knowledge current as of October 1999. All upper extents of distribution should be considered approximate. The four tables (one for each species) in Appendix A provide more detailed information on the source of the data shown in the distribution maps.

The information for all species distribution except bull trout was derived from: 1) WDFW StreamNet; 2) USFS Okanogan National Forest stream survey reports; 3) Yakama Nation (YN) spawning ground survey reports; and 4) professional knowledge and observation from Ken William, retired fisheries biologist for WDFW; Joel Hubble, fisheries biologist for YN; Jennifer Molesworth and Dave Hopkins, fisheries biologist and fish technician (respectively) for the Methow Ranger District of the USFS Okanogan National Forest; Heather Bartlett, fisheries biologist for WDFW; Lynda Hofmann, habitat biologist for WDFW; and Jeanette Smith, biologist for the Pacific Watershed Institute (PWI). The contact agency for this data is the Washington Conservation Commission: P.O Box 47721, Olympia; (360/ 407-6200); internet address: http://conserver.org/salmon. The bull trout distribution layer was generated using WDFW digital bull trout distribution data and mapping additions and edits from USFS Okanogan National Forest personnel in May 2000 (digital data was not available from the USFS because of technical problems with their bull trout distribution coverage). The contact person for the WDFW bull trout distribution data is Dick O’Conner, WDFW, Computer Information Consultant, (360/902-2778), email: oconnrjo@dfw.wa.gov. The contact persons for the USFS

Okanogan National Forest fish distribution data are Jennifer Molesworth, and Dave Hopkins.

Appendix B contains a table created by Joel Hubble (Yakama Nation), summarizing Methow watershed spring chinook redd counts from 1987 – 1999 (**Table B- 1**). The data is based on annual spawning ground surveys conducted by the Yakama Nation during that period. **Figure B- 1**, also in Appendix B, illustrates the percent of total redds identified in Early Winters Creek, Lost River, Methow River, Chewuch River, and the Twisp River during this same period, 1987 – 1999.

Bull Trout

Four general forms of bull trout are recognized, each with a specific behavioral or life history pattern; anadromous, adfluvial, fluvial, and stream-resident. The Methow River basin supports all life history forms except anadromous. Historically, these three forms were probably dispersed throughout the Methow watershed with distribution and population levels dictated by temperature and gradient. The adfluvial form matures in lakes and ascends tributary streams to spawn where the young reside for one to three years. Fluvial bull trout have a similar life history except they move from rivers to smaller tributaries to spawn. Adfluvials and fluvials often make extensive migrations, usually do not reach sexual maturity until age five or six, and can reach a size exceeding 22 pounds (110 kg; Fraley and Shepard 1989). Non-migratory, stream-resident bull trout spend their lives in headwater tributaries, apparently migrating very little, and seldom reach a size of over 14 inches (350 mm). Little is known particularly of the adult life stage of the stream-resident form in the Methow watershed (USFS 1995c).

Bull trout are strongly influenced by water temperature during all life stages and for all forms. Most bull trout spawn from mid-September through October, with timing related to declining water temperatures. In high elevation, cold waters, spawning has been documented to start as early as August in the upper Yakima system (elevation 3,500 feet; Brown 1992). Adult redd site selection is determined by substrate size and quality, hiding cover, streamflow, and groundwater sources (Spotts 1987, Baxter et al. 1999). Spawning sites are commonly found in association with groundwater seepage areas which mitigate severe winter temperatures and the formation of anchor ice. Incubation time to hatching has been documented at approximately 113 days, with emergence about 223 days from the date of deposition, temperature dependant (Brown 1992). Fry have been documented to remain in the gravel for three weeks after emergence (McPhail and Murray 1979). The long over-winter phase for incubation and development leaves bull trout vulnerable particularly to increases in fine sediment, especially during snow-melt events, and degradation of water quality (Fraley and Shepard 1989).

Good hiding cover is also important to all life stages of all forms of bull trout. Juvenile bull trout, particularly young-of-the-year (YOY), have very specific habitat requirements. Bull trout fry less than 4 inches (100 mm) are primarily bottom-dwellers, often found on margins over fine depositions of detritus(J. Molesworth, USFS, pers. comm., 2000). They occupy positions just above, in contact with, or even within the substrate. Fry and juveniles can be found in pools or runs in close proximity with cover provided by boulders, cobble, or large woody debris. Age 1+ and older juveniles utilize deeper, faster water than YOY, often in pools with shelter-providing large organic debris or clean cobble substrate. In large rivers, the highest abundance of juveniles can be found near rocks, along the stream margin, or in side channels. Fluvial populations overwinter in deep pools with boulder-rubble substrate or move further downstream to lower reaches of mainstem rivers where individuals make use of abundant woody debris and overhanging banks.

On June 12, 1998 bull trout in the Upper Columbia Distinct Population Segment (DPS) were listed as threatened under federal ESA. Currently, the "Bull Trout and Dolly Varden Appendix" to the Washington State Salmonid Stock Inventory (WDFW 1998a) identifies 17 bull trout/dolly varden stocks in the Methow River watershed. (NOTE: Although the Appendix refers to bull trout in the mid-Columbia River basin as "bull trout/dolly varden", Proebstel et al. (1998) provided conclusive evidence that bull trout (*Salvelinus confluentus*) are clearly distinct from dolly varden (*Salvelinus malma*) in the mid-Columbia basin.) They are the Gold Creek, Beaver Creek, Twisp River, East Fork Buttermilk Creek, West Fork Buttermilk Creek, Reynolds Creek, Lake Creek, Wolf Creek, Goat Creek, Early Winters Creek, Cedar Creek, Lost River, Monument Creek, Cougar Lake, First Hidden Lake, Middle Hidden Lake, and the West Fork Methow River stocks. The status of all bull trout stocks in the Methow River watershed has been classified as unknown by the Salmon Stock Inventory except for the Lost River stock which has been classified as healthy. The Inventory lists the South Fork of Beaver Creek stock and possibly the Eightmile stock as extirpated by brook trout competition (WDFW 1998a).

Both the Lost River and Early Winters Creek were reported to have healthy populations of resident bull trout (USFS 1996a; USFS 1999c). The Methow River upstream of the Lost River confluence(sometimes referred to as the West Fork of the Methow River), based on limited survey data, is reported to have the highest count of fluvial bull trout redds in the Methow (USFS 1998d). Wolf Creek was been identified by the USFS as containing important refugia habitat for the Methow River bull trout population (USFS 1997). In the Chewuch subwatershed the estimated range of bull trout has shrunk by about 30%, including the loss of the Boulder Creek and Eightmile Creek stocks to brook trout hybridization (USFS 1994). Bull trout are present in the mainstem Twisp River as a fluvial form. They are also present in Little Bridge, Buttermilk, West Fork Buttermilk, East Fork Buttermilk, Reynolds, South, and North Creeks, all in the Twisp River subwatershed. Historically, distinct stocks of native bull trout were found in the South Fork of Beaver Creek and Blue Buck Creek (WDFW 1998a). Stocks probably consisted of both the resident and fluvial life history forms (WDFW 1998a; USFS 2000a). The South Fork population is now extinct and the Blue Buck population is listed as "Unknown" but possibly "Critical" (WDFW 1998a; Proebstel et al. 1998). There is speculation that distinct stocks probably existed in the Middle Fork and Lightning Creeks as well based on available habitat (upper Beaver Creek, Lightning Creek and the Middle Fork have not been surveyed; WDFW 1998a). In 1992, a single bull trout/ brook trout first-generation hybrid was collected in the headwaters of Beaver Creek, inferring that at that time there were still "pure" bull trout in the Beaver Creek drainage (Proebstel et al. 1998). Brook trout were reported to have replaced bull trout in Beaver Creek by Mullan et al. (1992) although the Bull Trout and Dolly Varden Appendix to the Salmonid Stock Inventory (WDFW 1998a) attributes impacts from timber harvests, road construction, irrigation and hydroelectric development of the Columbia River as additional factors that may have contributed to the decline of bull trout populations in the Beaver Creek drainage. The Beaver Creek bull trout population is described as a remnant population in Blue Buck Creek that is not likely to persist because of the presence of brook trout and habitat degradation (USFS 1997). A limited population of bull trout persists in Crater Creek, a tributary to Gold Creek.

Bull trout distributions in the Methow watershed parallel the habitat conditions; the more pristine the habitat, the more robust the bull trout populations. Proebstel et al. (1998) reported that in general, bull trout were found to be persisting in small headwater populations. The Lost River and Robinson Creek Watershed Analysis (USFS 1999c) states, "Roads, access and resultant overfishing in most waters are probably the most limiting production factors to bull trout resulting from man's influence". To minimize further declines of stocks of this species, it will be important to maintain functioning habitat in its current healthy condition, reduce fishing pressure, minimize the access and colonization of brook trout into bull trout waters, and restore degraded habitat conditions that contribute to increased sediment recruitment, increased instream temperatures and low flows (B. Baer, USFS, pers. comm., 1999).

Coho Salmon

Because the historical stocks of coho were decimated in this region near the turn of the century, most life history information was obtained through affidavits from older residents. The historical information supports the theory that these fish were probably early-returning-type adults, ascending the mid-Columbia tributaries in August and September (Mullan 1983).

Lower Columbia River early-returning-type hatchery coho salmon spawn from October to mid-December. Columbia River coho salmon typically spend one year in freshwater before outmigrating as yearling smolts in the spring (April/May). After outmigrating, coho salmon spend approximately 18 months at sea before returning to spawn. Sexually precocious males (jacks) return to spawn after six months at sea (BPA et al. 1999)."

In the rest of Washington State, the onset of coho salmon spawning is tied to the first significant fall freshet. They typically enter freshwater from September to early December, but have been observed as early as late July and as late as mid-January (WDF et al. 1993). They often hold near the river mouths or in lower river pools until freshets occur. Spawning usually occurs between November and early February, but is sometimes as early as mid-October and can extend into March. Spawning typically occurs in tributaries and sedimentation in these tributaries can be a problem, suffocating eggs. As chinook salmon fry exit the shallow low-velocity rearing areas, coho fry enter the same areas for the same purpose. As they grow, juveniles move into faster water and disperse into tributaries and areas which adults cannot access (Neave 1949). Pool habitat is important not only for returning adults, but for all stages of juvenile development. Preferred pool habitat includes deep pools with riparian cover and woody debris.

Coho juveniles remain in the river for a full year after leaving the gravel nests. As with all salmonids, low flows during the summer after early rearing, can lead to problems such as a physical reduction of available habitat, increased stranding, decreased dissolved oxygen, increased temperature, and increased predation. Juvenile coho are highly territorial and can occupy the same area for a long period of time (Hoar 1958). The abundance of coho can be limited by the number of suitable territories available (Larkin 1977). Streams with more structure (logs, undercut banks, etc.) support more coho (Scrivener and Andersen 1982), not only because they provide more territories (useable habitat), but they also provide more food and cover.

In the autumn as the temperatures decrease, juvenile coho move into deeper pools to hide under logs, tree roots, and undercut banks (Hartman 1965). The fall freshets redistribute them (Scarlett and Cederholm 1984), and over-wintering generally occurs in available side channels, spring-fed ponds, and other off-channel sites to avoid winter floods (Peterson 1980). As coho juveniles grow into yearlings, they become more predatory on other salmonids. Coho begin to leave the river a full year after emerging from their gravel nests with the peak outmigration occuring in early May.

As an extirpated species, the Methow coho run is not addressed under the federal ESA or the Washington State Salmon and Steelhead Stock Inventory (SASSI; WDF 1993). The ESA and SASSI do not address extinct or extirpated stocks.

Primary among the impassable dams in the Methow watershed was the hydroelectric dam near Pateros on the lower Methow River (RM 6.4) that resulted in the extinction of the genetically unique stock of late-run coho salmon to the upper Methow (Mullan et al 1992; USFS 1995c; BPA et al. 1999). Mullan et al. (1992) reported that historically the Methow basin primarily supported coho salmon and was the strongest producer of coho in all the upper-Columbia tributaries, based on the geographic distribution of past habitat in terms of stream miles. Mullan (1984) estimated 23,000-31,000 adult coho may have originated in the Methow basin prior to European influence. By the early 1900's coho salmon populations were already decimated by lower Columbia River harvest rates, impassable dams, unscreened irrigation diversions, logging, mining, grazing, and water use practices in the tributaries (BPA et al. 1999). As mitigation for lost production resulting from the development of hydroelectric facilities on the Columbia River since the 1930's, forty-six million fry, fingerlings, and smolts from Leavenworth, Entiat, and Winthrop National Fish Hatcheries were planted in the mid-Columbia basins between 1942 and 1975 (BPA et al. 1999). Despite this effort, self sustaining coho populations were not established for several reasons: construction and operation of Columbia River hydroelectric facilities; habitat degradation; and poorly administered coho hatchery programs (BPA et al. 1999). From 1933 to 1943 only 475 coho salmon were counted at

Rock Island Dam, which counted fish bound for the Wenatchee, Entiat, Methow and Okanogan river systems.

The Yakama Nation (YN) has prepared a Final Environmental Assessment (BPA et al. 1999) on the feasibility of reintroducing coho salmon to the mid-Columbia region. Their goal is to restore natural production as identified in the Yakama Nation's "Coho Salmon Species Plan" (CSSP) for the Mid-Columbia Basin. The goal of this program is to initiate restoration of coho salmon populations in mid-Columbia tributaries to levels of abundance and productivity sufficient to support sustainable annual harvest by tribal and other fishers. Currently there are 200,000 – 250,000 coho juveniles being reared for release into the Methow River in the spring of 2000. Additionally there are 200,000 eggs being incubated, collected from coho intercepted at Wells Dam in the fall of 1999. It has not yet been determined whether young from this egg batch will be released into the Methow or the Wenatchee. The proposed acclimation sites for reintroduction of yearling coho are; the Eightmile Creek Ponds on the Chewuch River, the Rockview Ditch in the Upper Methow River, the Biddle Ponds at Wolf Creek and the Winthrop National Fish Hatchery. The Mid-Columbia Conservation Plan (Rocky Reach Hydroelectric Facility et al. 1998) considers the reintroduction of coho salmon to be outside the scope of their plan and will consider artificial propagation of coho only once natural populations are re-established.

Sockeye

Sockeye salmon differ from other species of salmon in their requirement of a lake environment for part of their life cycle. Sockeye salmon have a wide variety of life history patterns, which include both and anadromous (sockeye) and a non-anadromous (kokanee) forms. The distribution of sockeye salmon in the mid-Columbia region is limited to Lake Wenatchee (Wenatchee watershed) and Lake Osoyoos (Okanogan watershed). Limited numbers of adults and juveniles are periodically detected in the Methow and Entiat rivers (Carie 1996) and in isolated areas of the mid-Columbia River (Chapman et al. 1995b). Adult sockeye destined for the mid-Columbia River basin enter the lower Columbia River primairly in June and July. Spawners reach Lake Wenatchee and Lake Osoyoos during July - September (Mullan 1986). Both sockeye populations from the mid-Columbia basin begin spawning in September, with activity peaking in the Wenatchee system about the third week of September, and approximately a month later in the Okanogan River (Howell et al. 1985). Statewide, spawning ranges from September through February, depending on the stock.

In the mid-Columbia region, after sockeye fry emerge from the gravel in early to late spring they move to the nursery lake for rearing. Most sockeye in Lakes Osoyoos and Lake Wenatchee will reside in their lakes until the following spring, although some will remain for an additional year. Lake rearing in populations statewide ranges from 1-3 years. In the spring after lake rearing is completed, smolts migrate seaward where more growth occurs prior to adult return for spawning 1 to 3 (mostly 2 years) later (Schwartzbert and Fryer 1988).

Sockeye salmon are not thought to have been present in the Methow basin prior to the Grand Coulee Fish Maintenance Project (GCFMP) hatchery program begun in 1939 (Chapman et al. 1995b), therefore the sockeye that are found today in the Methow watershed are not addressed under ESA nor are they assigned a status under the Washington State SASSI. Prior to 1939, Peven (1992) reported that the majority of the Columbia River sockeye run was thought to be produced in the upper Columbia River (above the Grand Coulee Dam site), with only small numbers of fish present in the Wenatchee and the Okanogan river systems. Sockeye in the Methow River probably originated from hatchery stock released from the Winthrop National Fish Hatchery (Chapman et al. 1995b). Between 1941 and 1969, a mean of 85,900 sockeye juveniles were released in the Methow River annually (Chapman et al. 1995b). The present Methow sockeye originate from a mix of adults collected at Rock Island Dam between 1939 and 1943, with possible contribution from several other donor groups (Chapman et al. 1995b).

Today, a very limited number of remnant sockeye spawn in the lower- to mid-mainstem Methow River. Sockeye adults are observed nearly every year during annual chinook spawning ground surveys. The 1990 – 1994 average number of sockeye salmon seen in the Methow River is 52.6 (range 13 – 90; Chapman et al. 1995b). There is no management plan for this run (Caldwell and Catterson 1992).

Summer Chinook

Chinook salmon have three major run types in Washington State – spring, summer and fall. Summer and fall runs of chinook are referred to as an "ocean-type" (Healey 1983) meaning they spend less than one year in freshwater before migrating to the ocean as subyearlings. Most of their life is therefore spent in the ocean. Relative to other populations, ocean-type salmonids spend the shortest amount of their life in the tributaries. However, there is evidence that some subyearling summer chinook exhibit a slow rearing migration and forage behavior as they pass the reservoir system, thereby delaying their arrival at the estuaries until they are yearlings and of a larger size (Rock Island Dam Hydroelectric Facility et al. 1998). This phenomenon suggests that mainstem reservoirs influence the success of ocean-type salmonids. An important factor that separates this group from others is that juvenile fish have exited the subbasin prior to the lowest flows in fall and are not subject to harsh conditions in winter.

Summer chinook salmon return to the Methow River primarily in July and August, but may enter the river into early October (Rock Island Hydroelectric Facility et al. 1998). Peven (1992) reported that spawning begins in late September in the upstream reaches and ends in early November in the lower river. Eggs incubate in the gravel through winter with fry emerging from the substrate probably from January through April (Rock Island Hydroelectric Facility et al. 1998). Given adequate holding areas for fry, which may be limiting in the lower mainstem Methow River during the spring runoff (Chapman et al. 1994a), juveniles generally rear in the Methow River from one to four months after emerging from the gravel (Rock Island Hydroelectric Facility et al. 1998). They then migrate downstream into the Columbia River system.

SASSI lists the Methow Summer Chinook stock as “Depressed” based on a short-term severe decline and a long-term negative trend in escapement (WDF 1993). The upper Columbia River summer chinook have not been listed under the ESA.

Summer chinook spawning and rearing in the Methow watershed occurs only in the mainstem Methow River from its confluence with the Columbia River upstream to the vicinity of the Foghorn Diversion Dam at the Winthrop fish hatchery above Winthrop. No summer chinook salmon spawn in the tributaries of the Methow. The extent of juvenile summer chinook rearing in the Methow River system after emergence from the gravel (mid-February to end of April) may be a function of availability of low-velocity habitat in spring associated with cover (Chapman et al. 1994a). In the Methow River system below Winthrop, availability of suitable habitat may be scarce, forcing them to move out of the Methow basin fairly quickly and into the Columbia River system, where they may do extended rearing in the reservoir system (Chapman et al. 1994a).

Historically, summer chinook were abundant in the middle to upper Columbia River and may have been the most plentiful of the chinook runs (Chapman 1986, WDFW et al. 1990, Mullan et al. 1992). Historic runs size of summer chinook entering the Columbia River is difficult to determine. Chapman (1986) estimated that of the 3.8 to 4.3 million chinook entering the Columbia River, approximately 53% to 58% (2.0 to 2.5 million) of the run were summer chinook. These estimates were based on peak years of the harvest fishery in the 1880’s. Historic catch records show most of the fishing effort was concentrated in June and July (the summer chinook run time) until this large segment of the run was decimated from overfishing in the late 1880’s. The peak summer chinook catch in the early 1880’s averaged approximately 1.7 million fish (Chapman 1986). Fishing effort later targeted the other segments of the chinook run (spring and fall), and other species.

In 1933, salmon first began being counted in the mid-Columbia basin following completion of the Rock Island Dam (still before the construction of Grand Coulee Dam) but averaged only in the few tens of thousands by then (Peven 1992). Since 1967, runs of summer chinook salmon into the Methow River have declined dramatically. Since 1980 run-sizes have ranged from 400 to 1,500 adults (average 1000) based on redd count expansions. Summer chinook salmon counts at Wells Dam were record lows in 1991 and 1992. The Mid-Columbia Mainstem Conservation Plan identifies the primary consideration for summer chinook is to achieve a minimum natural escapement of 2,000 adults and jacks past Wells Dam, with an emphasis on meeting the 3,500 escapement level (Rocky Reach Hydroelectric Facility et al. 1998). These numbers include summer chinook bound for both the Methow and the Okanogan systems.

Spring Chinook

Spring chinook are considered a “stream-type” salmonid (spending one or more years in freshwater). Spring chinook enter the Methow River from mid-May through July (WDFW et al. 1990). Spawning occurs from late July- early August through September (Kohn 1987; Kohn 1988; Edson 1990; Scribner et al 1993). The eggs remain in the substrate and incubate through winter. The young (fry) emerge that following spring in April and May (WDFW et al. 1990). Chapman et al. (1995a) cited Joel Hubble, fish biologist for the Yakama Nation, as reporting that in 1994 fry were observed as early as late March in the Chewuch drainage and in early march in the upper Methow River). These same young will remain in freshwater environments, not migrating out as smolts until the following spring (Healey 1991). This extended freshwater period for both adults and juveniles makes spring chinook salmon more susceptible than the summer/fall (late-run) chinook salmon to impacts from habitat alterations in the tributaries. As reported in Chapman et al. (1995a), peak occurrence of outmigrating yearling chinook counted at Wells dam occurred between the middle of April through the first two weeks of May.

SASSI identified four stocks of spring chinook salmon in the Methow watershed. All were assigned a "Depressed" status. The stocks are; Methow Spring Chinook, Twisp Spring Chinook, Chewuch Spring Chinook, and Lost River Spring Chinook (WDF 1993). On March 16, 1999 all spring chinook in the Upper Columbia ESU were listed as endangered under the ESA.

The majority of spring chinook spawning in the mainstem Methow River occurs between the Foghorn Diversion dam (RM 51.5) upstream to the Lost River confluence (RM 73.0), although there is some overlap with summer chinook spawning downstream to at least the Methow Valley Irrigation District (MVID) diversion (RM 44.8, about 5 miles north of Twisp). There is spawning in the Lost River up to the Eureka Creek confluence. In Early Winters Creek spawning is known to occur up to the Klipchuck Campground. Spawning has been documented to occur upstream of RM 1.3 at the Wolf Creek Property Owners Association diversion, but below the Wolf Creek Reclamation District diversion at RM 4.0 (J. Easterbrooks, WDFW, pers. comm., 2000). In the Chewuch subwatershed spawning occurs in the mainstem Chewuch River to Chewuch Falls and in Lake Creek from the mouth upstream to RM 3.5, at the parking lot at the confluence of Disaster Creek. In the Twisp River spawning occurs in the mainstem Twisp River upstream to Roads End Campground. Spawning in Gold Creek occurs in the mainstem upstream to the confluence with Foggy Dew Creek. Appendix B provides a summary of Methow basin spring chinook redd counts and spawning distribution for years 1987- 1999 in the Lost River, Early Winters Creek, Methow River, Chewuch River and the Twisp River. The data identifies the importance of the upper Methow River reach as the primary spawning ground for naturally reproducing spring chinook in the Methow watershed. The Chewuch and Twisp rivers are also very important. Combined they have the potential to produce more juveniles than the upper Methow River. The tendency of the upper Methow River reach to dewater during dry years emphasizes the need to maintain the potential production in other fish-producing tributaries of the Methow.

Spring chinook rear where they spawn but also disperse into adjacent stream reaches. A portion of the juvenile Methow watershed population exhibits a fall outmigration into at least the lower Methow River, which has been explicitly documented for the Chewuch population (Hubble and Harper 1999). Rearing in the mainstem Methow River extends from Trout Creek in the upper Methow River downstream to the mouth of the Methow River. Juvenile spring chinook salmon have been observed in the mouths of Trout, Rattlesnake and Robinson creeks. Rearing occurs on the Lost River upstream to Monument Creek and at the mouth of Eureka Creek. Rearing in Early Winters Creek overlaps with the spawning area. Juveniles have been observed in the mouths of Little Boulder Creek and Goat Creek. Rearing in Wolf Creek has been documented up to RM 3.0 with potential rearing habitat extending up to the confluence of the North Fork Wolf Creek. Rearing on the mainstem Chewuch River extends upstream to Chewuch Falls, and on Lake Creek up to RM 3.5, at the parking lot at the confluence of Disaster Creek, similar to spawning activity. Additionally, juveniles have been observed in the mouths of Pearrygin, Boulder, Cub, Eightmile, Falls, Twentymile, Andrews, Thirtymile and Dog creeks, all tributaries to the Chewuch River. Juvenile chinook have also been observed in Bear Creek, a tributary to the Methow River. On the mainstem Twisp River, rearing distribution is the same as spawning, from Roads End Campground downstream to the mouth. Juveniles have also been observed in the mouths of North, South, Reynolds, War, Eagle, and Buttermilk creeks, all tributaries to the Twisp River. Juveniles have been documented in Little Bridge Creek, also a tributary to the Twisp River, up to the culvert barrier with potential rearing habitat extending upstream a short distance from the barrier. Rearing in the mainstem of Gold Creek is the same as the spawning distribution, with juveniles also being observed at the mouth of the South Fork Gold Creek.

The historic run size of spring chinook entering the Columbia River is difficult to determine. Most estimates are based on early commercial harvest. Chapman (1986) estimated that of the 3.8 to 4.3 million chinook salmon entering the river, 11 – 15 % of the run was spring chinook (420,000 to 650,000 fish). The peak commercial catch of spring chinook occurred between 1890 and 1895, after the earlier chinook fisheries had overexploited the larger, summer component of the run.

By the turn of the century, spring chinook runs to the Methow River system were severely diminished (Craig and Suomela 1941). In 1935 counting of spring chinook began at Rock Island Dam (spring chinook were not counted in 1933 and 1934). Total runs of salmon were very low at this time (Peven 1992) with numbers in the period 1935 to 1938 as counted at Rock Island Dam averaging around 30,000 fish bound for the Wenatchee, Entiat and Methow rivers. This coincided with commercial catch rates in the lower Columbia River of up to 86% of the runs (Mullan et al. 1992). Following reduction of harvest and the initiation of the Grand Coulee Fish Management Plan (GCFMP) in 1939- 1943, counts of returning spring chinook increased at Rock Island Dam. The GCFMP did not allow for any natural spawning of anadromous salmonids during that time, since all fish were collected for brood stock. Calculations and conclusions found in the literature regarding spring chinook population status in the Methow basin after 1943 vary based on use and interpretations of available data. Mullan (1987), WDFW et al. (1990), Mullan et al. (1992), Chapman et al. (1995a) and the hatchery section of Rock Island Dam Hydroelectric Facility et al. (1998) provide detailed discussions on this topic beyond the scope of this report. Adult spring chinook salmon counts passing Wells Dam from 1977-1999 (between May 1 and June 28), indicates a declining trend for adults bound for the Methow basin (Table 3).

A dramatic increase occurred in the 1980's (as with all runs of salmonids), but they have since declined steadily to a low count of 6 adults in 1998 passing the Wells Dam. In 1999, 191 adult spring chinook were counted passing Wells Dam (including in this number are the 50 adults originally captured at Wells Dam for broodstock, and later released from the Methow Hatchery). This information and data on salmon and steelhead return counts at all the Columbia basin dams, can be accessed at the Columbia River DART website (www.cqs.washington.edu/dart). In the Hatchery section of the Mid-Columbia Habitat Plan (Rock Island Dam Hydroelectric Facility et al. 1998), the decline in spring chinook escapement to current levels was described as cause for concern of extinction and warranted the need to quickly rebuild the population to reduce the probability of extinction.

Table 3 Adult spring chinook counted passing Wells Dam, 1977-1999

Year	Annual Return (5/1 - 6/28)	10-yr Average
1999	**191	769
1998	6	1131
1997	980	1338
1996	335	1594
1995	66	2103
1994	243	2385
1993	2601	2396
1992	1542	2496
1991	687	2584
1990	966	2582
1989	1633	2525
1988	3024	2566
1987	2272	2737
1986	2896	
1985	5151	
1984	3066	
1983	2726	
1982	2270	
1981	1837	
1980	941	
1979	971	
1978	3532	
1977	3976	

* Data taken from the Columbia River DART website (www.cqs.washington.edu/dart).

** Adjusted for 50 adults originally caught at Wells Dam and not therefore not counted, but then released from the Methow hatchery.

Summer Steelhead

Steelhead have the most complex life history patterns of any Pacific salmonid species (Shapovalov and Taft 1954). Washington State has two major run types, winter and summer steelhead, determined by their freshwater entry time, although both runs are spring spawners. Winter steelhead adults begin river entry in a mature reproductive state in December and generally spawn from February through May. Dominating inland areas such as the Columbia Basin, summer steelhead adults enter the river from May through October. These fish pass Rock Island Dam between July through May of the following year (counting at Rock Island ceases in November and resumes in April the following year), with the majority of fish passing between August and September. The fall migrants passing Rock Island Dam are thought to overwinter in the Columbia River and spawn the next spring. Spawning occurs between March and June, but has been known to occur as late as July (Fish and Hanavan 1948).

Time to hatching (incubation) varies with water temperature; the colder the temperature, the slower the developmental rate of the embryo and the longer time to hatching (Chapman et al.1994b). Barnhart (1986) reported that the number of days required for steelhead eggs to hatch in the Pacific Southwest varied form 19 days at about 59° F (32.7°C) to 80 days at 41°F (22.7°C). Wydoski and Whitney (1979) reported that eggs hatch in about 50 days (in 50°F/10°C water). No one has assessed empirically the length of time required for naturally-produced steelhead to hatch in the mid-Columbia basin (Chapman et al. 1994b). Time from hatching to fry emergence from the gravels also varies depending on temperature and to a lesser extent other factors. In the Methow watershed, fry emerging from the gravels probably occurs between early July and early October (Chapman et al 1994a). Mullan et al. (1992) indicates that median emergence time of steelhead fry in the coldest tributaries occurs around September 15.

The length of time juvenile steelhead will spend in freshwater before beginning seaward migration is mostly a function of water temperature (Mullan et al. 1992). Most fish that do not emigrate downstream early in life from the coldest environments are thermally-fated to a resident (rainbow trout) life history regardless of whether they were the offspring of anadromous or resident parents (Mullan et al. 1992). Smoltification may occur in one to three years in warmer mainstems or may take seven years in cold headwaters (Peven 1990; Mullan et al. 1992). The greatest proportion of steelhead spend two years in fresh water (Busby et al. 1996; Mullan et al. 1992). This extended period of freshwater residency places a heavy reliance by steelhead on freshwater habitat conditions. The timing of smolts outmigrating from the Methow watershed is derived from the timing of wild steelhead smolts passing Rock Island Dam. This has been reported since 1990. Most wild smolts pass Rock Island in May (Chapman 1994b). Upper Columbia River adults then spend one to three years in the ocean before returning to their natal streams (Mullen et al. 1992), with most spending one or two years in the ocean (WDFW et al. 1990).

SASSI identified wild summer steelhead in the Methow and Okanogan basins as a distinct stock based on the geographical isolation of the spawning population. The status of the Methow/Okanogan summer steelhead stock is listed as "Depressed" (WDF 1993). On August 18, 1997 summer steelhead in the Upper Columbia River ESU were listed as endangered under the ESA.

Spawning grounds are not surveyed for steelhead because adults generally spawn over a 4-5 month period coinciding with the spring run-off when water visibility is low and discharge is high. There is some limited local knowledge of steelhead spawning redds that could be verified. Specifically, Ben Dennis, a Methow fishing guide active in the Methow flyfishers association, has mentioned he has knowledge of some steelhead spawning locations. A 1999/2000 radio telemetry study of adult steelhead conducted by the Mid-Columbia River Public Utility Districts (Douglas County PUD, Chelan County PUD and Grant County PUD) displayed areas where concentrated steelhead spawning occurs in the lower reach of the Methow River below the town of Carlton (S. Bickford, Douglas County PUD, pers. comm., 2000).

Chapman et al. (1994b) reports steelhead are believed to spawn in the mainstem Methow River, the Chewuch River, the Twisp River, Beaver Creek, and Gold Creek. WDF (1993) reports spawner distribution to also include the Lost River, Early Winters Creek, Lake Creek, Wolf Creek, Little Bridge Creek, Buttermilk Creek, Libby Creek, North Fork Gold Creek and South Fork Gold Creek. No other reference in the literature identified steelhead spawning in the Methow watershed. For the purpose of this report, spawning is assumed to occur where rearing is documented.

Distribution of rearing juvenile steelhead/rainbow has been documented over a wide range in the Methow watershed. For the purposes of this report, rearing distribution includes both steelhead and the resident form, rainbow trout. The upper extent of anadromy is always a subset of the residency distribution. Anadromy in resident steelhead/rainbow is a function of growth potential as defined by the environment and genetic predilection (Mullan et al. 1992).

The Methow River supports steelhead rearing from the mouth at the Columbia River up to Rattlesnake Creek, and resident rearing up to the vicinity of Trout Creek. Trout Creek, Robinson Creek and Rattlesnake Creek in the upper Methow support rearing resident rainbow near the mouths. Steelhead/rainbow rear in the Lost River to Monument Creek and in Eureka Creek (resident only). In Early Winters Creek anadromous rearing occurs up to Cedar Creek and resident rearing extends up to the natural barrier falls. Cedar Creek in the Early Winters drainage supports rearing resident rainbow near the mouth. In Goat Creek rearing extends to the barrier falls and also occurs in Whiteface Creek (resident only). Little Boulder Creek supports anadromous rearing to the first fork in the creek. Hancock Creek supports rearing of steelhead/rainbow as well. Steelhead/rainbow rear in Wolf Creek to the barrier falls.

The Chewuch River supports anadromous rearing up to Chewuch Falls and resident rainbow rearing up to about Horseshoe Creek. Lake Creek in the Chewuch drainage supports anadromous rearing up to Black Lake, while Andrews and Eightmile creeks support rearing of mostly the resident form, rainbow trout. Thirtymile, Sheep, Twentymile, Falls, Boulder and Cub creeks in the Chewuch subwatershed support anadromous rearing at the mouths.

The Twisp River supports anadromous rearing from the confluence with the Methow River up to North Creek. South Creek, War Creek and and Eagle Creek support anadromous rearing up to their barrier falls. Canyon and Poorman creeks support only resident rainbow rearing. Buttermilk Creek supports anadromous rearing up to the confluence of the West and East Forks of Buttermilk Creek, with only the resident form known to rear in each of those forks of the Buttermilk. In Little Bridge Creek, anadromous rearing occurs in the first three to four miles of stream with resident-only rearing persisting upstream to about the West Fork.

The mainstem of Beaver Creek supports anadromous rearing upstream to a point midway between Frazer Creek and the South Fork of Beaver Creek, which can fluctuate depending on environmental conditions. Only resident rainbow occur upstream of that point to the vicinity of Blue Buck Creek. Individual rainbow trout were observed in Beaver Creek upstream of Blue Buck Creek but they were isolated observations and not indicative of reproduction. The South Fork Beaver Creek and Frazer Creek in the Beaver Creek drainage support resident rearing.

Steelhead/rainbow rear in Libby Creek with the upper extent fluctuating with occurrence of beaver dams but presumed to be in the vicinity of Smith Canyon. Resident rainbow juveniles have been observed upstream in Libby Creek to the South and North Fork confluence. Gold Creek supports anadromous rearing up to its confluence with the North Fork. Anadromous rearing also occurs up the South Fork of Gold Creek to its confluence with Rainy Creek with resident rearing extending up to the barrier falls. In Foggy Dew Creek steelhead/rainbow rearing occurs up to the barrier falls. Black Canyon Creek is the only tributary to the Methow downstream of Gold Creek known to support steelhead/rainbow. In Black Canyon Creek, anadromous rearing is known to occur in only about the first half mile with resident rearing extending upstream quite some distance.

Chapman (1986) estimated the historic run size of Columbia River steelhead entering the Columbia River ranged between 449,000 to 554,000. By the 1930’s the portion of the run destined for the mid-Columbia River runs was virtually gone (Craig and Suomela 1941). Since 1933, with the advent of hatchery programs following the construction of Columbia River dams, adult steelhead returns at Rock Island Dam and later at Wells Dam, demonstrated a long-term upward trend (Chapman et al. 1994b). Peven (1992) and the Hatchery section of Mid-Columbia Management Plan (Rock Island Dam Hydroelectric Facility et al. 1998) provide a more detailed discussion of the history and current status of the hatchery program in the upper Columbia River region. By 1990, steelhead adult returns were up; the average number of steelhead ascending Rock Island Dam between 1980 and 1990 (inclusive) was 15,700 (Peven 1992), with peaks during the mid-1980’s between 22,000 and 32,000 fish. However, the natural spawning component of the run has declined.

WDFW et al. (1990) reports that from 1982 to 1986 the natural summer steelhead run made up only 3% of the total steelhead run in the Methow watershed. Peven (1992) reported that in 1987, hatchery steelhead made up 73% of the steelhead run entering the Columbia River. Busby et al. (1996) estimated the proportion of hatchery fish in spawning escapement to be 81% in the Methow and Okanogan rivers. Recent 5-year (1989-1993) average natural spawning escapement estimates are 450 steelhead in the Methow and Okanogan rivers. The recommended escapement objective by the Northwest Power Planning Council (NPPC) subbasin plan for the Methow River is 1,500 wild/natural steelhead. The major concern for this ESU is the clear failure of the natural component to replace themselves (Rock Island Dam Hydroelectric Facility et al. 1998).

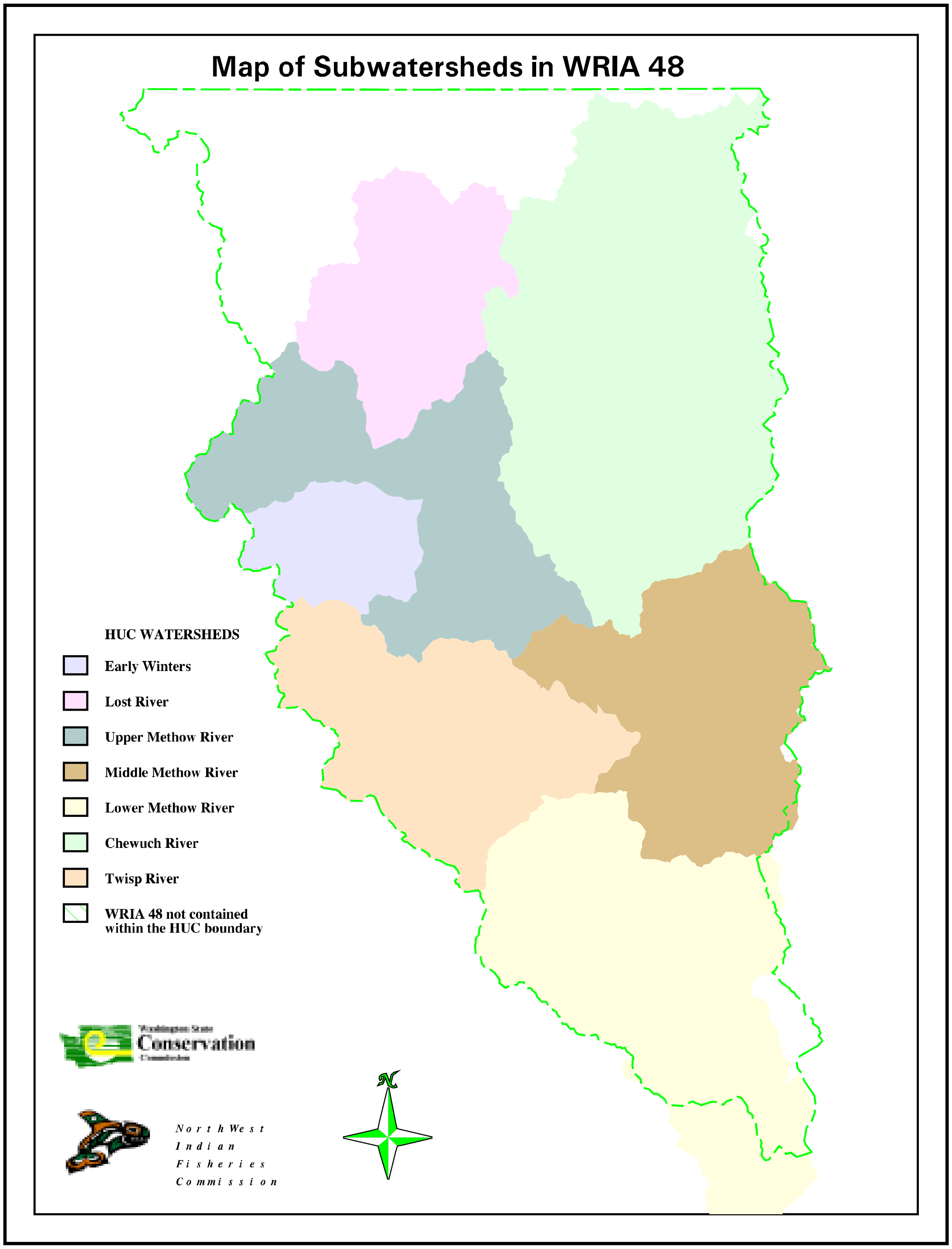
Introductions of large numbers of rainbow trout into the Methow watershed streams, designed to supplement a popular stream trout fishery, were common in the 1920’s and 1930’s and continued up until several years ago. Stocking of rainbow/steelhead trout in the Chewuch, Twisp and Methow Rivers to mitigate dam passage related mortalities to this species, still continues. Planted steelhead juveniles compete with wild fish for limited resources, especially while in natal tributaries. Steelhead plantings have also been documented to induce a “pied piper” effect on wild juveniles, leading them to move downstream, possibly prematurely. For returning adults, hybridization of native stocks with hatchery stocks represents a potential loss of biodiversity at the genetic level. To minimize these impacts, steelhead fish plantings used today are designed to supplement the outgoing smolt population and timed to coincide with the outmigration so as to minimize the competition for resources in the tributaries. Since 1939, upper Columbia River steelhead stocks have been mixed when steelhead were trapped at Rock Island Dam and released into the Methow , Entiat, and Wenatchee Rivers. Today these stocks remain hybridized and the potential loss of biodiversity of the tributary stocks has not been determined.

HABITAT LIMITING FACTORS BY SUBWATERSHED

Introduction

This chapter identifies the habitat factors limiting salmon, steelhead and bull trout performance within the seven subwatersheds of Water Resource Inventory Area (WRIA) 48. The subwatersheds of WRIA 48 are: the Upper Methow River, the Lost River, Early Winters Creek, the Chewuch River, the Middle Methow River, the Twisp River, and the Lower Methow River (Figure 3). The legislation governing the development of this report (ESHB 2496) defines habitat limiting factors as "Conditions that limit the ability of habitat to fully sustain populations of salmon." For the purpose of this report, habitat limiting factors are further defined as those habitat conditions negatively affecting salmonid productivity. Habitat capacity is also discussed. The information presented here represents a compilation of available data and literature on habitat conditions in the watershed and the combined professional knowledge of the Technical Advisory Group (TAG).

Figure 3 Map of subwatersheds in WRIA 48



The performance of a particular salmonid population is a function of productivity (habitat quality), capacity (habitat quantity), and life history diversity. This document focuses on the first two parameters – productivity and capacity. Productivity is a density-independent survival parameter such as temperature or the amount of fine sedimentation where the rate of response (ie. mortality) is not affected by population density. For example, sedimentation of a salmon spawning bed will tend to operate in a density-independent manner, causing an increase in mortality rate at all population sizes. Capacity is the density-dependent measure of the amount of key habitat available within a watershed for a specific species and/or life stage. The amount of habitat available becomes increasingly important as population densities increase (ie. as competition for limited resources increases). For example, the quantity of spawning beds available to a salmon population could be expected to contribute to egg mortality as spawner densities increase to the point that some spawners dig their nests at the same sites as slightly earlier spawners, causing mortality to eggs already deposited. At very low spawner densities the chance of superimposition of nests is reduced.

In this document, capacity is assessed by identifying appropriate habitat (species specific) currently inaccessible because of a passage issue. Productivity is assessed for each subwatershed by identifying habitat deficiencies in a habitat limiting factor category. These categories are described as follows:

Categories of Habitat Limiting Factors used by the Washington State Conservation Commission:

The factors limiting salmonid productivity through impacts to habitat have been broken into seven categories to facilitate the identification of those areas in need of restoration or rehabilitation and areas in need of protection. These categories show where field biologists have been and what they have seen or studied. They represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health. All references to River Miles (RM) are approximate.

Below is a brief synopsis of the habitat requirements for salmonids, followed by a explanation of each of the seven categories of Habitat Limiting Factors. The seven categories are: 1)Access to Spawning and Rearing Habitat; 2)Floodplains; 3)Riparian; 4)Large Woody Debris; 5)Channel Conditions and Streambed Sediment; 6)Water Quantity and Water Quality; and 7)Biological Processes. Within each category is a short description of the function and value of that habitat element and a list of conditions that may result from alterations to the habitat.

Reading through all the habitat limiting factors categories for a given subwatershed will provide the reader with a sense of the inter-connectedness of the habitat categories and how they relate to productivity of a species and particular life stages.

Habitat Requirements for salmonids. "The main habitat requirements of salmon in freshwater include a stream or lake, the adjacent border of vegetation (riparian zone) that serves as the interface between aquatic and terrestrial ecosystems, and the quality and quantity of water. The water must be clean enough and cool enough to support returning adults, for eggs to hatch, and for young to survive and grow until they migrate to sea. There must be enough water in the rivers at crucial times to make migration possible, to allow fish to escape predators, and to allow fish to find adequate food. Well-aerated streambed gravels are important for spawning. Streamside vegetation provides shade, which keeps the water cool; it provides a buffer against soil erosion, which maintains water quality; it provides living space for various animals that provide food and nutrients for streams; and it provides a source of large woody debris, which plays a key role in the formation of physical habitat and storage of sediment and organic matter and provides habitat complexity in stream channels, thus improving the stream environment for salmon. These requirements for environmental conditions in streams and adjacent riparian zones depend on the condition of the entire watershed in which they occur" (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids et al. 1996).

Access to Spawning and Rearing Habitat.

In general, spring spawning species (rainbow/steelhead) take advantage of high spring flows, accessing smaller tributaries, headwater streams and spring snowmelt-fed streams not accessible later in the year. Reproduction of late summer and fall-spawning species (spring chinook, summer chinook, and fluvial bull trout) occurs most frequently in alluvial reaches of larger streams and rivers where groundwater recharge strongly buffers local interstitial and surface water conditions from decreasing flows and increasing or decreasing water temperatures. Incubation of salmonid eggs and fry occurs within the interstitial spaces of gravels in the beds of cool, clean streams and rivers. Once emergence from the gravel is complete, young salmon are mobile, which increases their flexibility to cope with environmental variation by seeking suitable habitat conditions. Mobility is limited however, particularly for fry, so that suitable habitat and food resources must be available in proximity to spawning areas for successful first-year survival. Ideal rearing habitat affords low-velocity cover, a steady supply of small food particles, and refuge from larger predatory fishes, birds and mammals (Williams et al. 1996).

This category includes culverts, dikes, dams, and other artificial structures that restrict access to spawning habitat for adult salmonids or rearing habitat for juveniles. Included are barriers created by irrigation diversion dams and inadequate screens that allow access to unsuitable areas that result in mortality to salmonids. In the case of diversion dams, fish passage may be blocked or maintenance of the dam may require repeated manipulation of the stream bed (ie. "push-up" diversion dams).

CULVERTS:

- prevent access for salmonid fry and parr to off-channel overwinter refuges of ponds, wetlands and small creeks that are often dry during the summer;

- hinder or prevent passage of adult and juvenile fish due to high water velocity, insufficient water depth, elevated outlet, or debris accumulation;

- create flows of a greater velocity and/or a shallower depth than that in the natural stream, often resulting in conditions that restrict or prevent the upstream movement of fish;

- cause the erosion and downcutting of the stream due to the relatively high velocity of water exiting the downstream end of a culvert which can also result in the formation of a vertical drop that may prevent fish from accessing the lower end of the culvert.

DIKES, DAMS AND OTHER ARTIFICIAL STRUCTURES:

- block access to salmonid rearing habitat;

- block access to a portion of the floodplain;

- prevents further development of the side channel;

- prevents the recruitment of large woody debris;

- limits spawning gravel recruitment;

- confines the channel, concentrating flows within the mainstem, increasing the erosive nature of the flows. Bed scour within the reach can negatively impact salmonid redds.

IRRIGATION DIVERSIONS, DIVERSION DAMS, AND SCREENS:

- can allow fish to voluntarily or involuntarily move from the parent water body into the surface diversion leading to direct mortality from stranding when water diversions cease (diversion entrainment);

- can create fish passage barriers during periods of low flow;

- maintenance of diversions can require repeated entry into stream channels disturbing spawning gravels and temporarily increasing sediment levels;

- can allow fish to voluntarily or involuntarily move through, under or around the fish screen resulting in loss of fish from the population. This is a function of screen mesh opening size and gaps between the screen frame and canal structure walls (screen entrainment);

- can cause fish to involuntarily come in contact with and be entrapped by the screen surface due to approach velocities exceeding swimming capabilities resulting in direct mortality (impingment);

Floodplains.

Floodplains are relatively flat areas adjacent to larger streams and rivers that are periodically inundated during high flows. In a natural state, they allow for the lateral movement of the main channel and provide storage for floodwaters, sediment, and large woody debris. Floodplains generally contain numerous sloughs, side channels, and other features that provide important spawning habitat, rearing habitat, and refugia during high flows. Map Appendix B contains 6 maps showing side channels of the Methow, Chewuch, and Twisp rivers as they existed in the early 1990's. In 1999 the Pacific Biodiversity Institute in Methow, Washington, funded under a People for Salmon Grant to the Okanogan Conservation District, digitized the side channels from black and white digital orthophotographs (dated 1990; 2 meter resolution), color aerial photographs (dated 1994; 1:80,000 scale), and the National Wetlands Inventory (NWI) digital coverage. The resultant coverage was then intersected with the 1993 Okanogan County parcel layer (the expense of obtaining the 1999 Okanogan County parcel layer was cost-prohibitive). The database containing the ownership information for identified side channels is available by contacting the Okanogan Conservation District Manager Craig Nelson (509/422-0855; email craig-nelson@wa.nacdnet.org).

The alluvial fans area of the floodplain is an important feature of the floodplain throughout the Methow valley, dissipating flow energy and maintaining and creating suitable rearing and spawning habitat over a wide range of flows. Large woody debris in an active channel or floodplain creates conditions necessary for plant colonization within an alluvial plain. Large woody debris is a primary determinant of channel morphology, forming pools, creating low velocity zones, regulating the transport of sediment, gravel, organic matter and nutrients and providing habitat and cover for fish (Bisson et al. 1987).

This category includes direct loss of aquatic habitat from human activities in floodplains resulting from: diking, bank hardening, and draining of wetlands.

DIKES:

- block access to salmonid rearing habitat;
- block access to a portion of the floodplain;
- prevents further development of the side channel;
- prevents the recruitment of large woody debris;
- limits spawning gravel recruitment and,
- confines the channel, concentrating flows within the mainstem, increasing the erosive nature of the flows. Bed scour within the reach can negatively impact salmonid redds.

BANK HARDENING:

- concentrates stream flows;
- transfers energy downstream;
- increases channel scour;
- decreases bank stability;
- reduces riparian vegetation as cover and nutrient-energy sources;
- disrupts the run-riffle-pool sequence (Newbury, et al., 1997);
- prevents development and maintenance of salmonid spawning and rearing habitat;

DRAINING FLOODPLAIN WETLANDS:

- eliminates surface water storage in overbank areas;
- eliminates available wetland processes which reduce water velocities and remove sediment;
- eliminates recharge of shallow groundwater which supports subsurface flow in dry seasons;
- eliminates overwintering habitat for salmonids.

Riparian.

The riparian ecosystem is a bridge between upland habitats and the aquatic environment. The combination of shape, moisture, depositional soils, and disturbance regime unique to riparian areas contributes to their exceptional productivity in terms of plant growth, plant diversity, and structural complexity of the vegetation (Johnson and Carothers 1982; Mitsch and Gosselink 1986; Lee et al. 1987). Animals, in turn, have evolved to exploit directly or indirectly the rich vegetative habitat provided by riparian areas.

Riparian habitats often influence the water quality of adjacent aquatic systems. Riparian vegetation provides shade which shields the water from direct solar radiation, moderates extreme temperature fluctuations during summer and keeps streams from freezing during winter. Riparian vegetation helps stabilize banks by maintaining masses of living roots which reduce surface erosion, mass wasting of stream banks and consequently reducing sediment delivered to the stream channel (Platts 1991). Riparian ecosystems also act as reservoirs, storing run-off in soil spaces and wetland areas and diminishing erosive forces caused by high flow events. The presence of stream-side vegetation also reduces pollutants, such as phosphorous and nitrates through filtration and binding them to the soil. Riparian vegetation contributes nutrients to the stream channel from leaf litter and terrestrial insects which fall into the water. Riparian vegetation also contributes to the recruitment of LWD.

Salmonids have unique habitat requirements: adequate, but not excessive stream flows; cool, well-oxygenated, unpolluted water; streambed gravels that are relatively free of fine sediments; an adequate food supply; and instream structural diversity (interposed pools, riffles, hiding and resting cover). These requirments are met in part by healthy, functioning riparian habitat.

For example: adequate stream flows must be present in order for fish to access and use pools and hiding cover provided by root wads and LWD positioned at the periphery of the stream channel. Microclimate, soil hydration, and groundwater influence stream flow; these factors are in turn influenced by riparian and upland vegetation. Vegetation and the humus layer intercept rainfall and surface flows. This moisture is later released in the form of humidity and gradual metered outflow through groundwater. Through this process, stream flows are maintained through periods of drought (Knutson and Naef 1997).

This category addresses factors that limit the ability of native riparian vegetation to provide shade, nutrients, bank stability, and a source for LWD as a result of timber harvest or clearing for agriculture or development, and direct access by livestock to stream channels.

TIMBER HARVEST OR CLEARING (REMOVAL OF RIPARIAN VEGETATION):

- decreases bank stability;
- descreases LWD recruitment;
- results in a loss of shading;
- results in a loss of cold water refugia;
- increases sediment recruitment;
- decreases sources for nutrient input;

LIVESTOCK GRAZING:

- decreases bank stability;
- increases sediment recruitment;
- alters the composition of riparian vegetation;
- compacts soil.

Large Woody Debris (LWD):

The TAG (2000) considers LWD to be one of the most critical components of the mainstem Methow River. Nelson (1998) concurs, stating that the abundance of LWD is often associated with the abundance of salmonids and is thought to be the most important structural component of salmon habitat.

Large woody debris is generally described as wood material (>12 in diameter and >35 ft long; USFWS 1998) that mainly enters stream channels from stream bank undercutting, windthrow, and slope failures. Note: size standards for LWD are highly variable between agencies. LWD creates lateral channel migration and complexity. It sorts gravels, stores sediment and gravel, contributes to channel stabilization and energy dissipation and maintains floodplain connectivity. LWD provides important physical and biological functions in the wide variety of habitats used by all salmonids; such as cover in which to hide from predators or retreat from high velocities. The presence of LWD in the floodplain creates the diversity of habitat conditions that support multiple life stages of salmonids. In small streams, LWD traps sediment, causes local bed and bank scour, and creates pools. Small channels are highly dependent on in-channel woody debris structure for stability.

The large streams and rivers in the Methow are currently characterized by infrequent, but occasionally massive accumulations of LWD. The LWD tends to be of large diameter and often complete trees with rootwads and branches can hold together accumulations of smaller logs and other wood debris. Much of this debris has originated from upstream areas during flood events or has entered the channel from bank undercutting and erosion on gravel bars. Large accumulations of LWD in the lower floodplain can direct flow into meander loops and result in formation of riverine ponds and other off-channel habitat features, providing for the recruitment of new LWD from these side channel areas. Large woody debris can also indirectly function as a formative factor in channel processes.

This category addresses impacts resulting from: the removal or the lack of LWD.

ABSENCE OF LARGE WOODY DEBRIS:

- decreases complexity with fewer pools and less off channel habitat;
- lowers productivity;
- decreases channel stabilization;
- decreases energy dissipation;
- decreases cover.

<u>Channel Conditions and Streambed Sediments</u>

A stream channel represents the integration of several physical processes occurring within the watershed. The channel reflects the combined effects of sediment, water, and LWD supplied to the channel. At the same time channel form or morphology is naturally constrained both laterally and vertically by valley form, riparian conditions and geology. The channel form will change when any of these inputs are altered or when the channel is artificially confined or constrained. The quality and quantity of salmonid rearing and spawning habitat in a stream channel is controlled by the interaction of sediment and LWD with water and the transport of all three components through the channel network. Altering LWD levels or increasing sediment input can result in a decrease in the number and quality of pools, a decrease in the ability of the channel to retain sediment and organic matter, and an increasing width to depth ratio in low gradient reaches. A stream characteristically alternates between deep zones, or pools, and shallow zones, or riffles. In the Pacific Northwest, LWD has been found to have a significant influence on the formation of pools and channel form (Nelson 1998).

Roads can affect streams directly by accelerating erosion and sediment loading, by altering channel morphology, and by changing the runoff characteristics of watersheds. These changes can later physical processes in streams, leading to changes instreamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition and stability of slopes adjacent to streams (Furniss et al. 1991). Sediment entering stream is delivered chiefly by mass soil movements and surface erosion processes (Swanson 1991). Failure of stream crossings, diversion of streams by roads, washout of road fills, and accelerated scour at culvert outlets are also important sources of sedimentation in streams within roaded watersheds (Furniss et al. 1991).

Agricultural practices can also affect streams by accelerating erosion and sediment loading to streams. Farmed fields left fallow (ie. barren of vegetative cover) cause much surface erosion and sediment movement to streams as winter snow melts and runs off carrying soil into stream channels (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids et al. 1996). This is particularly a problem where riparian vegetation has been removed and the land is farmed up to the bank’s edge. Riparian vegetation naturally functions as a filter, capturing sediments and buffering the flow of surface runoff into stream channels.

This category addresses impacts resulting from: increases in sediment input from roads, agricultural practices, and accelerated bank erosion; and changes in sediment transport and storage.

ROADS, AGRICULTURAL PRACTICES AND ACCELERATED BANK EROSION:

- increases in percent fines;

- changes in sediment transport and storage:

- increased deposition of fines on spawning gravel;
- filling of pools;
- increased width to depth ratio resulting in a wider shallower channel.

CHANGES IN SEDIMENT TRANSPORT AND STORAGE:

- increased deposition of fines on spawning gravel;
- decreased pool quality and quantity;
- increased width to depth ratio resulting in a wider shallower channel;
- increased chronic delivery of sediment to downstream tributaries;
- accelerated bank erosion.

Water Quantity and Water Quality.

Changes in flow conditions can have a variety of effects on salmonid habitat. Streamflow is a major environmental factor affecting the survival and productivity of salmonids. Stream flow is moderated by riparian vegetation as well as vegetative cover in the uplands. Riparian areas, in particular, assist in regulating stream flow by intercepting rainfall, contributing to water infiltration, and using water via evapotranspiration. Plant roots increase soil permeability, and vegetation helps to trap water flowing on the surface, thereby aiding infiltration. Water stored in the subsurface sediments is later released to streams through subsurface flows. Through these processes, riparian and upland vegetation help to moderate storm-related flows and reduce the magnitude of peak flows and the frequency of flooding.

Extended periods of low flows can delay the movement of adults into streams, draining their limited energy reserves, affecting upstream distribution and spawning success. High winter flows can cause egg mortalities by scouring and/or sedimentation of the spawning beds. Low winter flows can contribute to anchor ice formation and result in the freezing of eggs or stranding of fry. The overwinter survival of juvenile fish can be negatively affected by the reduction in the quantity and quality of winter rearing habitat as a result of low flows. Prolonged periods of low flow in the summer reduce available rearing areas for juveniles. Water temperatures can also rise resulting in mortalities and stress for fish.

Roads modify natural drainage networks, accelerating erosion and sediment loading, and changing the runoff characteristics of the watershed. These changes can alter physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to streams (Furniss et al. 1991).

Timber harvest can alter the characteristics of upland vegetation resulting in a change in water runoff patterns and water retention. Timber harvest may substantially alter the spatial distribution of water and snow on the ground, the amount intercepted or evaporated by foliage, the rate of snowmelt or evaporation from snow, the amount of water that can be stored in the soil or transpired from the soil by vegetation, and the physical structure of the soil that governs the rate and pathways by which water moves to stream channels (Chamberlin et al. 1991).

Cool, well-oxygenated water is required by salmonids. As stream temperatures rise, their dissolved oxygen content is reduced. Water temperatures of approximately 23-25°C (73-77°F) are lethal to salmon and steelhead (Theurer et.al. 1985) and genetic abnormalities or mortality of slamonid eggs occurs above 11°C (51.8°F).

Temperature increases and consequent reductions in available oxygen tend to have deleterious effects on fish and other organisms by: 1) inhibiting their growth and disrupting their metabolism; 2) amplifying the effects of toxic substance; 3) increasing susceptibility to diseases and pathogens; 4) encouraging an overgrowth of bacteria and algae which further consume available oxygen; and 5) creating thermal barrier to fish passage.

Major potential stream pollutants include nutrients such as nitrates and phosphates, heavy metals from mining waste, and compounds such as insecticides, herbicides, and industrial chemicals.

This category addresses changes in flow conditions brought about by water diversions, road construction, and changes in upland vegetative cover. Changes to stream flow resulting from alterations to the floodplains are discussed in the ***Floodplain*** category. Changes to stream flow resulting from the loss of beaver activity are discussed in the ***Biological Processes*** category. Water quality factors addressed by this category include stream temperature, dissolved oxygen, and toxics that directly affect salmonid production. Turbidity is also included, although the sources of sediment problems are addressed in the streambed sediment category.

WATER DIVERSIONS:

- delay or prevent movement of spawning/migrating adults and rearing juveniles;
- reduce available rearing areas for juveniles;
- contribute to increased water temperatures and decreased dissolved oxygen.

ROAD CONSTRUCTION:

- accelerate erosion and sediment delivery to streams;
- increase magnitude of peak flow events.

CHANGES IN UPLAND VEGETATIVE COVER:

- influences snow accumulation and melt rates;
- influences evapotranspiration and soil water content;
- influences soil structure affecting infiltration and water transmission rates.

Biological Processes.

Beaver had a key role in creating and maintaining conditions of many headwater stream, wetlands, and riparian systems that were fundamentally important to the rearing of salmon (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids 1996). Their dams and ponds created storage locations for water, sediment, and nutrients. Beaver ponds were of particular importance in the more arid region where they also provided rearing habitat for salmon (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids 1996). The general decline of beaver and their associated habitats constituted perhaps the first major impact on salmon populations from the influx of Euro-American. Persistent trapping pressure over the decades has continued to keep beaver populations relatively low (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids 1996). Beaver impoundments stabilize stream flows in two ways: first, they act as reservoirs, increasing the water-holding capacity of the watershed, thus slowing the rate of runoff; second, flooding of land in the vicinity of the beaver colonies raises the level of the water table and the stored groundwater is slowly released back into the stream, which helps to maintain flow during periods of drought. Beaver impoundments have been found to improve the quality and diversity of riparian habitat. A diverse aquatic and riparian vegetation community contributes to fish production by providing escape cover, thereby minimizing mortality from predators; by attracting terrestrial insects, some of which fall to the water surface and are eaten by fish; and, in the case of submerged vegetation, by providing suitable habitat for aquatic insects and other invertebrates that are the principle source of fish food. The activities of beavers are also much involved in nutrient cycling which, in terms of fish production, may be as important as the role they play in moderating stream flows.

The impacts of decades of releases of hatchery salmonid stocks of summer chinook, spring chinook, rainbow trout, and steelhead are pervasive in the Methow watershed. The effects of the hatchery management strategy on salmonid populations bears mentioning but an assessment of its affects on naturally reproducing salmonids are outside the scope of this report. This includes the effects of coho reintroduction (for more information see Mid-Columbia Coho Reintroduction Feasibility Project Preliminary Environmental Assessment (BPA et al. 1999).

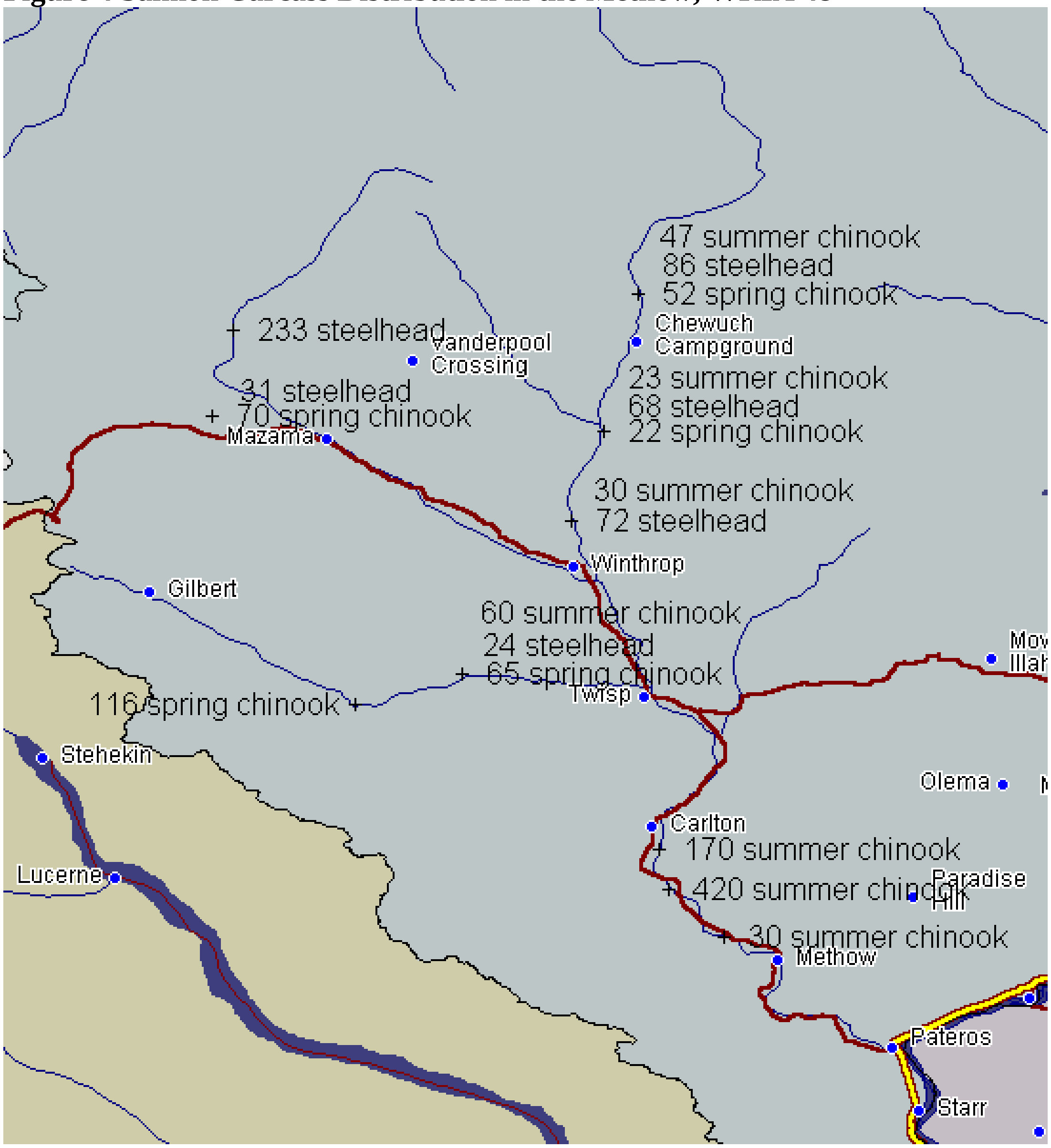
Brook trout are a non-native salmonid introduced into the Methow watershed and Washington State in general, to improve recreational fishing opportunities. These two species occupy the same habitat and hybridize extensively, leading to extirpation of bull trout populations (Mullan et al. 1992) and competition for rearing and spawning habitat.

Brook trout are known to mature earlier than bull trout (2 - 4 years for brook trout and 6 - 9 years for bull trout; H. Bartlett, WDFW, pers. comm., 2000) giving them a reproductive advantage.

Pacific salmon and other anadromous salmonids have been considered a major vector for returning significant amounts of nutrients from the Pacific Ocean back to land (ie., from marine to freshwater and terrestrial ecosystems; Cederholm et al. 1999). As wild spawning salmon numbers decline, it can be assumed that productivity of some freshwater and terrestrial ecosystems will be diminished because of reduced nutrients and biomass returned from the ocean. The fate and utilization of nutrients provided by decomposing salmon carcasses may depend on numerous variables, including species (spawning densities and location in the watershed preferred for spawning), in-stream physical structure (retention of organic debris or otherwise), discharge (high stream flows), biotic mechanisms (consumption by aquatic and terrestrial invertebrates, fish, and terrestrial wildlife), and riparian ecosystem conditions (the amount of light that limits primary productivity) (Cederholm et al. 1999). The impact of this nutrient deficit is difficult to quantify but deserves consideration especially in the Methow watershed which is known to be naturally nutrient-deficient (Mullan et al. 1992, TAG 2000).

During 1998 and 1999 local fishing group volunteers, in cooperation with WDFW planted a total of 1769 salmon and steelhead carcasses in various locations throughout the Methow River watershed: 315 spring chinook; 515 steelhead and 940 summer chinook (Figure 4). Although this effort did not include a monitoring or research component, Bilby (1998) has demonstrated that 18% of the nitrogen in stream-side vegetation came from spent salmon and their eggs, and that the dead fish provided some 15-30% of the nitrogen and carbon in insects, and 25-40% of the two nutrients in young trout and salmon. Data quantifying the extent to which the lack of salmon and steelhead carcasses are negatively affecting salmonid productivity in the Methow watershed is not available.

Figure 4 Salmon Carcass Distribution in the Methow, WRIA 48



The TAG (2000) recommended salmon carcass distribution be confined to historic anadromous spawning areas and numbers of carcasses reflect historic spawning densities.

This category addresses impacts to fish caused by the loss of beaver activity, the introduction of exotic plants and animals, and the loss of ocean-derived nutrients from a reduction in the amount of available salmon carcasses.

LOSS OF BEAVER ACTIVITY:

- decreased water storage capacity;
- decreased sediment storage capacity;

- decreased nutrient storage capacity;
- decreased quality and diversity of riparian habitat;

BROOK TROUT INTRODUCTION:

- extirpation of bull trout populations through hybridization and competition for habitat.
- DECREASE IN SALMON CARCASSES:
- reduction in nutrients like phosphorus and nitrogen;
- reduction in available biomass to support aquatic and terrestrial ecosystems.

Data Gaps

There are several areas where additional data is needed to improve the accuracy of the assessment of the habitat conditions within the Methow watershed. Additional data can also be helpful in validating assessments based largely on best professional knowledge where “hard” scientific data was unavailable. This would increase the ability of the public and technical staff to make natural resource management decisions at the watershed-level with a higher degree of confidence in the outcomes or results. Much of this data needs to be collected on a watershed-wide basis, although for some studies there are discrete areas in which data has already been compiled. In reviewing proposals for studies that address the following data needs, a thorough effort should be made to compile all existing data as a baseline.

Data needs specific to individual subwatersheds are listed at the end of each subwatershed chapter. Although there may be some redundancy to the list of watershed-wide assessments, it should be noted that these are areas where the Technical Advisory Group considered to be of particular importance.

Following are the overriding watershed-level inventory and assessment data gaps for the Methow watershed:

- An assessment of the extent salmonid productivity is being limited by habitat conditions, whether human-induced or natural. This assessment can be done on a reach basis, by species, by life stage. This would allow for the development of a coordinated, watershed-level strategy to protect and restore salmonid habitat. This can be accomplished using existing data and professional knowledge and can be fine-tuned as more data collection and analysis is completed. This information will provide the basis on which recovery projects can be prioritized sequentially. An example of this type of assessment methodology is the “Ecosystem Diagnosis and Treatment” (EDT) methodology developed by Mobrand Biometrics, Inc. (August 1999).

- A watershed-wide fish passage barrier and screen safety inventory and assessment to include both private and public lands. This should incorporate existing state, federal and local data and GIS into a single, accessible database and GIS coverage. A comprehensive inventory would include identification and prioritization of both artificial and natural barriers (culverts, diversion dams, gradients, etc.), and the location and condition of screens for gravity and pump water diversions. The maps in Map Appendix C show known artificial and natural fish passage barriers in the Methow watershed. Based on the professional field knowledge of the TAG participants, barriers were identified during a TAG mapping exercise conducted as part of the development of this document. Included in the barriers map are fish passage barriers identified during the 1998 survey of fish passage barriers, fish screens and diversions in Beaver Creek (Gower and Espie 1999). Appendix C provides additional information about the barriers identified on the map. The WDFW Salmonid Screening, Habitat Enhancement, and Restoration (SSHEAR) Division has inventoried fish passage and fish screening sites on WDFW owned lands in the Methow watershed. It includes an assessment of the habitat in the vicinity of identified fish passage barriers and water diversions, in some cases identifying additional barriers adjacent to WDFW lands. Brian Benson, WDFW, is the contact for this information and can be reached by email at bensoblb@dfw.wa.gov. This data was not available in its final form to be incorporated into the Fish Passage Barriers maps in Map Appendix C. The data will be finalized in a report due out in late 2000 (B. Benson, WDFW, pers. comm., 2000). Once this information is made available, additional field inventory may still be necessary to identify artificial fish passage barriers not captured by the TAG mapping exercise, the Beaver Creek fish passage and screen inventory, and the WDFW SSHEAR fish passage and screen inventory on WDFW owned lands. The WDFW SSHEAR Fish Passage Barrier Assessment and Prioritization Manual (1998b) offers six assessment options that range from only assessing targeted human-made barriers to a full physical survey assessing and prioritizing both man-made and natural barriers, including a habitat evaluation component. A copy of this manual is available from the WDFW website at www.wa.gov/wdfw/hab/engineering/habeng.htm. The map in Map Appendix D shows known diversions, fish screens, and irrigation canals in the Methow watershed. The points were pulled from a GIS coverage provided by the USFS and from latlong coordinates provided by the WDFW Screen Shop. The coverage does not include pump diversions except for the Beaver Creek drainage where both gravity and pump diversions are known. A follow-up field inventory is still be needed to locate water diversions and assess screen condition for areas of the watershed where this information has not been made available.

- A watershed-wide "channel migration zone" study is needed to define current floodplains in the Methow watershed in terms of channel form and process, as well as an assessment of lost floodplain function over time and impact to instream habitat resulting from floodplain impairment. In particular, there are still unmapped floodplains adjacent to the Twisp and the Chewuch Rivers and Gold Creek (Okanogan County 1996). This would contribute to the development of a habitat protection and restoration strategy that would address issues of maintaining habitat connectivity and habitat-forming processes. A channel migration zone study should examine the zone of influence dictated by 1) the underlying geology - which controls the vertical and horizontal movement of the river channel, 2) channel processes - such as bedload movement and large woody debris deposition which affect channel formation and abandonment patterns, and 3) hydrologic patterns - which supply the energy that drives the channel forming processes.

A GIS-based exercise would provide preliminary information to serve in the interim as a basis for identifying critical habitat for protection and restoration funding. An interim effort should include the interpretation of applicable aerial photographs and digital orthophoto, including satellite imagery interpretation and some field verification of the interpretation work. This could be accomplished over a period of a few months given the appropriate expertise.

A more comprehensive meander zone study should immediately follow and build upon the preliminary work. This would include a field season to capture a variety of field condition parameters including channel form, riparian vegetation condition, and diking and bank hardening within the meander zone. The extent of the field component and the approach to designing the meander zone study in general will vary depending on the level of expertise involved, funding levels, and required time to completion.

- A watershed wide inventory and assessment of riparian habitat and conditions including change over time. This should be developed at a 1:24,000 map scale. It should incorporate existing federal and non-profit data, along with data acquired from an inventory of non-federal lands, into a single, accessible GIS coverage. The Methow Conservancy has received funding to produce a "Riparian Protection Strategy" for the Methow valley. This will include an inventory of the "remaining best habitat" and the development of a prioritized list for acquisition of riparian habitat. Although the targeted wildlife species for this project are songbirds, the goal of identifying and prioritizing protection of the highest quality riparian habitats will also serve the needs of identifying riparian habitat in general in the Methow Valley. This Methow Conservancy project intends to use aerial photo analysis, GIS maps and local expert opinion to identify the list of key remaining riparian habitats. A final list of priority riparian habitat and the mapping will be completed in September 2000. This information would serve as one component of a channel migration zone study. An interim GIS/photo interpretation procedure is described above. A riparian vegetation inventory and condition assessment at the watershed level is necessary for identifying and prioritizing habitat projects that would protect, maintain and restore the habitat processes and ecological functions of riparian zones in a coordinated manner. As part of the Federal Emergency Management Agency's (FEMA) Flood Insurance Study for unincorporated Okanogan County (Federal Emergency Management Agency 1994), Flood Insurance Rate Maps and Flood Hazard Boundary Maps were published. To date these have served to generalize the possible location of riparian areas. The FEMA maps for Okanogan County are not adequate for determining the location and condition of riparian zones.

- A hydrologic assessment to evaluate groundwater and surface water interactions, identify critical ground water recharge areas, and locations where groundwater contributes to surface water. A measure of the affect this interaction has on moderating high summertime and low wintertime surface water conditions should be included. The study should include mapping of stream reaches known to dewater and the locations of water diversions and withdrawals. This is also a component of the channel migration zone study.

  The extent to which groundwater levels may be affected as surface water applied to fields percolates back into the aquifer, and as existing canal systems leak water back into the aquifer is unknown. A very simplified evaluation of this issue presented in the Final Methow Valley Irrigation District Project EA concluded that the recharge from the leaking canals associated with the MVID has a very limited and local influence on the groundwater quantity and level (BPA 1997). The extent to which irrigation water and canal seepage during the irrigation season contributes to surface water flows during winter months is unknown. For the MVID service area, a simplified model to approximate this last relationship was performed and the conclusion drawn was that no flows originating from the canals and irrigated fields would be expected after December (BPA 1997). The BPA report continued on to emphasize that without a complex study of the relationship between surface water diverted for irrigation and its contribution to surface and groundwater recharge, it is not possible to determine exactly how much of this water enters the ground table or reenters surface water.

- A watershed-wide assessment of how road conditions affect sediment contributions to watercourses is needed. Additionally, a Methow watershed, road/trail management plan for the purpose of reducing sediment delivery to streams is needed. This inventory and assessment should be done on a subwatershed (5^{th} HUC) basis. A rapid-assessment using a developed “road density/proximity to streams” coverage, soils data and slope information could be used to prioritize the order in which this work should be done in the Methow watershed, given time and funding. Another option would be to develop a road/trail management plan for one or two subwatersheds as pilot projects, given lack of funding or immediate management needs. The plans should determine roads, stream channel crossings, and trails in need of maintenance and upgrading to reduce erosion, sediment delivery, mass wasting, fish barriers, stream channel confinement and impacts, and riparian impacts. Actions may range from replacing culverts, improving drainage, or gating roads to replacing culverts with bridges, relocating roads or parts of roads, or total removal of the road prism and revegetation.

- The condition of pools and large woody debris needs to be determined based on standard criteria appropriate for the North Cascades ecosystem. This should rely on and add to the data accumulated in the existing North Cascades database maintained by the US Forest Service.

- Areas and opportunities for beaver reintroduction and management should be investigated as a low-cost strategy for improving salmon habitat conditions. The extent to which beaver influenced water, sediment and nutrient storage in Methow tributaries prior to European influence is unknown. The effects of the decrease in beaver activity within the Methow are also unknown. Beaver had a key role in creating and maintaining conditions of many headwater streams, wetlands, and riparian systems that were fundamentally important to the rearing of salmon. Beaver ponds were of particular importance in the more arid regions (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids et al. 1996).

- Throughout the Methow watershed brook trout compete with native species for food and habitat. A comprehensive survey is needed to establish the extent of the brook trout population in the area. This information would be used in making management decisions for maintaining bull trout populations in the Methow watershed.

Recommendations

The Technical Advisory Group (TAG) has provided a list of recommendations for each subwatershed meant to address the habitat concerns identified during the habitat limiting factors assessment process. The lists appears at the end of each subwatershed section in this chapter. The list is not ranked nor is it intended to be a comprehensive list of all recommended salmonid habitat protection and restoration projects. The recommendations provided should be used as guidance for the 2496 citizen steering committee for the development of a salmonid habitat protection and restoration projects list. The next step will require an evaluation of how the habitat conditions are limiting salmonid production by assessing the effects of the habitat conditions on a given life stage for a given salmonid species. This will require the collection and analysis of additional data as provided in the Data Gaps sections combined with the professional knowledge of the TAG. Then a watershed-wide recovery strategy can be developed that facilitates the development of a prioritized, coordinated list of habitat protection and restoration projects.

Upper Methow River Subwatershed

The Upper Methow River subwatershed contains approximately 322,385 acres, encompassing the upper Methow River from its headwaters (RM 86.8) downstream to the Chewuck River confluence (RM 50.1), a distance of approximately 35 river miles. It includes the tributaries: Brush Creek, Trout Creek, Rattlesnake Creek, Robinson Creek, Lost River, Early Winters Creek, Gate Creek, Goat Creek, Little Boulder Creek, Fawn Creek, Hancock Creek, Little Falls Creek, and Wolf Creek. The Lost River and Early Winters Creek, although identified as separate subwatersheds in the HUC classification system, are presented in this Upper Methow River Subwatershed section for discussion.

Maximum precipitation in the subwatershed is 80 inches along the Cascade crest with an average annual precipitation at Mazama between 1937 and 1998 of 20 inches. Approximately 80% - 90% of the subwatershed is in federal ownership managed by the USFS as Congressionally Withdrawn (Wilderness), Late-Successional Reserve, or Riparian Reserve (USFS 1998d). These designations provide a high level of protection of aquatic areas and the surrounding uplands. A peninsula of private land extends into this subwatershed along both banks of the mainstem Methow River from the Lost River to the Town of Winthrop. This ownership encompasses the stream meander zone of the Methow River and the alluvial fan areas of every tributary. The alluvial fans encompass those aquatic environments that control salmonid migration and movement within the mainstem Methow River and among its tributaries. State Highway 20 passes through the center or the subwatershed, paralleling the Methow River and connecting the towns of Winthrop and Mazama. At Early Winters Creek, Highway 20 turns west following the Early Winters drainage to the Cascade Crest.

Of the salmonid species this document addresses, the following species occur in the Upper Methow River Subwatershed; spring chinook, summer chinook, steelhead/rainbow trout and bull trout. Table 4 describes species use for the listed drainages within the subwatershed. Between the years 1987 – 1999, approximately 40 % of spring chinook spawning in the Methow watershed occurred in the upper Methow River subwatershed between the Lost River confluence (RM 73.0) and the Winthrop bridge (RM 49.8; Table B- 1in Appendix B). Within this reach, the highest percent of redds were counted between the Weeman bridge (RM 59.7) and the Winthrop bridge (RM 49.8). This compares to about 25.4% of redds in the Methow watershed counted in the Twisp River and 25.6 % counted in the Chewuch River for that same period. The Upper Methow River subwatershed is also critical for sustaining healthy populations of bull trout in the Methow watershed (USFS 1998d).

Mainstem Upper-Methow River (48.0007)

Access to Spawning and Rearing Habitat

Low flows and dewatering create a passage barrier to salmonids. In some years portions of the reach of the upper Methow River between Robinson Creek (RM 74.0) and

Weeman Bridge (RM 59.7) go dry during September, October and early November (Kohn 1987; Kohn 1988; WDFW et al. 1990; Caldwell and Catterson 1992; USFS 1998d). During years of extreme drought, the dewatered reaches extend in length (Caldwell and Catterson 1992; Rock Island Hydroelectric Facility et al 1998). During many years a period of somewhat increased stream flow occurs during the fall or early winter months. This increase is dependent on the occurrence of fall rains prior to freezing temperatures (EMCON 1993; Rock Island Hydroelectric Facility et al 1998). Lacking fall rains or, when sustained cold temperatures cause precipitation to fall only as

Table 4 Known salmonid species use in the Upper Methow River Subwatershed

Upper Methow River Subwatershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Bull Trout		
	spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration
Methow River	X	X	X	X	X	X	X	X	X		X	X
Lost River drainage	X	X	X				X	X	X	X	X	X
Early Winters Creek drainage	X	X	X				X	X	X	X	X	X
Goat Creek drainage		X					X	X	X	X	X	X
Wolf Creek drainage	X	X	X				X	X	X	X	X	X
Little Boulder Creek		X						X				
Hancock Creek								X				

snow during this time, low flows or anchor ice persist until spring thaw (Caldwell and Catterson 1992; EMCON 1993). Early Winters Creek, which enters the dewatering reach at RM 67.3, has two irrigation ditches that withdraw water from Early Winters Creek. The extent to which Early Winters Creek contributes to sustaining surface water flows in the dewatering reach of the Methow River below its confluence and downstream to the Mazama bridge is variable, complex and not fully understood. There are also other water diversions from the various tributaries that feed into this loosing reach of the upper Methow River. The extent to which these diversions affect the duration and extent of dewatering in the Methow River has not been investigated and is not fully understood (TAG 2000).

<u>Lost River Dike</u> (SW ¼ Section 05, T37N R19E). Built without permits partially on private land and partially on USFS land at the confluence of the Lost and the Methow Rivers, the Lost River Dike cuts off ¼ to ½ mile of side channel from the Methow River.

<u>McKinney Mountain Dike</u> (SW ¼, Section 04, T35N R20E). Built on private lands in 1975 by the Army Corps of Engineers, the McKinney Mountain Dike cuts off approximately one mile of side channel rearing habitat from the Methow River. It was reconstructed in 1997 and in 1999 by the Army Corps of Engineers after being “washed-out” (Tom McCone, Okanogan County Public Works, pers. comm., 2000). The side channel is located in a reach of the Methow River that supports the highest average concentration of spring chinook spawning redds (YN spawning ground surveys 1987 – 1999). This reach also maintains surface flows even during dry years when the main

channel both upstream and downstream dewaters. A portion of the Methow Valley ski trail runs along the top of the dike.

Dike (RM 55.5). Built on the Methow River on DNR property upstream of Wolf Creek and across from the Big Valley Ranch, the dike cuts off a side channel of the Methow River. The road protected by the dike provides access to the “People Mover”. This dike, together with the hatchery dike, cuts off approximately 1.5 miles of side channel habitat.

Upstream anadromous fish access is blocked by an impassable natural falls at RM 83.2 on the Methow River.

Floodplains.

Lost River Dike (SW ¼ Section 05, T37N R19E). Built without permits partially on private land and partially on USFS land at the confluence of the Lost and the Methow Rivers, the Lost River Dike constrains the floodplain in this reach of the Methow valley.

McKinney Mountain Dike (SW ¼, Section 04, T35N R20E). Built on private lands in 1975 by the Army Corps of Engineers, the McKinney Mountain Dike constrains the floodplain in this reach of the Methow valley. The TAG indicated that the dike may be redirecting the flow of the mainstem Methow River against the Goat Creek Road. The dike was reconstructed in 1997 and in 1999 by the Army Corps of Engineers after being “washed-out” (Tom McCone, Okanogan County Public Works, pers. comm., 2000).

Portions of Highway 20, the Lost River Road and the Goat Creek Road (from Goat Creek to Mazama) are located in the floodplain (TAG 2000).

USFWS Hatchery Dike (Sections 02 & 03, T34N R21E). Built to protect the hatchery complex, the dike is about one mile long. A section of the Methow Valley Trail runs along its top. The dike constrains the floodplain in this reach of the Methow valley.

Just above Hancock Creek at RM 59, ¼ mile of the Methow River stream bank has been hardened constraining the floodplain in this reach of the Methow valley.

The banks of the Methow River from RM 53 to RM 54 upstream of the Wolf Creek confluence (RM 52.8) have been rip-rapped, constraining the floodplain in this reach of the Methow Valley.

At RM 63.5 near Little Boulder Creek, bank stabilization measures taken to protect the Suspension Bridge structure from the effects of erosion, are constraining the floodplain in this reach.

At RM 64, below the Mazama bridge but above Goat Creek, one mile of river bank has been hardened constraining the floodplain in this reach of the Methow valley.

At RM 63.5, above Weeman bridge and across from the Bible Camp, floodplain wetlands have been drained.

Riparian

From the Early Winters confluence downstream to the Mazama bridge, sections of riparian habitat have been converted to agricultural and residential use. Bank erosion has been observed along these devegetated stream banks.

In the vicinity of the Wolf Creek confluence and River Run Inn, riparian vegetation has been removed along the stream banks. Bank erosion has been observed along these devegetated stream banks

From Robinson Creek downstream to Lost River, there is dispersed recreational use on USFS land on skid roads in the floodplain (TAG 2000).

Large Woody Debris

All reaches of the mainstem Methow River within this subwatershed have LWD levels below the Okanogan National Forest Plan standards and guidelines of 106 pieces/mile (UDFS 1998d). It is important to note that required stream survey techniques used to count LWD levels do not include LWD in side channels or abandoned channels (USFS 1998d). In a large river system like the Methow River, this is where most of the LWD naturally accumulates (USFS 1998d). Therefore analysis of the data collected using this technique may not accurately reflect the Methow River's true degree of functionality (USFS 1998d).

Based on local, professional knowledge, it is the TAG's opinion that from the headwaters downstream to Goat Creek, LWD in the Methow River is reaching an "adequate" amount although not to historic levels (TAG 2000). The Methow River Stream Survey summary (USFS 2000i) supports this opinion. The summary states that although LWD is scarce from the confluence with Goat Creek upstream to the confluence with Trout Creek (RM 78), amounts of wood in the channel have been recently increasing, especially in a very low gradient stream segment near Gate Creek at RM 69, where wood is accumulating in large jams (visual observation). Amounts of LWD are much higher above the confluence with Trout Creek, as this segment of the river basin is in fairly pristine condition (USFS 2000i).

An inventory of LWD levels from Goat Creek downstream to the Chewuch River confluence has not been conducted although the literature has documented in general, the practice of LWD removal from the Methow River for the purpose of flood control, firewood gathering, logging, and kayaker/rafter safety (USFS 1997, USFS 2000i). The extent to which LWD is lacking in this reach of the river is a data gap.

Wood recruitment potential from the Lost River confluence upstream to the headwaters is "good" as the banks are well forested (USFS 1998d). The potential for wood recruitment from the Lost River confluence downstream has been reduced to an undetermined extent by dike construction in the floodplain, the loss of mature riparian vegetation in the channel migration zone, and stream bank hardening practices (USFS 1998d; TAG 2000; USFS 2000i).

Channel Conditions and Streambed Sediments

Substrate condition is poor (>30% cobble embeddedness) from RM 63.2 – 67.0 (Goat Creek upstream to Mazama; USFS 1998d). The USFS stream survey of the upper Methow River did not extend downstream of the Goat Creek confluence so no data has been collected regarding cobble embeddedness downstream of Goat Creek.

Management activities in the Goat Creek and Wolf Creek drainages (timber harvest, roads and grazing) are contributing to increased sediment levels in the mainstem Methow River from the Goat Creek confluence downstream to the to the Town of Winthrop (TAG 2000, USFS 2000i). The highest density of spring chinook spawning redds in the Methow River also occurs in this reach of the Methow River. The extent to which sediment, delivered from the Goat and Wolf Creek drainages, may be affecting spawning success is a data gap.

The portion of the Methow River from Goat Creek to the Lost River confluence is susceptible to increasing width/depth ratios. This reach has a low gradient, highly braided channel type that readily accumulates sediment and is naturally susceptible to channel changes and lateral migration of stream channels. Removal of shoreline riparian vegetation will most likely result in accelerated bank destabilization in this reach. Low levels of LWD impede a stream's natural ability to manage sediment transport and support the establishment of riparian vegetation (Fetherston et al. 1995;).

Few pools exist in the 4 mile, low gradient stream segment from Goat Creek upstream to Early Winters Creek. The Methow River Stream Survey summary (USFS 2000i) states this is due mainly to the lack of LWD in this low gradient reach although the TAG has stated that LWD levels in this reach are approaching an "adequate amount". Pool/riffle ratios are provided in Appendix B of Mullan et al. (1992) and would be useful in determining the "appropriate" number of pools for this reach. If pool frequency is determined to be low for this reach, increasing LWD consistent with the channel's morphology should be considered.

Water Quantity and Water Quality

The Methow River, at the inflow to the Winthrop National Fish Hatchery (RM 50.4), is listed on the State of Washington 303(d) list for exceedences of state water quality temperature criterion based on "WDFW data showing numerous excursions beyond State water quality criterion" (1998 303[d] list).

Dewatering in the upper Methow River has resulted in this subwatershed being placed on the State of Washington 303(d) list as water quality impaired for instream flows (Washington Department of Ecology 1998). The extent to which human induced changes (ie. fire suppression, roading, beaver removal, water diversions, alterations to alluvial fans, etc.) in the mainstem and its tributaries affect the extent and duration of the dewatering is unknown.

Dewatering of the Methow River from the vicinity of Robinson Creek to just upstream of the Weeman Bridge is a condition brought on by a seasonal decrease in water (Caldwell and Catterson 1992). It is a natural occurrence as documented by Gorman (1899) in 1898. He noted that in summer and early autumn, the Methow River disappeared in some places, the most notable of these disappearances being immediately below the Lost River confluence during October. The dewatered or low flow condition can begin in late summer/early fall of a given year and persist until the onset of spring runoff. It is especially common during dry years. The riverbed reaches on the upper Methow River identified below are the reaches that most commonly go dry. These reaches can expand in length during extreme drought years.

1. 1.5 miles from RM 60.7 to 62.2 (in between the Weeman bridge and the Mazama Bridge)

2. 5.5 miles from RM 67.5 to 73.0 (just upstream of Early Winters Creek up to the Lost River confluence)

3. 1.0 mile from RM 73.0 to 74.0 (from the confluence of the Lost River to the confluence of Robinson Creek)

Early Winters Creek provides some surface flows into the dewatering (loosing) reach of the Methow River below its confluence with Early Winters Creek at RM 67.3 (Scribner et al. 1993, TAG 2000). Early Winters Creek has two irrigation ditches that divert water from Early Winters Creek - the Early Winters irrigation ditch (RM 0.6) and the Willis ditch (RM 1.4). A total of five flow measurements were taken in each ditch below the fish screens by the Washington Department of Ecology (DOE) between mid-May and October 23, 1991 (Caldwell and Catterson, Appendix K4, 1992). Of the five measurements taken at Early Winters ditch, the maximum diversion recorded was 15 cfs on July 18, 1991. Of the five measurements taken at the Willis ditch, the maximum diversion recorded was 2.4 cfs measured on the same date. Water diversions measured on September 27, 1991 for the Early Winters ditch and the Willis ditch were 13 cfs and 0.2 cfs, respectively. Stream flows measured by Hosey and Associates in on September 27, 1990 (Caldwell and Catterson, Appendix K1, 1992) at RM 1.2 on Early Winters Creek were 24 cfs and, on the same date, 24 cfs also at RM 66.8 on the Methow River just below the Early Winters Creek confluence (RM 67.3). Above the confluence of Early Winters Creek, stream flow measurements taken on September 27, 1990 were 0.0 cfs at RM 69.3. The data provided in Caldwell and Catterson (1992) offers some measured values for comparison and discussion of the affect of Early Winters Creek stream flows to the mainstem Methow River below its confluence. Based on a diversion estimate of 15 cfs, the USFS has calculated that the Early Winters ditch diverts about 43% of the 2 year, 7 day average low flow in Early Winters Creek, which most likely occurs in late July, August, and September. Based on a diversion estimate of 1.7 cfs, they calculated that the Willis ditch diverts about 5% of the 2 year, 7 day average low flow in Early Winters Creek (USFS 1998c). The extent to which Early Winters Creek waters the Methow River below its confluence and downstream to the Mazama bridge is variable, complex and not fully understood (TAG 2000).

There are four other documented water diversions in the Upper Methow River Subwatershed, excluding the Wolf Creek diversions (Wolf Creek flows into the Methow River at RM 52.8, below the dewatering reach which ends around RM 61) and the Rockview diversion at RM 59.7. These are the Foster diversion on Goat Creek (1.8 cfs; USFS 2000e), the Kumm-Holloway diversion (RM 62.1), the McKinney Mountain diversion (RM 61.2) and the Edelewiess Subdivision on Fawn Creek (RM 61.0), all within the dewatering reach of the upper Methow River. Estimates of water diversion amounts were not available for the diversions. The extent to which these irrigation diversions affect the duration and extent of dewatering in the Methow River is variable, complex and not fully understood (TAG 2000).

Biological Processes

Brook trout are found in high numbers in the wetlands connected to the Methow River on the Heath Ranch WDFW property about 5 miles below Weeman Bridge, displacing native rearing salmonid. Brook trout were observed during a snorkel inventory in 1998 of wetland habitat adjacent to the Methow River just downstream and just upstream of the Goat Creek confluence. The extent to which brook trout may be displacing native salmonids in the mainstem Methow River in this subwatershed is unknown.

Brook trout have also been observed; at the mouth of Early Winters Creek and in isolated pools behind the McKinney Dike(TAG 2000).

The extent to which the decline in beaver activity is affecting water and nutrient storage, and instream flows is a data gap.

Habitat In Need of Protection

- Large wood accumulations in the floodplain.

- Functioning floodplain, riparian habitat and side channel habitat within the channel migration zone of the Methow River, to just upstream of the Lost River confluence. Upstream of the Lost River confluence, these areas are already in protected status under the USFS designation of Late Successional Reserve (LSR).

- Areas with ground water recharge to the stream channel.

- Beaver complexes (dams and wetlands).

- Spring chinook spawning habitat. The Methow River between Winthrop and the Lost River confluence is the most productive spring chinook salmon spawning habitat in the entire Methow watershed. Protecting functioning floodplain, riparian habitat and side channels within the channel migration zone of the Methow River in this subwatershed is critical to sustaining naturally producing spring chinook in the Methow watershed. Protection of habitat within this reach that sustains flows through the winter during dry years, especially stream channel sections where ground water recharge occurs, should be given the highest priority. Protection of this habitat will also maintain migration corridors for salmonids, provide rearing habitat for salmon, steelhead and bull trout, and protect summer chinook spawning that occurs in the vicinity of the Town of Winthrop.

- Water conservation measures should be promoted and implemented to assist in maintaining optimum flows for salmonids, thereby protecting access to and the quality of existing habitat.

Data Gaps

- An analysis to identify stream reaches appropriate for LWD recruitment and deposition.

- Monitor the condition of spawning habitat in key areas of the mainstem Methow River from the Lost River confluence to the Wolf Creek confluence.

Recommendations

- Habitat projects that support improved instream base flows (ie. restoring drained wetlands), restore cut off side channels, rehabilitate riparian areas, and remove constrictions and constraints within the channel migration zone (ie. dikes, roads and inadequately sized stream crossing structures) should receive priority.

- The McKinney Mountain dike should be considered for removal. The side channel blocked-off by this dike is located in the reach of the upper Methow River that usually maintains surface flows even during dry years when the main channel both upstream and downstream dewaters. To restore access to the year-round juvenile rearing habitat blocked by the McKinney dike and to restore the functionality of this reach, the dike will need to be removed.

- Existing LWD needs to be protected and overall LWD levels need to be increased to "acceptable levels" within the mainstem Methow River. Options for facilitating further recruitment and establishment of LWD need to be investigated.

- From Goat Creek to Mazama, where accelerated erosion is occurring along banks that have been impacted by agricultural and residential development, attempts should be made to reestablish mature vegetated buffers. An evaluation of the location of these eroding sites relative to the channel migration zone and an evaluation of the impact of the stabilization to bed and banks in the vicinity should be included. Conservation easements to secure riparian buffers should be pursued.

- There should be no further development within the channel migration zone that will constrict or constrain the channel, degrade riparian areas, negatively impact ground water and surface water interactions, or in any other way degrade stream channel functions.

- Project proposals to maintain the dike (RM 55.5 on the Methow River) that protects the road leading to the “People Mover” should not be funded. This dike together with the hatchery dike, cuts of approximately 1.5 miles of side channel habitat.

<u>Goat Creek (48.1364)</u>

The Goat Creek drainage runs north to south, contains about 22,200 acres, and ranges in elevation from 8,000 feet in its headwaters to 2,100 feet at its mouth. Goat Creek drains into the Methow River from the north at RM 64, about one mile downstream of the Town of Mazama. Goat Creek is 12.5 miles in length with nine named tributaries that include Montana Creek, Whiteface Creek, Long Creek, Short Creek, Roundup Creek and Cougar Creek. The upper third of the stream course has a moderate gradient and flows through a U-shaped valley that begins in alpine meadows and avalanche paths. The middle six miles flow through a high gradient inner gorge before the valley opens up into an alluvial fan where the stream drops large amounts of bedload. In the 1970’s the lower1.5 miles of Goat Creek were channelized. The maximum average annual precipitation is 35 – 40 inches in the northern part of the watershed and lessens to a low of 15 – 20 inches at the mouth of Goat Creek.

The entire drainage, with the exception of some private land at the mouth, was designated a Late-Successional Reserve in 1992 where management will favor old growth and species which depend on late successional forest. The upper third of the drainage is in a relatively natural condition, with few roads and trails. The lower two thirds have been heavily logged, roaded and grazed (USFS 1995a). In 1994, ten percent of the Goat Creek drainage (3,672 acres) was burned in the Whiteface Fire. In late summer and fall Goat Creek flows subsurface near the mouth. There is one irrigation ditch at RM 1.2 that diverts about 1.8 cfs.

Goat Creek supports a population of resident bull trout. Summer steelhead may spawn and rear in Goat Creek. The rainbow trout population at the headwaters was genetically tested and found to be “essentially pure” interior redband rainbow trout (USFS 2000e). Spring chinook spawn in the Methow River above and below the confluence with Goat Creek and probably rear in the mouth of Goat Creek.

<u>Access to Spawning and Rearing Habitat</u>

From the Goat Creek Road Bridge to the mouth, lower Goat Creek typically experiences low flows or dewatering during August and September (USFS 1995a; K. Terrell, USFWS, pers. comm., 2000). This condition in complex and not fully understood.

There is a water diversion on the right bank of Goad Creek at RM 1.2 that diverts about 1.8cfs (USFS 2000e). The fish screen, installed in 1995, is functioning properly, but for lack of proper maintenance and operation, salmonid juveniles are entering the ditch. The screen, designed for 4.3 cfs and operation during spring, summer and fall flows, can be overtopped during spring runoff if not properly maintained, carrying juvenile salmonids into the ditch (J. Easterbrooks, WDFW, pers. comm., 2000).

At RM 12.0 there is a natural falls that is a barrier to upstream fish passage.

The USFS Rd. 52 crossing over Whiteface Creek (RM 0.25) is a barrier to fish at certain flows due to the steep gradient, high water velocity, and lack of a jump pool at the outlet of the culvert crossing.

Floodplains

The lower 1½ miles of Goat Creek was channelized in the late 1970's. A channel meander reconstruction project has been funded for this reach. The project will be implemented in the summer/fall of 2000 pending compliance with Section 7 of the Endangered Species Act (ESA).

Riparian

The Goat Creek drainage has been intensely managed for timber harvests in the past, including in the riparian areas of Goat Creek up to about RM 10. Much of the sediment from roads and slope failures is being transported through the Goat Creek system into chinook salmon spawning areas in the Methow River (USFS 2000e).

Large road networks are found in heavily harvested areas in the west part of the drainage, in the Whiteface Creek, Roundup Creek, Long Creek and Short Creek subdrainages. Many of these roads are impacting riparian areas in these subdrainages (USFS 2000e).

Many skid roads crossed, paralleled or trailed directly up some tributaries to Goat Creek. Today, these skid roads are used by livestock thereby suppressing natural vegetation regeneration (USFS 1995e). Cattle grazing is damaging riparian vegetation in some of the tributary drainages to Goat Creek as well (USFS 2000e).

Large Woody Debris

Amounts of large wood in the channel are considerably higher in the upper part of the drainage. Amounts of large wood are low in the lower 9 miles, probably due to the effects of riparian harvests in the lower and middle segments of the stream, as well as the high gradient channel. The upper segment of Goat Creek (above Cougar Creek at RM 9.7) is densely forested, providing good recruitment of wood to the stream. Log jams are abundant in upper Goat Creek. Recruitment potential of large wood is lower below the confluence with Cougar Creek due to past harvests in the riparian area(USFS 2000e).

Channel Conditions and Streambed Sediment

Pool habitat is lacking in the lower 6 surveyed stream miles of stream (the stream survey began at the USFS boundary). The last mile of Goat Creek, where the gradient flattens out, is on private land and was not included in the survey. There were fewer than 15 pools per mile found in this stream survey segment (USFS 2000e). Pool habitat was higher and of better quality above RM 6, with greater than 22 pools per mile in the upper half of the surveyed stream segment (USFS 2000e).

The high gradient channel and larger substrate in Goat Creek flush sediment through the system, depositing it into the Methow River, evidenced by the amount of turbidity during spring run-off (USFS 2000e). Sediment sources include roads built on steep banks in the drainage (including a road across the stream to access a the Crown Point Mine), cattle trampling in meadows along the banks in the headwaters, and high road densities and timber harvests in subdrainages lower in the basin.

The Goat Creek drainage has over 150 miles of roads, greater than 4 miles of road per square mile (USFS 2000e). Federal standards and guidelines describe >2.4 miles of road per square mile, with many valley roads as functioning at an unacceptable level (USFWS 1998). Nearly all the roads are found in the lower half of the drainage, below Vanderpool Crossing (RM 6.5; USFS 2000e). Road 400 and several spur roads are found above the left bank above Vanderpool Crossing. The road crosses several small tributaries to Goat Creek. Large road networks are found in heavily harvested areas in the west part of the drainage, in the Whiteface Creek, Roundup Creek, Long Creek and Short Creek subdrainages (USFS 2000e).

The Crown Point Mine Road built across the stream to access the site in the 1930s, noticeably changed the Goat Creek stream course (1956 aerial photo interpretation), depositing large amounts of sediment and widening the downstream channel (USFS 2000e). As recently as 1992, aerial photos of the site show some recovery but still show some unstable banks and bank failures in the area that could become active during a high flow event (USFS 1995a; USFS 2000e).

Whiteface Creek and the mainstem Goat Creek show evidence of higher bed load movement, increased width/depth ratios, shallower flows and less canopy coverage. These symptoms are consistent with riparian harvests, LWD removal associated with past logging practices, and reduced LWD recruitment (USFS 1995a).

Water Quantity and Water Quality

From the Goat Creek Road Bridge to the mouth, lower Goat Creek typically experiences low flows or dewatering during August and September (USFS 1995a; K. Terrell, USFWS, pers. comm., 2000). This condition in complex and not fully understood. The extent to which the hydrology of Goat Creek has been altered from its natural potential is unknown. The Goat Creek Watershed Analysis (USFS 1995a) stated that any activities that increase bedload deposition on the Goat Creek alluvial fan may increase the duration of time that the lower reach dries up, blocking fish passage and isolating fish populations. Kate Terrell, biologist for the USFWS, has stated that lower Goat Creek dewaters primarily as a result of the channel course being altered by dredging during the late 1970’s. In the 1930’s the Crown Point Mine Road crossing of Goat Creek was constructed altering the downstream channel. This also disrupted the bed load equilibrium of segments of Goat Creek, possibly aggravating the tendency of Goat Creek to dry up by increasing outwash onto the fans. Past logging impacts in the riparian zone and grazing of the riparian areas has suppressed riparian vegetation recovery.

There is one known water diversion in lower Goat Creek at RM 1.2 (Foster diversion) that diverts approximately 1.8 cfs (USFS 2000e).

Water temperatures > 59° F (15°C) based on a 7-day average are considered to be functioning at an unacceptable level for rearing and migration (USFWS 1998). Water temperatures in the lower and middle Goat Creek exceeded 60^{o}F on 15 days during the summer of 1997, reaching a high temperature of 64^{o}F (RM 1.3). The highest water temperature recorded by surveyors in 1992 was 65^{o}F on August 13 (RM 4.0). High water temperatures in lower and middle Goat Creek could be attributed to the aspect of the drainage (south facing), the lack of seeps and springs in the confined channel, and the removal of vegetative cover in Goat Creek and in its lower tributaries (USFS 2000e). Low flows can also contribute to higher instream temperatures. Stream temperatures in upper Goat Creek (RM 9.0) were very cold, reaching a high temperature of 54^{o}F in 1997. Upper Goat Creek is unharvested and well-shaded, with numerous seeps and springs. Populations of bull trout are found only in upper Goat Creek where stream temperatures remain cooler (USFS 2000e).

Biological Processes

In 1969 stream surveys reported eleven old areas of beaver use in lower Goat Creek from Montana Creek to Vanderpool crossing . In 1992 no recent beaver activity was noted.

Data Gaps

- Bedload/sediment budget analysis
- An analysis of ground water and surface water interactions in the alluvial fan. This should include an evaluation of human-induced changes in the subwatershed on water storage and water runoff (ie. timber harvest, roading, grazing, beaver removal, and water diversions.
- There is a need for thermographs to be placed throughout Goat Creek.
- USFS Road 52 barrier culvert (RM 9.0) was replaced in 1996. The site needs to be monitored to determined if bull trout access has been improved.

Recommendations

- Stream restoration is needed in some areas of the channel from just below Vanderpool Crossing (RM 6.5) upstream to about RM 9.5. The total length of channel needing restoration is about 1 to 1.5 miles.

- Fish are being entrained in the Foster ditch during high spring flows. There may also be problems with entrainment during the winter. Alternatives to address this problem should be investigated.

- Restore fish passage at the USFS Rd. 52 crossing on Whiteface Creek.

- Restore channel function within the floodplain in the lower 1.5 mile channelized section of Goat Creek.

- Roads above Vanderpool Crossing should be obliterated and replanted, as identified in watershed analysis (USFS 2000e).

Wolf Creek (48.1300).

The Wolf Creek drainage runs east to west, encompasses about 25,800 acres, and ranges in elevation from 8,897 feet (Gardner Mountain is the highest point in Okanogan County) in its headwaters to near 2,000 feet at its mouth. It drains into the Methow River from the south at RM 52.8, about 3 miles upstream of the Town of Winthrop (RM 50.0). Wolf Creek is 14 miles in length. Its named tributaries are Little Wolf Creek, North Fork Wolf Creek, South Fork Wolf Creek, and Hubbard Creek. The upper portion of the drainage is confined in a steep valley until it opens up onto an alluvial fan 1.5 miles upstream from the confluence with the Methow river. The portion of Wolf Creek that runs through the alluvial fan has been channelized and confined into a narrow channel.

Eighty percent of the drainage is managed as wilderness and in excellent condition from the wilderness boundary to the headwaters. The remainder of the portion of the drainage under Forest Service management is managed for multiple uses. The lower 1 – 1 ½ mile of Wolf Creek is under private ownership. Impacts from roading and timber harvest are isolated mainly to the Little Wolf Creek drainage. Little Wolf Creek is diverted by the Wolf Creek Reclamation District (WCRD) on a year round basis and no longer flows into Wolf Creek. There are four water diversions on Wolf Creek and one on Little Wolf Creek, all originating on private land with the exception of the Wolf Creek Reclamation District diversions. Wolf Creek is an adjudicated drainage.

Wolf Creek is a spawning and rearing stream for fluvial bull trout, summer steelhead, and spring chinook. Spring chinook rearing is limited to the lower 3.0 miles of Wolf Creek (USFS 1998a) with spring chinook spawning documented to occur upstream of RM 1.3, but below the WCRD diversion at RM 4.0 (J. Easterbrooks, pers. comm., 2000). Spring chinook salmon have also been observed holding in lower Wolf Creek (an adult chinook salmon was observed at about RM 1.0 during snorkeling surveys conducted by the USFS in September, 1999). Spawning use in Wolf Creek was documented in late August/early September of 1993 by Bob Steele and John Easterbrooks, both of WDFW, who found two spawned-out spring chinook carcasses (one male with a 39" fork length and one female) which had floated down from an unlocated spawning bed upstream. The female was floating in front of the fish screen for the water diversion at RM 1.3. The male was in Wolf Creek just downstream of the diversion point. (The diversion at RM 1.3 was the second diversion built by landowner Al Perrow on Wolf Creek. It was transferred to the Wolf Creek Property Owner's Association when Mr. Perrow later sold his property. This diversion is still called the "Perrow" diversion in the WDFW Screen Shop fish screen database but should not be confused with the old "Perrow diversion" at RM 0.5 which was sold to Bill Biddle.). Wolf Creek is also an important resident bull trout stream.

Access to Spawning and Rearing Habitat

Low stream flows from the mouth to about RM 1.5 present a barrier during the dry times of the year (USFS 1998a). On multiple occasions the section below the Perrow diversion at RM 0.5, has gone dry. These conditions potentially prohibit the upstream migration of bull trout and spring chinook salmon affecting access to rearing and spawning habitat.

A large log jam at RM 4.5 is a temporary barrier to some fish at low flows (some bull trout made it past this barrier in 1999).

A 12 foot high waterfall at RM 10.6 is a barrier to upstream movement of salmonids.

Floodplains

There is a dike constructed within the upper 1000 feet of the alluvial fan.

Conversion of portions of the alluvial fan to residential development and the placement of the Wolf Creek Road within the alluvial fan constrict the floodplain.

The portion of Wolf Creek that that passes through the alluvial fan is currently in a stable condition, maintained by a low gradient and intact riparian vegetation. Future fan function and processes may be compromised by development in the fan and by the Wolf Creek Road.

Construction of County Road # 1145 which crosses Wolf Creek at the mouth, is contributing to the confinement of the stream channel within its floodplain (USFS 2000k).

Riparian

Most of the drainage is in wilderness (no scheduled timber harvests). The small portion of USFS land below the wilderness boundary is designated as "matrix" under the Northwest Forest Plan. Timber has been harvested mainly in the southern part of the drainage, away from the stream (steep banks have prohibited past timber harvests near the stream). A major scheduled timber harvest in the northern part of the drainage did not occur due to bankruptcy. Past timber harvests on USFS owned land in the drainage have not had a major impact on stream conditions in Wolf Creek (USFS 2000k).

The Methow Conservancy recently paid the permittee of the cattle allotment in Wolf Creek to waive his permit back to the Forest Service. The Forest Service currently has no plans to reissue the grazing permit (USFS 2000k). Cattle had been impacting the stream, especially in the meadows above the banks at the headwaters, and in meadows at the confluence of Wolf Creek and the North Fork of Wolf Creek. A major cattle crossing about 0.2 miles below the irrigation diversion at RM 4.5 had been impacting bull trout habitat (bull trout redds were seen just above and below the crossing in 1999; USFS 2000k).

Below RM 4.6, conversion of land to agriculture and residential use has contributed to a loss of riparian habitat. Channelization of the lower 1.5 miles has further degraded riparian conditions.

Large Woody Debris

Amounts of large woody debris are very low in the lower 1.5 miles of the stream (private land), with only 1 piece per mile with a diameter greater than 12 inches and greater than 35 feet long (federal standards and guidelines identify >20 pieces/mile that are >12 inches in diameter and >35 feet in length as acceptable; USFWS 1998). This is a depositional reach (alluvial fan) where LWD would be expected to accumulate. Future recruitment is poor in this stream segment as a result of the removal of large trees along the banks in the riparian zone. Although amounts of woody debris were much higher in the stream segment between RM 1.5 and 4.5, this reach was still well below Plan standards and guidelines for amounts of large wood (about 25 pieces per mile were counted in 1994) due to high gradient and flushing flows. Amounts of large wood in the channel were high in the upper 7.5 surveyed miles, especially in the area of the Hubbard Burn. Future recruitment potential for large wood is excellent above RM 1.5, due to the heavily forested riparian area and lack of large-scale timber harvesting.

Channel Conditions and Streambed Sediment

The Wolf Creek irrigation ditch is a source of sediment input into Wolf Creek. Several large bank failures are found below the ditch. The potential for bank failure has been reduced by enclosing ‘at risk’ portions of the ditch in pipe. There is still active gully erosion occurring just upstream of the ditch flume. The gully is delivering to Little Wolf Creek, which then contributes to Wolf Creek, and is passed down to the Methow River.

Pool habitat is low in the lower 1.5 miles of Wolf Creek (USFS 1997). Pool habitat is also below expected levels up to RM 4.5 (USFS 2000k). In these low gradient reaches, this is probably an affect of low LWD and channelization of lower Wolf Creek (USFS 1997).

Water Quantity and Water Quality

Wolf Creek is listed on the State of Washington 303(d) list (DOE 1998) for low instream flows.

The lower 0.5 mile of Wolf Creek (below Perrow diversion, RM 0.5) goes dry from about late July to October (USFS 1998a). There are three identified diversion points on Wolf

Creek from RM 4.0 to the mouth. They are identified by the USFS (1998a) as follows: Haub Brothers Enterprises Trust (HBET) and Bud Hover, both at RM 0.25 – 0.5; the Perrow Ditch (RM 0.5); and the WCRD (RM 4.0). The U.S. Government and a couple of other landowners (not identified in the literature) also have water rights (<1.0cfs) allowing for the diversion of water for the purpose of watering wildlife and stock (locations of diversions are not identified in the literature). Water is also diverted from Little Wolf Creek (the location is not identified in the literature) by the WCRD. Low flows and dewatering create a barrier to spring chinook and fluvial bull trout that migrate to Wolf Creek to spawn (USFS 1998a). The dewatering also reduces available habitat and causes stranding of bull trout, juvenile spring chinook, and rainbow/steelhead trout (USFS 1998a).

Although stream temperatures in excess of 60°F were recorded at the mouth of Wolf Creek during the summer of 1999 (unpublished data, H. Bartlett, WDFW), high water temperatures are not believed to be the factor limiting salmonid production in Wolf Creek (TAG). During the period of record, on all occasions when water temperatures were recorded in excess of 60°F at the mouth of Wolf Creek, during the evening and early morning hours water temperatures dropped back below the 60°F threshold. It is the TAG's professional opinion that 7-day average water temperatures provides a more revealing indication of water temperature relative to its potential to affect salmonid behavior and health. In the case of the stream reach at the mouth of Wolf Creek, because the riparian canopy is intact at this location and the Wolf Creek Reclamation District ditch ran only for about 3 weeks in August 1999 at reduced withdrawal rates of about 4 – 6 cfs, the TAG believes water temperature exceedences at the mouth during August of 1999 were a function of natural fluctuations given the existing natural environmental conditions.

Biological Processes

Although brook trout have been stocked in Patterson Lake and in beaver ponds above the lake, they have not been found in Wolf Creek.

There is evidence of past beaver activity in the Wolf Creek drainage and there is an active beaver pond on Virginia Ridge which drains into Wolf Creek. Damage to this pond by livestock has been documented in the past. Current beaver use of the drainage is low.

Data Gaps

- Water temperature and stream flow data on Wolf Creek

Recommendations

- Address the impacts of channelization on the lower 1.5 miles of Wolf Creek, restoring natural functions to the extent practical and rehabilitating habitat where restoration is not practical.

- Eliminate unstable bank sections along the Wolf Creek irrigation ditch which contribute sediment to Wolf Creek.

- Improve stream channel conditions and investigate water savings options to address low stream flows downstream of RM 4.6 and dewatering downstream of RM 0.5.

- Provide signage and control recreational use of the riparian buffer at the North Fork confluence where bull trout spawning and rearing occur.

- Develop a channel condition assessment and restoration needs assessment for Little Wolf Creek. The assessment should evaluate the current channel condition and its effects on Wolf Creek.

Other Drainages in the Upper Methow River Subwatershed: Hancock Creek (48.1355); Little Boulder Creek (48.1400); Fawn Creek (48.1358); Gate Creek (48.1577); Robinson Creek (48.1794); Rattlesnake Creek (48.1842); Trout Creek (48.1872).

Access to Spawning and Rearing Habitat

Little Boulder Creek. There is a fish-blocking culvert at RM 0.1 on Hwy 20 at MP 181 as identified in the WDOT fish barrier inventory database. The culvert, located in a stream reach susceptible to channel migration patterns, constricts Little Boulder Creek. At this location, it appears the Methow River has migrated away from its confluence as well, contributing to the deposition of large amounts of gravel bedload in the channel of Little Boulder Creek just downstream of the culvert outlet. Flows passing through the culvert have scoured a deep drop at the outlet perching the culvert above the channel bed. After passing through the culvert, flows are now dispersed in a wide, shallow manner across the gravel bar until reaching the Methow River. This creates a passage barrier to juvenile salmonid rearing habitat in Little Boulder Creek.

Little Boulder Creek. The lower section typically experiences low flows or dewatering during periods of low water availability thereby restricting fish passage and stranding juveniles (Mullan et al 1992).

Hancock Creek. The Wolf Creek County Road culvert is acting as a barrier at high flows. This culvert does not appear in the Fish Passage Barriers map for the Methow watershed (Map Appendix C, Map C-1) due to an error at the time of final printing for this report. In 1999 a project was proposed to replace the culvert with a bottomless arch culvert to allow year round passage. The culvert replacement project is on hold pending approval from DOE for a request for a change of a point-of-diversion upstream of the culvert (D. Beich, Okanogan County Water Resources Department, pers. comm., July 2000). Efforts to develop a Comprehensive Resource Management Plan (CRMP) encompassing the entire stream length (0.75 miles) were initiated in 1999 and the Plan is currently underway as of July 2000. The drainage is used by spring chinook and steelhead. When full fish passage is restored, Hancock Creek will offer excellent salmonid rearing habitat year-round (K. Terrell, USFWS, pers. comm., 2000).

Robinson Creek (48.1794). Upstream anadromous fish passage is blocked by an impassable natural falls at RM 0.6.

Rattlesnake Creek (48.1842). Upstream anadromous fish passage is blocked by an impassable natural falls at RM 0.7.

Trout Creek (48.1872). Upstream anadromous fish passage is blocked by an impassable natural falls at RM 0.5.

Floodplains

No additional information available.

Riparian

Hancock Creek. There is no riparian cover in the upper reach above the culvert at the Wolf Creek County Road crossing (K. Terrell, USFWS, pers. comm., 2000), a result of livestock grazing (C. Fisher, CCT, pers. comm., 2000). A CRMP is currently underway in the Hancock Creek drainage which is addressing grazing management needs.

Large Woody Debris

Fawn Creek. Large woody debris is scarce in most reaches of Fawn Creek as a result of past timber harvests (USFS 1998d). The scarcity of LWD in the channel limits the sediment storage capacity of Fawn Creek, resulting in faster sediment delivery to the Methow River from this high gradient stream. The reach of the Methow River that Fawn Creek flows into is a major spawning and rearing area for spring chinook (USFS 1997).

Channel Conditions and Streambed Sediment Conditions.

Gate Creek. Sediment levels in upper Gate Creek are elevated as a result of road building and other human activities.

Hancock Creek. The substrate is highly embedded, a result of cattle grazing in the stream, and there is a low pool/riffle ratio (K. Terrell, USFWS, pers. comm., 2000).

Water Quantity and Water Quality

Hancock Creek. There is a water diversion above the Wolf Creek county road culvert on Hancock Creek. The lessee has applied for a change of point-of-diversion and is presently awaiting approval from DOE (D. Beich, Okanogan County Water Resources Department, pers. comm., July 2000).

Fawn Creek. Fawn Creek, which is not known to support salmonids, has an irrigation withdrawal at the mouth of the Creek for group domestic use in the Edelwiess subdivision. Fawn Creek flows into the reach of the Methow River, where periodic dewatering occurs (USFS 1997).

Biological Processes

Brook trout have been observed in Little Boulder Creek, Spring Creek, and Hancock Creek (TAG 2000).

Recommendations.

- Replace the fish blocking culvert on Hwy. 20 at Little Boulder Creek with a bridge or bottomless arch.
- Address low flow concerns in lower Little Boulder Creek to improve fish passage.
- Improve grazing management on Hancock Creek.
- Replace the fish blocking culvert on Hancock Creek at Wolf Creek Road with a bridge or bottomless arch.
- Reduce sediment delivery to Gate Creek from roads by reducing road densities.
- Restore riparian buffers in Fawn Creek. Improve LWD levels in Fawn Creek to appropriate levels.

Lost River Subwatershed

The Lost River subwatershed runs north to south and encompasses about 107,400 acres, of which approximately 95% (102,100 acres) are within the Pasayten Wilderness. The land at the confluence of the Lost River and the Methow River is privately owned. Elevation ranges from around 6,900 feet in its headwaters to about 2,600 feet at its mouth (USFS 1999c). It drains into the Methow River from the north at RM 73.0, about six miles upstream from the Early Winters Creek confluence. Lost River is 22.5 miles in length. Its tributaries include Eureka Creek, Monument Creek and Drake Creek. Habitat conditions in the Lost River subwatershed have remained virtually unchanged since the arrival of the Euroamerican influence, with the exception of fire suppression activities, isolated livestock use, recreational riparian use in the headwaters of the Lost River, and development and diking in the Lost River alluvial plain (from the mouth to RM 0.9).

The subwatershed ranges from moderately steep to steep mountainous terrain that has a moderately to highly dissected landscape. Landslide activity, mainly occurring as debris flows or debris avalanches, are a normal component of the ecosystem. Upper subwatershed stream channels may be slightly entrenched over bedrock or moderately entrenched in glacial till and debris. Stream reaches in the lower elevations are slightly entrenched in deep glacial-fluvial outwash. Bars composed of boulders, cobbles, gravel, sand and large woody material are common throughout these reaches. Within portions of the lower stream reaches, surface water flow goes subsurface during the driest and hottest times of the year.

Spring chinook salmon spawn in Lost River to the confluence with Eureka Creek, at RM 4.0. Summer steelhead spawn and rear in Lost River. Bull trout spawn and rear in Lost River, and in several tributaries to Lost River (Monument Creek in lower Lost River, Ptarmigan Creek in upper Lost River).

Access to Spawning and Rearing Habitat

For a distance of about 4 to 5 miles, Lost River flows subsurface between Drake Creek (RM 11.7) and Monument Creek (RM 7.1). Subsurface flow is also found for about half a mile below Cougar Lake (at RM 20.3) near the headwaters of Lost River, limiting the range of adfluvial bull trout spawning in upper Lost River from Cougar Lake (USFS 2000h). Intermittent flows are a natural condition in a subwatershed that lies almost entirely within the Pasayten Wilderness where roads are restricted to the lower few miles of the creek.

There are no man made fish passage barriers in this subwatershed.

Diking and road construction in the alluvial fan restrict access to spawning and rearing habitat.

Floodplains

Lost River Dike (SW ¼ Section 05, T37N R19E). Built without permits partially on private land and partially on USFS land at the confluence of the Lost and the Methow Rivers, the Lost River Dike constrains the floodplain in this reach of the Methow valley.

The lower 0.6 miles of the alluvial fan have been channelized confining the river.

Riparian

From RM 1.0 to the headwaters, riparian conditions are in near pristine condition. Timber has been harvested in the riparian area on private land near the mouth for home site development and to create land for pastures (USFS 2000h).

Large Woody Debris

Large woody debris levels in the lower one mile of the river were low as a result of the removal of large wood for flood control and firewood gathering (USFS 2000h). Wood recruitment potential is good from the upper reaches of the subwatershed, the majority of which is in Wilderness.

Channel Conditions and Streambed Sediment

Pool habitat was of poor quality and quantity in the lower mile above the mouth, due mainly to the removal of large wood from the channel (USFS 2000h).

Off-channel habitat was minimal in the lower mile of the stream due to channelization and diking (USFS 2000h).

Water Quantity and Water Quality

Low flows/subsurface flows are a natural condition throughout the Lost River subwatershed. The 1987 Yakama Nation (Kohn 1987) spawning ground survey report documented dewatering from RM 7.7 to 11.7 (Monument Creek to Drake Creek). Lost River was also reported to go subsurface for about ½ mile just below Cougar Lake (RM 20.3; USFS 2000h). Intermittent flows were also reported as occurring, although rarely, downstream of Monument Creek (RM 7.7) and extending as far downstream as Eureka Creek (RM 4.0; WDFW et al.1990).

Water temperatures in Lost River are very cold for a stream its size and elevation, due partly to 5 miles of subsurface flow in the summer time. The highest water temperature recorded in Lost River during the summer of 1994 was 54^{o}F, on August 26 (USFS 2000h).

Biological Processes.

There are no issues or concerns identified within this category.

Recommendations.

- Habitat projects that propose alternatives to the maintaining the dike on Lost River built on National Forest land should be considered. The primary focus should be reestablishing the habitat forming processes themselves. Structural components of such a project should complement the restoration of the watercourse's access to the stream meander zone and riparian growth and instream woody debris maintenance.

- There should be no further development on the alluvial fan and immediately upstream to the bridge, that will constrict or constrain the channel, degrade riparian areas, negatively impact ground water and surface water interactions, or in any other way degrade stream channel functions.

- Develop an MOU with agencies and private citizens to manage LWD being transported into the alluvial fan so that both biological/hydrological function and property/safety concerns are balanced.

Early Winters Creek Subwatershed

The Early Winters Creek subwatershed runs north to south and is about 51,925 acres in size. Approximately 99% (51,548 acres) is under USFS ownership, while the remaining 1% (447 acres), near the confluence, is privately owned (USFS 1996a). Land under USFS ownership is designated as a Scenic Highway Corridor along State Route Highway 20 and the remainder is designated as a Late Successional Reserve where management will favor old growth and those species dependent on late successional forest. Elevation ranges from 8,440 feet (Tower Mountain) to 2,140 feet at the mouth (USFS 1996a). The mainstem sources near Liberty Bell Peak at 6,500 feet and flows about 15.7 miles, entering the Methow River at RM 67.3, about 3.5 miles upstream from the town of Mazama. Major tributaries are Cedar and Varden Creeks. The maximum average annual precipitation near the mouth of Early Winters Creek at Mazama, is 20 inches. Maximum annual precipitation in the subwatershed is 80 inches at the Cascade Crest (USFS 1996a).

Land forms at the head of Early Winter Creek include cirques and glaciated head walls. Downstream features include U-shaped glacial troughs and valley bottoms full of glacial till. Debris avalanches are fairly common. Habitat conditions in the subwatershed have remained virtually unchanged since the arrival of the Euro-American influence with the exception of fire suppression and development in the lower 1.5 miles. The construction of State Highway 20, recreational use, irrigation withdrawal, diking, and residential development have had significant impacts in the lower 1.5 miles. Approximately 15 miles of the North Cascades National Scenic Highway (State Route Highway 20) follows Early Winters Creek, crossing it three times, until it crosses the Cascade divide at Washington Pass. Two designated USFS campgrounds are located in the riparian area along Early Winters Creek – Early Winters Creek (RM 0.3 – 0.7), and Lone Fir (RM 9.5). In the alluvial fan, the highway crossing and Early Winters campground facilities are confining the stream contributing to channel downcutting. Downstream from the highway crossing a dike blocks off two high flow channels. There are two water diversions within the first rivermile - Early Winters ditch (RM 0.6) and Willis ditch (RM 1.4). Early Winters Creek is a major tributary of the Methow River, and generally has flow when the Methow River runs dry.

Spring chinook salmon spawning and year-round rearing occur in the lower 4 miles of Early Winters Creek (up to about Klipchuck campground; Kohn 1987; USFS 2000d). Spawning habitat is available for summer steelhead and fluvial bull trout in the lower 8 miles of the stream (fluvial bull trout have been seen by surveyors in the lower 8 miles of Early Winters Creek, but spawning areas are unknown). Spring Chinook salmon also spawn in the Methow River above and below the confluence with Early Winters Creek. Bull trout are found in Cedar Creek (up to RM 2.0), a major tributary to Early Winters Creek, and in the first 0.5 miles of Huckleberry Creek, a tributary to Cedar Creek. Resident bull trout and cutthroat trout are the only fish species found above the waterfall barrier at RM 8.0.

Access to Spawning and Rearing Habitat

A 25 foot waterfall at RM 8.0 is a barrier to upstream fish migration (USFS 2000d).

In some years during late summer and early fall, low flow conditions persist from the Willis ditch to the mouth (J. Hubble, YN, pers. comm., 2000). This would most likely occur in July, August and September, impeding or preventing the upstream and downstream movement of juvenile salmon, steelhead and bull trout into upper Early Winters Creek (J. Hubble, YN, pers. comm., 2000) and the passage of bull trout, migrating to spawning habitat upstream (USFS 1998c).

Floodplains

Highway 20 precludes natural flood plain function and has resulted in the loss of side channels and floodplain capacity. The lower 0.5 mile of Early Winters Creek has been rip-rapped and diked to keep the channel in a stable location to accommodate Highway 20, the Early Winters Campground development, and to protect private property. There is a proposal to improve mainstem complexity through the placement of LWD in the lower mainstem channel. Confinement of the floodplain in this reach concentrates high flows into a single channel resulting in channel incision and entrenchment. High water velocities then scour the channel, destabilizing banks and flushing out spawning gravels (USFS 1998c).

Riparian

Early Winters Creek campground (RM 0.25) is located within the flood prone area of Early Winters Creek and is experiencing active erosion along the north side of the campground for about 300 – 400 lineal feet. This area, located on the outside of a meander bed made of loose alluvium, is naturally unstable. The channel above this point has been channelized and rip-rapped to accommodate the Highway 20 bridge (USFS 1998c). These actions have increased velocities and shear stress on the bank, further accelerating bank erosion. Additionally, the riparian vegetation along this bank has been degraded as a result of campground use. The Early Winters campground and the Willis and Early Winters ditch headgates are located within the riparian reserve along a portion of this lower reach (USFS 1998c).

Large Woody Debris

The levels of LWD from the confluence up to RM 2.0 are considered low for several reasons, 1) channel condition in the lowermost 0.5 RM prevent the accumulation of LWD, 2) LWD has been removed in the vicinity of Early Winters Creek campground for various flood control measures, and 3) removal of hazard trees along the riparian zone at the Early Winters campground. Upstream of RM 2.0 to the waterfalls (RM 8.0) LWD levels are considered good with the exception of areas in association with the Klipchuck (RM 4.0) and Lone Fir (RM 9.5) campgrounds where hazard tree were removed (USFS 2000d).

Channel Conditions and Stream Sediment

From RM 0.0 – 1.9 the channel is incising as a result of riprapping and diking in the lower reach, leading to an increased stream gradient, the loss of pool habitat, increased stream velocities in riffle-run habitat, and the loss of spawning gravels (USFS 1998c). Upstream of RM1.9 the stream channel has only minor disturbances associated with campgrounds and the paved trail above Lone Fir Campground (RM 9.5) which crosses Early Winters Creek (USFS 1998c).

Fine sediments levels in the lower 8.0 RM's (to the falls) are considered low (USFS 2000d), although there are eroding banks in the lower 1.5 miles associated with Early Winters Creek campground, the Highway 20 road crossing and the Early Winters ditch headgate. The immediate 2.7 RM reach upstream to the falls has a low gradient (1.3%) with good LWD levels, and stores much of the upper basin fine sediments (USFS 1998c). Most sediment sources in the subwatershed are of natural causes (USFS 2000d).

There is a potential for increased sediment delivery from Highway 20, if sanded year-round.

Pool habitat is fair in the first 0.3 miles of the stream (from the mouth to the Early Winters irrigation diversion), due to the high velocities created by channel confinement and low LWD levels (USFS 2000d). Fair pool habitat quality and quantity may also be a reflection of the natural channel forming conditions within the alluvial fan (J. Smith, PWI, pers. comm., 2000).

About one mile up the abandoned Crater Creek road, there is a culvert crossing of Crater Creek . There is a potential for failure of this culvert that will deliver a significant amount of sediment to Crater Creek and ultimately to Early Winters Creek (TAG 2000).

Water Quantity and Water Quality

During July, August and September of 1989, water temperatures were collected in Early Winters Creek by WDFW (Mullan et al. 1992). In the lower 1.5 mile reach, the peak weekly mean water temperatures from RM 0.0 – 1.5 was recorded at 56.4° F. Federal standards and guidelines identify temperatures exceeding 59°F (>15° C) as presenting potential thermal barriers to migrating salmonids and negatively impacting rearing salmonids (USFWS 1998). Water temperatures in excess of 59° F at the mouth could impede bull trout migrating and spawning and salmon and steelhead rearing (USFS 1998c). At the time of the development of this report, water temperature monitoring was being conducted in the lower 1.5 miles of Early Winters Creek to more thoroughly investigate whether high water temperatures are occurring, but were not captured during the short monitoring window in 1989.

In some years during late summer and early fall and extending into the winter until spring runoff, low flow conditions persist in the lower 1.4 miles of Early Winters Creek (from the Willis ditch to the mouth; J. Hubble, YN, pers. comm., 2000). It is unknown the extent, if at all, to which human-induced channel alterations and irrigation diversions in the lowermost 1.4 rivermiles may contribute to lower base flows. There is a connection between runoff from the Early Winters Creek subwatershed and base flow conditions in the mainstem Methow River from its confluence with Early Winters downstream. Early Winters Creek is important to sustaining whatever levels of flow do occur in this stretch of the Methow River and downstream to the Weeman Bridge (USFS 1998d).

There are two irrigation diversions on Early Winters Creek - Early Winters irrigation ditch at RM 0.6 on the right bank and the Willis ditch at RM 1.4 on the left bank. Low flows during late summer and early fall in part are a result of water withdrawal by these two ditches (USFS 1998c; J. Hubble, YN, pers. comm., 2000). Low base flows naturally occur during the winter months. Low flows impede or prevent the upsteam and downstream movement of juvenile salmon, steelhead and bull trout into upper Early Winters Creek (J. Hubble, YN, pers. comm., 2000) and the migration and spawning of bull trout (USFS 1998c). Early Winters Creek provides some surface flows into the dewatering (loosing) reach of the Methow River below its confluence with Early Winters Creek at RM 67.3 (Scribner et al. 1993; TAG 2000). A total of five flow measurements were taken in each ditch below the fish screens by DOE between mid-May and October 23, 1991 (Caldwell and Catterson, Appendix K4, 1992). Of the five measurements taken at Early Winters ditch, the maximum diversion recorded was 15 cfs on July 18, 1991. Of the five measurements taken at the Willis ditch, the maximum diversion recorded was 2.4 cfs measured on the same date. Water diversions measured by DOE on September 27, 1991 for the Early Winters ditch and the Willis ditch were 13 cfs and 0.2 cfs, respectively. Stream flows were measured by Hosey and Associates in 1990 (Caldwell and Catterson, Appendix K1, 1992). On September 27, 1990 stream flows at RM 1.2 on Early Winters Creek were 24 cfs and on the same date, 24 cfs also at RM 66.8 on the Methow River just below the Early Winters Creek confluence (RM 67.3). Above the confluence of Early Winters Creek, stream flow measurements taken on September 27, 1990 were 0.0 cfs at RM 69.3. The data provided in Caldwell and Catterson (1992) offers some measured values for comparison and discussion of the affect of Early Winters Creek stream flows to the mainstem Methow River below its confluence. Based on a diversion estimate of 15 cfs, the USFS has calculated that the Early Winters ditch diverts about 43% of the 2 year, 7 day average low flow in Early Winters Creek, which most likely occurs in late July, August, and September. Based on a diversion estimate of 1.7 cfs, they calculated that the Willis ditch diverts about 5% of the 2 year, 7 day average low flow in Early Winters Creek (USFS 1998c). The extent to which Early Winters Creek waters the Methow River below its confluence and downstream to the Mazama bridge is variable, complex and not fully understood (TAG 2000).

The lower mile of Early Winters Creek experiences high peak flows during spring runoff. Channel alterations in the lower mile of Early Winters Creek concentrate peak flows during periods of runoff, scouring existing redds and reducing spawning habitat. Refuge from high flows are also reduced by bank hardening and loss of access to low velocity side channels.

There is a potential for spills on Hwy. 20 to be directly delivery to Early Winters negatively impacting water quality (TAG 2000).

Biological Processes

No brook trout were observed in the Early Winters Creek watershed on surveys conducted by the USFS in 1992. In 1999, the Pacific Watershed Institute (PWI) snorkeled below RM 1.5 and observed multiple brook trout in the lower reach.

Data Gaps

- A study of groundwater/surface water interaction analysis is in progress.
- Salmonid use in the Early Winters Creek subwatershed.

Recommendations

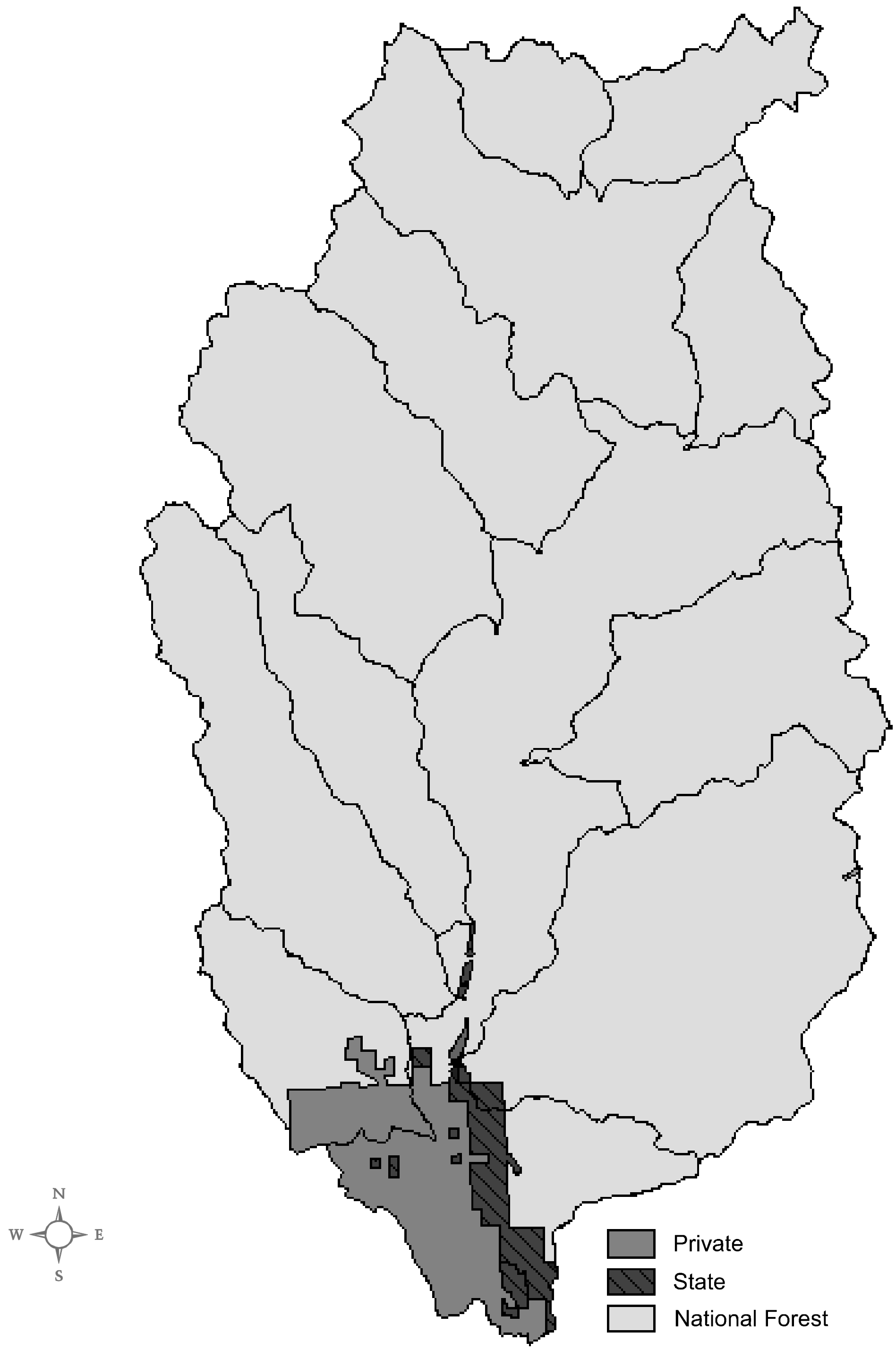
- Restore natural functions within the alluvial fan.
- Improve riparian conditions in the lower reach.
- Address improving low flow conditions in the lower reach and determine biologically based instream flows below the two diversions.
- Evaluate Crater Creek road and the culvert crossing on Crater Creek (mile 1.0) for removal.
- To the extent Early Winters Creek can be rehabilitated to support more beaver, they should be encouraged to repopulate.

Chewuch River Subwatershed

The Chewuch River subwatershed contains approximately 340,000 acres (USFS 2000c), is oriented north-to-south, and drains into the Methow River at the town of Winthrop (RM 50.0). The Chewuch River is 44.8 miles in length from its headwaters to the mouth. Tributaries include Cub Creek, Boulder Creek, Eightmile Creek, Falls Creek, Lake Creek, Andrews Creek, Twentymile Creek, Thirtymile Creek, and Dog Creek. Upper natural falls barriers have been mapped on all these tributaries. All other tributaries to the Chewuch River also have natural upstream migration barriers (either falls or steep gradients) reflecting the geological formation of the mainstem Chewuch valley, a U-shaped trough with side slopes often in excess of 60-70%.

Annual precipitation ranges from approximately 35 inches in the upper reaches of the subwatershed to about 15 inches at the mouth (Richardson 1976); elevation ranges from near 8,700 feet to 1,700 feet at the confluence with the Methow River. Soil types within the Chewuch subwatershed have varied origins and erosion potentials with the Eightmile, Boulder, Lake, and Andrews Creek drainages and the upper Chewuch River from about the Boulder Creek confluence (RM 8.8) upstream, showing some of the highest erosion rate potentials in the subwatershed (USFS 1994). The USFS manages about 95% (320,000 acres) of the drainage, 34% (108,000 acres) of which are in the Paysayten Wilderness bordering Canada. Along the Chewuch River, the USFS boundary begins at RM 7.0 with a mix of private and federal lands along RM 7.0 – 8.0. At RM 30.0 (Thirtymile Creek confluence) the wilderness boundary begin. Other lands within the subwatershed include 5,000 acres (1.5%) managed by WDFW and 15,000 acres (4.4%) private land, all located within the lowest reaches of the watershed. Lands downstream of RM 7.0 along the Chewuch River are all privately owned. (Figure 5).

Figure 5 Chewuch Subwatershed Landownership Map (provided by the USFS, Okanogan National Forest, Methow Valley Ranger District)



It is estimated that approximately 50% of the subwatershed is still in functioning condition (J. Molesworth, USFS, pers. comm., 2000), with most human-related impacts having occurred in the lower half of the subwatershed, outside of the wilderness area and along the mainstem Chewuch River and its tributaries downstream of RM 25.0. Downstream of RM 25.0, human land-use impacts within the tributaries and along the mainstem of the lower 25 miles of the Chewuch River are limiting productivity in the subwatershed (USFS 1994; TAG 2000). There are a 5 ditches diverting water within the subwatershed; three on from the Chewuch River and two from Eightmile Creek. Two main roads parallel the Chewuch River, one above each bank; the road above the west bank extends to about RM 32.0 and the road above the east bank ends at about RM 20.0. Most of the tributaries in the lower two-thirds of the subwatershed have roads paralleling the watercourse. There are an estimated 1000 stream crossings in the Chewuch subwatershed (USFS 1994). Specifically, chronic sediment delivery to streams (correlated to highly erodible soils exacerbated by road densities and road placements) and the reduced levels of LWD in the system (a result of from stream cleanouts and a loss of mature riparian LWD recruitment material) are driving habitat degradation in the lower half of the Chewuch subwatershed (USFS 1994). This condition is compounded by channelization in the alluvial fans at Farewell, Lake Creek, Twentymile, and Boulder Creek, removal of large trees in the riparian zone along the lower 25 miles of the Chewuch river and lower Lake Creek, a decrease in beaver activity over historic times, and low flows in the lower 8 miles of the Chewuch river. Since 1994, on-going restoration efforts have focused on improving in-channel LWD levels and long-term LWD recruitment, restoring riparian vegetation, and reducing the impacts of roads, livestock grazing, and recreation (J. Molesworth, pers. comm., 2000; PWI 1996).

Of the salmonid species this document addresses, the following species occur in the Chewuch River subwatershed; spring chinook, steelhead/rainbow, and bull trout. Table 5 describes species use for the listed drainages within the subwatershed. Spring chinook salmon spawn in the mainstem Chewuch River and steelhead rear in the mainstem and spawn in the tributaries (USFS 2000c). Between the years 1987 – 1999, 25.6 % of spring chinook spawning in the Methow watershed occurred in the Chewuch River (Appendix B). This compares with 40 % in the upper Methow River (Lost River to Winthrop) and 25.4 % in the Chewuch River for that same period. Bull trout spawn in the Lake Creek drainage and have been observed in the Chewuch River and in the lower reaches of Boulder Creek, Twentymile Creek, and Andrews Creek (below natural fish barriers; USFS 2000aa). Bull trout historically occurred in Eightmile Creek before being extirpated by brook trout competition (WDFW 1998a). Brook trout are found in the Chewuch River and in all of the fish-bearing tributaries below Twentymile Creek (USFS 2000c).

Table 5 Known salmonid species use in the Chewuch River Subwatershed

Chewuch River Subwatershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Bull Trout		
	Spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration
Chewuch River	X	X	X				X	X	X		X	X
Pearrygin Creek		X										
Pete Creek		X										
Cub Creek		X					X	X	X			
Boulder Creek		X					X	X		X	X	
Eightmile Creek		X					X	X	X			
Falls Creek		X					X	X				
Twentymile Creek		X					X	X		X	X	
Lake Creek	X	X	X				X	X	X	X	X	X
Andrews Creek		X					X	X	X	X	X	
Sheep Creek							X	X				
Thirtymile Creek - (mouth only)		X					X	X				
Dog Creek – (mouth only)		X										

Mainstem Chewuch River (48.0728)

Access to Spawning and Rearing Habitat

At approximately RM 34.6 on the Chewuch River there is a natural falls that is a barrier to anadromous fish passage.

Floodplain Conditions

Post-flood channel clearing and debris removal early in the 1960’s and again in 1972, impacted aquatic habitat by eliminating major logjams from the Chewuch River (Figures 6 and 7).

Figure 6 Large woody debris (LWD) removal in the Chewuch River in 1963 (before).

Figure 7 Large woody debris (LWD) removal in the Chewuch River in 1963 (after).

In 1961, the USFS funded the removal of debris and logjams in both the Chewuch River and Boulder Creek. After the 1972 flood, the Army Corps of Engineers and the National Guard assisted with the channel clearing and levy building. Channel clearing, bank hardening, and road placement have isolated sections of the main channel from its floodplain and side-channel habitat.

In general the location of the west and east side Chewuch roads on terraces or along the valley margin does not significantly isolate the river from its floodplain . However, in several locations the presence of the east side road along the Chewuch above Boulder Creek is a chronic source of sediment and permanent loss of riparian vegetation directly adjacent to the river. In addition, maintenance of this road across the alluvial fans at Brevicomis and Twentymile Creeks on to the end of the road has affected flood channel formation, run-off patterns, and sediment transport to the mainstem.

The floodplain of the Chewuch River near the Town of Winthrop is naturally confined in a bedrock canyon. Rip-rap placed along the left bank through the town limits primarily limits the development of riparian vegetation, but does not significantly affect the lateral migration of the river. Above this reach, the floodplain is much broader, allowing some side channel and off-channel habitat development. Small areas of rip-rap have been placed on outer bends below where homes have been built and these may have affected the persistence of some of these off-channel areas. However, rapid deposition of sediment in these areas may be a larger factor in the isolation of these habitats from the active channel. Despite the lack of remaining older riparian forests, the riparian corridor in this reach is in good condition where vegetation has not been removed for housing, recreation and agricultural development.

Starting below Cub Creek and extending up above Boulder Creek there is extensive rip-rap and old dikes placed for flood protection and bridge construction. Side channels that existed below the Cub Creek alluvial fan are no longer connected to the main channel. A meander cut-off on the left bank is no longer connected to the river, but is a permanently wetted pond. Ramsey Creek is confined to a ditch as its alluvial fan has been under cultivation for over 75 years and the entire stream margin along the fan is rip-rapped. Dikes and rip-rap have been placed above and below the bridge below Boulder Creek, preventing overbank flow on the floodplain below the bridge.

There is a 0.25 mile side channel on the right bank just below the headgate for the Skyline ditch. This side channel conveys overflow from the ditch to the river. It generally flows year-round, but has no upstream connection to the Chewuch River.

There are several areas of rip-rap on the left bank near the Chewuch North sub-division, just above Boulder Creek, placed to protect summer homes close to the river bank. Most of the riparian area in the sub-division has been replaced with mowed grass. Bank slumping is occurring more regularly. Several small areas of the floodplain have been filled in the sub-division to create raised pads for homes.

Below the Eightmile bridge, on the left bank, is an area of bank hardening approximately ¼ mile long.

Across from Cub Creek, on the left bank, ¼ mile of bank hardening cuts off approximately ¼ mile of side channel habitat.

Within Sections 23 and 26, T35N R21E, on the right bank, in the vicinity of the Golf Course below Cub Creek, the side channel habitat has been disconnected from the mainstem.

From above Sheep Creek to Thirtymile Creek (RM 27.0 to RM 30.0), F.S.Road 5100 (51250) is within the floodplain. It is generally flooded each year (J. Smith, PWI, pers. comm., 2000).

Riparian

Along the lower 25 miles of the river the mature timber was extensively harvested during the 1950's. In 1973 the USFS began preparing the Chewuch River Salvage Sale, in which 90mbf of mature timber were selectively removed from the Chewuch river corridor. The effects of these harvest practices impact aquatic habitat today, with limited availability of large trees for instream LWD recruitment and numerous skid roads leading to the river.

Skid roads in riparian areas facilitate access and increase impacts to riparian areas by recreationists. Impacts include soil compaction, increased bank erosion, and decreased LWD recruitment. Since 1994 USFS has begun assessing the impacts from recreational horse use and to provide education and fencing (J. Molesworth, USFS, pers. comm., 2000).

Conversion of riparian to residential/commercial use within the Town of Winthrop from RM 0.0 to RM 0.75, allows development of lots and building within 25 feet of the Mean Ordinary High Water Mark.

Large Woody Debris

A survey from RM 8.0 to 20.0 by the USFS (1994) found LWD to be lacking and found no log jams within that reach. Generally, LWD is lacking from the mouth to RM 8.0 as well (TAG 2000). Loss of LWD recruitment is still occurring due to removal of riparian trees in the lower 8 miles. From RM 8.0 upstream, instream LWD is being protected, and LWD recruitment processes are being restored. The number of pieces of LWD is approaching an acceptable number but piece size is reduced due to lack of recruitment of mature wood. Ongoing recovery will be slow, 100 to 200 years (TAG 2000). The presence of roads on both sides contribute to the recruitment problem.

Channel Conditions and Streambed Sediment

The lower 19.5 miles have low LWD levels, a reduced amount of adequate side channel habitat, accelerated bank erosion, and high sediment levels. The limited amounts of LWD and logjams and the effects this has had on channel maintaining processes, riparian areas, side-channel development, sediment storage, nutrient storage, cover, and water storage, are critical habitat problems for fish in the Chewuch drainage (USFS 1994; TAG 2000). Another critical problem is the recruitment of large wood, which can function as key components of log jams.

High levels of bank erosion have been identified from RM 8 to approximately RM 20. This corresponds to the portion of the Chewuch subwatershed with the highest road densities, dispersed recreation use, and past timber harvest. This area corresponds to the portion of the Chewuch with the lowest LWD counts and the highest observed embeddedness and width/depth ratios. This area also represents the portion of the Chewuch subwatershed where the majority of spring chinook spawning redds are found (Appendix B, Table B- 1).

High road densities in tributaries streams (Doe Creek, Boulder Creek, Eightmile Creek, Falls Creek and Cub Creek) have been a chronic source of sediment to the Chewuch. Road densities exceed 3.5 miles/square mile along most of the Chewuch River corridor from RM 0.0 to RM 8.0. The extent to which excess sediment is affecting salmonid productivity is unknown. Analysis of channel changes over time suggests that off-channel areas in the Chewuch River subwatershed may be blocked or filled by sediment deposition fairly quickly (J. Smith, PWI, pers. comm., 2000).

Water Quantity and Water Quality

Temperature data in this reach has not indicated a thermal barrier, but higher temperature may cause migration delays of hours with cooler temperatures recovered during the night. Temperature data was collected by the Pacific Watershed Institute and provided to the USFS for 1996 and 1997 (J. Smith, PWI, pers. comm., 2000). The Chewuch River is listed on the State of Washington 303(d) list for inadequate instream flows (Caldwell and Catterson 1992; WDF 1993).

There are a total of 5 ditches diverting water from the Chewuch subwatershed. Three of these ditches divert water from the Chewuch River: the Fulton Canal (RM 0.9) and the Chewuch Canal (RM 8.1) both with diversions on private land, and the Skyline Ditch (approximately RM 9.0) with a diversion on USFS land. Two of these ditches divert water from Eightmile Creek: the Eightmile Ranch Ditch (approximately RM 0.25) and the Lucille Mason Ditch (located on the opposite bank from the Eightmile Ranch Ditch), both with a diversions on USFS land. Low flows during late summer (August and September) through winter do reduce the availability and quantity of rearing habitat for steelhead/rainbow and spring chinook. However, currently low flows in the Chewuch River do not appear to be a limiting factor to any life stage of salmonids and do not appear to be limiting salmonid production in the Chewuch subwatershed (TAG 2000). In the lower 8 miles of the Chewuch River, water diversions may exacerbate this condition by extending the low flow period into July and further reducing access, but the TAG does not believe this is the single most limiting habitat condition in the Chewuch subwatershed.

Biological Processes.

Historically, more beaver were found than at present in the off-channel areas along the mainstem Chewuch River. The extent to which loss of beaver activity in off-channel areas along the mainstem has affected salmon productivity is unknown.

Data Gaps

- An inventory of the existing condition of roads in the Chewuch subwatershed and their contribution to sediment delivery to the surface water network. The Forest Service has begun this work. It needs to be completed.
- Temperature monitoring of summer and winter thermal refugia.
- Grazing effects in Eightmile, Boulder, Falls and Cub creeks on sediment delivery and channel stability.
- Assessment of the impacts of livestock (recreational packstock) to riparian areas in upper mainstem Chewuch River.

Recommendations.

- Restore the habitat-forming processes to sustain natural levels of channel complexity as a long-term approach to the degraded condition of the lower 28 miles of the Chewuch subwatershed.
- Continued monitoring of LWD accumulations and recruitment for the Chewuch River from RM 0.0 to RM 30.0.
- Review and revise land use regulations (federal, state and local) for the lower 8 miles of the Chewuch River.
- Water conservation should be pursued.
- Habitat projects in the lower 8 miles of the Chewuch River should seek to increase habitat complexity by allowing LWD accumulation and recruitment and restricting development.
- Reduce road densities, particularly in highly erosive areas (such as mid-slope areas) and riparian areas.
- Manage recreation activities in riparian areas, including an educational component.

- Distribute carcasses for nutrient enrichment in reaches where spawning occurs.

Boulder Creek (48.0770)

Access to Spawning and Rearing Habitat.

At RM 1.0 there is a natural falls that is a barrier to fish passage.

Floodplain Conditions

The alluvial fan has been channelized.

Riparian

The riparian areas along Boulder Creek were selectively logged for mature trees during the 1950's. The effects of these harvest practices impact aquatic habitat today, with reduced availability of large trees for instream LWD, numerous skid roads leading to the river and associated highly dispersed recreational use, and accelerated bank erosion and sedimentation.

Large Woody Debris

LWD levels are low from the North Fork of Boulder Creek confluence downstream to the mouth. Potential for recruitment is limited naturally and exacerbated by road placement and wood removal after previous events.

Channel Conditions and Streambed Sediment

Upper natural falls barrier has also been mapped for Boulder Creek at RM 1.0

Boulder Creek has naturally very high background sediment levels exacerbated by the channelized alluvial fan and low LWD levels from the North Fork Boulder Creek confluence downstream. Boulder Creek drainage's highly erosive soils make it especially susceptible to erosion. Fire in the early 1970's (South Fork Fire) also added to the problems of sediment transport.

Extensive meadows and ponds in the headwaters of Boulder Creek have had a long history of grazing and recent disturbance from fire and fire line construction that may be contributing to a loss of water storage and increase in sediment delivery to these tributaries and the Chewuch system (J. Smith, PWI, pers. comm., 2000).

Extensive harvest and associated road construction in the Boulder Creek drainage is contributing to coarse and fine sediment delivery to the Chewuch. In addition, poor road placement in highly erodible soils in tributaries of Boulder Creek (such as Bromas Creek) has lead to large scale mass wasting directly into the streams. The USFS has made efforts to restore some of these problem areas and has met with mixed success (J. Smith, PWI, pers. comm., 2000).

Water Quantity and Water Quality

The Boulder Creek Road is the main factor contributing to high sediment levels and channel scour in Boulder Creek. This is exacerbated by its channelized alluvial fan and low LWD levels from the North Fork Boulder Creek confluence downstream. Boulder Creek drainage's highly erosive soils make it especially susceptible to erosion.

Biological Processes

Brook trout have been widely stocked in the Chewuch and its tributaries since the 1920's. Strong populations of these fish can be found in Cub, Eightmile, Falls, Twentymile, and Boulder Creeks. These fish are prolific and doing well in all of these tributaries. Hybridization and elimination of bull trout has occurred in Eightmile and Boulder Creeks.

Eightmile Creek (48.0901)

Access to Spawning and Rearing Habitat

At RM 1.7, the road location may be constricting the channel, creating a velocity barrier. Brook, rainbow and cutthroat trout were recorded upstream of the barrier.

Floodplain Conditions

Livestock presence, recreational use, and USFS Road 5130 placement are negatively impacting the floodplain from RM 1.7 upstream.

Riparian

Livestock grazing from RM 1.7 to the headwaters is heavily degrading wetlands and floodplains. Particularly the riparian area both above and below Copper Glance Creek, including impacts to beaver ponds and a loss of adequate food supply for remaining beavers, has been impacted by livestock grazing. Impacts to riparian areas from both heavy livestock grazing and timber harvest are also notable from Deer Creek to the Roughed Grouse campground.

Large Woody Debris– no information available.

Channel Conditions and Streambed Sediment

Sediment delivery rates are very high. Natural sediment storage is being lost due to loss of beaver activity in the area.

Extensive harvest, with associated road construction is contributing to coarse and fine sediment delivery to the Chewuch.

Water Quantity and Water Quality

Harsh winter conditions can result in icing conditions during some years in this subwatershed. At the confluences of Eightmile Creek, Twentymile Creek and some of the larger side channels such as the one near No Snake Creek, ground water recharge occurs. Alterations to channel reaches may reduce the potential for the maintenance of thermal refuges during icing conditions.

There are two irrigation ditches operating on Eightmile Creek: the Eightmile Ranch Ditch (approximately RM 0.25) and the Lucille Mason Ditch (located on the opposite bank from the Eightmile Ranch Ditch), both with a diversions on USFS land. Low flows in the Chewuch River do not appear to be a limiting factor to any life stage of salmonids and do not appear to be limiting production in the Chewuch subwatershed (TAG 2000). Reduction of beaver created wetlands have reduced water storage capabilities. The extent and it's effect on salmonid productivity is unknown (TAG 2000).

Biological Processes.

Brook trout have been widely stocked in the Chewuch and its tributaries since the 1920's. Strong populations of these fish can be found in Cub, Eightmile, Falls, Twentymile, and Boulder Creeks. These fish are prolific and doing well in all of these tributaries. Bull trout have been extirpated in Eightmile Creek.

Area beaver dams have been lost during high water events. Heavy grazing and occasional dispersed recreation sites have eliminated other areas of the riparian corridor. Grazing in the valley bottom has lead to degradation of beaver ponds and a loss of adequate food supply for remaining beaver.

Twentymile Creek (48.0977)

Access to Spawning and Rearing Habitat

At RM 0.6 there is a natural falls that is a barrier to fish passage.

Floodplain Conditions

Due to the flood flows of 1972, a large beaver pond complex was eliminated from the alluvial fan at the junction of Twentymile Creek and the Chewuch River. In addition, within the alluvial fan of Twentymile Creek was excavated into a single straight channel with large rock berms placed along both sides of the channel for over 0.5 miles. This channelization has reduced floodplain functions within the alluvial fan and contributed to the loss of water and sediment storage on the alluvial fan over the last 30 years. In 1997, access to the flood channel was partially restored allowing flood flow to spread out over a much larger area of the fan. New fords at these flood channels were constructed in 1999.

Riparian

In the alluvial fan, riparian development is naturally sparse due to the effects of the 1972 flood (J. Smith, PWI, pers. comm., 2000).

Large Woody Debris – no information available.

Channel Conditions and Streambed Sediment

The channel substrate of Twentymile Creek is naturally coarse and mobile (J. Smith, PWI, pers. comm., 2000). An old native-surface road up the northeast side of Twentymile Creek contributes to mass wasting directly into the stream system. Another road and harvest landing on the south side of Twentymile Creek contributes sediment to the riparian area. This sediment is not being delivered directly to the stream at this time however.

About 1972, a large beaver pond complex was eliminated from the alluvial fan at the junction of Twentymile Creek and the Chewuch River. In addition, within the alluvial fan of Twentymile Creek was excavated into a single straight channel with large rock berms placed along both sides of the channel for over 0.5 miles. This channelization has reduced floodplain functions within the alluvial fan and contributed to the loss of water and sediment storage on the alluvial fan over the last 30 years. In 1997, access to the flood channel was partially restored allowing flood flow to spread out over a much larger area of the fan. New fords at these flood channels were constructed in 1999.

Extensive meadows and ponds in the headwaters of Twentymile Creek have had a long history of grazing and recent disturbance from fire and fire line construction that may be contributing to a loss of water storage and increase in sediment delivery to these tributaries and the Chewuch system (J. Smith, PWI, pers. comm., 2000).

Water Quantity and Water Quality

In the last five years the lower 1/4 mile of Twentymile creek has dewatered. It is not known if there have been other times when the creek has been dry. The recent occurrences appear to have been related to extreme low flows for the year in which they occurred. There may be some relationship to the diking that has occurred in the reach, but there has been no investigation of this issue (J. Smith, PWI, pers. comm., 2000).

Harsh winter conditions can result in icing conditions during some years in this subwatershed. At the confluences of Eightmile Creek, Twentymile Creek and some of the larger side channels such as the one near No Snake Creek, ground water recharge occurs. Alterations to channel reaches may reduce the potential for the maintenance of thermal refuges during icing conditions.

Biological Processes

Brook trout have been widely stocked in the Chewuch and its tributaries since the 1920's. Strong populations of these fish can be found in Cub, Eightmile, Falls, Twentymile, and Boulder Creeks. These fish are prolific and doing well in all of these tributaries. Bull trout have possibly been extirpated from Twentymile Creek.

Although beaver can still be found within the Chewuch subwatershed, historic records indicate a much higher level of use (Bryant, F.G. and Z.E. Parkhurst 1950). Historic photos show a large beaver created wetland associated with the Twentymile fan . Surveyors in 1937 observed Twentymile Creek flowing into a side-channel created by beaver. Analysis of aerial photos and observation from the air shows the mark of old beaver dams on many of the high elevation meadows in the watershed. Most of these are inactive now.

Other Drainages in the Chewuch River Subwatershed: Cub Creek (48.0977); Falls Creek (48.0940); Doe Creek (48.0969); Farewell Creek (48.1021); Lake Creek (48.1020); Andrews Creek (48.1087); Thirtymile Creek (48.1136); and Dog Creek (48.1139).

Access to Spawning and Rearing Habitat

At RM 0.4 on Cub Creek there is a natural falls that is a barrier to fish passage. Above this natural barrier to anadromous fish passage, there are perched culverts at the West Chewuch Road crossing and at RM 1.75, both barriers to resident fish passage. Only brook trout were observed in this tributary during recent snorkel surveys (J. Smith, PWI, pers. observations, 1999). The USFS and the Pacific Watershed Institute evaluated the value to replacing these culverts for resident fish, and decided the cost was to great relative to the benefit gained from brook trout.

At RM 0.2 on Falls Creek there is a natural falls that is a barrier to fish passage.

At RM 9.2 on Lake Creek there is a natural falls that is a barrier to fish passage.

At RM 0.5 on Andrews Creek there is a natural falls that is a barrier to fish passage.

At RM 0.3 on Thirtymile Creek there is a natural falls that is a barrier to fish passage.

At RM 0.25 on Dog Creek there is a natural falls that is a barrier to fish passage.

Floodplain Conditions

Farewell Creek. After the 1972 flood, the bottom reach of Farewell Creek was re-routed into Lake Creek. A large dike was placed along the channel cutting off future access to the alluvial fan associated with Farewell Creek.

Cub Creek. Several houses with their associated roads and driveways have been built on the alluvial fan of Cub Creek in the last 15 years. The conversion of the alluvial fan to residential development has confined the stream channel to primarily one location within the alluvial fan. A side channel on the south side is becoming disconnected from the main channel. In this area, as well as other locations in upper Cub Creek a large number of road crossings and roads paralleling Cub Creek have reduced or confined the lateral migration of Cub Creek.

Lake Creek. Past diking and the presence of the west side road bridge prevents Lake creek from accessing the remainder of the alluvial fan. The lower 0.5 mile is fairly confined and entrenched.

Riparian.

Cub Creek. A large number of road crossings and roads paralleling Cub Creek have reduced the growth of riparian vegetation and increased bank erosion and sediment delivery to the stream. Heavy grazing and occasional dispersed recreation sites have eliminated other areas of the riparian corridor. Grazing in the valley bottom has lead to degradation of beaver ponds and a loss of adequate food supply for remaining beaver.

Lake Creek. Two dispersed camp areas have eliminated riparian undergrowth along small sections of the lower reach of Lake creek. This is only a small portion of the total riparian area however.

Large Woody Debris– no information is available.

Channel Conditions and Streambed Sediment.

Thirtymile Creek and Dog Creek. Extensive meadows and ponds in the headwaters of Thirtymile Creek and Dog Creek have had a long history of grazing and recent disturbance from fire and fire line construction that may be contributing to a loss of water storage and increase in sediment delivery to these tributaries and the Chewuch system (J. Smith, PWI, pers. comm., 2000).

Falls Creek and Doe Creek. Extensive harvest and associated road construction in the Falls Creek and Doe Creek drainages are contributing to coarse and fine sediment delivery to the Chewuch. In addition, poor road placement in highly erodible soils in Doe have lead to large scale mass wasting directly into the streams. The USFS has made efforts to restore some of these problem areas and has met with mixed success.

Water Quantity and Water Quality–

Cub Creek. There is one known diversion at approximately RM 1.0. No additional information is available except that the amount diverted is “small”.

Biological Processes

Brook trout have been widely stocked in the Chewuch and its tributaries since the 1920's. Strong populations of these fish can be found in Boulder, Cub, Eightmile, Falls and Twentymile Creeks. These fish are prolific and doing well in all of these tributaries.

Data Gaps

- An analysis to determine the extent harvest and road development in Eightmile Creek is affecting flow regimes in Eightmile and in the mainstem Chewuch River.

- Sediment budget study.

- Assessment of livestock impacts on riparian conditions, including beaver ponds, particularly in Boulder, Eightmile, and Twentymile Creeks.

- Assessment of the loss of beaver activity in the Chewuch subwatershed in general, Eightmile Creek in particular, to determine the extent of loss of maintenance of channel function, and water and sediment storage.

Recommendations.

- Habitat projects to restore floodplain function and increase the LWD in the alluvial fans of Twentymile and Farewell Creeks should be pursued.

- Sediment delivered to Boulder Creek should be reduced.

- Habitat projects aimed at decreasing road densities in Cub, Boulder, Eightmile and Falls Creek drainages, through road abandonment and road stabilization, should be pursued to reduce sediment delivery and improve surface hydrology impacts, two factors contributing to habitat degradation in this portion of the Chewuch subwatershed.

- Determine if Eightmile road is creating a barrier and if so, repair it.

- Eliminate impacts to riparian areas from dispersed campground on Lake Creek, particularly in reaches where bull trout are know to spawn.

- Habitat projects that seek to improve beaver populations in the subwatershed should be considered.

Middle Methow River Subwatershed

The Middle Methow River subwatershed contains 15,600 acres, encompassing the mainstem Methow River from its confluence with the Chewuch River at Winthrop (RM 50.1) downstream to the town of Carlton (RM 26.8), a distance of approximately 23 river miles. It includes the Alder Creek, Bear Creek, Beaver Creek and Benson Creek drainages and the towns of Twisp and Carlton.

County roads and state highways parallel both sides of the Methow River along its entire length within this subwatershed. State Highway 20 parallels the Methow River from Winthrop to just upstream of the Beaver Creek confluence (RM 35.2) before heading east to follow Beaver Creek and then Frazer Creek up to Loup Loup Pass. State Highway 153, picking up where Hwy. 20 leaves off, continues south, paralleling the Methow River downstream to the town of Carlton. The Eastside Winthrop-Twisp Road and the Twisp-Carlton Road are the two county roads running from Winthrop to Carlton.

Of the salmonid species that this document addresses, the following species occur in the Middle Methow River Subwatershed; spring chinook, summer chinook, rainbow/steelhead, and bull trout. Table 6 describes species use for the listed drainages in the subwatershed.

Table 6 Known salmonid species use in the Middle Methow River Subwatershed

Middle Methow River Subwatershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Bull Trout		
	spawning	Rearing	migration	spawning	Rearing	migration	spawning	rearing	migration	spawning	rearing	migration
Methow River	X	X	X	X	X	X	X	X	X		X	X
Alder Creek		X						X				
Bear Creek		X										
Beaver Creek		X					X	X	X	X	X	X
Frazer Creek							X	X	X			
South Fork Beaver Creek							X	X	X			
Blue Buck Creek							X	X		X	X	

<u>Mainstem middle-Methow River (48.0007) and Alder Creek (48.0296)</u>

<u>Access to Spawning and Rearing Habitat</u>

<u>Methow River – Dike (opposite Smoke Jumper's Base)</u> (Section 25, T34N R21E). A dike constructed at this location cuts off approximately 1 mile of side channel habitat from the mainstem Methow River

Methow River - Vandermyers Dike (NW ¼ Section 31, T33N R22E). One-quarter to ½ mile of side channel has been partially disconnected from the mainstem Methow River by filling and culverting.

Methow River - Town of Twisp Army Corps Dike (N½, NE¼, Section 07, T33N R22E). The dike was constructed in 1972 on the right bank of the Methow River about one mile north of the town of Twisp. It is approximately 1,600 feet long.

Methow River - West County Road Side Channel (Section 21, T33N R22E). This side channel is not connected to the main channel.

Methow River - Alder Creek Side Channel. A dike constructed at the confluence of Alder Creek cuts off approximately ½ mile of side channel habitat from the mainstem Methow River.

Methow River - Silver Side Channel Dike (Section 34, T33N R22E). A 1,000 ft. dike constructed at this location in 1972 blocks approximately 1 mile of side channel habitat from the mainstem Methow River.

Methow River - Methow Valley Irrigation District (MVID) East Canal Fish Screen (Section 24, T34N R21E; RM 44.8). The fish screen and diversion structure are not in compliance with federal standards and guidelines provided to protect fish from entering the irrigation canal or becoming impinged on the screen material. An Environmental Assessment (BPA 1997) describes alternatives for addressing the impacts of the MVID East Canal irrigation system on salmonids, which would address the inadequate screening concerns. As of the date of the publication of this report, no action has been taken to bring the fish screen and the diversion structure into compliance.

Alder Creek . There is a fish-blocking culvert on Alder Creek at the Twisp-Carlton Road crossing. Two hundred feet upstream from this culvert there is another blocking culvert on the WDFW Wildlife Area access road. About ½ mile further up on the WDFW Wildlife Area access road there is a three-culvert crossing on Alder Creek forming another fish passage barrier. At some point in the past, Alder Creek was channelized, making it impassable, in addition to the passage problems created by the blocking culverts. Further investigation would be necessary to determine the potential of making this channel passable to salmonids (TAG 2000).

Floodplains

Methow River. Conversion of floodplain areas to agricultural, residential and commercial use has occurred and is occurring throughout the Methow Valley. The location, extent and impact of conversions of functioning floodplain areas to residential and commercial use is a data gap.

Methow River. Conversion of riparian to residential/commercial use within the Town of Winthrop from RM 0.0 to RM 0.75, allows development of lots and building within 25 feet of the Mean Ordinary High Water Mark.

Methow River. Highway 20 confines the Methow River to an undetermined extent.

Alder Creek. Conversion of floodplains to agricultural and residential use and the placement of roads in the floodplain have negatively impacted floodplain functions.

Riparian

Methow River. Past livestock grazing practices within the riparian areas of the mainstem Methow River have negatively impacted these areas. On-going livestock grazing practices are continuing to have negative impacts in the riparian areas. The location and the extent of the impacts have not been inventoried and assessed. It is a data gap.

Methow River. Roads constructed within the river corridor have eliminated mature ponderosa pines and permanently displaced riparian vegetation. The location and the extent of the impacts have not been inventoried and assessed. It is a data gap.

Alder Creek. Agricultural practices and timber harvest has reduced riparian habitat in this drainage (TAG 2000).

Large Woody Debris

Methow River. The portion of the mainstem within this subwatershed has been cleared of woody debris in the past and LWD levels are still low.

Methow River. Large woody debris accumulations do not persist within the Methow River, with the river acting more as a transport reach. Increased velocities resulting from channel confinement (ie. bank hardening, diking-off access to side channels and floodplain areas) are affecting LWD deposition (TAG 2000).

Channel Conditions and Streambed Sediment

Methow River. Portions of the Methow River are confined by state or county constructed roads constructed within the channel migration zone. Bank hardening (riprap) has been applied along various sections of channel bank. The location and the extent of the impacts have not been inventoried and assessed. It is a data gap.

Alder Creek. High road densities exist in Alder Creek (USFS 1997). Ponds at the lower end of Alder Creek may capture suspended sediments allowing them to drop out prior to reaching the Methow River (L. Hofmann, WDFW, pers. comm., 2000).

Water Quantity and Water Quality

Methow River and Alder Creek. There are elevated concentrations of cadmium (Cd), copper (Cu), selenium (Se), and zinc (Zn) in the streamwater and sediments of Alder Creek. This is a consequence of heavy metal-laden effluent from the abandoned Alder

Mine, located approximately 3 miles south of Twisp on the western slope of McClure Mountain (Sections 25,26,35 and 36 of T33N R21E) (Peplow and Edmonds 1999). Cadmium and zinc in Alder Creek streamwater exceeded the Washington State Acute Water Quality Criteria for the duration of the study (September 1998 – September 1999). These metals have reduced species richness and abundance in the community structure of benthic macroinvertebrates in Alder Creek and cadmium and zinc were discovered to have concentrated in the gills and livers of rainbow trout sampled during the study (Peplow 1999). The extent of the problem reaches the confluence of Alder Creek and the Methow River. Metals exceeding water quality criteria at the confluence of Alder Creek and the Methow River pose a risk to threatened species of juvenile salmonids which use the lower portion of Alder Creek as rearing habitat (Peplow 1999).

The extent to which discharge from the Winthrop and the Twisp Sewage Treatment Plants may be negatively impacting water quality and affecting fish productivity is unknown (TAG 2000).

The Methow Valley Irrigation District (MVID) withdraws water from the reach of the mainstem within this subwatershed, using what is named the east canal. The east canal diverts on average about 41 cfs at about 5 miles north of the town of Twisp at RM 44.8. It rejoins the river at RM 26.6. (The MVID also diverts water from the Twisp River using what is named the west canal. This canal rejoins the Methow River at RM 28.9.) River Mile 44.8 on the Methow River is at about the midpoint between two USGS gauging stations on the Methow River located at RM 40.0 and RM 49.8. If the mean September flows at these two gauging stations are used, and the change in flow prorated over the distance between the stations, a river flow of about 301 cfs is calculated at the diversion to the east canal (RM 44.8). The average September east canal diversion of 39.3 cfs is about 13% of the mean September flow in the Methow River at this point (BPA 1997). The percent of the Methow River being diverted for irrigation is greatest in September (TAG 2000). Rearing of juvenile chinook salmon and steelhead are known to occur in this reach. Water uses and land use impacts that reduce seasonal low flows have the potential to cause stranding and reduce rearing habitat in general. The extent to which MVID's water use is affecting salmonid productivity in the mainstem Methow River, if any, is unknown. If there is an impact, its would be its reduction of available rearing habitat. The MVID's impact on salmonids from inadequate screening on the East Canal diversion is presented above under "A*ccess to Spawning and Rearing Habitat*".

Biological Processes

Alder Creek. Brook trout are found above the barrier on Alder Creek.

Habitat In Need of Protection.

- Functioning floodplain, riparian habitat and side channel habitat within the channel migration zone of the Methow River.

Data Gaps.

- An inventory of dikes and channel hardening (ie. riprap) is needed. Should include an assessment of the potential for restoration.

Recommendations.

- The channel migration zone of the Methow River should be protected from activities that will constrict or constrain the channel, degrade riparian areas, negatively impact ground water and surface water interactions, or in any other way degrade stream channel functions.

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

- Restore access to floodplain areas that have been disconnected by dikes.

- Bank hardening projects (riprap) where unavoidable, should incorporate design elements to reduce velocities (ie. j-hook veins and riparian vegetation)

- Increase LWD levels in the mainstem. This should be done by: restoring the river's access to its floodplain to allow habitat-forming processes to occur (ie LWD recruitment, stream energy dissipation, riparian plant community development, bedload transport and deposition); and improving riparian habitat conditions to allow for the development of a mature stand component.

Bear Creek (48.0708).

Access to Spawning and Rearing Habitat.

The culvert at the Lower Bear Creek Road crossing is a fish passage barrier. No other information is available.

Upstream of the Lower Bear Creek Road stream crossing an irrigation ditch crosses Bear Creek. This crossing is a barrier to fish passage. No other information is available.

Floodplains.

The conversion of floodplain to agriculture, residential, and grazing use have negatively impacted floodplain functions.

Riparian.

The riparian vegetation removal associated with the conversion of floodplains to agriculture, residential, and grazing use have negatively impacted riparian functions.

Large Woody Debris . – no information available.

Channel Conditions and Streambed Sediment.

The conversion of floodplain and riparian areas to agriculture and residential use is contributing to sediment delivery to the stream.

Water Quantity and Water Quality.

Livestock grazing and golf course and residential development along the stream corridor have the potential to negatively impact water quality (TAG 2000).

The return flow from the Barclay Irrigation Ditch has the potential to negatively impact water quality in Bear Creek (TAG 2000).

Beaver Creek Drainage

The Beaver Creek drainage runs northeast to southwest, encompassing about 71,400 acres. It drains into the Methow River east at RM 35.2 about 5 miles downstream of the town of Twisp (RM 40.0). Beaver Creek is 22.3 miles in length and includes the following tributaries; Frazer Creek, South Fork Beaver Creek, Middle Fork Beaver Creek, Lightning Creek, and Blue Buck Creek. Water uses in the Beaver Creek drainage have been adjudicated with water use exceeding water availability most years during late irrigation season (USFS 1997). In a 1998 fish passage barrier and screen safety inventory (Gower and Espie 1999) a total of 78 partial and full fish passage barriers (includes both culverts and dams) were identified in the Beaver Creek drainage (Map Appendix C; inventory included Beaver Creek and all its tributaries). Of the 36 water diversions located, 20 gravity diversions and 6 pump diversions were unscreened.

State Highway 20 cuts through this drainage following Beaver Creek briefly from Finley Canyon Road to the Frazer Creek confluence (RM 2.8), a distance of about one mile. Highway 20 then continues east paralleling Frazer Creek up to Loup Loup Pass. Road densities overall in the Beaver Creek drainage are the highest in the Methow watershed with 41% of the drainage having road densities of 2.1 to 5 miles/sq. mile (USFS 1997). More specifically, 43% of the mainstem Beaver Creek portion of the drainage has road densities of 2.1 to 5 miles/sq. mile, 55% of the Frazer Creek portion of the drainage has road densities of 2.1 to 5 miles/sq. mile, and 45% of the South Fork Beaver Creek portion of the drainage has road densities of >5 miles/sq. mile (USFS 1997). Timber has been intensively harvested from the Beaver Creek drainage since the 1960s (USFS 2000a). About 130 million board feet on 17,800 acres have been harvested from the Beaver Creek drainage (USFS 1993). The harvesting of timber and construction of roads for logging have impacted the Beaver Creek system with heavy sediment loading, and has reduced the recruitment potential of large woody debris. The amount of newly created openings in the watershed and high road densities may also be causing channel damage from flashier spring runoffs (USFS 2000a).

Historically, distinct stocks of native bull trout were found in the South Fork of Beaver Creek and Blue Buck Creek (WDFW 1998a). Stocks probably consisted of both the resident and fluvial life history forms (WDFW 1998a; USFS 2000a). The South Fork population is now extinct and the Blue Buck population is listed as "Unknown" but possibly "Critical" (WDFW 1998a; Proebstel et al. 1998). There is speculation that distinct stocks probably existed in the Middle Fork and Lightning Creeks as well based on available habitat (upper Beaver Creek, Lightning Creek and the Middle Fork have not been surveyed; WDFW 1998a). In 1992, a single bull trout/ brook trout first-generation hybrid was collected in the headwaters of Beaver Creek, inferring that at that time there were still "pure" bull trout in the Beaver Creek drainage (Proebstel et al. 1998). Brook trout were reported to have replaced bull trout in Beaver Creek by Mullan et al. (1992) although the Bull Trout and Dolly Varden Appendix to the Salmonid Stock Inventory (WDFW 1998a) attributes impacts from timber harvests, road construction, irrigation and hydroelectric development of the Columbia River as additional factors that may have contributed to the decline of bull trout populations in the Beaver Creek drainage. The Beaver Creek bull trout population is described by the USFS as a remnant population in Blue Buck Creek that is not likely to persist due to brook trout presence and habitat degradation (USFS 1997).

Juvenile spring chinook are known to utilize the confluence area of Beaver Creek during rearing but there is no evidence that this species has ever used the Beaver Creek drainage to any greater extent (K. Williams, retired WDFW, pers. comm., 1999; TAG 2000). Ken Williams, retired fish biologist for WDFW, has observed steelhead navigating pass the State Highway 153 culvert barrier at RM 0.26 and the diversion dams upstream, establishing steelhead use in the mainstem Beaver Creek. Williams locates the upper extent of anadromy as occurring between Frazer Creek and the South Fork of Beaver Creek, depending on environmental conditions. Resident rainbow trout are known to occur up to the headwaters of Beaver Creek, in Frazer Creek, South Fork Beaver Creek and Blue Buck Creek.

Access to Spawning and Rearing Habitat

Beaver Creek Drainage. During the 1998 field season, there were 78 fish passage barriers identified in the Beaver Creek drainage (Gower and Espie 1999). **Table C- 2** in Appendix C lists the barriers; Map Appendix C illustrates the barriers. Both partial and complete barriers are included, based on WDFW Salmonid Screening, Habitat Enhancement, and Restoration Division's (SSHEAR) criteria (WDFW 1998b). The first barrier up from the mouth at RM 0.26 is a WDOT culvert on Highway 153 at MP 29.28 listed as a full barrier to anadromous fish passage. In contrast, Ken Williams (retired WDFW, pers. comm., 2000) has observed adult steelhead attempting to pass a large beaver dam that existed just upstream of the Washington Department of Transportation (WDOT) culvert years ago. A couple of hatchery steelhead were eventually able to navigate the beaver dam. The beaver dam has since been washed out, as beaver dams come and go, and it is Williams' professional opinion that adult steelhead can generally pass any "barrier" that might be found in Beaver Creek. Based on this knowledge and his sampling of adult steelhead/rainbow, he has identified the upper extent of anadromy as occurring between Frazer Creek and the South Fork of Beaver Creek on the mainstem Beaver Creek, varying between years based on environmental factors.

Beaver Creek (48.0307). During low water years, lower Beaver Creek goes dry up to about RM 0.5 miles (J. Molesworth, USFS, pers. comm., 2000) during the latter part of the irrigation season (L. Hofmann, USFS, pers. comm., 2000). Mullan et al. (1992) however, reported that the lower 0.3 miles of Beaver Creek remained a substantial stream until the end of irrigation season because of return irrigation flows. This loss of flow creates a passage barrier to rearing juvenile salmonid movement (TAG 2000).

Floodplains

Beaver Creek. The Beaver Creek Road runs parallel to Beaver Creek confining the floodplain in some reaches. One location where this has been identified is a reach of upper Beaver Creek in Section 35 T34N R22E. Riprapping of approximately one mile of stream bank in this reach has also occurred.

Beaver Creek. Conversion of floodplains to agricultural use has occurred in portions of the floodplain along Beaver Creek (TAG 2000).

Riparian

Beaver Creek. The USFS does not maintain a campground in the Beaver Creek drainage. A large State campground is found on the left bank of Beaver Creek just below the Forest Boundary. Heavy horse use and camping with horses has damaged the riparian area in this campground (USFS 2000a). Cattle, grazing on allotments on National Forest Service land, also move down into the riparian areas within the state campground further damaging the area (J. Mountjoy, WDFW, pers. comm., 2000). During 1999 and 2000, WDFW fenced approximately one mile of the riparian area on the east side of the creek to prevent entry by cattle. Outside of the WDFW campground, several large dispersed campgrounds and many small dispersed sites are found in the Beaver Creek drainage. A large, popular dispersed campground is found at the beginning of the Lightning Creek trailhead, off USFS Spur Road 4225213. A large area is denuded of vegetation in the riparian area at this site, with soil compaction occurring from vehicles driving near the banks at this site. A smaller dispersed campground is found on USFS Spur Road 4225212, located just below the campground on USFS Spur Road 4225213. Many small campsites, mainly used during hunting season, are found throughout the drainage, most on the numerous spur logging roads.

Beaver Creek. Livestock use in lower Beaver Creek from the State Highway 20 crossing down to the mouth have degraded the riparian conditions (TAG 2000).

Beaver Creek. The removal of riparian vegetation form the conversion of riparian areas to agricultural use has impacted approximately two miles of riparian habitat in lower Beaver Creek on private lands (TAG 2000).

Frazer Creek (48.0366). Three miles of riparian vegetation has been cleared along the banks of the creek within the power line right-of-way (TAG 2000).

South Fork of Beaver Creek (48.0342). Cattle are congregating at the cattle guard on USFS Road 4225 in the lower part of the South Fork drainage, causing bank erosion and devegetation of the riparian zone (USFS 2000a). Cattle have been fenced from the beaver dammed stream and meadows in the South Fork Meadows (this has been the most cattle impacted area in the drainage; USFS 2000a).

South Fork of Beaver Creek. The south bank from RM 0.2 to 1.8 has had significant logging in the riparian area with the bank almost cleared of large timber in a stretch of more than 0.75 miles (USFS 2000a).

Large Woody Debris

Beaver Creek. A large State campground is found on the left bank of Beaver Creek just below the Forest Boundary. Heavy horse use and camping with horses has damaged the riparian area in this campground reducing potential for LWD recruitment (TAG 2000).

South Fork of Beaver Creek. LWD levels are below their natural potential and sediment is also high (USFS 1997). The south bank from RM 0.2 to 1.8 has had significant logging in the riparian area with the bank almost cleared of large timber in a stretch of more than 0.75 miles (USFS 2000a). Future recruitment of LWD from this reach is very poor (USFS 2000a).

Frazer Creek. LWD in Frazer Creek is scarce and sedimentation levels are high (USFS 1997). The location of State Highway 20 in close proximity to the Creek for a six mile stretch contributes to this condition by displacing riparian vegetation (TAG 2000).

Middle Fork of Beaver Creek (48.0343). LWD are scarce in the Middle Fork of Beaver Creek. Pools do not meet the standards for depth in this watercourse. Sediment levels are high (USFS 1997).

Channel Conditions and Streambed Sediment

Beaver Creek. The banks in the vicinity of the WDFW campground are eroding, a result of heavy use by campers and their horses and cattle grazing (USFS 1997). Based on visual observation by USFS surveyors, the stream channel within this reach has accumulations of fine sediment, the result of natural and management-related sources (USFS 1997). Overall, amounts of sediment were considered very high in every surveyed reach of every stream surveyed. Habitat inspected for cobble embeddedness was judged by surveyors to be embedded in every surveyed reach. Although sediment within the system is largely a natural condition due to the sandy soils in the drainage, the degree of sedimentation is excessive due largely to past management activities (USFS 2000a).

Beaver Creek. Livestock use in lower Beaver Creek from the State Highway 20 crossing down to the mouth have negatively impacted stream banks (TAG 2000).

Frazer Creek. Frazer Creek receives large quantities of sediment from Highway 20 based on an informal, visual observation during the USFS 1993 Beaver Creek survey (USFS 1997). Forest roads are also delivering sediment and are changing the manner in which water is routed though the system. Pools were observed filling with sediment (USFS 1997).

Frazer Creek. Stream bank are in fair condition based on an evaluation in the 1980's. This rating was mostly attributed to observed damage to stream banks from livestock use (USFS 1997). The other factor negatively affecting stream bank condition and channel function on Frazer Creek is the location of State Highway 20 in close proximity to the channel for a six mile stretch. To maintain the structural integrity of the highway, on-going bank hardening (riprap) applications along this reach are necessary (TAG 2000).

South Fork of Beaver Creek (48.0342). There is accelerated accumulation of coarse sand in the stream, a result of livestock grazing and the proximity of USFS Road 4225. The most extensive timber harvest and the highest road densities in the Beaver Creek drainage occur in the South and Middle Forks. The proximity of the road to the stream also creates a risk of stream diversion onto the road during a major storm event. The South Fork also probably receives the heaviest use by livestock of the entire Beaver Creek drainage.

Middle Fork Beaver Creek. The most extensive timber harvest and the highest road densities in the Beaver Creek drainage occur in the South and Middle Forks. Road cut and road surface erosion deliver quantities of sediment to the creek (USFS 1997).

Blue Buck Creek (48.0309). In a 1993 stream survey, pool frequency and pool quality was low with many of the pools filled with sediment. At the time of the survey a recent clear-cut harvest crossed the stream channel impacting the riparian zone and the uplands (USFS 1997).

Lightning Creek (48.0361). In 1995 a mass wasting event occurred on a clear-cut slope of Lightning Creek delivering rock, sand and silt to the stream (USFS 1997). In general, road crossings, road surface erosion, and cut-and-fill slope erosion are delivering sediment into the stream channel (USFS 1997).

Water Quantity and Water Quality

Beaver Creek (48.0307). Beaver Creek is listed on the 1998 Washington State 303(d) list for inadequate instream flows. Beaver Creek is an adjudicated drainage where water uses are provided for in excess of available water during some part of the irrigation season (USFS 1997).

Blue Buck Creek. In 1992, Jennifer Molesworth, USFS Regional Fish Biologist, observed dewatering from RM 0.0 - 0.75 of the Blue Buck Creek.

Frazer Creek. There is a potential for spills from Hwy. 20 to be delivered directly into Frazer Creek negatively impacting water quality (TAG 2000).

Biological Processes

Beaver Creek. The lower 9 miles of the stream is low gradient (<2%), and historically supported a large population of beaver (USFS 2000a). Beaver were trapped as the land was developed for agriculture (USFS 2000a).

South Fork of Beaver Creek. Beaver were replanted, but did not survive, in the South Fork of Beaver Creek early in the 1990s (USFS 2000a). In the South Fork Meadows area of this drainage where beaver have reestablished naturally, cattle have been fenced from the beaver dammed stream and meadows (this has been the most cattle impacted area in the drainage; USFS 2000a).

Lightning Creek . There are inactive beaver ponds greater than ten acres in size in the headwaters of Lightning Creek. The dams are breached and water levels have dropped. Sedimentation rates are accelerated in the ponds and the streams, due to natural causes, roads, and the absence of beaver (USFS 1997).

Brook trout were reported to have replaced bull trout in the Beaver Creek drainage by Mullan et al. (1992). The Beaver Creek drainage bull trout population is described by the USFS as "a remnant population in Blue Buck Creek that is not likely to persist due to brook trout presence and habitat degradation and isolation" (USFS 1997). The Bull Trout and Dolly Varden Appendix to the Salmonid Stock Inventory (WDFW 1998a) lists the South Fork population as extinct and the Blue Buck population as "Unknown" but possibly "Critical".

Data Gaps

- A road condition and impact analysis is needed in the Beaver Creek drainage. This should result in a road management plan that focuses of reducing sediment delivery to streams and reducing the hydrologic impacts of roading density and proximity to the watercourses.

- An analysis of the impact of livestock grazing on water quality is needed on both public and private lands.

Recommendations

- The riparian habitat in the WDFW campground on Beaver Creek should be managed to exclude livestock and control camping impacts to allow for recovery of the riparian habitat.

- Throughout the drainage, slopes destabilized by past timber harvest management practices should be identified and efforts made to revegetate. Riparian buffer zones degraded by past harvests should be identified, stabilized and revegetated as needed. Road densities, particularly in proximity to streams, should be stabilized or abandoned to reduce sediment delivery to stream. Increases in LWD and beaver activity, where appropriate, would also provide for improved sediment management.

- Habitat projects are needed in the South Fork of Beaver Creek to reduce sediment delivery to the watercourses, especially sediment delivered from roads. LWD levels should be increased concurrently to manage sediment transport.

- Frazer Creek is suffering from increased sediment levels, bank destabilization and riparian impacts from observed livestock grazing and roads. Grazing management should be changed to allow for improvement of these conditions. Alternative should be investigated to reduced sediment delivery to the stream from roads. LWD levels need to be increased.

- In the Middle Fork of Beaver Creek, habitat projects that reduce sediment delivery to streams from roads should be proposed.

- To the extent possible, beaver should be reintroduced into the drainages of Beaver Creek. The ponds in upper Lightning Creek are prime candidates for beaver reintroduction.

- Property should be purchased that would provide for channel migration.

- Brook trout numbers need to be reduced.

Twisp River Subwatershed

The Twisp River subwatershed contains approximately 157,000 acres (USFS 1995c), is oriented generally east-to-west, and drains into the Methow River at the town of Twisp. The Twisp River extends approximately 28 river miles from its headwaters to its confluence with the Methow River (RM 40.2). Its tributaries include Poorman, Newby, Little Bridge, Canyon, Buttermilk, Eagle, War, Reynolds, South, and North Creeks.

Annual precipitation ranges from 90 inches along the Cascade crest to 20 inches in Twisp; elevation ranges from 8,500 feet at the upper ridges to 1,600 feet at the confluence with the Methow. Approximately 95 % of the Twisp River subwatershed is in federal ownership (145,200 acres). Of that federal land nearly half, including the headwaters and much of the uplands, is in the Lake Chelan-Sawtooth Wilderness area (72,000 acres). The remaining federal land is managed as Late Successional Reserves or Matrix (USFS 1995c). Lower elevation Forest Service land above the confluence with Buttermilk Creek has been allocated as Late Successional Reserves. Forest Service land below the confluence with Buttermilk Creek has been allocated as Matrix. This includes Canyon, Little Bridge, Poorman and Newby Creeks, and the lower reaches of both forks of Buttermilk Creek. The remaining 5 % of the subwatershed is in private ownership (8,000 acres), encompassing the mainstem Twisp River up to about RM 15.0, including the lower reaches of Poorman and Newby Creeks (USFS 1995c). The Twisp River Road parallels the Twisp River, confining the floodplain up to about RM 9.0 (TAG 2000).

Roads are also constructed in the floodplains of Poorman, Newby, Little Bridge, and Buttermilk Creeks. The Little Bridge and Buttermilk drainages have the highest road densities in the subwatershed (USFS 1995c, TAG 2000). Timber harvests have occurred in about 25% of the Twisp River watershed, mainly in the drainages east of and including Buttermilk Creek (USFS 2000j). There are six irrigation ditches diverting water from the Twisp River (TAG 2000) and four irrigation diversions on tributaries to the Twisp River, including Buttermilk Creek, Eagle Creek and two in Little Bridge Creek (TAG 2000).

Of the salmonid species this document addresses, the following species occur in the Twisp River subwatershed; spring chinook, steelhead/rainbow, and bull trout. Spring chinook salmon and summer steelhead spawn and rear in Twisp River for nearly its entire length. Bull trout are found in the Twisp River and several of its tributaries. Between the years 1987 – 1999, 25.4 % of spring chinook spawning in the Methow watershed occurred in the Twisp River (Appendix B, **Table B- 1**). This compares with 40 % in the upper Methow River (Lost River to Winthrop) and 25.6 % in the Chewuch River for that same period. Table 7 describes species use for the listed drainages in the subwatershed .

Mainstem Twisp River

Access to Spawning and Rearing Habitat.

The MVID west canal diversion can result in complete blockage of the stream channel in low flow water years as a result of the use of “push-up” diversion dams to divert flow into the canal (D. Bambrick, NMFS, pers. comm., 2000). For the period of record 1980 – 1998, at the Methow River Near Pateros stream flow gage (USGS Station #12449950; RM 6.7) the mean flow for September – December was below average 11 of the 19 years. The period-of-record for the Twisp River Near Twisp stream flow gage (USGS Station # 12448998; RM 1.6) in recent decades dates back to only 1990. For the period-of-record 1990 – 1998, the flows at the Twisp River Near Twisp followed the same trend as for the Methow River Near Pateros gaging station. For both sites, with the exception of 1996 at the Methow River site, below average flows occurred for the same years (1991 – 1994 and 1998). This suggests that the same trend observed on the Methow River would apply

Table 7 Known salmonid species use in the Twisp River Subwatershed

	spawning	rearing	migration	spawning	rearing	migration	spawning	Rearing	migration	spawning	Rearing	Migration
Twisp River	X	X	X				X	X	X		X	X
Poorman Creek							X	X	X			
Little Bridge Creek		X					X	X	X	X	X	X
Buttermilk Creek Drainage		X					X	X	X	X	X	X
Canyon Creek							X	X				
Eagle Creek		X					X	X				
War Creek		X					X	X		X	X	
Reynolds		X					X	X		X	X	
South Creek		X					X	X		X	X	
North Creek		X					X	X		X	X	

to the Twisp River for the 1980 - 1998 period-of-record (J. Hubble, YN, pers. comm., 2000). At least for this nearly 20-year flow record, below average flows may be occurring about 50% of the time in the Twisp River below the MVID west canal diversion.

During the 1992 spring chinook spawning ground survey, on September 3rd the Twisp River between Poplar Flats campground (RM 22.0) and South Creek (RM 24.4**)** was observed to be dewatered (Scribner et al. 1993). Dewatering was also documented in 1987 at the Poplar Flats campground during the spring chinook spawning ground survey (Kohn 1987). Kohn (1987) indicated that the Twisp River in the vicinity of the Poplar Flats campground goes dry almost every year. This is considered a natural occurrence since there are no water diversions upstream of this location and all but the valley floor is managed as Wilderness (TAG 2000).

The ladder at the fish weir for the acclimation pond site (RM 6.9) need to be monitored to determine if it is successfully passing fish (TAG 2000).

At RM 29.4 there is a natural falls that is a barrier to upstream fish passage.

Floodplains

Floodplain wetlands along the lower Twisp River from the mouth to RM 12.5 have been isolated from the channel by dikes and roads. These impacts may be correlated to higher instream temperatures in the lower Twisp River.

From the mouth to RM 12.7 (Buttermilk Creek confluence), the Twisp River has been channelized, diked and riprapped for flood control and to convert floodplains to agricultural and residential uses. This has resulted in a highly simplified channel.

Bates area (RM 1.0) – Located at the Twisp city boundary, about ½ mile of side channel habitat in this area has been converted to ponds. Flows into the converted side channel area are controlled by a flow control structure (TAG 2000).

Poorman confluence area (RM 3.0) – About ½ mile of side channel habitat in this area has been converted to ponds. Flows into the converted side channel area are controlled by a flow control structure (TAG 2000).

The Twisp River Road confines the floodplain to from the mouth to RM 9.0 (TAG 2000).

Twispavia Residential Development (RM 13.5) – The development is located along the north bank of the Twisp River between the Lime Creek and Scaffold Camp Creek confluences (SE¼ of SE¼ of Section 17, T33N R20E). It is bounded on the north by the Twisp River Road. The extent to which this development is located within the floodplain and the channel migration zone is unknown. There are unmapped floodplains adjacent to the Twisp River and where the floodplain has not been mapped by the Federal Emergency Management Agency (FEMA) the County has no authority to regulate development based on flood hazards (Okanogan County 1996).

On Forest Service land, the presence of roads on either side of the Twisp River, and to a much lesser degree dispersed recreation, are interfering with natural processes that deliver organic and bedload material to the river (TAG 2000). The significance of this is unknown.

Riparian

The conversion of broad cottonwood galleries in the floodplain of the lower Twisp River (RM 0.0 – 12.0) for agriculture and residential development has been extensive (TAG 2000), reducing these riparian areas to thin strips. Grazing and the loss of out-of-bank flood flows to these areas continues to limit their development (TAG 2000).

In addition to the loss of the cottonwood galleries, the conversion of all types of riparian habitat for grazing and residential development in the lower Twisp River (RM 0.0 – 12.0) are negatively impacting the aquatic environment (TAG 2000).

Large Woody Debris

During the1960s and the 1970s, LWD was removed from the channel of the Twisp River from the mouth to the end of the Twisp River Road (RM 27.0). In the upper Twisp River (RM 16.5 – 30.0) LWD levels are improving although they are probably still well below pre-cleanout levels (TAG 2000). Recruitment potential for LWD in the upper Twisp River is very good, except where roads impede the natural delivery of LWD to the stream channel (USFS 2000j; TAG 2000). In the lower Twisp River (RM 0.0 – 16.5) LWD levels are well below amounts expected for a low gradient, well-forested, low elevation channel like the lower Twisp River (USFS 2000j). Recruitment potential for LWD on private lands in the lower half of the Twisp River has been reduced by clearing along its banks, harvest in the tributaries, and the continued clearing of instream material (USFS 2000j; TAG 2000).

Channel Conditions and Streambed Sediment

Nearly half of the subwatershed is designated wilderness and therefore roadless. This includes all but the Twisp River valley bottom, and the drainages below Buttermilk Creek (including Buttermilk Creek) which make up the easternmost third of the subwatershed.. Road densities are highest in the easternmost third of the drainage with greater than 3 miles of road/square mile (USFS 2000j). Sediment delivery from Forest Service lands and private lands in the Little Bridge, Poorman and Newby Creek drainages is contributing to the degradation of the lower 15 miles of the Twisp River. This is the result of high road densities and high timber harvest levels (TAG 2000).

Numerous areas of bank erosion were noted on the Twisp River between Buttermilk Creek (RM 9.8) and South Creek (RM 24.4). Two large mass-wasted banks are found below the Reynolds Creek confluence (RM 20.9) in the vicinity of the Mystery Campground (RM 20.5; USFS 2000j).

The MVID East Canal diversion on the Twisp River at RM 3.9 is a rock levee dam that must be pushed up by a bulldozer each year (BPA 1997) disturbing salmonid rearing and spawning habitat.

From the confluence of South Creek downstream(RM 24.4), pool quality and quantity were below expected levels for low gradient watercourses like the Twisp River (USFS 2000j).

Based on professional observation, the bed of the lower Twisp River appears to be unstable and behaving as a transport reach from the mouth to RM 9.3 (TAG 2000). This is supported by the lack of observation of cobble embeddedness during USFS stream surveys (USFS 2000j). The unstable bed would have the greatest negative impact on spawning success or egg-to-fry survival in the Twisp River (TAG 2000). The extent to which this is a condition brought about by the removal of LWD, channel confinement, and sediment loading is unknown (TAG 2000).

Water Quantity and Water Quality

The Twisp River is listed on the 1998 Washington State 303(d) list for inadequate instream flow and for temperature exceedences, based on 2 excursions beyond the criterion near the mouth. Temperatures of 17.2°C/69.9°F on August 29, 1989 and 17.9°C/64.2°F on August 30, 1989 were recorded.

The MVID diverts on average about 26 cfs of water from the Twisp River at RM 3.9 using what is named the west canal. This canal rejoins the Methow River at RM 28.9 upstream of Carlton (BPA 1997, page 34). The mean river flow at the gauging station (located at RM 1.6 on the Twisp River) during the month of September is 54 cfs. The average September diversion amount of 24.6 cfs is approximately 46% of the mean September flow in the Twisp River at this point (BPA 1997, page 34). Presently the canal, the diversion structure, and the fish screen are inefficient and in need of repair (BPA 1997). Discussions are on-going to address these inadequacies.

There are a total of seven irrigation diversions identified on the Twisp River, including the MVID diversion at RM 3.9. They are as follows:

- Risley (Airey) Ditch (RM 0.7) – located in the vicinity of the State Highway 20 bridge. A request for a "Change of Point of Diversion" was submitted to DOE in 1999 to allow the user to convert to a well. This request has not been processed (TAG 2000).;
- Northside/Doran ;
- MVID Diversion (RM 3.9) – located just downstream of the Poorman Creek confluence;
- Brown/Gillihan Ditch (RM 4.6) – located downstream of the Twisp River Power and Irrigation Ditch;
- Hottel Diversion (RM 6.0) - located just downstream of the mouth of Elbow Coulee;
- Twisp River Power and Irrigation Ditch (RM 6.9) – located downstream of Canyon Creek;
- Elmer Johnson/Libby/Culbertson Ditch (RM 11.1) - located between Canyon and Little Bridge Creeks.

The reduction of flows from water diversions has the greatest effect on salmonid production from RM 3.9 to the mouth when natural low flows in late summer/early fall coincide with high irrigation water use (TAG 2000). The resultant decrease of instream flows reduces access to and quantity of rearing habitat in a reach with a natural potential for high quantity, high quality rearing habitat. In this reach, the average diversion from the MVID (24.6 cfs; BPA 1997, page 34) totals 45% of the mean flow during September, where the mean flow during September is 54 cfs (BPA 1997, page 34). Combined with the Twisp River Power and Irrigation Ditch diversion at RM 6.9 (no diversion flow measurements made available) the potential reduction of instream flows increases.

During the 1992 spring chinook spawning ground survey, on September 3rd the Twisp River between Poplar Flats campground (RM 22.0) and South Creek (RM 24.4**)** was observed to be dewatered (Scribner et al. 1993). Dewatering was also documented in 1987 at the Poplar Flats campground during the spring chinook spawning ground survey (Kohn 1987). Kohn (1987) indicated that the Twisp River in the vicinity of the Poplar Flats campground goes dry almost every year. This is considered a natural occurrence since there are no water diversions upstream of this location and all but the valley floor is managed as Wilderness (TAG 2000).

Temperature readings collected at the Twisp River adult trap (RM 5.0) in 1994 by Heather Bartlett, WDFW, show water temperatures (Fahrenheit) in the mid-to-upper 60's recorded during some days in July and August. Environmental conditions during that period were extremely hot and dry and should be taken into consideration when evaluating the extent to which the high instream temperatures were a function of natural conditions or human-influence (H. Bartlett, WDFW, pers. comm., 2000).

A study conducted by the USFS has concluded that there is enough gold ore in the basin above North Lake (North Creek drainage) to warrant a mining operation (USFS 2000j). Development of trails or roads to access mine claims has the potential to heavily impact bull trout and spring chinook spawning areas in the Twisp River subwatershed (USFS 2000j).

Biological Processes

Beaver activity is very limited in the lower Twisp River where the large cottonwood galleries and low gradients would once have supported beaver colonies (TAG 2000). The reasons for the decline include the loss of habitat, food sources, and trapping (TAG 2000).

Brook trout have been found throughout the mainstem Twisp River, at the mouth of Reynolds Creek, in War Creek, and spawning in the small wetland at Elbow Coulee.

Data Gaps

- Baseline data for water quality parameters (ie. nutrients, dissolved oxygen, temperatures, etc.)

- An assessment of the affects of water diversions on flow, habitat condition and availability, temperature and salmonid behavior

- An inventory of the existing condition of roads in the Twisp River subwatershed and their contribution to sediment delivery to the surface water network is needed. The USFS has completed this assessment for the Little Bridge and Buttermilk drainages.

Recommendations

- Increase LWD levels and LWD recruitment in the Twisp River. Also improve retention of LWD in the Twisp River.
- Reduce road densities and their effects on hydrology and instream sediment conditions.
- Protect floodplains through acquisition and conservation easements.
- Restore access to the floodplain and reconnect side channels in the lower 15 miles of the Twisp River.
- Investigate alternatives to improve low flow conditions in the subwatershed.
- Evaluate critical areas ordinances and floodplain ordinances for inclusion of floodplains not presently mapped (Okanogan County 1996). Floodplains are defined as “lowland areas that are periodically inundated by the lateral overflow of streams or rivers”.
- Gather baseline temperature data.
- Require MVID to conduct a baseline monitoring study documenting the effects of improvements to their diversion system on aquatic systems supporting salmonids.

Tributaries to the Twisp River: Little Bridge Creek (48.0423); East Fork Buttermilk Creek (48.0470); Eagle Creek (48.0541); War Creek (48.0559); Reynolds Creek (48.0613); South Creek (48.0641); and North Creek (48.0674).

Access to Spawning and Rearing Habitat

Little Bridge Creek. A culvert at the mouth is a partial barrier to fish passage (TAG 2000).

Little Bridge Creek. The Tourangeau diversion dam (RM 0.25) was a barrier to fish passage but was washed out in 1998 and in 1999 (TAG 2000). The owner of this ditch would like to convert to a well (USFS 2000j).

Little Bridge Creek. At RM 2.1, about 300 feet upstream of the USFS Rd. 030 culvert crossing, there is an irrigation diversion dam (Aspen Meadows diversion). A wooden fish ladder has been constructed and needs to be monitored to determine its effectiveness at passing fish. Bull trout have been observed downstream of this barrier and rainbow/steelhead trout have been observed upstream.

Little Bridge Creek. Culverts at F.S. Road 030 (RM 2.0) and 100 crossings (RM 3.0) are barriers to fish passage. The USFS is conducting Environmental Assessments for the proposed repair to these barriers.

East Fork Buttermilk Creek. At low flows the culvert crossing at USFS Road 500 (RM 1.5) is a complete barrier to fish passage. The USFS is investigating the removal of this culvert (TAG 2000).

East Fork Buttermilk Creek. At RM 3.0 there is a natural falls that is a full barrier to migration of salmonids.

Eagle Creek. The culvert under USFS Road 4420 (RM 0.2) is a possible barrier to anadromous fish.

Eagle Creek. Approximately 500' downstream of the natural falls at RM 0.5 there is a diversion dam (Eagle Creek/Marshall Miller irrigation diversion) that could be a barrier to juvenile salmonids (TAG 2000). It is currently unscreened. The owner would prefer to change his point-of-diversion to a well (TAG 2000).

Eagle Creek. At RM 0.5 on Eagle Creek, a series of spectacular falls terminates upstream fish passage.

War Creek. At RM 1.2 there is a large barrier falls that prevents upstream fish passage.

Reynolds Creek. At approximately RM 0.25 there is a culvert blocking anadromous fish passage. There are brook trout below this culvert blockage and bull trout above. A natural falls just another ¼ mile upstream presents a total barrier to all fish passage. The USFS has decided to retain this barrier to protect the bull trout population upstream of this barrier from brook trout downstream of the barrier (TAG 2000).

Reynolds Creek. At RM 0.5 there is a natural falls that is a barrier to fish passage.

South Creek. At RM 0.5 on South Creek there is a natural fall that is a barrier to upstream fish passage.

North Creek. At RM 0.5 on North Creek there is a natural fall that is a barrier to upstream fish passage.

Floodplains.

Little Bridge Creek. After the flood of 1972 the creek was channelized below the Twisp River Road bridge by the Army Corps of Engineers (Methow Valley News, Vol. 70, June 29, 1972). There has been no analysis of how much floodplain capacity was lost by this action.

North Creek. Secondary roads and trails off the Twisp River Road are placed in the alluvial fan diverting the flow out of the channel and creating the potential to strand bull trout (TAG 2000). The town of Gilbert was once at the confluence of North Creek and the Twisp River. It has been abandoned since the turn of the century.

Eagle, War, Reynolds, and South Creeks. USFS Road 4430 confines the floodplain where it crosses at RM 0.2 (TAG 2000).

Riparian.

Poorman Creek (48.0386), Newby Creek (48.0409), Coal Creek (48.0419), Little Bridge Creek (48.0423), Buttermilk Creek (48.0466), Canyon Creek (48.0458) and Lime Creek (48.0532). These streams have roads in or along their riparian areas to a large degree, confining the channel and negatively impacting riparian habitat in sections.

Large Woody Debris.

Little Bridge Creek. Amounts of LWD are below acceptable levels. Log structures were placed in the creek in the early 1990s above and below the F.S. Road 100 crossing. Future LWD recruitment is reduced by timber harvests along stream banks in some segments of the stream (USFS 2000j).

Buttermilk Creek. Aerial photos from 1952 show that Buttermilk Creek was scoured by the 1948 flooding. Additionally, LWD was likely removed from the Creek as flood control subsequent to the 1948 flooding (USFS 2000j). After the flood of 1972, LWD was removed from and the creek was re-channeled below the Twisp River Road bridge by the Army Corps of Engineers (Methow Valley News, Vol. 70, June 29, 1972). Levels of LWD are still below acceptable levels (USFS 2000j).

Channel Conditions and Streambed Sediment.

Poorman Creek, and Newby Creek. Poorman and Newby Creeks, although smaller systems, are also delivering sediment to the Twisp River, a result of road placement and timber harvest. (TAG 2000).

Little Bridge Creek. Little Bridge Creek delivers large amounts of sediment to the Twisp River, a result of past timber harvest management and roading associated with logging (USFS 1995c). The lower two-thirds of the creek have road densities of >3 road miles/ square mile (USFS 2000j). Major bank erosion sites are located about ½ mile below the F.S. Road 030 crossing and between the F.S. Road 100 crossings and at the confluence of Sheep Creek (USFS 2000j). Culverts at the 030 and 100 crossings have altered the drainage pattern of the stream above and below the culverts (USFS 2000j). Forest Service Road 4415 is delivering sediment to the creek, with large areas of erosion from the road cut. About 25 miles of roads will obliterated in the Little Bridge Creek drainage including about 16 miles in riparian areas (USFS 2000j). Some restoration was completed at some of these sites in the late 1990s (USFS 2000j). Cattle grazing along the lower four miles, in the wetland seeps above the banks, and in some of the tributaries is delivering sediment to the creek (USFS 2000j). Current restoration projects in the drainage include the installation of 2255 feet of buck and pole fence at several sites in the drainage, mainly to deny cattle access to streams and riparian areas (USFS 2000j). The high width to depth ratio (16:1) for this type of channel in lower Little Bridge Creek (a B-type Rosgen channel) is an indicator of excess sediment (USFS 2000j). Channel downcutting has disconnected Little Bridge Creek from its floodplain in some areas, especially between RM 0.5 and 2.0 as evidenced by numerous dry side channels on elevations above the creek (USFS 2000j).

Little Bridge Creek. A large beaver complex has been abandoned in this system. Sediment captured by the complex is continuing to erode into the creek (TAG 2000).

Buttermilk Creek. Buttermilk Creek delivers large amounts of sediment to the Twisp River, a result of past timber harvest management and roading associated with logging (USFS 1995c). Large bank failures are found in the mainstem Buttermilk Creek and in the first 2.5 miles of the West Fork Buttermilk Creek (USFS 2000j). Road densities in the portion of the Buttermilk Creek drainage below the wilderness boundary are about 4 miles of road/square mile (USFS 2000j). Many of the roads scheduled for decommissioning in the Twisp River watershed are in the Buttermilk Creek drainage (USFS 2000j).

Buttermilk Creek. In 1995 a beaver dam blew out in this drainage, putting a pulse of sediment into the creek (TAG 2000). No additional information is available.

West Fork Buttermilk Creek (48.0466) Multiple landslides from timber harvests and road failure are contributing sediment to the stream.

Watershed-wide. Data from the Twisp River watershed indicate the presence of approximately 220 miles of road with 530 stream crossings (USFS 1995c). In addition, approximately 70 miles of road is within 200 feet of the stream (USFS 1995c). The USFS completed a limited sampling of existing roads in the Twisp subwatershed and estimated the extent of soil erosion from the roads and sediment delivery to nearby streams. Erosion rates varied from as low as 9.0 tons/acre of road prism/year to a high of 34.0 tons/acre of road prism/year (USFS 1995c). On 28.0% of the roads sampled, there was no sedimentation measured or observed entering the stream (USFS 1995c). On 72% of the roads sampled, stream sedimentation from roads ranged from 10.0 tons/mile of road to 130.0 tons/mile of roads (USFS 1995c). With these conditions, sediment will continue to enter streams and accelerated sediment production is likely within portions of the watershed for decades to come (USFS 1995c).

Water Quantity and Water Quality.

Poorman Creek. There are two irrigation diversions known on Poorman Creek: Moore Ditch and Second Mile Ranch Ditch. No additional information is available regarding the location, condition of screens, or amount of water diverted.

Little Bridge Creek. There are two irrigation diversions known on Little Bridge Creek: Tourangeau/Guy Walker Ditch (RM 0.25) and Aspen Meadows Ditch (RM 2.5). The owner of the Tourangeau Ditch would like to convert to a well. The Aspen Meadows ditch was diverting 0.65 cfs in August 1993 (USFS 2000j).

Buttermilk Creek. The Buttermilk Ditch irrigation diversion is located at RM 1.8. On August 1993 it was diverting about 4.0 cfs (USFS 2000j). The current condition and impact of these diversions to salmonids is unknown.

Eagle Creek. There Eagle Creek/Marshall-Miller irrigation diversion is located at RM 0.3 diverting 1.7 cfs in August 1993. The owner of the diversion is planning on converting to a well (USFS 2000j). The current condition and impact of the diversion to salmonids is unknown.

North Creek. A five-inch metal pipe diverts a small amount of water from a side channel of North Creek just below the culvert at RM 0.5 for domestic use at a miner's cabin (USFS 2000j).

North Creek. There are three mining claims located in the headwaters of North Creek that have been judged to be valid claims by the Bureau of Land Management (BLM) in the sense that sufficient gold mineralization was found by the Forest Service Mineral Examiner to justify the continued existence of the claims (USFS 1995c). Although Forest Service Surface Management regulations can minimize surface disturbance caused by mineral activities, they cannot prevent the staking of mining claims or preempt the statutory right of the miner to reasonably occupy and use the surface for mining and exploration purposes (USFS 1995c). Development of these mine site has the potential to negatively impact water quality in North Creek and potentially in the Twisp River.

Biological Processes.

Little Bridge Creek. There has been a decline in beaver activity in the Little Bridge Creek drainage (TAG 2000). A large beaver complex has been abandoned in this system. Sediment previously captured by this complex is eroding into the creek (TAG 2000).

War Creek. Brook trout were introduced in the past above the natural falls and still occur there.

Reynolds Creek. Brook trout occur below the culvert fish passage barrier about 0.25 miles upstream from the mouth of the creek.

Data Gaps.

- An inventory of water diversions in the Twisp River subwatershed and an assessment of their contribution to low flow conditions.

- An inventory of the existing condition of roads and culvert placement in the Twisp River subwatershed and its effects on sediment delivery and transport

Recommendations.

- Address the irrigation diversion structures acting as fish passage barriers on Little Bridge Creek.

- Do not remove the culvert acting as a barrier on Reynolds Creek. Brook trout are found below the culvert and bull trout above it. Replacing the fish blocking culvert with a passable structure would expose the bull trout population in upper Reynolds Creek to brook trout competition.

- Evaluate road densities and their effects on hydrology and instream sediment conditions in the subwatershed. This should include identifying roads and culverts which are no longer needed and evaluating them for obliteration and removal.

- Monitor the implementation and success of the USFS plan to reduce sediment delivery rates from Little Bridge Creek and Buttermilk Creek by reducing road densities in these drainages.

- Investigate alternatives to improve low flow conditions in the subwatershed.

Lower Methow River Subwatershed

The Lower Methow River subwatershed contains 200,000 acres, encompassing the mainstem Methow River and its tributaries from the town of Carlton (RM 27.0) downstream to the mouth of the Methow River, a distance of approximately 27 river miles. The river, running in a northwesterly to southwesterly direction, carves a gorge as the valley narrows considerably in this part of the watershed compared to the broader floodplains and terraces from above Winthrop down to Carlton (USFS 1999a). Valley widths vary from about a mile at the upper end to less than half a mile at the lower end (USFS 1999a). Tributaries to the Methow River include Texas Creek, Libby Creek, Gold Creek, McFarland Creek, French Creek, Squaw Creek and Black Canyon Creek. The subwatershed also includes the towns of Carlton and Methow.

Elevation ranges from 8,646 feet at Hoodoo Peak in the Libby Creek drainage to 800 feet at the confluence of the Methow and Columbia Rivers (USFS 1999a). Annual precipitation ranges from 50 inches in the highest reaches of Libby and Gold Creek drainages to 10 inches at the mouth of the Methow River (Richardson 1976). State Highway 153 parallels the Methow River along its entire reach within the subwatershed with approximately a dozen bridge crossings.

Most of the subwatershed is federally owned and managed by the National Forest Service as the Okanogan National Forest with a small portion of upper Libby Creek lying within the Lake Chelan – Sawtooth Wilderness. The majority of federal land is west of the Methow River, with only a small portion of federal land east of the Methow River in the upper reaches of the North Fork Texas Creek and upper French Creek. The Methow River valley floor, including the lower reaches of Libby, Gold, McFarland, Squaw, and

Black Canyon Creek drainages and the majority of land east of the Methow River are a patchwork of private lands, DNR managed lands and WDFW managed lands. The lower elevation land adjacent to the river is mostly private and is occupied by orchards, field crops, rangeland, and family residences.

Of the salmonid species this document addresses, the following species occur in the Middle Methow River Subwatershed; spring chinook, summer chinook, rainbow/steelhead, and bull trout. Table 8 describes species use for the listed drainages in the subwatershed.

Table 8 Known salmonid species use in the Lower Methow River Subwatershed.

Lower Methow River Subwatershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Bull Trout		
	spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration	spawning	rearing	migration
Methow River		X	X	X	X	X	X	X	X		X	X
Libby Creek							X	X	X			
S. Fk. Libby Creek							X	X	X			
N. Fk. Libby Creek							X	X	X			
Gold Creek	X	X	X				X	X	X			
S. Fk. Gold Creek		X					X	X	X			
Foggy Dew Creek							X	X	X			
Crater Creek										X	X	
N. Fk. Gold Creek							X	X	X			
Black Canyon Creek							X	X	X			

<u>Mainstem Lower-Methow River</u>

The lower Methow River is a migratory corridor for all anadromous salmonids and fluvial bull trout that spawn and rear in the Methow watershed. It also serves as rearing habitat for all salmonid species. Summer chinook salmon are known to spawn in the lower Methow River; spring chinook salmon do not spawn this far downstream in the mainstem. A 1999 – 2000 radio telemetry study conducted by the Mid-Columbia PUDs displayed concentrated steelhead spawning activity in the lower mainstem Methow (S. Bickford, Douglas County PUD, pers. comm., 2000). Acknowledging that this represents only one year of data, it shows where significant spawning areas are currently based upon tagged fish.

Habitat conditions for this segment of the Methow River are undocumented in the literature nor did the technical advisory group have professional knowledge of habitat conditions in this reach. Although it is known that the Methow River in the lower reach is mostly confined by bedrock, possible key habitat areas remain unidentified. For this reason, there is nothing to enter under the habitat categories for this section of the Lower Methow River Subwatershed.

Libby Creek Drainage

The Libby Creek drainage runs east-to-west and contains about 25,000 acres. Libby Creek is approximately 14 miles in length and drains into the Methow River at RM 26.4 about 0.5 mile downstream of the town of Carlton (RM 27.0). Tributaries include Smith Canyon, Chickamun Canyon, Ben Canyon, Mission, South Fork Libby and North Fork Libby Creeks.

Much of the drainage has been heavily managed for timber harvesting and livestock grazing. It is also heavily used by recreationists (USFS 1999b). The headwaters of the North and South Forks of Libby Creek are located in the Lake Chelan – Sawtooth Wilderness. The lower reach of the mainstem up to RM 2.9 and most of the Smith Canyon stream bottom are privately owned. Roads parallel every perennial stream in the drainage having a major affect on aquatic habitat (USFS 2000g). Road density is 2.1 miles/square mile with a road density in the riparian reserve of 4.6 miles /square mile (USFS 1999a).

Of the salmonid species considered in this report only summer steelhead have been documented in the Libby Creek drainage, where they are known to spawn and rear. Bull trout were not observed during snorkeling surveys in the summer of 1998 (USFS 1999b).

Stream survey information is not available for Libby Creek from the RM 0.0 - 2.9. The USFS stream survey began at RM 2.9 on Forest Service land.

Access to Spawning and Rearing Habitat

Libby Creek (48.0203). At RM 6.6, under F.S. Road 100 there is a culvert that appears to be a velocity barrier to fish migration during high flows (USFS 1999b).

Libby Creek. There are two documented irrigation diversion on Libby Creek; Larson Ditch (SWSW of Section 30, Township 22N, Range 32 E, WM); and Williams Ditch (RM 1.7). The screen on the Larson ditch is in compliance with state standards (TAG 2000). The diversion dams associated with these two diversions may act as impediments to fish passage at some flows. The Williams ditch, which originates on USFS land, will have a temporary screen in place for 2000 that meets state standards (TAG 2000). At RM 5.9 there is an unscreened, four-inch pipe in a man-made side channel that appears to be diverting water from the stream. There is no information available as to the legitimacy of this diversion (USFS 1999b). Libby Creek is an adjudicated watercourse that allows for the diversion of a total of 3.0cfs. This exceeds base flows during August and September of some years, dewatering the lower reach of the creek (USFS 1995b; Methow Valley Water Pilot Planning Project Planning Committee 1994). The dewatering could strand juveniles and negatively impact rearing habitat in this reach (TAG 2000).

North Fork Libby Creek (48.0229). The culverts at the two road crossings on the North Fork of Libby Creek (USFS Roads 43 and 700; RM 0.9 and 2.5) may be velocity barriers to fish migration during high flow (USFS 1999b).

North Fork Libby Creek. At RM 4.6 on North Fork Libby Creek there is a 10 foot waterfall that is a barrier to upstream movement of salmonids (USFS 1999b).

Smith Canyon (48.0206), Chicamun Canyon (48.0221) and Ben Canyon (48.0229). Some culverts in these streams are barriers to the upstream migration of rainbow/steelhead trout, keeping them from using historical spawning and rearing areas (USFS 1995b). Rainbow/steelhead have been observed in the lower reaches of Smith Canyon, Chicamun Canyon and Ben Canyon Creeks during an electrofishing survey (USFS 1995b). These culverts are located on both private and Forest Service lands within the Okanogan National Forest boundaries.

South Fork Libby Creek (48.0232). The culvert under Road 43 crossing South Fork Libby Creek (RM 0.6) appears to be a velocity barrier to fish migration during high flow (USFS 1999b).

South Fork Libby Creek. Several smaller waterfalls and high gradient riffles restrict fish passage in the South Fork at about RM 2.5 (USFS 1999b).

Floodplains

Libby Creek. The lower 2.9 miles have been channelized and straightened (TAG 2000). Bank hardening has occurred in sections of this same reach (TAG 2000).

Libby Creek. County Road 1049/ USFS Road 43 constrains the floodplain to RM 2.5 (TAG 2000).

Libby Creek. Wetland alteration has occurred below RM 2.5.

Smith Canyon. Smith Canyon Road constrains the creek. The road crosses the creek multiple times confining the creek (TAG 2000).

Riparian.

Libby Creek. From the mouth upstream to RM 1.0, grazing and agricultural practices have degraded the riparian area (TAG 2000).

Libby Creek. At RM 1.7, the Williams ditch occupies a 30 foot by 500 foot section of the riparian zone. The banks of the ditch are eroding, delivering sediment into Libby Creek just upstream of a known steelhead spawning area identified in Appendix D of the Mullan report (Mullan et al. 1992)

Libby Creek. Trees have been harvested in the past in the riparian areas and on the banks, Extensive harvesting in the riparian areas has been documented between RM 6.2 and 6.7 (USFS 1999b).

Libby Creek. Dispersed campsites at the F.S. Road 100 crossing were damaging riparian vegetation (USFS 2000g).

Libby Creek Drainage. Most of the perennial streams are paralleled by roads (TAG 2000).

Libby Creek. Libby Creek Road/ F.S. Road 43 parallel the Creek (TAG 2000).

South Fork Libby Creek. The roads in the riparian reserves are most likely eroding into the creek, increasing sediment levels. The USFS Road 180, located in the riparian reserve should be considered for closure or restoration by the USFS (USFS 1999b). These roads are also providing passageways to riparian areas for livestock, resulting in a general decline in riparian vegetation and stream channel condition.

North Fork Libby Creek. Based on survey data of the lower 4.6 miles, riparian habitats are in fair-good condition, with some isolated impacts from timber harvest and grazing. Roads 121 and 803 are located in the riparian reserve and should be considered for closing or restoration by the USFS (USFS 1999b).

North Fork Libby Creek. The spring-fed wetlands/ponds above the left bank of the creek at RM 0.5 have been damaged in the past by cattle grazing. The USFS has since changed the grazing permit but this wetland area should be monitored to make sure cattle impacts do not reoccur (USFS 1999b; USFS 2000g).

Mission Creek (48.0241), Ben Canyon, and Chicamun Canyon. Riparian vegetation has been impacted by many years of livestock grazing. This may be related to the proximity of roads, hence livestock travel corridors to creeks, increased timber sale activity opening areas to grazing previously less accessible, and a lack of livestock movement controls on the allotment. (USFS 1995b). Over utilization of the shrub component in the riparian areas was documented as early as 1911 (USFS 1995b). More recently, at sites in these canyons the USFS has documented changes from riparian shrub/grass/sedge plant associations to a dryer, shrub species/grass plant association (USFS 1995b), speculating that this is a factor related to cattle grazing (USFS 1995b). As of 1999, the USFS has made a change in its grazing lease but natural recovery of riparian areas impacted by soil compaction, noxious weed infestation, and decades of grazing is very slow (TAG 2000).

Large Woody Debris

Libby Creek. Large woody debris is scarce throughout the mainstem of Libby Creek (USFS 2000g). From RM 2.9-4.6 only 15 pieces of large wood /mile were counted (>35' long, >12" diameter at the small end; USFS 2000g). From RM 0.0 - 2.9, although not surveyed, this same condition exists (TAG 2000). Large woody debris is lacking due to past timber harvest on the banks and the removing of wood from the streams after timber harvest. Future recruitment of LWD to the stream was considered poor in many areas due to timber removal on the banks and in the riparian areas.

Channel Conditions and Streambed Sediment

Libby Creek (48.0203). Since 1963 eleven timber sales covering 16,670 acres were sold in the watershed. Over 10,000 acres were tractor logged leading to soil compaction (J. Molesworth, USFS, pers. comm., 2000). Thirty-nine percent of this total area was harvested (USFS 1995b). Much of the sediment in Libby Creek appears to be from roads and slope failures caused by timber harvesting (USFS 2000g). From RM 0.0 to 6.0 substrate conditions are poor based on professional knowledge (TAG 2000) and USFS survey reports. Between RM 2.9 and 6.0, pebble count data indicates 20% - 27% of particles sampled were fine sediments (<2mm; USFS 1999b).

Libby Creek. The Libby Creek road (F.S. Road 43) parallels the mainstem above the right bank. Road 43 was built on a steep grade, with erosional chutes leading down to the valley bottom and in the mid-1990s a large road failure closed the road for several years (USFS 1995b; USFS 2000g).

Libby Creek. Road 100, which crosses Libby Creek at RM 6.4 is delivering a large amount of sediment into the stream at the upstream end of the culvert during spring runoff and heavy rains (USFS 1995b; USFS 2000g).

Libby Creek. Pool habitat was considered poor in most of the mainstem Libby Creek with numbers of quality pools well below USFS Plan Standards and Guidelines. Only about 3 pools/mile were >3' deep. Pools were generally shallow, with a residual depth of about 1.6 feet. Hiding cover was poor, with wood, which is scarce, providing most of the cover in the mainstem (USFS 1999b).

South Fork Libby Creek. The USFS Road 4340 is the main spur road, leading from the South Fork drainage into the Gold Creek drainage. In 1995, a large slope failure (about half a mile south of the S. Fork stream crossing) which originates from a timber-harvested area, was delivering sediment to Libby Creek via South Fork Libby Creek which flows through the failure (USFS 1995b; USFS 2000g).

North Fork Libby Creek. Three large slope failures are found on the North Fork, all between USFS Roads 43 and 700. All three failures appeared to be caused by timber harvests on the slope above the stream. During high spring runoff, roads built along the streams are carrying sediments into the streams.

Water Quantity and Water Quality

The current Washington State 303 (d) list does not include any waters in the Lower Methow watershed.

Libby Creek. Libby Creek is an adjudicated watercourse that allows for the diversion of a total of 3.0cfs. This exceeds base flows during August and September of some years, dewatering the lower reach of the creek (USFS 1995; Methow Valley Water Pilot Planning Project Planning Committee 1994). The dewatering strands juveniles and negatively impacts rearing habitat (TAG 2000).

Elderberry Creek (48.0207). There is a USFS special use permit for water diversion at the mouth of Elderberry Creek for domestic use (USFS 1995b, page 32).

Smith Canyon Creek. There is a USFS special use permit for water diversion from Smith Canyon Creek for irrigation use (USFS 1995b, page 32).

Libby Creek. Water temperatures were monitored at the mouth of Libby Creek (elevation 1,500') and at the confluence of the South and the North Forks (elevation 2,500') during 1998. Water temperatures exceeded the Pacfish standard (maximum daily temperatures greater than 60° F; USFS and BLM 1995) for salmonid spawning on 15 days during the summer of 1998 at the mouth and on 3 days at the upper elevation monitoring site. The maximum water temperature recorded at the mouth was 63° F on July 27, 1998. Water temperatures exceeded the 7 day average maximum temperature of > 59°F at the mouth on 26 days during the summer. Given the elevation of Libby Creek at the mouth and the relative smallness of Libby Creek with its higher gradient, higher elevation and better stream shading, the USFS stated that even with these exceedances of Standards, water temperatures are not considered excessive (USFS 1999b; USFS 2000g).

Biological Processes

Libby Creek, South Fork Libby Creek, and North Fork Libby Creek. Brook trout found in the mainstem of Libby Creek and are suspected to be present in the accessible reaches of both the North and the South Forks of Libby Creek (USFS 1995b). During a 1998 snorkeling survey in which 20% of the habitat was randomly sampled, no brook trout were seen in the mainstem, the North Fork or the South Fork of Libby Creek, indicating densities are low (USFS 1999b).

Libby Creek. Beaver have historically played a major role in Libby Creek (USFS 1999b) but their presence in the drainage has declined (TAG 2000). Pools from old beaver dams are found at the beginning of RM 2.9, where the stream survey of Libby Creek began. A 1937 map showed no beaver activity in Libby Creek but there is physical evidence that a large beaver dam once existed on the mainstem just upstream from Ben Canyon. Current beaver activity was found only at RM 4.4 on the mainstem where beaver dams in a side channel were creating nice pool habitat, with many fish seen in the pools.

Data Gaps.

- A riparian habitat inventory and an assessment of restoration opportunities from RM 0.0 to 2.9 is needed.

- An assessment of water diversions and their affect on stream flow, aquatic habitat, and riparian habitat.

- An assessment of road location on sediment delivery and stream channel function is needed. This should include both county and USFS roads.

- The extent of brook trout and bull trout occurrence in the mainstem Libby Creek and North Fork Libby Creek.

Recommendations

- Based on the results of a fish passage barrier and assessment, address fish passage barriers in a coordinated, prioritized manner. This should be based on the species affected and the habitat quantity and quality to be made available.

- Libby Creek is over ajudicated, resulting in the dewatering of lower Libby Creek during low flow years. This results in direct mortality to steelhead juveniles, an ESA listed species, and a decrease in steelhead habitat. Management strategies should be implemented to avoid this occurrence.

- Address sedimentation in the drainage by identifying roads for closure, relocation, obliteration, and drainage improvements. Specifically F.S. Roads 121 and 803 located in the riparian reserve along North Fork Libby Creek and F.S. Road 180 located in the riparian reserve along South Fork Libby Creek, should be considered for closure or restoration by the USFS (USFS 1999b).

- Increase LWD levels in the mainstem of Libby Creek through instream placement and riparian restoration.

- Conduct a night snorkeling survey in September to look for brook trout and bull trout in upper Libby Creek and North Fork Libby Creek.

- On USFS and private lands, manage livestock grazing to avoid and minimize impacts to existing riparian habitat and to allow for the recovery of riparian stands to mature stands.

- Following completion of a riparian assessment for the Libby Creek drainage, the projects identified for protection and restoration should be implemented.

- A permanent screen needs to be installed on the Williams Ditch diversion and the eroding ditch bank needs to be stabilized.

Gold Creek Drainage

The Gold Creek drainage runs east to west and encompasses about 58,800 acres. It drains into the Methow River from the east at RM 21.8, about 6 miles downstream of the town of Carlton (RM 27.0). Gold Creek is 10.2 miles in length. Its tributaries include South Fork Gold Creek, North Fork Gold Creek, Foggy Dew Creek, and Crater Creek.

Much of the drainage has been heavily managed for timber harvesting and livestock grazing. (USFS 1996b). It is one of the more heavily used areas for recreation in the Methow Valley Ranger District (USFS 2000f). None of the drainage is located in the wilderness. The lower reaches of the mainstem and South Fork Gold Creek are privately owned. Roads parallel every major stream in the drainage having a major affect on aquatic habitat (USFS 2000f).

Summer Chinook salmon spawn in the Methow River below the confluence with Gold Creek. Small numbers of spring chinook salmon spawn in the first 3 miles of Gold Creek (Edson 1990; USFS 2000f). Fluvial bull trout spawn and rear in Crater Creek. Summer steelhead spawn and rear in the Gold Creek drainage (USFS 2000f).

Forest Service stream survey information is not available for Gold Creek from RM 0.0 - 2.9. The USFS stream survey began at RM 2.9 on Forest Service land. Forest Service stream survey information is not available for South Fork Gold Creek from RM 0.0 - 2.1. The USFS stream survey began at RM 2.1 on Forest Service land.

Access to Spawning and Rearing Habitat

Gold Creek (48.0104). There are two irrigation diversions on private land on the mainstem of Gold Creek: the Campbell diversion (RM 0.2) and the Umberger/McCall diversion (RM1.3). The Campbell diversion becomes a full barrier to upstream fish passage at low flows (TAG 2000). Screen conditions are unknown.

South Fork Gold Creek (48.0105). A concrete bottomed box culvert on South Fork Gold Creek at the confluence with Rainy Creek (RM 3.6) is a full barrier to salmonid passage. At the same location there are two metal pipes which create a barrier to fish passage.

South Fork Gold Creek. At RM 6.8 on South Fork Gold Creek there is a 25 foot waterfall that is a barrier to upstream movement of salmonids.

Foggy Dew Creek (48.0153). On Foggy Dew Creek a 15 foot falls at about RM 4.3 (about 1 mile above the end of USFS Road 500) creates a barrier to upstream passage of salmonids.

Crater Creek (48.0177). On Crater Creek a 30 foot falls at RM 2.9 (about 0.1 mile below the confluence with Martin Creek) creates a barrier to upstream passage of salmonids.

North Fork Gold Creek (48.0178). Natural low flows are a barrier on North Fork Gold Creek above its confluence with Crater Creek. Crater Creek supplies about 90% of the flow in N. Fk. Gold Creek.

Floodplains

Gold Creek. From the mouth to the North Fork Gold Creek confluence (RM 3.5) USFS Road 4340 occupies portions of the floodplain reducing floodplain function (TAG 2000).

Gold Creek. From RM 0.3 – 3.5 bank portions of the stream bank have been riprapped confining the channel (TAG 2000).

South Fork Gold Creek. On private land in the lower reach, alterations to the floodplain may be negatively impacting floodplain functions (TAG 2000).

Riparian

Gold Creek (48.0104). The conversion of riparian areas to agricultural and residential use in lower Gold Creek has degraded aquatic habitat (L. Hofmann, WDFW, pers. comm., 2000). The USFS Road 4340 parallels the mainstem continuing up along the North Fork to its headwaters and over into the Libby Creek drainage.

South Fork Gold Creek and North Fork Gold Creek. Timber has been cut along the streambanks as evidenced by many cut stumps. Dogwood and alder have replaced conifers in some areas, lessening the future recruitment of LWD. Saplings and small trees are the dominant size classes of trees both along the banks and in the floodplain, along with scattered large ponderosa pines (USFS 1996b). All the land has been designated for intensive timber harvesting and grazing under the Okanogan National Forest Plan as amended by the Northwest Forest Plan which requires 300 foot riparian buffers (USFS 1996b). On South Fork Gold Creek most of the harvesting near and along the banks is found from RM 4.0 to RM 5.0 (USFS 1996b).

South Fork Gold Creek and North Fork Gold Creek. Roads parallel all the major streams in the Gold Creek drainage negatively affecting riparian areas. The USFS Road 4340 is located close along the mainstem Gold Creek and the North Fork of Gold Creek, where it continues after leaving the Gold Creek stream corridor (USFS 2000f). Forest Service Road 4330 parallels the South Fork of Gold Creek. Spur logging roads are found in the riparian areas on South Fork Gold Creek between RM 3.4 and 5.5.

Foggy Dew Creek. Three campsites located in the USFS Foggy Dew Campground (RM 3.9) are right on the banks of the creek. Damage to the stream banks at this location is causing sediment to be delivered to the creek (USFS 2000f).

Foggy Dew Creek. Numerous tree have been cut in a large dispersed campsite on USFS Spur Road 4330225 (to enlarge the campsite, use for firewood and to mill; USFS 2000f) negatively impacting the riparian habitat.

Foggy Dew Creek. The USFS Road 500 parallels Foggy Dew Creek for the first 4.0 miles.

Crater Creek. The USFS Road 300 or F.S. Road 4340 parallels Crater Creek for the first 2 miles. Spur roads off USFS Road 300 are found above the left bank to the Crater Lake trailhead.

Large Woody Debris

South Fork Gold Creek, North Fork Gold Creek and Crater Creek. Large woody debris is scarce throughout the entire surveyed area of the Gold Creek drainage (USFS 2000f). Large woody debris has been removed from the streams in the past by timber harvesters under terms of the timber contracts. Wood probably has been removed to lessen the effects of flooding and to increase fish passage (USFS 2000f). The future recruitment potential of large woody debris is poor on the North Fork of Gold Creek below the confluence with Crater Creek due to the removal of trees in the riparian area, and in the mainstem of Gold Creek (trees removed for agriculture).

Channel Conditions and Streambed Sediment

Gold Creek. The USFS Road 4340 was built close to the stream, paralleling the creek and causing erosion (USFS 2000f). The 0.6 mile stream segment between the USFS boundary and the confluence with Foggy Dew Creek (RM 3.9) has major bank erosion problems, with about 12.5% of the banks eroding in this segment. A bank erosion site about 215 feet long and 25 feet high is being caused by runoff from USFS Road 4340 just below the confluence with Foggy Dew Creek (water pipe from the road located at the top of the bank; USFS 2000f).

South Fork Gold Creek. Bank erosion is delivering large amounts of sediment from RM 3.4-6.8 on the South Fork of Gold Creek. Much of the erosion appears to be caused by timber harvests. An old logging road which crosses the South Fork at about RM 4.5 is causing some erosion along the banks. The worst erosional sites were caused by failures below USFS Road 600, particularly above the stream crossing at RM 5.5. These erosional sites were directly below USFS Road 600, possibly the result of the road being constructed on a steep grade.

South Fork Gold Creek. Over half the pools from RM 3.4–5.5 were embedded, while 27% (27 of 100) of the pools had fine sediment loads of greater than 40% of total substrate. Fine sediment averaged 20% in pebble counts conducted on 2 riffles in the reach. Sedimentation was a problem from RM 5.5-6.8 as well, with about 19% of the pools embedded, and average fine sediment loads in pools at about 20%, especially high for such a high gradient stream segment (7%). Much of the sediment is coming from eroding banks. Another major source of sediment is from a tributary, which enters the left bank near RM 5.5, just above the USFS Road 600 stream crossing. A very large amount of sediment was seen in this tributary, which was dry at the time of the survey in July 1996 (USFS 1996b).

North Fork Gold Creek. Over half the pools in the first mile above the confluence of the North Fork of Gold Creek and Crater creek were embedded, and 16 of the 43 pools in this reach had fine sediment loads > 40% of the total substrate. It was determined that the sediment source was mostly upstream.

North Fork Gold Creek. The North Fork of Gold Creek is a heavily roaded and heavily harvested drainage with an extensive network of spur logging roads at its headwaters (USFS 1996b). Along with timber harvests on steep slopes, USFS Road 4340 built close to the stream for most of its length, is a major source of bank erosion in the drainage (USFS 2000f). A large area of mass wasting, possibly caused by water being diverted from USFS Road 4340, was found on the North Fork of Gold Creek.

Crater Creek. An old closed logging road paralleling Crater Creek at RM 0.7 is actively eroding. This site, about 60 feet long and 20 feet high.

Water Quantity and Water Quality

Gold Creek. There are two irrigation diversions on private land on the mainstem of Gold Creek: the Campbell diversion (RM 0.2) and the Umberger/McCall diversion (RM1.3). Gold Creek flows over permeable glacial deposits below RM 3.0 and there are alternating reaches dewatered (Appendix D, Mullan et al. 1992). The extent to which this is a natural function or exacerbated by water diversions is unknown.

South Fork Gold Creek. Water is diverted from the South Fork of Gold Creek into ponds on private land (the old Shaw place – no better information available; TAG 2000). Screen conditions are unknown. The diverted water flows back into the South Fork, resulting in no net-loss of stream flow (USFS 1996b).

North Fork Gold Creek. There is one known water diversion on the North Fork called the Creveling diversion (no better information available; TAG 2000). Screen condition is unknown.

Biological Processes

Gold Creek Drainage. Evidence of old beaver dams were found throughout the surveyed area. A decline in activity is indicated by the lack of current activity in the drainage (USFS 2000f).

Data Gaps.

- A riparian habitat inventory and an assessment of restoration opportunities from RM 0.0 to 3.5 is needed.
- An assessment of water diversions and their affect on stream flow, aquatic habitat, and riparian habitat.
- An assessment of road location on sediment delivery and stream channel function is needed. This should include both county and USFS roads.
- An assessment of the affects on salmonid productivity of the pond habitat on the "Old Shaw Place" on South Fork Gold Creek is needed.

Recommendations

- Address sedimentation in the drainage by identifying roads for closure, relocation, obliteration, and drainage improvements.
- Increase LWD levels in the mainstem of Gold Creek through instream placement and riparian restoration.
- Screen conditions for the Campbells, Umberger/McCall, Old Shaw Place, and Creveling diversions should be assessed and screened according to standards.
- The Campbell diversion should be improved so it does not act as a fish barrier.
- The bull trout populations in the Gold Creek drainage should be protected.
- The USFS Road 339, which comes in one mile above USFS Road 300, should be closed (TAG 2000).

Squaw Creek (48.0043) and Black Canyon Creek (48.0015).

Little information on habitat conditions is available for these drainages. Squaw Creek joins the Methow River at RM 9.0 and has a drainage of about 16 square miles (USFS 1999a). It is considered to have very little influence on anadromous habitat in the Methow River (USFS 1999a) and no stream survey has been conducted in this drainage. Black Canyon Creek joins the Methow River at RM 8.1, has a drainage of about 25 square miles (15,940 acres; USFS 1999a), and is 7.2 miles in length. Summer steelhead spawn in the lower 0.4 miles of Black Canyon Creek (USFS 1999a) and resident rainbow trout are known to occur further upstream to about F.S. Road 100 (TAG 2000). The State Highway 153 culvert crossing at the mouth of Squaw Creek blocks anadromous fish passage into Squaw Creek (USFS 1999a). Rainbow trout were noted in Squaw Creek up to and just above the FS Road 125 crossing (about RM 3.0; November 1998 field notes, D. Hopkins, USFS fish technician).

Access to Spawning and Rearing Habitat.

Squaw Creek. There is a barrier culvert under State Highway 153 at the mouth of Squaw Creek that blocks anadromous access into the Squaw Creek drainage. It is undetermined whether this naturally narrow constriction in the channel was ever passable to salmon or steelhead (TAG 2000).

Black Canyon Creek. At RM 3.5 on Black Canyon Creek there is a 20 foot falls that is a barrier to upstream movement of salmonids.

Floodplains. - no information available.

Riparian

Black Canyon Creek. The USFS Rd. 4010 is the main road through the drainage, paralleling the stream for most of its length from the mouth to the Cascade Crest. The main road crosses the stream just above the Forest boundary (RM 1.0) and at the headwaters. Numerous spur logging roads access the slopes above the creek. Many of the spur logging roads in the riparian areas have been closed. Closed USFS Rd. 050 crosses Black Canyon Creek at about RM 3.0 (USFS 2000ab).

Black Canyon Creek. Cattle grazing occurs in much of the drainage. Although cattle were damaging the riparian area of Black Canyon Creek at the USFS Rd. 050 crossing in the past, minimal cattle damage was noted during the 1994 survey (USFS 2000b).

Black Canyon Creek. The Forest Service has no maintained campgrounds in Black Canyon Creek. Two large dispersed campgrounds are found at the first road crossing (RM 1.0), above the left bank. These campsites had sanitation and erosion problems. Vehicles are driving across the stream despite the presence of a bridge less than 100 feet above the creek crossing.

Large Woody Debris.

Black Canyon Creek. Large woody debris was scarce in the 3.8 mile surveyed stream segment (RM 0.8 to 4.6), with only 17 pieces per mile greater than 35 feet long with a diameter greater than 12 inches. The lack of large wood is largely due to the two large fires (in the 1920s, and in 1970), which burned a large part of the drainage, and from timber harvesting. Future recruitment potential for large wood is considered poor due to the seedling/sapling size deciduous vegetation growing on the stream banks along much of the stream.

Channel Conditions and Streambed Sediment.

Black Canyon Creek. Sediment levels are very high in Black Canyon Creek, due to heavy management in the drainage (roading, timber harvesting, and cattle grazing), from highly erosive soils, and from two major fires in the drainage this century. Every pool inspected for cobble embeddedness (each measured pool) was judged to be embedded by surveyors. Bank erosion was high (650 feet per mile) in the first surveyed reach (RM 0.8 to 2.3; USFS 2000b).

Black Canyon Creek. The USFS Rd. 4010 is the main road through the drainage, paralleling the stream for most of its length from the mouth to the Cascade Crest. The main road crosses the stream just above the Forest boundary (RM 1) and at the headwaters (USFS 2000b). Numerous spur logging roads access the slopes above the creek. Many of the spur logging roads in the riparian areas have been closed. Closed USFS Road 050 crosses Black Canyon Creek at about RM 3.0.

Black Canyon Creek. Pool habitat was lacking in Black Canyon Creek, with less than 5% of the total habitat area consisting of pools. Existing pool habitat was of poor quality, due to the lack of depth and hiding cover (small stream size and lack of large wood and large substrate).

Black Canyon Creek. Cattle grazing in units on the tributaries could be delivering sediment to Black Canyon Creek (USFS 2000b).

Black Canyon Creek. Timber harvesting has occurred throughout much of the drainage. Timber harvesting in the headwaters (450,000 board feet, in 1991) may be a factor in the large amount of sediment in Black Canyon Creek (USFS 2000b).

Black Canyon Creek. The Forest Service has no maintained campgrounds in Black Canyon Creek. Two large dispersed campgrounds are found at the first road crossing (RM 1.0), above the left bank. These campsites had sanitation and erosion problems. Vehicles are driving across the stream despite the presence of a bridge less than 100 feet above the creek crossing.

Water Quantity and Water Quality.

Black Canyon Creek. Water is diverted from a man-made side channel just above the USFS boundary (RM 0.8) into a 12" pipe for irrigation on private land. The permittee was told the pipe needs to be screened to prevent fish loss into the pipe (USFS 2000b). The status of the screen is unknown.

Black Canyon Creek. Black Canyon Creek is entirely or substantially dewatered during periods of high irrigation water use in the summer and early fall month (Methow Valley Water Pilot Planning Project Planning Committee 1994).

Biological Processes.

Black Canyon Creek. Brook trout are found in the side channel wetlands created by beaver dams in the surveyed reach (RM 0.8 to 4.6).

Black Canyon Creek. Sixteen beaver dams were located between RM 2.0 and 4.0, although most appeared to be inactive (USFS 2000b).

Data Gaps

- A temperature monitoring device should be placed in the creek to determine temperature trends.

- Conduct surveys for summer steelhead redds, if possible, to determine if steelhead still spawn in the stream (habitat is degraded).

Recommendations

- The vehicle crossing just below the bridge at RM 1.0 needs to be barricaded to prevent vehicles from driving across the stream.

ASSESSMENT OF HABITAT LIMITING FACTORS

Table 9, Assessment of habitat conditions limiting salmonid performance in WRIA 48, provides a rating of habitat factors by stream or stream reach. The table only includes streams where salmon, rainbow/steelhead, or bull trout are known to occur. Habitat factors rated coincide with the habitat limiting factors categories presented in the "Habitat Limiting Factors by Subwatershed" chapter of this report. However, decreased beaver activity and the loss of salmon carcass nutrients as listed in the Biological Processes category were not rated in the table. It is the professional opinion of the TAG that beaver activity throughout the Methow watershed represents a decrease from historic levels and therefore all streams ranked would rate poor for beaver activity where it applies. The same situation applies to the decrease in nutrient input in the Methow watershed as a result of the significant decrease in salmon carcasses; all streams or reaches which once benefited from nutrients derived from salmon carcasses would rate poor for salmon carcass nutrients. When rating pools, only pools in the stream reach downstream of natural barriers were considered for their potential to affect salmonid productivity. The habitat factors rated focus on: 1) artificial barriers; 2) lost floodplain connectivity; 3) degraded riparian areas; 4) decreased LWD; 5) elevated fine sediment levels; 6) substrate embeddedness; 7) sediment delivery; 8) decreased pool quality and quantity; 9) increasing width/depth ratios; 10) water temperature exceedences; 11) water quality contamination by toxic materials; 12) changes in peak and/or base flows; 13) dewatering; and 14) brook trout.

The information upon which the assessment is based was derived from published sources and the combined professional knowledge of the 2496 Methow TAG participants. Therefore, each rating incorporates how one or more biologists judged the quality of habitat at various locations based on available information. The assessment was completed over a period of three 8-hour TAG meetings on April 12, 19 and 25, 2000. During these meetings, TAG participants assigned a rating of "Good" (Properly Functioning), "Fair" (At Risk) or "Poor" (Not Properly Functioning) using the criteria provided in the "Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors in the Methow Watershed" (Appendix D). The number "1" assigned to the rating indicates quantitative studies or published reports exist to support the rating. The number "2" assigned to the rating indicates the professional knowledge of the TAG was used to rate the condition and data analysis, data, or published reports were not available.

Habitat ratings provided in the assessment table can be correlated back to habitat conditions presented in the "Habitat Limiting Factors by Subwatershed" chapter of the report. For example, floodplain connectivity for Early Winters Creek is rated "P1" (poor based on qualitative studies or published reports). Turning to the Early Winters Subwatershed section of the "Habitat Limiting Factors by Subwatershed" chapter, subheading, "Floodplains" (page 41 of 96), the lower 0.5 miles of Early Winters Creek is identified as having been riprapped and diked confining the floodplain in this reach.

The assessment table shows where field biologists have been and what they have seen or studied. Where "**DG**" (data gap) appears in the table, there was so little information available on the habitat condition (published or professional knowledge) that the TAG did not feel confident making even a qualitative determination of condition for the habitat factor. The absence of a stream on the list does not necessarily mean salmon, rainbow/steelhead or bull trout do not occur in the stream or imply that the stream is in good health. Some streams may not be listed because they have not been documented to support salmon, rainbow/steelhead, or bull trout nor surveyed for stream health conditions. This is usually the case for stream reaches not on federal land. Others streams may show more impacts because they are easily accessible or have been the focus of more scientific study.

Table 9 Assessment of habitat conditions limiting salmonid performance in WRIA 48

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Methow River (NB at RM 83.2)	48.0007														
RM 0.0 - 33.0 (Benson Creek)		G2	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	F2
RM 33.0 - 50.1 (Winthrop)		G1	P2	P2	P2	DG	DG	DG	DG	DG	DG	DG	G2	F2	P1
RM 50.1 - 73.0 (Lost River)		G1	F2	F2	P2	DG	F2	F2	F2	F2	DG	DG	P1	DG	P1
RM 73.0 - 86.7 (headwaters)		G1	G1	G2	G2	G2	G2	G2	G2	G2	G2	G2	P2	G2	F2
Black Canyon (NB at RM 3.5)	48.0015	DG	DG	F2	P1	DG	P1	P1	P1	DG	DG	G2	P1	P1	F2
Gold Creek	48.0104														
RM 0.0 - 3.9 (Foggy Dew Crk. confluence)		P1	F2	F2	P2	DG	DG	P2	DG	DG	G1	DG	P1	P1	F2
S. Fork Gold Creek (NB at RM 6.8)	48.0105	P1	F2	F2	P2	DG	P1	P1	F2	F2	G1	G2	G2	G2	F2
Foggy Dew Creek (NB at RM 4.3)	48.0153	G1	G2	G2	P2	DG	G2	G1	G1	G2	G1	G2	G2	G2	F2
Crater Creek (NB at RM 2.9)	48.0177	G2	G2	G2	P2	DG	G2	G2	G1	G2	G2	G2	G2	G2	F2
N. Fk. Gold Creek (RM 3.9 - 10.2/headwaters)	48.0178	G2	G2	F2	P2	DG	F2	P1	F2	F2	G1	G2	G2	G2	F2

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Libby Creek	48.0203														
RM 0.0 - 2.9		F2	P2	P2	P1	DG	P2	P2	P2	DG	G2	G2	P1	P1	P1
RM 2.9 - 6.8 (N. Fk. & S. Fk. confluence)		P2	P2	F2	P1	DG	P2	P2	P1	DG	G2	G2	G2	G2	P1
N. Fk. Libby Creek (NB at RM 4.6)	48.0229	F2	G2	F2	F2	DG	F2	P2	P2	F2	G2	G2	G2	G2	F2
S. Fk. Libby Creek (NB at RM 2.5)	48.0231	F2	G2	F2	F2	DG	G2	F2	F2	F2	G2	G2	G2	G2	F2
Beaver Creek	48.0307														
RM 0.0 - 9.0 (state campground)		P1	P2	P2	P2	DG	P2	P2	DG	DG	DG	DG	P1	P1	P1
RM 9.0 - 22.3 (headwaters)		P1	G2	G2	G2	DG	P2	P2	F2	DG	DG	G2	G2	G2	P1
Frazer Creek	48.0366	P1	P2	P2	P2	DG	DG	DG	DG	P2	DG	F2	G2	F2	P1
S. Fk. Beaver Creek	48.0342	P1	P2	F2	F2	DG	P1	P2	F1	DG	DG	G2	G2	F2	P1
Blue Buck Creek	48.0309	G1	G2	G2	G2	DG	F2	F2	P2	DG	DG	G2	P2	DG	P1
Lightning Creek	48.0361	G1	G2	G2	G2	DG	P1	F2	F2	DG	DG	G2	G2	DG	P1
Alder Creek	48.0296	P1	P2	P2	DG	P2	P2	P2	DG	DG	DG	P1	G2	DG	P2

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Twisp River (NB at RM 29.4)	48.0374														
RM 0.0 - 6.9		F2	P2	P2	DG	DG	F2	P2	DG	DG	F1	DG	G2	P1	P1
RM 6.9 - 12.7		G2	P2	F2	P1	DG	F2	P2	P1	F2	G1	G2	G2	F1	P1
RM 12.7 - 28.2 (headwaters)		G2	G2	G1	F1	DG	G2	F1	F2	G2	G2	G2	P1	G2	P1
Poorman Creek	48.0386	DG	F2	P2	DG	DG	DG	P2	DG	DG	DG	DG	DG	F2	F2
Little Bridge Creek	48.0423	P2	P1	P1	P1	P1	P1	P1	P1	P1	DG	DG	G2	P2	F2
Canyon Creek	48.0548	DG	DG	P2	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	F2
Buttermilk Creek	48.0466	G2	G2	F1	P1	G2	G2	P1	F1	G1	DG	DG	G1	F2	F2
E. Fk. Buttermilk Creek (NB at RM 3.6)	48.0470	P1	G1	G1	G1	DG	G1	G1	G1	G1	G1	G1	G1	G1	F2
W. Fk. Buttermilk Creek	48.0466	G1	G1	G1	G1	DG	G1	P1	G1	G1	G1	G1	G1	G1	F2
Eagle Creek (NB at RM 0.5)	48.0541	P2	F2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G1	G1	F2
War Creek (NB at RM 1.2)	48.0559	G1	F2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G1	G1	P1
Reynolds Creek (NB at RM 0.5)	48.0613	P1	F2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G1	G1	P1
South Creek (NB at RM 0.5)	48.0641	G1	F2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G1	G1	F2
North Creek (NB at RM 0.5)	48.0674	G1	P2	F2	F2	G2	G2	G2	G2	G2	G2	G2	G2	F2	F2

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Twisp River cont'd Bear Creek	48.0708	P1	F2	P2	DG	DG	P2	P2	DG	DG	DG	DG	G2	F2	P1
Chewuch River (NB at RM 34.6)	48.0728														
RM 0.0 - 8.8 (Boulder Crk. confluence)		F2	F1	G2	F2	DG	P1	P1	P2	G2	P1	G2	G1	P1	P1
RM 8.8 - 23.4 (Lake Crk. confluence)		G1	F1	F2	P1	DG	P1	P1	F1	F2	F1	G2	G1	F2	P1
RM 23.4 - 44.8 (headwaters)		G1	F1	G2	F1	DG	P1	F1	G1	G2	G2	G2	G2	G2	P1
Cub Creek (NB at RM 0.4)	48.0737	G1	F2	P2	DG	DG	DG	P2	DG	DG	DG	DG	G2	G2	P1
Boulder Creek (NB at RM 1.0)	48.0770	G1	P1	P2	P1	F2	F2	P1	G1	F2	F2	G2	G2	F2	P1
Eightmile Creek	48.0901	P1	P2	F1	F2	P2	P2	P1	F2	P2	G1	DG	G2	F2	P1
Falls Creek (NB at RM 0.2)	48.0940	G1	G2	F2	F2	DG	F2	P2	G2	G2	G2	G2	G1	F2	P1
Twentymile Creek (NB at RM 0.6)	48.0977	G2	P1	P1	P2	F2	G2	P2	P1	P1	G2	G2	P1	F1	P1
Lake Creek (NB at RM 9.2)	48.1020	G2	G2	G1	G1	DG	F2	F2	G1	G1	G1	G2	G1	G2	F1
Andrews Creek (NB at RM 0.5)	48.1087	G2	G2	G2	G2	DG	G2	G2	G1	G1	G2	G1	G1	G1	F1

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Wolf Creek (NB at RM 10.6)	48.1300														
RM 0.0 - 4.0		G1	F2	F2	F1	DG	DG	F2	F2	G2	G1	G2	P1	P1	P2
RM 4.0 - 14.0 (headwaters) (NB at RM 10.6)		G1	G1	G2	G1	DG	DG	F2	G2	G2	G2	G2	G1	G1	P2
Hancock Creek	48.1355	P1	G2	P2	P2	P2	P2	F2	P2	P2	DG	DG	G2	F2	P2
Goat Creek (NB at RM 12.0)	48.1364														
RM 0.0 - 1.5		G1	P1	P1	P1	P1	G1	P1	P1	P1	P1	G1	P1	F2	P2
RM 1.5 - 12.5 (headwaters) (NB at RM 11.6)		G1	F1	P1	P1	P1	G1	P1	P1	F1	P1	G1	G1	F2	P2
Whiteface Creek	48.1401	F1	G1	P1	DG	DG	DG	P2	DG	DG	DG	G2	G2	F2	G2
Little Boulder Creek	48.1400	P1	P2	F2	DG	DG	DG	P2	DG	DG	DG	G2	DG	P2	DG
Early Winters Creek (NB at RM 8.0)	48.1408														
RM 0.0 - 1.5		G1	P1	F1	F1	G1	G1	F1	P1	F1	G1	F2	F2	P1	P1
RM 1.5 - 15.7 (headwaters) (NB at RM 8.0)		G1	G1	G1	G1	G2	F2	F2	G2	G2	G1	F2	G1	G1	P1
Cedar Creek (NB at RM 2.0)	48.1411	G1	N/A	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2

STREAM NAME	WRIA INDEX	Artificial Barrier	Floodplain Connectivity	Riparian Condition	Large Woody Debris	Channel Conditions					Water Quality		Water Quantity		Biological Processes
						Fine Sediment	Substrate embeddedness	Sediment Delivery	Pools	Width/ Depth Ratio	Temperature	Toxics	Dewatering	Flows	Brook Trout
Lost River	48.1592														
RM 0.0 - 1.0		G1	F2	P2	F2	G2	G2	F2	P1	F2	G2	G2	G1	G1	G1
RM 1.0 - 7.1 (Monument Crk)		G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1
RM 7.1 - 22.5 (headwaters) (natural flow barrier at RM 7.1)		N/A	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Eureka Creek (NB at RM 0.3)	48.1600	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Monument Creek	48.1602	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Ptarmigan Creek (NB at RM 0.5)	48.1700	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Robinson Creek (NB at RM 0.6)	48.1794	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Rattlesnake Creek (NB at RM 0.7)	48.1842	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Trout Creek (NB at RM 0.5)	48.1872	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2

P = Average habitat condition considered to be poor (Not Properly Functioning)

F = Average habitat condition considered to be fair (At Risk)

G = Average habitat condition considered to be good (Properly Functioning)

1 = Quantitative studies or published reports documenting habitat condition, including comparison of USFS stream survey data with the Interagency Aquatic Database and GIS.

2 = Professional knowledge of the TAG members

DG = Data Gap; the stream or reach has not been surveyed, visited by members of the TAG, or so little information is available that the TAG did not feel qualified rating the condition.

NB = Natural Barrier

NAT = Natural

N/A = Not Applicable

NOTE: Pool quality is rated only up to the natural barrier.

LITERATURE CITED

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) – steelhead trout. USFWS Biological Report 82(11.60). Army Corps of Engineers, TR EL-82-4. 21 p.

Baxter, C.V., C.A. Frissell and F.R. Hauer. 1999. Geomorphology, logging roads, and the distribution of bull trout spawning in a forested river basin: implications for management and conservation. Transactions of the American Fisheries Society. 128(5): 854-867.

Beck, R. W. and Associates. 1973. Floodplain information. Methow River: Mazama to Twisp, Okanogan County, Washington. WA Department of Ecology, Olympia, WA.

Beechie, T. and S. Bolton. 1999. An approach to restoring salmonid habitat-forming processes in Pacific Northwest watersheds. Fisheries. 24(4):6-15.

Bilby, R.E., B.R. Fransen, P.A. Bisson, and J.K. Walter. 1998. Response of juvenile coho salmon (Oncorhynchus kisutch) and steelhead (Oncorhynchus mykiss) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Can. J. Fish. Aquat. Sci. 55:1,909-1,918.

Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B.Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. In: E.O. Salo and T.W. Cundy (Editors), Streamside Management: Forestry and Fishery Interactions. Contrib. No. 57, Institute of Forest Resources, University of Washington, Seattle, WA, pp. 143-190.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. In: W.R. Meehan (Editor), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19:83-138.

Bonneville Power Administration. 1997. Methow Valley Irrigation District Project Final Environmental Assessment and Finding of No Significant Impact. DOE/EA – 1181. Portland, OR.

Bonneville Power Association, the Yakima Nation and the Washington Department of Fish and Wildlife. 1999. Mid-Columbia coho salmon reintroduction feasibility project, Preliminary Environmental Assessment. DOE/EA-1282. 67 p.

Brown, LG. 1992. Draft management guide for the bull trout Salvelinus confluenctus (Suckley) on the Wenatchee National Forest. Prepared for the Wenatchee National Forest, WDFW, Wenatchee. 103 p.

Bryant, F.G. and Z.E. Parkhurst. 1950. Survey of the Columbia and its tributaries; area III, Washington Streams from the Klickitat and Snake rivers to Grand Coulee Dam with notes on the Columbia and its tributaries above Grand Coulee Dam. USFWS, Spec. Sci. Rept. 37-108 p..

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U. S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Caldwell, B. and D. Catterson. 1992. Methow River Basin Fish Habitat Analysis Using the Instream Flow Incremental Methodology. Publication #92-82, WA Department of Ecology, Olympia, WA. 196 p.

Carie, D. G. 1996. Spring and summer chinook salmon and sockeye salmon spawning ground surveys on the Entiat River, 1995. U. S. Fish and Wildlife Service, Leavenworth, WA.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24(10): 6-15.

Chamberlin, T.W., R.D. Harr, and F.H. Everest. 1991. Timber harvesting, silviculture, and watershed processes. In: Influences of Forest and Rangeland Management of Salmonid Fishes and Their Habitats. W.R. Meehan (Editor). American Fisheries Society Special Publication 19:297-323. 751 p.

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Amer. Fish. Soc. 115:662-670.

Chapman, D. W., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B. Suzumoto, R. Klinge. 1994a. Status of summer/fall chinook salmon in the mid-Columbia region. Don Chapman Consultants, Boise, ID.

Chapman, D. W., C. Peven , T. Hillman, A. Giorgi , F. Utter. 1994b. Status of summer steelhead in the mid-Columbia river. Don Chapman Consultants, Boise, ID.

Chapman, D. W., C. Peven , A. Giorgi, T. Hillman, F. Utter. 1995a. Status of spring chinook salmon in the mid-Columbia region. Don Chapman Consultants, Boise, ID.

Chapman, D.W., C. Peven, A. Giorgi, T. Hillman, F. Utter, M. Hill, J. Stevenson, and M. Miller. 1995b. Status of sockeye salmon in the mid-Columbia region. Don Chapman Consultants, Inc. Boise, ID.

Columbia River Inter-Tribal Fish Commission (CRITFC). 1995. Wy-Kan-Ush-Mi-Wa-Kish-Wit, Spirit of Salmon; the Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Volume II, Subbasin Plans.

Committee on Protection and Management of Pacific Northwest Anadromous Salmonids, Board of Environmental Studies and Toxicolgy, and Commission on Life Sciences. 1996. Upstream: salmon and society in the Pacific Northwest. National Academy of Sciences, Washington, D.C. 452 p.

Craig, J.A. and A.J. Suomela. 1941. Time of appearance of the runs of salmon and steelhead trout native to the Wenatchee, Entiat, Methow, and Okanogan rivers. Unpub. MS. USFWS. 35 pp. Plus 18 affidavits and accompanying letters of corroboration.

Don Chapman Consultants, Inc. 1989. Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Final Report to Chelan County Public Utility District, Wenatchee, Washington. 301 p.

Edson, S.A. 1990. Spring chinook spawning ground surveys of the Methow River, 1990. Yakama Indian Nation, Fisheries Resource Management. Toppenish, WA.

EMCON Northwest, Inc. 1993. Draft Report Upper Methow River Valley Hydrogeological Summary Report. EMCON Northwest, Inc., Portland, OR., prepared for Okanogan County, WA.

Federal Emergency Management Agency. 1994. Flood Insurance study: Okanogan County, Washington, unicorporated areas.

Fetherston, K. L., R.J. Naiman, and R.E. Bilby. 1995. Large woody debris, physical process, and riparian forest development in montane river networks of the Pacific Northwest. Geomorphology. 13:153-144.

Fish, F.F. and M.G Havana. 1948. A report upon the Grand Coulee Fish-Maintenance Project 1939 – 1947. USFWS, Special Scientific Report No. 55. 63p.

Fraley, J. and B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Northwest Science 63:133 143.

Frissel, C.A. and R.K. Nawa. 1992. Incidence and causes of physical failure of artificial habitat structure in streams of Western Oregon and Washington. North American Journal of Fisheries Management. 12:182-197.

Frissel, C.A. 1993. A new strategy for watershed restoration and recovery of Pacific Salmon in the Pacific Northwest. Pacific Rivers Council, Inc. Eugene, OR. 33 p.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. In: Influences of Forest and Rangeland Management of Salmonid Fishes and Their Habitats. W.R. Meehan (Editor). American Fisheries Society Special Publication 19:297-323. 751 p.

Golder Associates Inc. 1993. Report to Economic and Engineering Services Inc. on Water Budget for the Methow Basin. 28 p.

Gorman, M.W. 1899. The Eastern Part of the Washington Forest Reserve. Extract from the Nineteenth Annual Report of the U.S. Geological Survey. Washington D.C. Government Printing Office.

Gower, E. and E. Espie. 1999. Beaver Creek Fish Passage and Water Diversion Inventory. Washington Department of Fish and Wildlife, Habitat and Lands Services Program, Salmonid Screening, Habitat Enhancement and Restoration (SSHEAR) Division, Olympia, WA.

Groot, C. and L. Margolis (Editors). 1991. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, BC. 564 p

Healey, M.C. 1983. Coastwide contribution and ocean migration patterns of stream-and ocean-type chinook salmon Oncorhynchus tshawystcha. Canandian Field Naturalist 97-427-433.

Healey, M.C. 1991. Life history of chinook salmon (Oncorhynchus tshawytscha). In: Groot, C. and L. Margolis (Editors). Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, BC. 564 p.

Hartman, G. F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon and steelhead trout. J. of the Fisheries Research Board of Canada 22:1035-1081.

Hoar, W.S. 1958. The evolution of migratory behavior among juvenile salmon of the genus Oncorhynchus. J. Fish. Res. Board. Can. 15:391-428.

Howell, P., K. Jones, D Scarnecchia, L. LaVoy. W. Kendrea, and D. Ortmann. 1985. Stock assessment of Columbia River anadromous salmonids; Vol. 1: chinook, soho, chum, and sockeye salmon stock summaries. Rep. For Bonneville Power Administration, 83-335, Portland, OR.

Hubble, J. and D. Harper. 1999. Methow Basin Spring Chinook Salmon Supplementation Plan – Natural Production Study. 1995 Annual Report. Prepared for Douglas County Public Utility District, E. Wenatchee, WA. 59 pp.

Issac, L.A. 1924. Forest Cover Map. Chelan National Forest, In: Fire Atlas 1931 – 1940, Okanogan National Forest, fire dispatch files.

Johnson, R.R. and S.W. Carothers. 1982. Riparian habitats and recreation: interrelationships and impacts in the Southwest and Rocky Mountain region. Eisenhower Consortium for West. Eniviron. For. Res. Bull. 12:1-31.

Knutson, K.L. and V.L. Neaf. 1997. Management recommendations for Washington's priority habitats: riparian. Wash. Dept. Fish and Wildl., Olympia. 181pp.

Kohn, M. 1987. Spring and summer chinook spawning ground surveys, Methow and Okanogan River Basins. Yakama Indian Nation, Fisheries Resource Management. Toppenish, WA.

_______. 1988. Spring and summer chinook spawning ground surveys - Methow and Okanogan River Basins 1988. Yakama Indian Nation Fisheries Management report to the Douglas County PUD.

Larkin, P.A. 1977. Pacific Salmon, p. 156-186. In: J.A. Gulland (ed.). Fish population dynamics. J. Wiley & Sons, New York, NY.

Lee, L.C., Muir, T.A., and R.R. Johnson. 1987. Riparian ecosystems as essential habitat for raptors in the American West. Pages 15-26. In: Proc. of the western raptor management symposium and workshop. Nat. Wildl. Fed., Washington, DC.

Lestelle, L.C., L.E. Mobrand, J.A. Lichatowich, T.S. Vogel. 1996. Applied Ecosystem Analysis – A Primer. Project No. 9404600. Prepared for the U.S. Dept. of Energy, Bonneville Power Administration, Portland, OR. 95pp.

McPhail, J.D. and C. Murray. 1979. The early life history and ecology of Dolly Varden (Salvelinus Malma) in the upper Arrow Lakes. Report to the British Columbia Hydro and Power Authority and Kootenay Department of Fish and Wildlife.

Methow Valley Ground Water Advisory Committee. 1994. Methow Valley Ground Water Management Plan. Okanogan County Office of Planning and Development, Okanogan, WA.

Methow Valley Water Pilot Planning Project Planning Committee. 1994. Draft Methow River Basin Plan. Okanogan County Office of Planning and Development, Okanogan, WA.

Milhous, R. T., G. Sorlie, and D. Richardson. 1976. Water Resources of the Methow Basin. Office Report No. 56, Water Resources Analysis and Information Section, WA Department of Ecology, Olympia, WA. 57 p.

Miller, R. R. 1965. Quaternary freshwater fishes of North America. In: The Quaternary of the United States. Princeton University Press, Princeton, New Jersey. Pp. 569-581.

Mitsch, W. J., and J.G. Gosselink. 1986. Wetlands. Van Nostrand Reinhold Company. New York, NY. 537 p.

Mobrand Biometrics, Inc. 1999 Draft. The EDT Method. Vashon Island, WA. 34 pp.

Montgomery Watershed Group, Inc. 1996. Methow Valley Irrigation District Water Supply Facility Plan, Vols. I, II, Appenices. Kirkland, WA.

Mullan, J.W. 1983. Overview of artificial and natural propagation of coho salmon (Onchorhynchus kisutch) on the mid-Columbia river. Fisheries Assistance Office, U.S. Fish and Wildlife Service, Leavenworth, WA.

Mullan, J.W. 1984. Overview of artificial and natural propagation of coho salmon *(O. Kisutch*) in the Mid-Columbia Rivers. Rep. No. FRI/FAO-84-4, USFWS, Leavenworth, WA.

______, J.W. 1986. Determinants of sockeye salmon abundance in the Columbia River, 1880's – 1982: a review and synthesis. USFWS Biological Report 86(3). 111p.

______, J.W. 1987. Status and propagation of chinook salmon in the mid-Columbia River through 1985. USFWS Biol. Rep. 87(3). 111p.

Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman and J.D. McIntyre. 1992. Production and habitat of salmonids in Mid-Columbia River tributaries. Monograph 1, U.S. Fish and Wildlife Service, Leavenworth, WA.

Neave, F. 1949. Game fish populations of the Cowichan River. Bull. Fish. Res. Board Can. 84:1-32.

Nelson, Kurt. 1998. The influence of sediment supply and large woody debris on pool characteristics and habitat diversity. Master of Science Thesis. University of WA, Seattle. 73p.

Newbury, R., Gaboury, M. and D. Bates. 1997. Restoring habitats in channelized or uniform streams using riffle and pool sequences. In: P.A. Slaney and D. Zaldokas eds. Fish Habitat Rehabilitation Procedures. Watershed Rest. Tech. Circ. No. 9. Ministry of Env., Lands and Parks, Vancouver, BC.

Okanogan County. 1996. Draft Multi-objective river corridor plan for the Methow Basin. Office of Planning and Development, Okanogan, WA.

Pacific Watershed Institute. 1996. Chewuch River restoration and monitoring program Challenge Cost-Share Program Accomplishment Report 1995 – 96. Prepared for the Methow Valley Ranger District, Okanogan National Forest. 32 pp.

Pearsons, T.N. and C.W. Hopley. 1999. A practical approach for assessing ecological risks associated with fish stocking programs. Fisheries 24(9): 16-23.

Peplow, D. and R.Edmonds. 1999. Effects of Alder Mine on the water, sediments and benthic macroinvertebrates of Alder Creek. BPA project 98-035-00. University of Washington, College of Forest Resources, Ecosystem Science Division. Seattle, WA. 97pp.

Peplow, D. 1999. Results: Cadmium and zinc accumulation by trout in water contaminated by heavy metals from the abandoned Alder Mine in Okanogan County, Washington. October 5, 1999, University of Washington, College of Forest Resources, Ecosystem Science Division. Seattle, WA.

Peterson, N.P. 1980. The role of spring ponds in the winter ecology and natural production of coho salmon (Oncorhynchus kisutch) on the Olympic Peninsula, Washington. M. Sc. Thesis. University of Washington Seattle, WA 96 p.

Peven, C. M. 1990. The life history of naturally produced steelhead trout from the mid-Columbia River Basin. MS these, University of Washington, Seattle.

_____, C.M. 1992. Population status of selected stocks of salmonids from the Mid-Columbia River Basin. Chelan County Public Utilities Division, Wenatchee, WA. 52 p.

Platts, W.S. 1991. Livestock grazing. American Fisheries Society Special Pub. 19:389-423.

Proebstel, D.S., R.J. Behnke, and S.M. Noble. 1998. Identification of salmonid fishes from tributary streams and lakes of the mid-Columbia basin. USFWS, Leavenworth, WA.

Quigley, T.M. and S.J. Arbelbide. 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, OR: U.S. Department of Agriculture, Forest Service Pacific Northwest Research Station. 4 vol. (Quigley, T.M., tech. Ed.; The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Richardson, Don. 1976. Natural monthly streamflow in the Methow Basin. Water Resources Analysis and Information Section, Office Report No. 46. Washington Department of Ecology, Olympia, WA. 7p.

Rock Island Dam Hydroelectric Facility, Rocky Reach Dam Hydroelectric Facility, and Wells Dam Hydroelectric Facility. 1998. Application for individual incidental take permits filed with the National Marine Fisheries Service (NMFS) July 30, 1998; Exhibit D – "Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow and Okanogan Watersheds" and "Biological Assessment and Management Plan, Mid-Columbia River Hatchery Program".

Scarlett, W.J. and C.J. Cederholm. 1984. Juvenile coho salmon fall-winter utilization of two small tributaries of the Clearwater River, Jefferson County, Washington, p. 227-242. In: J.M. Walton and D. B. Houston (eds.). Proceedings of the Olympic Wild Fish Conference, March 23-25, 1983. Fisheries Technology Program, Peninsula College, Port Angeles, WA.

Schwartzberg, M. and J. Fryer. 1988. Identification of Columbia basin sockeye salmon stocks based on scale pattern analyses, 1987. Tech. Rept. 88-2, Columbia River Inter-Tribal Fish Commission, Portland, OR.

Scribner, T., T.K. Meekin, J. Hubble, and W. Fiander. 1993. Spring Chinook Spawning Ground Surveys of the Methow River Basin. Yakima Indian Nation Fisheries Resource Management, Toppenish, WA.

Scrivener, J.C. and B.C. Andersen. 1982. Logging impacts and some mechanisms which determine the size of spring and summer populations of coho salmon fry in Carnation Creek, p. 257-272. In: G.F. Hartman (ed.) Proceedings of the Carnation Creek Workshop: a ten year review. Pacific Biological Station, Nanaimo, BC.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Onchorhynchus kisutch) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish Game Fish Bull. 98, 375 p.

Spotts, J.V. 1987. Bull trout surveys conducted in Yakima, Kittitas, and Chelan Counties, Washington 1982-1986. WDW. Unpub. Rep. 22 p.

Swanson, D. N. 1991. Natural Processes. In: Influences of Forest and Rangeland Management of Salmonid Fishes and Their Habitats. W.R. Meehan (Editor). American Fisheries Society Special Publication 19:139-179. 751 p.

Theurer, F.D., I. Lines and T. Nelson. 1985. Interaction between riparian vegetation , water temperature and salmonid habitat in the Tucannon River. Water Resour. Bull. (21).

USBR. 1993. Methow Valley Water Planning Pilot Project; Skyline and Fulton Canals Irrigation Alternatives. Boise, ID.

USDA Forest Service and USDI Bureau of Land Management. 1995. Decision Notice/ Record of Decision, Finding of No Significant Impact, Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). Washington, DC.

USFS. 1993. Beaver Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1994. Chewuch River Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1995a. Goat Creek Watershed Analysis and Interim Late Successional Reserve Assessment. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

_____. 1995b. Libby Creek Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

_____. 1995c. Twisp River Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1996a. Early Winters Creek Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1996b. Gold Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1997. Middle Methow Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1998a. Biological Assessment for authorization for water conveyance by the Wolf Creek Reclamation District Irrigation Ditch. March 25, 1998. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1998b. Biological Assesment for water conveyance within the Chewuck watershed. March 10, 1998. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1998c. Biological Assessment of Riparian and Aquatic Habitat Restoration in Early Winters Creek. July 23, 1998. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1998d. Upper Methow Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1999a. Draft Lower Methow Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1999b. Libby Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 1999c. Lost River and Robinson Creek Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000a. Beaver Creek Stream Survey Summary, 08 – 92 to 09 – 92. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000b. Black Canyon Creek Stream Survey Summary, 06– 94 to 07 – 94. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000c. Chewuch River Stream Survey Summary, 09 – 93 to 10 – 93. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000d. Early Winters Creek Stream Survey Summary, 08 – 93 to 09 – 93. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000e. Goat Creek Stream Survey Summary, 08 – 92 to 09 – 92. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000f. Gold Creek Stream Survey Summary, 07 – 96 to 09 – 96. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000g. Libby Creek Stream Survey Summary, 07 – 98 to 08 – 98. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000h. Lost River Stream Survey Summary, 08 – 94 to 09 – 94. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000i. Methow River Stream Survey Summary, 07 – 94 to 08 – 94. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000j. Twisp River Stream Survey Summary, 08 – 93 to 09 – 93. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

____. 2000k. Wolf Creek Stream Survey Summary, 07 – 94 to 08 – 94. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS and BLM. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl; Standards and Guidelines for Management and Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. USDA and USDI, Washington D.C.

USFS and BLM. 1995. Decision Notice/Decision Record, Finding of No Significant Impact Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California. USDA and USDI, Washington D.C.

USFWS. 1998. Draft framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. Adapted from the NMFS, February 1998.

Waitt, R.B. Jr, 1972. Geomorphology and glacial geology of the Methow Drainage Basin, Eastern North Cascade Range, Washington. PhD. Dissertation, University of Washington, Seattle.

Walters, K. L. and E. G. Nassar. 1974. Water in the Methow River Basin, Washington. Water Supply Bulletin 38. Washington Department of Ecology, Olympia, WA. 59 p.

Washington Department of Ecology. 1998. 1998 Section 303(d) list – WRIA 48.

Washington Department of Fish and Wildlife. 1993. 1992 Washington State Salmon and Steelhead Stock Inventory; Appendix Three, Columbia River Stocks. Olympia, WA.

_____________________________________. 1998a. 1998 Washington Salmonid Stock Inventory; Appendix: Bull trout and dolly varden. WDFW Fish Program, Olympia, WA. 437 p.

_____________________________________. 1998b. Fish passage barrier assessment and prioritization manual. Habitat and Lands Services Program, Salmonid, Screening, Habitat Enhancement, and Restoration (SSHEAR) Division. Olympia, WA.

Washington Department of Fish and Wildlife, Yakama Indian Nation, and the Colville Confederated Tribes. 1990. Methow and Okanogan Rivers Subbasin, Salmon and Steelhead Production Plan. Columbia Basin System Planning, Northwest Power Planning Council, Portland, OR. 158 p.

Williams, R.F., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization. Wash. Dept. Fish and Wildl., Olympia.

Williams, R.N., L.D. Calvin, C.C. Coutant, M.W. Erho, Jr., J.A. Lichatowich, W.J. Liss, W.E. McConnaha, P.R. Mundy, J.A. Stanford, R.R. Whitney. 1996. Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem. Northwest Power Planning Council, Portland, OR. 584 p.

Willms, R. and W. Kendra. 1990. Methow River Water Quality Survey and Assessment of Compliance with Water Quality Standards. Environmental Investigations and Laboratory Services Program (EILS), Washington Department of Ecology, Olympia, WA.

Wydoski, R.S. and R.R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press, Seattle. 220p.

GLOSSARY

303 (d) List: The federal Clean Water Act requires states to maintain a list of stream segments that do not meet water quality standards. The list is called the 303(d) list because of the section of the Clean Water Act that makes the requirement.

Adaptive management: Monitoring or assessing the progress toward meeting objectives and incorporating what is learned into future management plans.

Adfluvial: Migratory between lakes and rivers or streams or, life history strategy in which adult fish spawn and juveniles subsequently rear in streams but migrate to lakes for feeding as subadults and adults. Compare fluvial.

Administratively Withdrawn Areas: A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Administratively Withdrawn Areas are identified in current Forest and District Plans or draft plan preferred alternatives and include recreation and visual areas, back county, and other areas where management emphasis precludes scheduled timber harvest.

Aggradation: The geologic process of filling and raising the level of the streambed or floodplain by deposition of material eroded and transported from other areas.

Alluvial: Deposited by running water.

Alluvial fan: A relatively flat to gently sloping landform composed of predominantly coarse grained soils, shaped like an open fan or a segment of a cone, deposited by a stream where it flows from a mountain valley onto a plain or broader valley, or wherever the stream gradient suddenly decreases. Alluvial fans typically contain several to many distributary channels that migrate back and forth across the fan over time. This distribution of flow across several stream channels provide for less erosive water velocities, maintaining and creating suitable rearing salmonid habitat over a wide range in flows.

Anadromous fish: Species that are hatched in freshwater mature in saltwater, and return to freshwater to spawn.

Anchor ice: Forms along the channel bottom form the accumulation of frazil ice particles on the rough surfaces of coarse bottom sediments and on the lee sides of pebble, cobbles, and boulders.

Aquifer:

1. A subsurface layer of rock permeable by water. Although gravel, sand sandstone and limestone are the best conveyors of water, the bulk of the earth’s rock is composed of clay, shale and crystalline.

2. A saturated permeable material (often sand, gravel, sandstone or limestone) that contains or carries groundwater.

3. An underground, water-bearing layer of earth, porous rock, sand, or gravel, through which water can seep or be held in natural storage. Aquifers generally hold sufficient water to be used as a water supply.

Basin: The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

Basin flow: Portion of stream discharge derived from such natural storage sources as groundwater, large lakes, and swamps but does not include direct runoff or flow from stream regulation, water diversion, or other human activities.

Bioengineering: Combining structural, biological, and ecological concepts to construct living structures for erosion, sediment, or flood control.

Biological Diversity (biodiversity): Variety and variability among living organisms and the ecological complexes in which they occur; encompasses different ecosystems, species, and genes.

Biotic Integrity: Capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region; a system's ability to generate and maintain adaptive biotic elements through natural evolutionary processes.

Biological oxygen demand: An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic waste.

Braided stream: Stream that forms an interlacing network of branching and recombining channels separated by branch islands or channel bars.

Buffer: An area of intact vegetation maintained between human activities and a particular natural feature, such as a stream. The buffer reduces potential negative impacts by providing an area around the feature that is unaffected by this activity.

Capacity: the amount of available habitat for a specific species or lifestage within a given area. Capacity is a density-dependent measure of habitat quantity.

Carrying capacity: Maximum average number or biomass of organisms that can be sustained in a habitat over the long term. Usually refers to a particular species, but can be applied to more than one.

Channelization: Straightening the meanders of a river; often accompanied by placing riprap or concrete along banks to stabilize the system.

Channelized stream: A stream that has been straightened, runs through pipes or revetments, or is otherwise artificially altered from its natural, meandering course.

Channel Migration Zone: lateral movement of channel leads to a sequence of events through time where terraces are formed and new floodplain areas are defined.

Channel Stability: Measure of the resistance of a stream to erosion that determines how well a stream will adjust and recover from changes in flow or sediment transport.

Check dams: Series of small dams placed in gullies or small streams in an effort to control erosion. Commonly built during the 1900s.

Confinement: When a channel is fixed in a specific location restricting its pattern of channel erosion and migration

Confluence: the flowing together of two or more streams, or the combined stream formed by the conjunction.

Congressionally Reserved Areas: A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). These areas include Wildernesses, Wild and Scenic Rivers, National Monuments, as well as other federal lands not administered by the Forest Service or BLM.

Connectivity: Unbroken linkages in a landscape, typified by streams and riparian areas.

Constriction: The narrowing of a channel that impedes the downstream movement of water or debris

Critical Stock: A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

Depressed Stock: A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.

Debris torrent: A type of landslide characterized by water-charged, predominantly coarse grained soil and rock fragments, and sometimes large organic material, flowing rapidly down a pre-existing channel.

Degradation: The lowering of the streambed or widening of the stream channel by erosion. The breakdown and removal of soil, rock and organic debris.

Deposition: The settlement of material out of the water column and onto the streambed.

Distributaries: A river branch flowing away from the main stream.

Diversity: Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems. See *species richness.*

Ecological restoration: Involves replacing lost or damaged biological elements (populations, species) and reestablishing ecological processes (dispersal, succession) at historical rates.

Ecosystem: Biological community together with the chemical and physical environment with which it interacts.

Ecosystem management: Management that integrates ecological relationships with sociopolitical values toward the general goal of protecting or returning ecosystem integrity over the long term.

Endangered Species Act: A 1973 Act of Congress that mandated the protection and restoration of endangered and threatened species of fish, wildlife and plants.

Endangered Species: Any species which is in danger of extinction throughout all, or a significant portion of its range, other than a species of the Class Insecta, as determined by the Secretary to constitute a pest.

Escapement: Those fish that have survived all fisheries and will make up a spawning population.

Estuarine: Of, or relating to, or formed in an estuary.

Estuary: A partly enclosed coastal body of water that has free connection to open sea, and within which seawater is measurably diluted by fresh river water.

Eutrophic: Pertaining to a lake or other body of water rich in dissolved nutrients, photosynthetically productive, and often deficient in oxygen during warm periods. Compare *oligotrophic.*

Evolutionary Significant Unit (ESU): A definition of a species used by National Marine Fisheries Service (NMFS) in administering the Endangered Species Act. An ESU is a population (or group of populations) that is reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species.

Extirpation: The elimination of a species from a particular local area.

Flood: A rising and overflowing of a body of water especially onto normally dry land.

Floodplain: The low-lying, topographically flat area adjacent to a stream channel which is regularly flooded by stream water on a periodic basis and which shows evidence of the action of flowing water, such as active or inactive flood channels, recent fluvial soils, rafted debris or tree scarring. It varies in width depending on size of river, relative rates of downcutting and resistance of the bedrock in the valley walls.

Flow regime: Characteristics of stream discharge over time. Natural flow regime is the regime that occurred historically.

Fluvial: Of or pertaining to, or living in streams or rivers; also, organisms that migrate between main rivers and tributaries. Compare *adfluvial*.

Frazil ice: Thin particles of ice suspended in the water. Produced where extensive channel ice is formed and the freezing supercools the stream water producing nuclei of “frazil ice” particles.

Gabion: Wire basket filled with stones, used to stabilize streambanks, control erosion, and divert stream flow.

Genetic Diversity Unit (GDU) is defined as: A group of genetically similar stocks that is genetically distinct from other such groups. The stocks typically exhibit similar life histories and occupy ecologically, geographically and geologically similar habitats. A GDU may consist of a single stock

Geomorphology: Study of the form and origins of surface features of the Earth.

Glides: Stream habitat having a slow, relatively shallow run of water with little or no surface turbulence.

Healthy Stock: A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.

Hydrologic Unit Code (HUC): classification system used to describe the sub-division of hydrologic units. The codes represent the four levels of classification in the hyrdrologic unit system. The first level divides the US into 21 major geographic areas, or regions, based on surface topography, containing the drainage area of a major river or series of rivers. The second level divides the 21 regions into 222 sub-regions, which includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin or, a group of streams forming a coastal drainage area. The third level subdivides many of the subregions into accounting units. These 352 units nest within, or are equivalent to, the sub-regions. The fourth level is the cataloging unit, a geographic area representing part or all of a surface drainage basin, a combination of basins, or a distinct hydrologic feature. These units subdivide the sub-regions and accounting units into approximately 2150 smaller areas.

Hydrograph: A graphic representation or plot of changes in the flow of water or in the elevation of water levels plotted against time.

Hydrology: Study of the properties, distribution, and effects of water on the Earth’s surface, subsurface, and atmosphere.

Interagency Aquatic Database and GIS: contains Stream Inventory information from the USFS, Oregon Department of Fish and Wildlife, and the Bureau of Land Management and can be sorted by stream width and stream gradient.

Intermittent stream: Stream that has interrupted flow or does not flow continuously. Compare *perennial stream*.

Interstitial: Between the grains (or cells or other solid objects). Having to do with the small, narrow spaces (interstices) found in between grains of sand, large cells or atoms or molecules, different tissues in the body, or within soil. The pores between minerals in a rock or the areas in a crystal which are not lattice sites.

Intraspecific interactions: Interactions within a species.

Large Woody Debris (LWD): Any large piece of relatively stable woody material having a diameter greater than 10 cm and a length greater than 3 meters. LWD is an important part of the structural diversity of streams. The nature and abundance of LWD in a stream channel reflects past and present recruitment rates. This is largely determined by the age and composition of past and present adjacent riparian stands. Synonyms include: Large Organic Debris (LOD) and Coarse Woody Debris (CWD). Specific types of large woody debris include:

Affixed logs: Singe logs or groups of logs that are firmly embedded, lodged, or rooted in a stream channel.

Deadheads: Logs that are not embedded, lodged or rooted in the stream channel but are submerged and close to the surface.

Digger log: Log anchored to the stream banks and/or channel bottom in such a way that a scour pool is formed.

Free logs: Logs or groups of logs that are not embedded, lodged or rooted in the stream channel.

Rootwad: The root mass of the tree.

Snag: A standing dead tree, or, a sometimes a submerged fallen tree in large streams. The top of the tree is exposed or only slightly submerged.

Sweeper log: Fallen tree whose bole or branches form an obstruction to floating objects.

Large Woody Debris Recruitment: The standing timber adjacent to the stream that is available to become large woody debris. Activities that disturb riparian vegetation including timber removal in riparian areas can reduce LWD recruitment. In addition, current conditions also reflect the past history of both natural and management-related channel disturbances such as flood events, debris flows, splash damming and stream cleanout.

Late-Successional Reserves (LSR’s): A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Late-Successional Reserves are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including he northern spotted owl. Limited stand management is permitted.

Limiting Factor: Single factor that limits a system or population from reaching its highest potential.

Macroinvertebrates: Invertebrates large enough to be seen with the naked eye (e.g., most aquatic insects, snails, and amphipods).

Mass wasting: Landslide processes, including debris falls, debris slides, debris avalanches, debris flows, debris torrents, rockfalls, rockslides, slumps and earthflows, and all the small scale slumping collapse and raveling of road cuts and fills.

Matrix: A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). The matrix consists of those federal lands outside of the six categories of designated areas (Congressionally Reserved Areas, Late –Successional Reserves, Adaptive Management Areas, Managed Late-Successional Area, Administratively Withdrawn Areas, and Riparian Reserves). Most timber harvest and other silvicultural activities would be conducted in that portion of the matrix with suitable forest lands, according to standards and guidelines. Most timber harvest takes place in the matrix.

Native: Occurring naturally in a habitat or region; not introduced by humans.

Non-Point Source Pollution: Polluted runoff from sources that cannot be defined as discrete points, such as areas of timber harvesting, surface mining, agriculture, and livestock grazing.

Oligotrophic: Pertaining to a lake or other body of water characterized by extremely low nutrient concentrations such as nitrogen or phosphorous and resulting in very moderate productivity.

Parr: Young trout or salmon actively feeding in freshwater; usually refers to young anadromous salmonids before they migrate to the sea. See *smolt*.

Plunge pool: A pool created by water passing over or through a complete or nearly complete channel obstruction, and dropping vertically, scouring out a basin in which the flow radiates from the point of water entry.

Productivity: A measure of habitat quality which varies by species and lifestage. Productivity is a density-independent measure of habitat quality. Examples include, water temperature, water discharge, channel complexity, riparian condition, etc.

Rain-on-snow events: The rapid melting of snow as a result of rainfall and warming ambient air temperatures. The combined effect of rainfall and snow melt can cause high overland stream flows resulting in severe hillslope and channel erosion.

Rearing habitat: Areas required for the successful survival to adulthood by young animals.

Recovery: The return of an ecosystem to a defined condition after a disturbance.

Redds: Nests made in gravel (particularly by salmonids) for egg deposition consisting of a depression that is created and the covered.

Rehabilitation: Returning to a state of ecological productivity and useful structure, using techniques similar or homologus in concept; producing conditions more favorable to a group of organisms or species complex, especially that economically and aesthetically desirable flora and fauna, without achieving the undisturbed condition.

Resident fish: Fish species that complete their entire life cycle in freshwater.

Riffle: Stream habitat having a broken or choppy surface (white water), moderate or swift current, and shallow depth.

Riparian: Pertaining to the banks and other adjacent, terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, and surface-emergent aquifers, whose imported waters provide soil moisture significantly in excess of that otherwise available through local precipitation – soil moisture to potentially support a mesic vegetation distinguishable from that of the adjacent more xeric upland.

Riparian Area: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains which support riparian vegetation.

Riparian Habitat Conservation Areas (RHCA): Portions of watersheds where riparian-dependent resources receive primary emphasis, and management activities are subject to specific standards and guidelines. The RHCAs include traditional riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris and nutrient delivery systems (USFS AND BLM 1995/ PACFISH)

Riparian Reserves: A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994/ Northwest Forest Plan). The Riparian Reserves provide an area along all stream, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.

Riparian Vegetation: Terrestrial vegetation that grows beside rivers, streams and other freshwater bodies and that depends on these water sources for soil moisture greater than would otherwise be available from local precipitation.

Riprap: Large rocks, broken concrete, or other structure used to stabilize streambanks and other slopes.

Rootwad: Exposed root system of an uprooted or washed-out tree.

Run: An area of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

SaSI (Salmonid Stock Inventory): A list of Washington's naturally reproducing salmonid stocks and their origin, production type and status.

SASSI (Salmon and Steelhead Stock Inventory): former name of SaSI.

SSHIAP (Salmon, Steelhead Habitat Inventory and Assessment Project): A partnership based information system that characterizes distribution and freshwater habitat conditions of salmonid stocks in Washington.

Salmonid: Fish of the family salmonidae, including salmon, trout chars, and bull trout.

Salmon: Includes all species of the family Salmonid

Sediment: Material carried in suspension by water, which will eventually settle to the bottom.

Sedimentation: The process of subsidence and deposition of suspended matter carried in water by gravity; usually the result of the reduction in water velocity below the point at which it can transport the material in suspended form.

Side channel: Lateral channel with an axis of flow roughly parallel to the mainstem, which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel. Side channel habitat may exist either in well defined secondary (overflow) channels or in poorly defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.

Sinuosity: Degree to which a stream channel curves or meanders laterally across the land surface.   Can be determined by the ratio of the stream length to valley floor, or, the ratio of the channel length between two points on a channel to the straight line distance between the same points.

Slope: Water surface slope is determined by measuring the difference in water surface elevation per unit stream length. Typically measured through at least twenty channel widths or two meander wavelengths.

Slope stability: The degree to which a slope resists the downward pull of gravity.

Smolt: Juvenile salmonid, 1 or more years old, migrating seaward; a young anadromous trout, salmon, or char undergoing physiological changes that will allow it to change from life in freshwater to life in the sea. The smolt stage follows the parr stage. See *parr*.

Stock: Group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction. Generally, a local population of fish. More specifically, a local population – especially that of salmon, steelhead (rainbow trout), or other anadromous fish – that originates from specific watersheds as juveniles and generally returns to its birth streams to spawn as adults.

Stream Number: A unique six-digit numerical stream identifier, with the first two digits representing the WRIA and the last four digits representing the unique stream identifier from the WDF Stream Catalog (Williams et al. 1975) where available. For streams where the Stream Catalog does not provide a stream identified: (1) unassigned numbers in the sequence are used; or (2) an additional single-character alpha extension may be added to the end of the four-digit stream identifier for the next downstream numbered stream. Alpha extensions are generally used for tributaries to a numerically identified stream proceeding from downstream to upstream.

Stream Order: A classification system for streams based on the number of tributaries it has. The smallest unbranched tributary in a watershed is designated Order 1. A stream formed by the confluence of two order 1 streams is designated Order 2. A stream formed by the confluence of two order 2 streams is designated Order 3; and so on.

Stream Reach: a homogeneous segment of a drainage network characterized by uniform channel pattern, gradient, substrate and channel confinement.

Stream Types:

Type 1: All waters within their ordinary high-water mark as inventoried in “Shorelines of the State”.

Type 2: All waters not classified as Type 1, with 20 feet or more between each bank’s ordinary high water mark. Type 2 waters have high use and are important from a water quality standpoint for domestic water supplies, public recreation, or fish and wildlife uses.

Type 3: Waters that have 5 or more feet between each bank’s ordinary high water mark, and which have a moderate to slight use and are more moderately important from a water quality standpoint for domestic use, public recreation and fish and wildlife habitat.

Type 4: Waters that have 2 or more feet between each bank’s ordinary high water mark. Their significance lies in their influence on water quality of larger water types downstream. Type 4 streams may be perennial or intermittent.

Type 5: All other waters, in natural water courses, including streams with or without a well-defined channel, areas of perennial or intermittent seepage, and natural sinks. Drainage ways having a short period of spring runoff are also considered to be Type 5.

Subwatershed: One of the smaller watersheds that combine to form a larger watershed.

Supplementation: the collection, rearing, and release of locally adapted salmon in ways that promote ecologic and genetic compatibility with the naturally produced fish.

Terrace: Abandoned floodplain.

Thalweg: The path of maximum depth in a river or stream.

Watershed: An area so sloped as to drain a river and all its tributaries to a single point or particular area. The total area above a given point on a watercourse that contributes water to its flow.

Watershed restoration: Reestablishing the structure and function of an ecosystem, including its natural diversity; a comprehensive, long-term program to return watershed health, riparian ecosystems, and fish habitats to a close approximation of their condition prior to human disturbance.

Watershed-scale approach: Consideration of the entire watershed in a project or plan.

Weir: Device across a stream to divert fish into a trap or to raise the water level or divert its flow. Also a notch or depression in a dam or other water barrier through which the flow of water is measured or regulated.

Width-depth ratio: Describes the dimension and shape factor as the ratio of bankfull channel width to bankfull mean depth.

Wild Stock: A stock that is sustained by natural spawning and rearing in the natural habitat regardless.

APPENDIX A – CHINOOK, STEELHEAD/RAINBOW AND BULL TROUT DISTRIBUTION

Table A- 1 Spring Chinook distribution in the Methow, WRIA 48						
Stream Name	**Species Use**	**Status**	**Data Source**	**Published Source**	**Professional Observation**	**Comments**
Alder Creek	Rearing	Known	1, 2	1	1	Lower extent of known rearing in Alder Creek. On Sept. 4, 1998, during a snorkeling survey, 4 juvenile chinook salmon approximately 100mm in length, were identified. Heather Barltlett, WDFW biologist, verified the identification.
Alder Creek	Rearing	Known	1, 2	1	1	Upper extent of known rearing in Alder Creek. On Sept. 4, 1998, during a snorkeling survey, 4 juvenile chinook salmon approximately 100mm in length, were identified. Heather Bartlett, WDFW biologist, verified the identification.
Andrews Creek	Rearing	known	2		2	Lower extent of known rearing
Andrews Creek	Rearing	Known	2		2	Upper extent of known rearing is about 1/4 mile up from mouth.
Bear Creek	Rearing	Known	2		3, 4	Lower extent of known rearing
Bear Creek	Rearing	Known	2		3, 4	Upper extent of known rearing
Beaver Creek	Rearing	Known	1	4		Lower extent of known rearing
Beaver Creek	Rearing	Known	1	4		Upper extent of known rearing. There is no information in the literature to support that spring chinook ever used Beaver Creek for rearing or spawning, except as a pull-out at the mouth of Beaver Creek. Use as a pull-out for brief periods is based on professional knowledge and was identified in a USFS stream survey report in the mid-1990's.
Boulder Creek	Rearing	Known	1, 2	2	4	Lower extent of known rearing
Boulder Creek	Rearing	Known	1, 2	2	4	Upper extent of known rearing
Buttermilk Creek	Rearing	Known	2		3	Lower extent of known rearing
Buttermilk Creek	Rearing	Known	2		3	Upper extent of known rearing
Chewuch River	Spawning	Known	1, 2	3, 5 (1990,pg. 21; 1991, pg. 16; 1993, pg. 24)	3	Lower extent of known spawning
Chewuch River	Spawning	Known	1, 2	3, 5 (1990,pg. 21; 1991, pg. 16; 1993, pg. 24)	3	Upper extent of known spawning is Chewuch Falls.
Chewuch River	Rearing	Known	2		3	Lower extent of known rearing is at the confluence of the Methow River.
Chewuch River	Rearing	Known	2		3	Upper extent of known rearing is at Chewuch Falls.

Table A- 1 Spring Chinook distribution in the Methow, WRIA 48

Stream Name	Species Use	Status	Data Source	Published Source	Professional Observation	Comments
Cub Creek	Rearing	Known	1	4		Lower extent of known rearing
Cub Creek	Rearing	Known	1	4		Upper extent of known rearing at barrier.
Dog Creek	Rearing	Known	2		3	Lower extent of known rearing
Dog Creek	Rearing	Known	2		3	Upper extent of known rearing is about 1/4 mile up from mouth.
Eagle Creek	Rearing	Known	1	4		Lower extent of known rearing
Eagle Creek	Rearing	Known	1	4		Upper extent of known rearing
Early Winters Creek	Rearing	Known	1, 2	2	3	Lower extent of known rearing at the mouth of Early Winters Creek.
Early Winters Creek	Rearing	Known	1, 2	3	4, 5	Upper extent of known rearing at the barrier falls at RM 8.0 on Early Winters Creek.
Early Winters Creek	Spawning	Known	1	5 (1992, pg. 30)		Lower extent of known spawning
Early Winters Creek	Spawning	Known	1	5 (1992, pg. 30)		Upper extent of known spawning at RM 4.0 (Klipchuck Campground).
Eightmile Creek	Rearing	Known	1	4		Lower extent of known rearing
Eightmile Creek	Rearing	Known	1	4		Upper extent of known rearing at road crossing.
Eureka Creek	Rearing	Known	1			Lower extent of known rearing. Eureka Creek is not identified in the Stream Catalogue but exists as a tributary to the Lost River, entering the Lost River at approximately RM4.5, right bank.
Eureka Creek	Rearing	Known	1	2		Upper extent of known rearing is at falls. Eureka Creek is not identified in the Stream Catalogue but exists as a tributary to the Lost River, entering the Lost River at approximately RM 4.5, right bank.
Falls Creek	Rearing	Known	2		3, 4	Lower extent of known rearing
Falls Creek	Rearing	Known	2		3, 4	Upper extent of known rearing
Goat Creek	Rearing	known	1, 2	2	4	Lower extent of known rearing
Goat Creek	Rearing	Known	1, 2	2	4	Upper extent of known rearing
Gold Creek	Rearing	Known	2		2, 6	Lower extent of known rearing.
Gold Creek	Rearing	Known	2		2, 6	Upper extent of known rearing

Table A- 1 Spring Chinook distribution in the Methow, WRIA 48

Stream Name	Species Use	Status	Data Source	Published Source	Professional Observation	Comments
Gold Creek	Spawning	Known	1	5, (1990, pg. 21)		Lower extent of known spawning
Gold Creek	Spawning	Known	1	5, (1990, pg. 21)		Concurrence by WDFW (Ken Williams), Yakama Indian Nation (Joel Hubble), USFS (Jennifer Molesworth), and Pacific Watershed Institute (Jeanette Smith) that this is upper extent of known spawning.
Lake Creek	Rearing	Known	1	4		Lower extent of known rearing
Lake Creek	Rearing	Known	1	4		Upper extent of known rearing
Lake Creek	Spawning	Known	1	5 (1992, pg. 30)		Lower extent of known spawning
Lake Creek	Spawning	Known	1	5 (1992, pg. 30)		Upper extent of known spawning goes to the parking lot. Has not been surveyed beyond this point.
Little Boulder Creek	Rearing	Known	1, 2	3	6	Lower extent of known rearing
Little Boulder Creek	Rearing	Known	1, 2	3	6	As of the fall of 1999, there is a known culvert barrier at Milepost 181.30 on SR20. This is approximately 500 feet up Little Boulder Creek from the confluence with the Methow River. Mullan et. al on pg. D-243 says there is "a scattering of chinook juveniles" in Little Boulder Creek. Mullan et al. also says the "delta (is) usually dry in summer". Joel Hubble stated juvenile spring chinook salmon probably only use the first few hundred feet of the Creek.
Little Bridge Creek	Rearing	Known	1, 2	2	4	Lower extent of known rearing. The stream survey map was compiled by the USFS from stream survey reports through 1998 as part of the preparation for a Biological Assessement.
Little Bridge Creek	Rearing	Known	1, 2	2	4	Upper extent of known rearing
Little Bridge Creek	Rearing	Potential	2		3, 4	Lower extent of potential rearing habitat
Little Bridge Creek	Rearing	Potential	2		3, 4	Upper extent of potential rearing habitat
Lost River	Rearing	Known	1	4		Lower extent of known rearing
Lost River	Rearing	Known	1	4		Upper extent of known rearing is at Monument Creek
Lost River	Spawning	Known	1	5 (1992, pg. 27)		Lower extent of known spawning
Lost River	Spawning	Known	1	3, 5 (1992, pg. 27)		Upper extent of known spawning; p. D-245, spawning occurs primarily below Eurka Creek (RM 3.9)
Methow River	Rearing	Known	2		2	Lower extent of known rearing
Methow River	Rearing	Known	2		2	Upper extent of known rearing documented by Ken Williams in a 1990 or 1991 observation. Joel Hubble (Yakama Indian Nation), Jennifer Molesworth (USFS) and Jeanette Smith (Pacific Watershed Institute) all concurr that this is the upper extent of known rearing in the Methow River.

Table A- 1 Spring Chinook distribution in the Methow, WRIA 48

Stream Name	Species Use	Status	Data Source	Published Source	Professional Observation	Comments
Methow River	Spawning	Known	1, 2	5	6	Lower extent of known spring chinook spawning on the mainstem Methow River as accepted by Joel Hubble, the Yakima Indian Nation (YIN) fish biologist, is at the Methow Valley Irrigation Distric t(MVID) diversion midway between Twisp and Winthrop. Although past YIN survey reports have identified redds located as far downstream as Carlton bridge as spring chinook redds, it is now (9/21/99) Joel Hubble's professional opinion that after mid-September, redds located below the MVID diversion can not conclusively be identified as either spring or summer chinook redds because of the overlap between these two runs in spawning times and spawning areas on the mainstem Methow. Note that it is Ken Williams' professional opinion, retired fish biologist for WDFW, that the lowest extent of known spawning could be at the Twisp confluence on the Methow River.
Methow River	Spawning	Known	2		2	Upper extent of know spawning just upstream of Trout Creek on the Methow River, documented by Ken Williams (WDFW) in a 1990 or 1991 observation. Note that YIN spring chinook spawning ground surveys have only documented spring chinook spawning redds as far upstream as the Lost River confluence.
North Creek	Rearing	Known	1	2		Lower extent of known rearing
North Creek	Rearing	Known	1	2		Upper extent of known rearing
Pearrygin Creek	Rearing	Known	2		3, 6	Lower extent of known rearing
Pearrygin Creek	Rearing	Known	2		3, 6	Upper extent of known rearing
Rattlesnake Creek	Rearing	Presumed	2		6	Lower extent of presumed rearing
Rattlesnake Creek	Rearing	Presumed	2		6	Upper extent of presumed rearing
Reynolds Creek	Rearing	Known	1	4		Lower extent of known rearing
Reynolds Creek	Rearing	Known	1	4		Upper extent of known rearing
Robinson Creek	Rearing	Known	2		4	Lower extent of known rearing
Robinson Creek	Rearing	Known	2		4	Upper extent of known rearing
S. Fk. Gold Creek	Rearing	Presumed	2		2, 3, 4, 6	Lower extent of known rearing
S. Fk. Gold Creek	Rearing	Presumed	2		2, 3, 4, 6	Upper extent of known rearing
South Creek	Rearing	Known	1	4		Lower extent of known rearing
South Creek	Rearing	Known	1	4		Upper extent of known rearing
Thirtymile Creek	Rearing	Known	2		3	Lower extent of known rearing

Table A- 1 Spring Chinook distribution in the Methow, WRIA 48

Stream Name	Species Use	Status	Data Source	Published Source	Professional Observation	Comments
Thirtymile Creek	Rearing	Known	2		3	Upper extent of known rearing
Trout Creek	Rearing	Presumed	2		6	Lower extent of presumed rearing
Trout Creek	Rearing	Presumed	2		6	Upper extent of presumed rearing
Twentymile Creek	Rearing	Known	2		3	Lower extent of known rearing
Twentymile Creek	Rearing	Known	2		3	Upper extent of known rearing
Twisp River	Rearing	Known	1, 2	2	2, 4, 6	Lower extent of known rearing
Twisp River	Rearing	Known	1, 2	2	2, 4, 6	Upper extent of known rearing
Twisp River	Spawning	Known	1, 2	5 (1990, pg. 21)	2, 4	Lower extent of known spawning
Twisp River	Spawning	Known	1, 2	5 (1990, pg. 21)	2, 4	Upper extent of known spawning
War Creek	Rearing	Known	1	4		Lower extent of known rearing
War Creek	Rearing	Known	1	4		Upper extent of known rearing
Wolf Creek	Rearing	Known	1, 2	4	4	Lower extent of known rearing at mouth of Wolf Creek.
Wolf Creek	Rearing	Known	1, 2	4	4	Upper extent of known rearing to RM 3.0 based on observation of juvenile spring chinook salmon during 1994 snorkeling survey.
Wolf Creek	Rearing	Potential	2		2, 4	Lower extent of potential rearing habitat.
Wolf Creek	Rearing	Potential	2		2, 4	Upper extent of potential rearing habitat
Wolf Creek	Spawning	Known	2		7	Lower extent of know spawning
Wolf Creek	Spawning	Known	2		7	Upper extent of known spawning is the vicinity of the Perrow ditch diversion (RM 0.5). In late Aug. or early Sept. 1993, Easterbrooks identified 2 spawned out carcasses - 1male (approx. 39" fork length) and one female. The female was floating in front of the Perrow fish screen. The male was in the creek just downstream. The redd was never located. Photographs of both fish were taken and details recorded on file under "Wolf Crk. Fish Screen" in the Yakima Screen Shop. Easterbrooks places the limit of spawning at RM 0.5 or a short distance upstream where the gradient increases dramatically and substrate size become unsuitable for spawning chinook.

CODES

1. Data Source: 1 = Published Source

2 = Professional Observation

2. Published Source: 1 = Dan Peplow. 1999. Results: Alder Creek Juvenile Salmonid Snorkeling Survey. Center for Streamside Studies, Univ. of WA, Seattle.

2 = U.S. Forest Service, Methow Valley Ranger District, Winthrop, WA. Hand-produced map of fish distribution information gathered from stream survey reports.

3 = Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams. USFWS Monograph 1, Leavenworth, WA.

4 = U.S. Forest Service, Methow Valley Ranger District, Winthrop, WA. Stream Survey Reports.

5 = Yakama Nation, Toppenish, WA. Spring Chinook Spawning Ground Surveys of the Methow River Basin

3. Professional Observation: 1 = Heather Bartlett, Washington Department of Fish and Wildlife (WDFW), Omak, WA. Area Fish Biologist, Region 2.

2 = Ken Williams, WDFW (retired), Omak, WA. Area Fish Biologist, WDFW Region 2

3 = Jeanette Smith, Pacific Watershed Institute, Winthrop, WA. Biologist.

4 = Jennifer Molesworth, U.S. Forest Service (USFS), Okanogan-Wenatchee National Forest, Methow Valley Ranger District, Winthrop, WA. District Fish Biologist.

5 = Dave Hopkins, U.S. Forest Service (USFS), Okanogan-Wenatchee National Forest, Methow Valley Ranger District, Winthrop, WA. Fisheries Technician.

6 = Joel Hubble, Yakama Nation, Toppenish, WA. Fish Biologist.

7 = John Easterbrooks, WDFW, Yakima, WA. Area Fish Biologist, Region 3.

Table A- 2 Summer Chinook distribution in the Methow, WRIA 48

Map ID #	WRIA Index	Stream Name	Species Use	Status	Data Source 1	Data Source 2	Published Data Source 1	Professional Observation Contact 1	Professional Observation Contact 2	Comments
1	48.0007	Methow River	Spawning	Known	Published Source	Professional Knowledge	Yakama Indian Nation spawning ground surveys, late-1980's.	Joel Hubble, Yakama Indian Nation Fish Biologist, Toppenish		Lower extent of known spawning. This coincides with lower extent of known rearing, which is the mouth of the Methow River.
2	48.0007	Methow River	Spawning	Known	Published Source	Professional Knowledge	Yakama Indian Nation spawning ground surveys, late-1980's.	Joel Hubble, Yakama Indian Nation Fish Biologist, Toppenish		Upper extent of know spawning at the Foghorn Diversion Dam above Winthrop. This coincides with the upper extent of known rearing also.
3	48.0007	Methow River	Rearing	Known	Published Source	Professional Knowledge	USFS Stream Survey Reports	Joel Hubble, Yakama Indian Nation Fish Biologist, Toppenish	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	Lower extent of known rearing coincides with lower extent of known spawning, which is the mouth of the Methow River.
4	48.0007	Methow River	Rearing	Known	Published Source	Professional Knowledge	USFS Stream Survey Reports	Joel Hubble, Yakama Indian Nation Fish Biologist, Toppenish	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	Upper extent of known rearing at the Foghorn Diversion Dam above Winthrop. This also coincides with the upper extent of known spawning.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Alder Creek	Rearing	R	Known	1, 2	1	1	Lower extent of known rearing in Alder Creek. On Sept. 4, 1998, during a snorkeling survey, one native steelhead/rainbow trout juvenile, approximately 100mm in length, was identified. Heather Bartlett, WDFW biologist, verified the identification.
Alder Creek	Rearing	R	Known	1, 2	1	1	Upper extent of known rearing in Alder Creek; anadromy is not documented in Alder Creek. On Sept. 4, 1998, during a snorkeling survey, on native steelhead trout juvenile, approximately 100mm in length, was identified. Heather Bartlett, WDFW biologist, verified the identification.
Andrews Creek	Rearing	A	Known	2		2, 3	Lower extent of known rearing in Andrews Creek.
Andrews Creek	Rearing	A	Known	2		2, 3	Upper extent of known anadromy in Andrews Creek is at the confluence of Little Andrews.
Andrews Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Andrews Creek. This coincides with the upper extent of known anadromy.
Andrews Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout only occurrence in Andrews Creek.
Beaver Creek	Rearing	A	Known	2		2	Lower extent of known rearing in Beaver Creek is at mouth.
Beaver Creek	Rearing	A	Known	2		2	Upper extent of known anadromy in Beaver Creek. Williams has observed adult steelhead up to approximately one mile downstream of the S. Fk. Beaver Creek confluence. The point at which anadromy ends and residency begins in Beaver Creek will vary depending on environmental conditions, but lies between Frazer Creek and S. Fk. Beaver Creek. Williams has observed adult steelhead passing the WDOT culvert and does not believe any man-made structure currently in Beaver Creek to be a barrier to adult steelhead passage.
Beaver Creek	Isolated individual(s)	N/A	Known	2		2, 4	Lower extent of observed isolated individual rainbow trout in Beaver Creek. This represents the upper extent of known productive rainbow trout habitat in Beaver Creek.
Beaver Creek	Isolated individual(s)	N/A	Known	2		2, 4	Upper extent of observed isolated individual rainbow trout in Beaver Creek. These individuals are usually males that have pushed up into the furthest extent of the watercourse and it is unlikely they will find another individual with which to mate. Observation of these isolated individuals are not considered to be indicative of productive habitat.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Beaver Creek	Rearing	R	Known	1	3		Upper extent of known resident rainbow trout only occurrence in Beaver Creek. This includes observation of isolated individual rainbow trout in Beaver Creek. The Mullan et al. report (Appendix D, p. 237) describes distribution in Beaver Creek as an "enigma" in that the gradient in the lower 9 miles is slight (1.4%) and the N. Fk. (upper Beaver Creek, RM 9.0) is indicated as only 6%. Yet residency is not known to extend much beyond the confluence of Blue Buck Creek. Mullan et al. cites beaver dams, past and present, and irrigation withdrawal impacts on flow, especially during late summer, as factors limiting fish passage in the Beaver Creek system.
Beaver Creek	Rearing	R	Known	1	3		Lower extent of known resident rainbow trout only occurrence in Beaver Creek. This coincides with the upper extent of known anadromy.
Black Canyon Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Black Canyon Creek
Black Canyon Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Black Canyon at RM .4
Black Canyon Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Black Canyon Creek. This coincides with the upper extent of known anadromy.
Black Canyon Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout only occurrence in Black Canyon.
Blue Buck Creek	Isolated individual(s)	N/A	Known	2		4	Lower extent of observed individual rainbow trout in Blue Buck Creek; individuals observed but no evidence of productivity.
Blue Buck Creek	Isolated individual(s)	N/A	Known	2		4	Upper extent of observed individual rainbow trout in Blue Buck Creek; individuals observed but no evidence of productivity.
Boulder Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Boulder Creek.
Boulder Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Boulder Creek is at the natural barrier.
Buttermilk Creek	Rearing	A	Known	2		2	Lower extent of known rearing in Buttermilk Creek
Buttermilk Creek	Rearing	A	Known	2		2	Upper extent of known anadromy in Buttermilk Creek is at the W. Fork/E. Fork split.
Canyon Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in Canyon Creek; anadromy in Canyon Creek has not been documented.
Canyon Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout in Canyon Creek; anadromy in Canyon Creek has not been documented.
Cedar Creek	Rearing	R	Known	1	3		Lower extent of known resident rainbow trout in Cedar Creek; anadromy is not known to occur in Cedar Creek.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Cedar Creek	Rearing	R	Known	1	3		Upper extent of known resident rainbow trout in Cedar Creek; rainbows were found about 1/4 mike up from the mouth.
Chewuch River	Rearing	A	Known	1	6		Lower extent of known rearing on Chewuch River.
Chewuch River	Rearing	A	Known	1	6		Upper extent of known anadromy on the Chewuch River is at 2nd falls (Chewack Falls).
Chewuch River	Rearing	R	Known	2		2, 3, 4	Lower extent of reach of the Chewuch River that supports only resident rainbow trout; is same as the upper extent of anadromy; need genetic sampling to determine if the rainbows are native or planted.
Chewuch River	Rearing	R	Known	2		2, 3, 4	Upper extent of known resident rainbow trout only occurrence in Chewuch River; genetic sampling is needed to determine if rainbows are native or planted.
Cub Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing on Cub Creek.
Cub Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy on Cub Creek is at natural barrier.
E. Fork Buttermilk Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in E. Fork Buttermilk Creek; anadromy has not been documented in E. Fork Buttermilk Creek.
E. Fork Buttermilk Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout in E. Fork Buttermilk Creek is approximately one mile below the barrier falls.
Eagle Creek	Rearing	A	Known	1	2		Lower extent of known anadromy in Eagle Creek; anadromy extends all the way up Eagle Creek to the barrier falls.
Eagle Creek	Rearing	A	Known	1	2		Upper extent of known anadromy in Eagle Creek extends to the barrier falls.
Early Winters Creek	Rearing	A	Known	2		2	Lower extent of known rearing in Early Winters Creek.
Early Winters Creek	Rearing	A	Presumed	2		2	Upper extent of known anadromy in Early Winters Creek.
Early Winters Creek	Isolated individual(s)	N/A	Known	1, 2	2	2	Lower extent of observed isoated individual rainbow trout in Early Winters Creek. This represents the upper extent of known productive rainbow trout habitat in Early Winters Creek.
Early Winters Creek	Isolated individual(s)	N/A	Known	1, 2	2	2	Upper extent of observed isolated individual rainbow trout in Early Winters Creek. These individuals are usually males that have pushed up into the furthest extent of the watercourse and it is unlikely they will find another individual with which to mate. Observation of these isloated individuals are not consiedered to be indicative of productive habitat.
Early Winters Creek	Rearing	R	Known	1	6		Lower extent of known resident rainbow trout only occurrence in Early Winters Creek. This coincides with the upper extent of known anadromy.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Early Winters Creek	Rearing	R	Known	1	6		Upper extent of known resident rainbow trout only occurrence in Early Winters Creek is at RM 5.0. This includes observations of any isolated individual rainbow trout in Early Winters Creek.
Eightmile Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing in Eightmile Creek.
Eightmile Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy in Eightmile Creek is at natural barrier.
Eightmile Creek	Rearing	R	Known	2		3, 4	Lower extent of known resident rainbow trout only occurrence in Eightmile Creek. This coincides with the upper extent of known anadromy.
Eightmile Creek	Rearing	R	Known	2		3, 4	Upper extent of known resident rainbow trout in Eightmile Creek is at Miller Corral.
Eureka Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in Eureka Creek, a tributary to Lost River, RB at approximately RM 3; anadromy is not known to occur in Eureka Creek.
Eureka Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout in Eureka Creek, a tributary to Lost River, RB at approximately RM 3; anadromy is not known to occur in Eureka Creek.
Falls Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing in Falls Creek.
Falls Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy in Falls Creek is the falls.
Foggy Dew Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing in Foggy Dew Creek.
Foggy Dew Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy in Foggy Dew Creek.
Foggy Dew Creek	Rearing	R	Known	2		2	Lower extent of known resident rainbow trout in Foggy Dew Creek. This coincides with the upper extent of known anadromy.
Foggy Dew Creek	Rearing	R	Known	2		2	Upper extent of known resident rainbow trout in Foggy Dew Creek.
Frazer Creek	Rearing	R	Known	1	2		Lower extent of resident rainbow trout occurrence in Frazer Creek; anadromy has not been documented in Frazer Creek.
Frazer Creek	Rearing	R	Known	1	2		Upper extent of resident rainbow trout occurrence in Frazer Creek; anadromy has not been documented in Frazer Creek.
Goat Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Goat Creek.
Goat Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Goat Creek.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Goat Creek	Isolated individual(s)	N/A	Known	1	2		Lower extent of observed isolated individual rainbow trout in Goat Creek. This represents the upper extent of known productive rainbow trout habitat in Goat Creek.
Goat Creek	Isolated individual(s)	N/A	Known	1	2		Upper extent of observed isolated individual rainbow trout in Goat Creek. These individuals are usually males that have pushed up into the furthest possible extent of the watercourse and it is unlikely they will find other individuals with which to mate. Observations of these isolated individuals are not considered to be indicative of productive habitat.
Goat Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Goat Creek. This coincides with the upper extent of known anadromy in Goat Creek.
Goat Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout only occurrence in Goat Creek. This includes observations of any isolated individual rainbow trout in Goat Creek
Gold Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Gold Creek
Gold Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Gold Creek at confluence with N. Fork
Hancock Creek	Rearing	A	Known	2		3, 6	Lower extent of known rearing in Hancock Creek. There is good rearing habitat in the beaver pond area.
Hancock Creek	Rearing	A	Known	2		3, 6	Upper extent of known anadromy in Hancock Creek. There is good rearing habitat in the beaver pond area
Hancock Creek	Rearing	A	Presumed	2		3, 6	Lower extent of presumed rearing in Hancock Creek- anadromous; this is the same as the upper extent of known anadromous rearing in Hancock Creek; above the old beaver ponds is a short stretch of gravel areas that could be used for spawning.
Hancock Creek	Rearing	A	Presumed	2		3, 6	Upper extent of presumed rearing in Hancock Creek - anadromous; above the old beaver ponds is a short stretch of gravel areas that could be used for spawning.
Lake Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Lake Creek.
Lake Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Lake Creek is at Black Lake.
Libby Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Libby Creek.
Libby Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Libby Creek.
Libby Creek	Rearing	A	Presumed	2		4	Lower extend of presumed anadromy on Libby Creek. This is the same as the upper extent of known anadromy on Libby Creek.
Libby Creek	Rearing	A	Presumed	2		4	Upper extent of presumed anadromy on Libby Creek is at Smith Canyon.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
Libby Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Libby Creek. This coincides with the upper extent of known anadromy.
Libby Creek	Rearing	R	Known	1	2		Upper extent of known rainbow trout in Libby Creek.
Little Boulder Creek	Rearing	A	Known	1	6		Lower extent of known rearing in Little Boulder Creek.
Little Boulder Creek	Rearing	A	Known	1	6		Upper extent of known anadromy in Little Boulder Creek is at the first river fork.
Little Bridge Creek	Rearing	A	Known	2		4	Lower extent of known rearing on Little Bridge Creek.
Little Bridge Creek	Rearing	A	Known	2		4	Upper extent of known anadromy in Little Bridge Creek is 3 to 4 miles up from the mouth.
Little Bridge Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Little Bridge Creek. This coincides with the upper extent of known anadromy.
Little Bridge Creek	Rearing	R	Known	1	2	2	Upper extent of known resident rainbow trout only occurrence in Little Bridge Creek.
Lost River	Rearing	A	Known	1	6		Lower extent of known rearing in Lost River.
Lost River	Rearing	A	Known	1	6		Upper extent of known anadromy in Lost River is at Monument Creek; Lost River naturally goes dry each summer from Monument Creek to Drake Creek.
Methow River	Rearing	A	Known	2		2, 3, 4, 6	Lower extent of known rearing in the Methow River begins at the mouth.
Methow River	Rearing	A	Known	2			Upper extent of known anadromy in the Methow River is at the Lost River Confluence.
Methow River	Rearing	A	Presumed	2		4	Lower extent of presumed anadromy on the Methow River. This is at Lost River which is the same as the upper extent of known anadromy on the Methow River.
Methow River	Rearing	A	Presumed	2		4	Upper extent of presumed anadromy on the Methow River is at Rattlesnake Creek.
Methow River	Rearing	R	Known	2		2	Lower extent of known resident rainbow trout only occurrence in the Methow River as documented by Ken Williams, WDFW fish biologist, in unpublished field notes. This coincides with the upper extent of known anadromy.
Methow River	Rearing	R	Known	2		2, 5	Upper extent of known resident rainbow trout on the Methow River is 4.0 RMs upstream of the Trout Creek confluence as documented by Dave Hopkins, USFS fish technician, in a snorkeling survey in 1994.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
N. Fork Gold Creek	Rearing	R	Known	1	6		Lower extent of known rearing in N. Fork Gold Creek; no anadromy in N. Fork Gold Creek documented.
N. Fork Gold Creek	Rearing	R	Known	1	6		Upper extent of known rainbow trout in N. Fork Gold Creek; no anadromy in N. Fork Gold Creek has been documented.
N. Fork Libby Creek	Rearing	R	Known	1	4 (March 1999)		Lower extent of known resident rainbow trout in N. Fork Libby Creek; anadromy in N. Fork Libby Creek has not been documented.
N. Fork Libby Creek	Rearing	R	Known	1	4 (March 1999)		Upper extent of known resident rainbow trout occurrence in N. Fork of Libby Creek.
Poorman Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in Poorman Creek; this is a small stream and it is doubtful that anadromy occurs (Jennifer Molesworth, USFS Methow Valley Ranger District fish biologist).
Poorman Creek	Rearing	R	known	1	2		Upper extent of known resident rainbow trout in Poorman Creek; anadromy is not known to occur in Poorman Creek.
Rattlesnake Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in Rattlesnake Creek; anadromy is not known to occur in Rattlesnake Creek.
Rattlesnake Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout in Rattlesnake Creek; anadromy is not known to occur in Rattlesnake Creek.
Reynolds Creek		A	Known	1	3		Lower extent of known anadromy in Reynolds Creek is at mouth.
Reynolds Creek		A	Known	1	3		Upper extent of known anadromy in Reynolds Creek is at RM 0.5 at natural falls This was recorded in 1992 in the Mullan et al (1992). Presently (1999) there is a documented culvert (F.S. Rd. 4435) barrier at RM 0.25 blocking anadromous fish passage. The USFS has decided to retain this barrier to protect known bull trout populations upstream of the barrier from the brook trout known to occur below the culvert barrier.
Robinson Creek	Rearing	R	Known	1	6		Lower extent of known rearing in Robinson Creek is at the mouth of Robinson Creek; anadromy has not been documented in Robinson Creek.
Robinson Creek	Rearing	R	Known	1	6		Upper extent of known rainbow trout occurrence in Robinson Creek; anadromy has not been documented in Robinson Creek.
S. Fk. Beaver Creek	Isolated individual(s)	N/A	Known	1	2, 3		Isolated individuals of resident rainbow trout have been observed in S. Fk. Beaver Creek. Observation of isolated individuals in not considered indicative of productive habitat.
S. Fk. Beaver Creek	Isolated individual(s)	N/A	Known	1	2, 3		Upper extent of observation of isolated individuals of resident rainbow trout in S. Fk. Beaver Creek. Observation of isolated individuals is not considered indicative of productive habitat.
S. Fk. Gold Creek	Rearing	A	known	1	3		Lower extent of known rearing in S. Fork Gold Creek is at the mouth of this creek.

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
S. Fk. Gold Creek	Rearing	A	Known	1	3		Upper extent of known anadromy on S. Fork Gold Creek.
S. Fork Gold Creek	Rearing	R	Known	1	3		Lower extent of known resident rainbow trout only occurrence in S. Fk. Gold Creek. This coincides with the upper extend of known anadromy.
S. Fork Gold Creek	Rearing	R	Known	1	3		Upper extent of known resident rainbow trout in S. Fork Gold Creek.
S. Fork Libby Creek	Rearing	R	Known	1	2, 3	2	Lower extent of known resident rainbow trout in S. Fork Libby Creek; anadromy in S. Fork Libby Creek has not been documented.
S. Fork Libby Creek	Rearing	R	Known	1	2, 3	2	Upper extent of known resident rainbow trout in S. Fork Libby Creek; anadromy in S. Fork Libby Creek has not been documented.
Sheep Creek	Rearing	A	Known	2		2, 3, 4, 6	Lower extent of known rearing in Sheep Creek, tributary to Chewack, 2nd LB stream into Chewack upstream of Andrews Creek which comes in on RB of the Chewack.
Sheep Creek	Rearing	A	Known	2		2, 3, 4, 6	Upper extent of known anadromy in Sheep Creek, tributary to Chewack, 2nd LB stream into Chewack, upstream of Andrews Creek which comes in on RB of the Chewack; there are lots of seeps and inflowing water into this creek.
South Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing on South Creek.
South Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy in South Creek is at barrier falls.
Thirtymile Creek	Rearing	A	Known	2		2, 3, 4, 6	Lower extent of known rearing in Thirtymile Creek.
Thirtymile Creek	Rearing	A	Known	2		2, 3, 4, 6	Upper extent of known anadromy in Thirtymile Creek.
Trout Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout in Trout Creek; anadromy is not known to occur in Trout Creek.
Trout Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout occurrence in Trout Creek; anadromy is not known to occur in Trout Creek.
Twentymile Creek	Rearing	A	Known	1	2		Lower extent of known rearing in Twentymile Creek.
Twentymile Creek	Rearing	A	Known	1	2		Upper extent of known anadromy in Twentymile Creek is at the barrier falls.
Twisp River	Rearing	A	Known	1	6		Lower extent of known rearing in the Twisp River
Twisp River	Rearing	A	Known	1	6		Upper extent of known anadromy in the Twisp River at the confluence with North Creek

Table A- 3 Summer Steelhead/Rainbow trout distribution in the Methow, WRIA 48

Stream Name	Species Use	Production Strategy	Status	Data Source	Published Source	Professional Observation	Comments
W. Fork Buttermilk Creek	Isolated individual(s)	N/A	Known	1	2		Lower extent of known resident rainbow trout in W. Fork Buttermilk Creek; anadromy has not been documented in W. Fork Buttermilk Creek.
W. Fork Buttermilk Creek	Isolated individual(s)	N/A	Known	1	2		Upper extent of observed resident rainbow trout individuals; upper extent of what is considered productive habitat is downstream.
W. Fork Buttermilk Creek	Rearing	R	Known	2		2	Lower extent of known resident rainbow trout only observation in W. Fk. Buttermilk Creek; anadromy is not known to occur in W. Fk. Buttermilk Creek
W. Fork Buttermilk Creek	Rearing	R	Known	2		2	Upper extent of known resident rainbow trout only occurrence in W. Fk. Buttermilk Creek; anadromy is not known to occur in W. Fk. Buttermilk Creek. This includes observations of isolated individual trout in W. Fk. Buttlermilk Creek.
War Creek	Rearing	A	Known	1	2, 6		Lower extent of known rearing on War Creek.
War Creek	Rearing	A	Known	1	2, 6		Upper extent of known anadromy in War Creek is at the falls.
Whiteface Creek	Rearing	R	Known	1	2		Lower extent of resident rainbow trout occurrence in Whiteface Creek, a tributary to Goat Creek, RB at approximately RM 4; anadromy has not been documented in Whiteface Creek.
Whiteface Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout in Whiteface Creek, a tributary to Goat Creek, RB at approximately RM 4; anadromy has not been documented in Whiteface Creek.
Wolf Creek	Rearing	A	Known	2		2	Lower extent of known rearing in Wolf Creek.
Wolf Creek	Rearing	A	Known	2		2	Upper extent of known anadromy in Wolf Creek.
Wolf Creek	Rearing	R	Known	1	2		Lower extent of known resident rainbow trout only occurrence in Wolf Creek. This coincides with the upper extent of known anadromy.
Wolf Creek	Rearing	R	Known	1	2		Upper extent of known resident rainbow trout only occurrence in Wolf Creek. This includes any observations of isolated individual rainbow trout in Wolf Creek.

Table A-3 Summer Chinook distribution in the Methow, WRIA 48

CODES

1. Data Source:	1 = Published Source
	2 = Professional Observation
2. Published Source:	1 = Dan Peplow. 1999. Results: Alder Creek Juvenile Salmonid Snorkeling Survey. Center for Streamside Studies, Univ. of WA, Seattle.
	2 = U.S. Forest Service, Methow Valley Ranger District, Winthrop, WA. Hand-produced map of fish distribution information gathered from stream survey reports.
	3 = Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams. USFWS Monograph 1, Leavenworth, WA.
	4 = U.S. Forest Service, Methow Valley Ranger District, Winthrop, WA. Stream Survey Reports.
	5 = Yakama Nation, Toppenish, WA. Spring Chinook Spawning Ground Surveys of the Methow River Basin
	6 = WDFW StreamNet database.
3. Professional Observation:	1 = Heather Bartlett, Washington Department of Fish and Wildlife (WDFW), Omak, WA. Area Fish Biologist, Region 2.
	2 = Ken Williams, WDFW (retired), Omak, WA. Area Fish Biologist, WDFW Region 2
	3 = Jeanette Smith, Pacific Watershed Institute, Winthrop, WA. Biologist.

Table A-3 Summer Chinook distribution in the Methow, WRIA 48

CODES

4 = Jennifer Molesworth, U.S. Forest Service (USFS), Okanogan-Wenatchee National Forest, Methow Valley Ranger District, Winthrop, WA. District Fish Biologist.

5 = Dave Hopkins, U.S. Forest Service (USFS), Okanogan-Wenatchee National Forest, Methow Valley Ranger District, Winthrop, WA. Fisheries Technician.

6 = Joel Hubble, Yakama Nation, Toppenish, WA. Fish Biologist.

7 = John Easterbrooks, WDFW, Yakima, WA. Area Fish Biologist, Region 3.

Table A- 4 Bull trout distribution in the Methow, WRIA 48

Map ID #	WRIA Index	Stream Name	Tributary to:	Source	Comments
37,38	48.1087	Andrews Creek	Chewuch River	USFS - Dave Hopkins	From the mouth up to the natural barrier at RM 0.5.
59,60	48.0307	Beaver Creek	Methow River	USFS	A bull trout/brook trout hybrid was identified by the USFS in 1992, inferring that there was still a "pure" bull trout in the Beaver Creek drainage.
57,58	48.0309	Blue Buck Creek	Beaver Creek	StreamNet; USFS	Bull trout are known to occur in Blue Buck Creek and are described by the USFS as a "remnant population".
33,34	48.0770	Boulder Creek	Chewuch River	USFS - Dave Hopkins	From the mouth up to the natural barrier falls at RM 1.0.
43,44	48.0466	Buttermilk Creek	Twisp River	StreamNet; USFS	From the mouth up to the confluence of the West and the East Forks of Buttermilk Creek.
19,20	48.1411	Cedar Creek	Early Winters Creek	Mullan et al. 1992; USFS; StreamNet	From the mouth up to the natural barrier falls at RM 2.0.
31,32	48.0728	Chewuch River	Methow River	Mullan et al. 1992; USFS	From the mouth up to RM 30.8. The natural barrier falls is at RM 34.6.
61,62	48.0177	Crater Creek	Gold Creek	Mullan et al. 1992; USFS.	From the mouth up to about RM 1.5. There is a natural barrier falls at RM 2.9. The USFS presumes bull trout occur up to the falls since there are no known barriers between and the habitat is appropriate for bull trout.
47,48	48.0470	E. Fk. Buttermilk Creek	Twisp River	Mullan et al. 1992; USFS; StreamNet	From the confluence with Buttermilk Creek upstream to the natural barrier falls at RM 3.6.
17,18	48.1408	Early Winters Creek	Methow River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to RM 12.3. A natural barrier falls is at RM 8.0. Resident bull trout occur above the falls.
11,12	48.1600	Eureka Creek	Lost River	USFS	From the mouth up to the natural barrier falls at RM 0.3.
23,24	48.1364	Goat Creek	Methow River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to the natural barrier falls at RM 12.0.
21,22	48.1412	Huckleberry Creek	Cedar Creek	USFS - Dave Hopkins	Bull trout are known to occur in the lower 0.5 miles of Huckleberry Creek.
35,36	48.1020	Lake Creek	Chewuch River	Mullan et al. 1992;	From the mouth up the natural barrier falls at RM 9.2.

Table A- 4 Bull trout distribution in the Methow, WRIA 48

Map ID #	WRIA Index	Stream Name	Tributary to:	Source	Comments
				USFS; StreamNet	
49,50	48.0423	Little Bridge Creek	Twisp River	USFS - Dave Hopkins	From the mouth up to the culvert barrier at RM 2.0 at the USFS Rd 030 stream crossing.
9,10	48.1592	Lost River	Methow River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to the headwaters.
1,2	48.0007	Methow River	Columbia River	Mullan et al. 1992; USFS - Dave Hopkins; StreamNet	From the mouth up to the natural barrier falls on the Methow River at RM 83.2.
13,14	48.1602	Monument Creek	Lost River	Mullan et al. 1992; USFS; StreamNet	Mullan et al. surveyed the mouth and found bull trout. The USFS presumes bull trout occur from the mouth up to the headwaters because there are no known barriers.
29,30	48.1310	N. Fk. Wolf Creek	Wolf Creek	Mullan et al. 1992	From the mouth up to RM 0.5.
55,56	48.0674	North Creek	Twisp River	USFS - Dave Hopkins	From the mouth up to the natural barrier falls at RM 0.5.
15,16	48.1700	Ptarmigan Creek	Lost River	StreamNet; USFS	From the mouth up to the natural barrier falls at RM 0.5.
5,6	48.1842	Rattlesnake Creek	Methow River	Mullan et al. 1992; USFS - Dave Hopkins	From the mouth up to the natural barrier falls at RM 0.7.
51,52	48.0613	Reynolds Creek	Twisp River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to the natural barrier falls at RM 0.5.
7,8	48.1794	Robinson Creek	Methow River	Mullan et al. 1992; USFS	From the mouth up to approximately RM 0.2 - 0.4. The natural falls barrier is at RM 0.6.
53,54	48.0641	South Creek	Twisp River	Mullan et al. 1992; USFS.	From the mouth up to the natural barrier falls at RM 0.5.
3,4	48.1872	Trout Creek	Methow River	Mullan et al. 1992; USFS - Dave Hopkins	From the mouth up to the natural barrier falls at RM 0.5.

Table A- 4 Bull trout distribution in the Methow, WRIA 48

Map ID #	WRIA Index	Stream Name	Tributary to:	Source	Comments
39,40	48.0977	Twentymile Creek	Chewuch River	USFS - Dave Hopkins	From the mouth up to the natural barrier falls at RM 0.6.
41,42	48.0374	Twisp River	Methow River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to the natural barrier falls at RM 29.4.
45,46	48.0466	W. Fk. Buttermilk Creek	Twisp River	Mullan et al. 1992; USFS; StreamNet	From the confluence with Buttermilk Creek upstream about 2.5 miles.
25,26	48.1370	Whiteface Creek	Goat Creek	USFS - Dave Hopkins	From the mouth up to the culvert barrier at RM 0.25.
27,28	48.1300	Wolf Creek	Methow River	Mullan et al. 1992; USFS; StreamNet	From the mouth up to RM 7.2. A natural barrier falls is at RM 10.3.

APPENDIX B – SPRING CHINOOK SPAWNING GROUND SURVEY SUMMARIES

Table B- 1 Summary of Methow Basin Spring Chinook Redd Counts, 1987-99

River	Survey Reach	Number of redds and corresponding percentages.													Mean Percent	Range in redd counts	
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 /c	1997	1998 /c	1999	1987-1999	Min	Max
Chewuch River	30 Mile Br. - Andrews Cr.	**17**	**25**	**1**	**16**	**6**	**12**	**8**	**2**	**0**	**na**	**0**	**na**	**0**	**8**	**0**	**25**
		8.9%	**12.4%**	**0.6%**	**10.1%**	**6.6%**	**6.5%**	**9.6%**	**7.4%**	**0.0%**	**na**	**0.0%**	**na**	**0.0%**	**5.7%**	**0.0%**	**12.4%**
	Andrews Cr. - Lake Cr.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**na**	**0**	**na**	**0**	**0**	**0**	**0**
		0.0%	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**na**	**0.0%**	**na**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	Lake Cr. - Camp 4 Br.	**21**	**26**	**21**	**18**	**11**	**26**	**15**	**3**	**2**	**na**	**2**	**na**	**0**	**13**	**0**	**26**
		11.0%	**12.9%**	**13.1%**	**11.4%**	**12.1%**	**14.1%**	**18.1%**	**11.1%**	**100.0%**	**na**	**3.6%**	**na**	**0.0%**	**18.8%**	**0.0%**	**100.0%**
	Number of Redds Above The Index Reach	**38**	**51**	**22**	**34**	**17**	**38**	**23**	**5**	**2**	**na**	**2**	**na**	**0**	**21**	**0**	**51**
	Percent of Redds Above The Index Reach	**19.9%**	**25.2%**	**13.8%**	**21.5%**	**18.7%**	**20.5%**	**27.7%**	**18.5%**	**100.0%**	**na**	**3.6%**	**na**	**0.0%**	**24.5%**	**0.0%**	**100.0%**
	Camp 4 Br. - Falls Cr. C.G. **(index reach)**	**77**	**55**	**44**	**61**	**30**	**77**	**35**	**11**	**0**	**na**	**27**	**na**	**0**	**38**	**0**	**77**
		40.3%	**27.2%**	**27.5%**	**38.6%**	**33.0%**	**41.6%**	**42.2%**	**40.7%**	**0.0%**	**na**	**49.1%**	**na**	**0.0%**	**30.9%**	**0.0%**	**49.1%**
	Falls Cr. C.G. - Chewuch Br.	**54**	**63**	**52**	**42**	**16**	**61**	**20**	**1**	**0**	**na**	**22**	**na**	**5**	**31**	**0**	**63**
		28.3%	**31.2%**	**32.5%**	**26.6%**	**17.6%**	**33.0%**	**24.1%**	**3.7%**	**0.0%**	**na**	**40.0%**	**na**	**83.3%**	**29.1%**	**0.0%**	**83.3%**
	Chewuch Br. - Conf.	**22**	**33**	**42**	**21**	**28**	**9**	**5**	**10**	**0**	**na**	**4**	**na**	**1**	**16**	**0**	**42**

River	Survey Reach	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 /c	1997	1998 /c	1999	Mean Percent 1987-1999	Range in redd counts Min	Max
		11.5%	16.3%	26.3%	13.3%	30.8%	4.9%	6.0%	37.0%	0.0%	na	7.3%	na	16.7%	15.5%	0.0%	37.0%
	Number of Redds Below The Index Reach	76	96	94	63	44	70	25	11	0	na	26	na	6	46	0	96
	Percent of Redds Below The Index Reach	39.8%	47.5%	58.8%	39.9%	48.4%	37.8%	30.1%	40.7%	0.0%	na	47.3%	na	100.0%	44.6%	0.0%	100.0%
Annual chewuch Total		191	202	160	158	91	185	83	27	2	na	55	na	6	105	2	202
Annual Percent of Methow Basin		28.0%	27.6%	30.9%	31.7%	36.4%	25.1%	13.5%	20.3%	13.3%	na	36.7%	na	18.2%	25.6%	13.3%	36.7%
Twisp River	upstream - South Cr.	5	3	0	0	0	0	0	0	0	na	1	na	0	1	0	5
		3.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	3.1%	na	0.0%	0.7%	0.0%	3.1%
	South Cr. - Mystery Br.	39	42	28	12	12	12	40	13	0	na	0	na	6	19	0	42
		23.8%	21.1%	15.6%	10.7%	17.4%	8.5%	20.8%	40.6%	0.0%	na	0.0%	na	85.7%	22.2%	0.0%	85.7%
	Number of Redds Above The Index Reach	44	45	28	12	12	12	40	13	0	na	1	na	6	19	0	45
	Percent of Redds Above The Index Reach	26.8%	22.6%	15.6%	10.7%	17.4%	8.5%	20.8%	40.6%	0.0%	na	3.1%	na	85.7%	22.9%	0.0%	85.7%
	Mystery Br. - Buttermilk Br. **(index reach)**	79	111	100	77	40	73	108	13	2	na	12	na	1	56	1	111
		48.2%	55.8%	55.9%	68.8%	58.0%	51.8%	56.3%	40.6%	50.0%	na	37.5%	na	14.3%	48.8%	14.3%	68.8%

Number of redds and corresponding percentages.

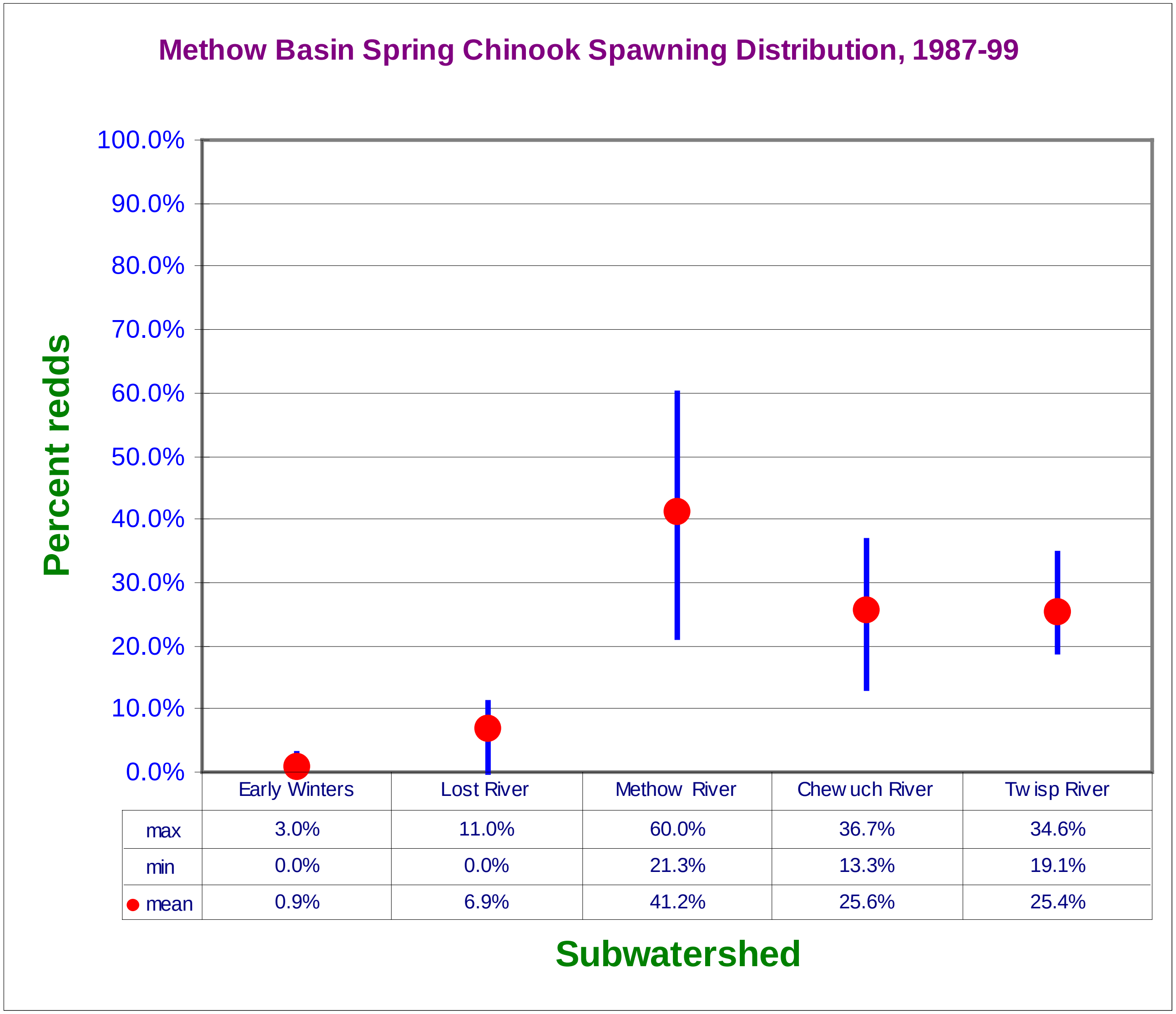
River	Survey Reach	Number of redds and corresponding percentages.													Mean Percent	Range in redd counts	
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 /c	1997	1998 /c	1999	1987-1999	Min	Max
	Buttermilk Br. - Little Br. \a	29	27	41	19	17	16	15	6	0	na	12	na	0	17	0	41
		17.7%	13.6%	22.9%	17.0%	24.6%	11.3%	7.8%	18.8%	0.0%	na	37.5%	na	0.0%	15.6%	0.0%	37.5%
	Little Br. - Conf. \b	12	16	10	4	0	40	29	0	2	na	7	na	0	11	0	40
		7.3%	8.0%	5.6%	3.6%	0.0%	28.4%	15.1%	0.0%	50.0%	na	21.9%	na	0.0%	12.7%	0.0%	50.0%
	Number of Redds Below The Index Reach	41	43	51	23	17	56	44	6	2	na	19	na	0	27	0	56
	Percent of Redds Below The Index Reach	25.0%	21.6%	28.5%	20.5%	24.6%	39.7%	22.9%	18.8%	50.0%	na	59.4%	na	0.0%	28.3%	0.0%	59.4%
Annual Twisp Total		164	199	179	112	69	141	192	32	4	na	32	na	7	103	4	199
Annual Percent of Methow Basin		24.1%	27.1%	34.6%	22.5%	27.6%	19.1%	31.1%	24.1%	26.7%	na	21.3%	na	21.2%	25.4%	19.1%	34.6%

\a in 1987 survey ended at Newby Cr.

\b in 1987 survey started at Newby Cr.

\c in 1996 & 1998 all fish were collected at Wells Dam for broodstock.

Figure B- 1 Methow Basin Spring Chinook Spawning Distribution, 1987-99



	Early Winters	Lost River	Methow River	Chewuch River	Twisp River
max	3.0%	11.0%	60.0%	36.7%	34.6%
min	0.0%	0.0%	21.3%	13.3%	19.1%
● mean	0.9%	6.9%	41.2%	25.6%	25.4%

APPENDIX C - TABLES OF KNOWN FISH PASSAGE BARRIERS IN THE METHOW, WRIA 48

Table C- 1 Methow Watershed Known Fish Passage Barriers

Map ID #	**WRIA Index**	Stream Name	Tributary to:	Barrier (**C**ulvert, **F**alls, **F**low, **T**emp, **D**am, **O**ther)	**P**artial or **F**ull Barrier	Published Data Source	Professional Contact	Comments
135	48.0296	Alder Creek	Methow River	Culvert	Full	WDFW Wildlife Area Inventory - Unresolved fish passage problem database (UFPP) 1999.		At approximately RM 0.75 the WDFW Wildlife access road 3-culvert crossing of Alder Creek is a barrier to fish passage. There are 2 other culverted crossings of Alder Creek downstream of this location that are also fish passage barriers.
136	48.0296	Alder Creek	Methow River	Culvert	Full	WDFW Wildlife Area Inventory – Unresolved fish passage problem database (UFPP) 1999.		At the Twisp-Carlton Road crossing of Alder Creek (approximately RM 0.25) there is a fish-blocking culvert. About 200 feet upstream from this culvert, on the WDFW Wildlife Area access road crossing of Alder Creek, there is another culvert blocking fish passage. About 1/2 mile further upstream, again at a crossing of Alder Creek by the WDFW Wildlife Area access road, there is a 3-culvert crossing that is a barrier to fish passage.
112	48.1087	Andrews Creek	Chewuck River	Falls	Full	USFS Stream Survey Report 1996	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.5 there is a natural falls that is a barrier to fish passage. Brook trout were seen above falls in 1996.
127	48.0015	Black Canyon Creek	Methow River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 3.5 there is a 20 foot waterfall that is a barrier to fish passage.
107	48.0770	Boulder Creek	Chewuck River	Falls	Full	USFS Stream Survey Report 1991& 1997	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 1.0 there is a falls that is a barrier to upstream fish passage. Brook trout/cutthroat above falls. Bull trout seen below falls.
147	48.1411	Cedar Creek	Early Winters Creek	Falls	Full		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 2.0 there is a falls (Cedar Falls) that is a barrier to upstream fish passage.
106	48.0728	Chewuck River	Methow River	Falls	Full	USFS Stream Survey Report 1993	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 34.6 there is a natural falls that is a barrier to upstream fish passage. Rainbow trout above falls - possible redbands.
123	48.0177	Crater Creek	Gold Creek	Falls	Full	USFS Stream Survey Report 1996	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 2.9 (about .1 mile below the confluence with Martin Creek) there is a 30' waterfall that is a barrier to all upstream fish passage on Crater Creek. Several smaller potential barriers found less than 1/2 mile downstream.
148	48.0977	Cub Creek	Chewuck River	Falls	Full	Mullan et al., 1992, USFWS Monograph 1, Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams		At RM 0.4 there is a natural falls that is a full barrier to upstream fish passage.

Map ID #	WRIA Index	Stream Name	Tributary to:	Barrier (**C**ulvert, **F**alls, **F**low, **T**emp, **D**am, **O**ther)	**P**artial or **F**ull Barrier	Published Data Source	Professional Contact	Comments
149	48.1139	Dog Creek	Chewuck River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.25 there is a natural falls that is a barrier to upstream fish passage.
115	48.0470	E. Fork Buttermilk Creek	Buttermilk Creek	Falls	Full	USFS Stream Survey Report 1992 & 1995	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 3.6 there is a natural falls that is a barrier to fish passage. Cutthroat trout are above the falls.
116	48.0541	Eagle Creek	Twisp River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.5 there is a series of natural falls that create a barrier to fish passage.
143	48.0541	Eagle Creek	Twisp River	Culvert	unknown		Methow Watershed 2496 Technical Advisory Group (TAG) 2000	At RM 0.2 the culvert crossing at USFS Road 4420 is a suspected barrier to anadromous fish passage. A field determination has not been made.
132	48.1408	Early Winters Creek	Methow River	Falls	Full	USFS Stream Survey Report 1993	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 8.0 there is a 25 foot waterfall that is a barrier to fish passage. Resident bull trout/ cutthroat found above falls.
108	48.0901	Eightmile	Chewuck River	Other - possible barrier, type not indicated	unknown	USFS Stream Survey Report 1992 & 1999	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 1.7 the road location may be constricting the channel, creating a velocity barrier. Brook trout, rainbow trout and cutthroat trout above possible barrier.
152	48.1600	Eureka Creek	Lost River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.3 there is a natural falls that is a barrier to fish.
109	48.0940	Falls Creek	Chewuck River	Falls	Full	USFS Stream Survey 1992 & 1999	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.2 there is a natural falls that is a barrier to fish passage. Brook trout/cutthroat trout above falls.
124	48.0153	Foggy Dew Creek	Gold Creek	Falls	Full	USFS Stream Survey Report 1996	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 4.3 ther is a 15 foot waterfall that is a fish barrier to all upstream fish passage on Foggy Dew Creek. This falls is about 1 mile above the end of Road 500.
131	48.1364	Goat Creek	Methow River	Falls	Full	USFS Stream Survey Report 1992	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 12.0 there is a natural falls that is a barrier to upstream fish passage. The culvert barrier downstream at Vanderpool crossing was replaced.
111	48.1020	Lake Creek	Chewuck River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 9.2 there is a natural falls that is a barrier to fish passage.
125	48.0203	Libby Creek	Methow River	Culvert		USFS Stream Survey Report 1998	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National	At RM 6.6 at the USFS Road 100 crossing of Libby Creek there is a culvert that

Map ID #	WRIA Index	Stream Name	Tributary to:	Barrier (**C**ulvert, **F**alls, **F**low, **T**emp, **D**am, **O**ther)	**P**artial or **F**ull Barrier	Published Data Source	Professional Contact	Comments
							Forest, Winthrop	is a potential velocity barrier to upstream fish passage during high flows.
134	48.1400	Little Boulder Creek	Methow River	Culvert	Partial	WDOT fish barrier inventory database		At RM 0.1 on Little Boulder Creek, at MP 181 on Hwy. 20, there is a culvert that is a barrier to juvenile salmonids.
99	48.0423	Little Bridge Creek	Twisp River	Irrigation Diversion Dam	unknown		Methow Watershed 2496 Technical Advisory Group (TAG) 2000	At RM 0.25 the Tourangeau diversion dam was a barrier to fish passage but was washed out in 1999. The owner of the ditch would like to convert to a well.
114	48.0423	Little Bridge Creek	Twisp River	Irrigation Diversion Dam	unknown	USFS Stream Survey Report 1992 & 1999	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 2.1, about 300 feet upstream of the USFS Rd. 030 culvert crossing, the operators of the Aspen Meadows irrigation diversion dam constructed a wooden fish ladder in 1999 to pass fish. The ladder's effectiveness at allowing fish passage needs to be monitored.
144	48.0423	Little Bridge Creek	Twisp River	Culvert	Partial		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At the mouth of Little Bridge Creek there is a culvert that is a partial barrier to fish passage.
145	48.0423	Little Bridge Creek	Twisp River	Culvert	Full		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 2.0 the culvert crossing of USFS Road 030 is a barrier to fish passage. The USFS in 2000 is conducting Environmental Assessments for the proposed repairs to the barriers.
146	48.0423	Little Bridge Creek	Twisp River	Culvert	Full		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 3.0 the culvert crossing of USFS Road 100 is a barrier to fish passage. The USFS in 2000 is conducting Environmental Assessments for the proposed repairs to the barriers
133	48.0592	Lost River	Methow River	Flow	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	Beginning at RM 7.1 (Monument Creek confluence), for a distance of about 4 - 5 miles (Drake Creek, RM 11.7), the Lost River flows subsurface during periods of low flow. This is a natural condition.
130	48.0007	Methow River	Columbia River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 83.2. Chinook salmon juvenile have been seen up to Trout creek.
126	48.0229	N. Fk. Libby Creek	Libby Creek	Falls	Full	USFS Stream Survey Report 1998	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 4.6 there is a 10 foot waterfall that is a barrier to fish passage. Several potenial smaller, non-permanent log jam barriers found downstream.
138	48.0229	N. Fk. Libby Creek	Libby Creek	Culvert	Partial	USFS Stream Survey Report 1999		At RM 0.9 a culvert crossing at USFS Road 43 is a possible velocity barrier to fish migration during high flows.
139	48.0229	N. Fk. Libby Creek	Libby Creek	Culvert	Partial	USFS Stream Survey Report 1999		At RM 2.5 a culvert crossing at USFS Road 700 is a possible velocity barrier to fish migration during high flows.

Map ID #	WRIA Index	Stream Name	Tributary to:	Barrier (Culvert, Falls, Flow, Temp, Dam, Other)	Partial or Full Barrier	Published Data Source	Professional Contact	Comments
120	48.0674	North Creek	Twisp River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.5 there is a natural falls that is a barrier to fish passage.
154	48.1700	Ptarmigan Creek	Lost River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.5 there is a 50' natural falls that is a barrier to fish passage.
155	48.1842	Rattlesnake Creek	Methow River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.7 there is a natural falls that is a barrier to fish passage.
102	48.0613	Reynolds Creek	Twisp River	Culvert	Full		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.25 there is a culvert that is a barrier to fish passage. There are brook trout below this barrier and bull trout upstream of the culvert barrier. AT RM 0.5 there is natural falls that is a full barrier falls to fish passage. The USFS decided in 1999 to retain this barrier to protect the bull trout population from brook trout.
118	48.0613	Reynolds Creek	Twisp River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.5 there is a natural falls that is a barrier to anadromous salmonids. About 1/4 mile below this falls is a culvert that is acting as a barrier to brook trout migration upstream. This is protecting a population of bull trout upstream of the culvert and should not be removed.
153	48.1794	Robinson Creek	Methow River	Falls	Full	Mullan et al., 1992, USFWS Monograph 1, Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams		At RM 0.6 there is a natural falls that is a barrier to upstream fish passage.
98	48.0105	S. Fk. Gold Creek	Gold Creek	Box culvert & 2 metal pipes	Full		Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	There are 2 barriers to fish passage at this same location. One is a box culvert with a concrete bottom leading to Rainy Creek. The other barrier is created by 2 metal pipes leading to S. Fk Gold Creek.
121	48.0105	S. Fk. Gold Creek	Gold Creek	Falls	Full	USFS Stream Survey Report 1996	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 6.8, just above the confluence with Fisher Creek, there is a 25 foot waterfall that is a barrier to all fish passage upstream.
140	48.0232	S. Fk. Libby Creek	Libby Creek	Culvert	Partial	USFS Stream Survey Report 1999		At RM 0.6 the culvert crossing at USFS Road 43 appears to be a velocity barrier to fish migration during high flows.
141	48.0232	S. Fk. Libby Creek	Libby Creek	Falls	Full	USFS Stream Survey Report 1999		At RM 2.5 there are several smaller waterfalls and high gradient riffles that restrict fish passage.
119	48.0641	South Creek	Twisp River	Falls	full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.5 there is a natural falls that is a barrier to fish passage. Need to snorkel for bull trout below falls.

Map ID #	WRIA Index	Stream Name	Tributary to:	Barrier (**C**ulvert, **F**alls, **F**low, **T**emp, **D**am, **O**ther)	**P**artial or **F**ull Barrier	Published Data Source	Professional Contact	Comments
97	48.0043	Squaw Creek	Methow River	Culvert		USFS Draft Lower Methow Watershed Analysis (Jan. 1999)	Ken Williams, Area Fish Biologist, WDFW Region 2, Ephrata	There is a barrier culvert under State Hwy. 153 that block anadromous access into the drainage. It is undetermined whether this naturally narrow constriction in the channel was ever passable to salmon or steelhead. Rainbow trout have been documented above the culvert by Dave Hopkins, USFS.
150	48.1136	Thirtymile Creek	Chewuck River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.3 there is a natural falls that is a barrier to fish passage.
156	48.1872	Trout Creek	Methow River	Falls	Full		Dave Hopkins, USFS Methow Valley Ranger District Fish Technician, Okanogan National Forest, Winthrop	At RM 0.5 there is a natural falls that is a barrier to fish passage.
110	48.0977	Twentymile Creek	Chewuck River	Falls	Full	USFS Stream Survey Report 1992 & 1999	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 0.6 there is a natural falls that is a barrier to upstream fish passage. Rainbow trout and cutthroat trout above.
113	48.0374	Twisp River	Methow River	Falls	Full	USFS Stream Survey Report 1993	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 29.4 there is a natural falls that is a barrier to fish passage. Cutthroat trout above falls
117	48.0559	War Creek	Twisp River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 1.2 there is a natural falls that is a barrier to fish passage. Brook trout are found in War Creek.
151	48.1401	Whiteface Creek	Goat Creek	Culvert	Partial			At RM 0.25 the culvert at the USFS Road 52 crossing of Whiteface Creek is a barrier to fish at certain flows due to the steep gradient , high water velocity amd lack of jump pool at the outlet of the culvert.
128	48.1300	Wolf Creek	Methow River	Falls	Full	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 10.6 there is a 12 foot high waterfall that is a barrier to fish.
129	48.1300	Wolf Creek	Methow River	Other - temporary log jam	Partial	USFS Stream Survey Report 1994	Jennifer Molesworth, Methow Valley Ranger District Fish Biologist, Okanogan National Forest, Winthrop	At RM 4.5 there is a partial temporary log jam barrier in the fall of 1999.

Table C- 2 Beaver Creek Drainage Known Fish Passage Barriers, WRIA 48

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980108	Claton Belmont	SR 153	29.28	Beaver Cr	0.26	SE	27	33N	22E	CO/CK/SH/CT/RB/DB/EB		culvert	DOT project, slope, sheet
980111	Unknown	NA		Beaver Cr	1.38	SW	23	33N	22E	CO/CK/SH/CT/RB/DB/EB	2224 meters upstream from Beaver Cr. mouth.	dam	Partial barrier for adults and total for juveniles.
980112	Bernard Thurlow	NA		Beaver Cr	1.64	SW	23	33N	22E	CO/CK/SH/CT/RB/DB/EB	2634 meters upstream from mouth of Beaver Cr.	dam	Concrete diversion dam is constructed of several steps.
980113	Tice	NA		Beaver Cr	2.06	NE	23	33N	22E	CO/CK/SH/CT/RB/DB/EB	3309 meters upstream from mouth of Beaver Cr.	dam	Diversion dam is a barrier, and in need of repair.

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980114	Claton Belmont	SR 20	205.8	Beaver Cr	2.14	NE	23	33N	22E	CO/CK/SH/CT/RB/DB/EB	Hwy 20 crossing MP 205.80.	culvert	E-files cont' from Habitat; 980108cb(SFBEAVERb); 980108d(VOLSTEAD)(1-2); 980108da(VOLSTEADa); 980108e(LIGHTNING); 980108f(BLUEBUCK)(1-2); 980108fa(BLUEBUCKa); 980108fb(BLUEBUCKb); 980108fs(BLUEBUCKc); 980108g; 980108h.
980115	Unknown	NA		Beaver Cr	2.91	SE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	4675 meters upstream mouth of Beaver Cr.	dam	Partial barrier due to drop, tarp and timber dam does provide little access.
980116	Unknown	Unnamed		Beaver Cr	2.96	SE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	4777 meters upstream mouth of Beaver Cr.	culvert	Velocity barrier at high flows. Hydraulic drop created by division of two pipes.
980117	Unknown	NA		Beaver Cr	3.26	NE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	5242 meters upstream mouth of Beaver Cr.	Dam	Log and tarp should be removed.
980118	Unknown	NA		Beaver Cr	4.16	SE	11	33N	22E	CO/CK/SH/CT/RB/DB/EB	6692 meters upstream mouth of Beaver Cr.	Dam	Rock constitutes a partial barrier, but diversion needs to be correctly screened.

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWNSHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980119	Unknown	NA		Beaver Cr	5	SW	2	33N	22E	CO/CK/SH/CT/RB/DB/EB	8039 meters upstream mouth of Beaver Cr.	Dam	Dam could easily be reconfigured to allow 100% of fish passage.
980124	Claton Belmont	SR 20	206.9	Frazer Cr	0.35	NE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	State Route 20 MP 206.90.	Culvert	Future WDFW project, scheduled for 2002 with dedicated funding.
980125	Thurlow family	NA		Frazer Cr	0.32	NE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	Alongside State Route 20	Dam	At current flows it is a total barrier. Higher flow probably 33% passable.
980126	Unknown	Unnamed		Frazer Cr	26	NE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	417 meters upstream of mo	Culvert	Perched, slope and vegetation due to lack of utilization, create a barrier.
980127	Unknown	Unnamed		Frazer Cr	0.44	NW	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	710 meters upstrea of mou	Culvert	Inside barrier culvert is POD for unscreened gravity diversion.
980129	Unknown	NA		Frazer Cr	0.49	NW	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	795 meters upstream mouth of Frazer.	Dam	If dam was full spanning it would be 100% barrier.
980131	Claton Belmont	SR 20	208.5	Unnamed	0.02	SW	7	33N	23E	CO/CK/SH/CT/RB/DB/EB	State Route 20 M.P. 208.5	Culvert	Very steep slope, and undersized. Future WDFW project, scheduled for 2002 with dedicated $.
980132	Unknown	Unnamed		Frazer Cr	2.13	SW	7	33N	23E	CO/CK/SH/CT/RB/DB/EB	Private driveway off Hwy 20, approximately M.P. 208.4.	Culvert	Large outfall drop and slightly undersized.

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980133	Jim Mountjoy	Unnamed		Unnamed	0.08	SW	7	33N	23E	CO/CK/SH/CT/RB/DB/EB	.1 miles up access road of Wildlife Area entrance off Hwy 20.	culvert	Easy fix. Little fill and only dirt surfacing.
980136	Unknown	NA		Beaver Cr	8.99	SW	24	34N	22E	CO/CK/SH/CT/RB/DB/EB	710 meters upstrea of mouth.	dam	
980137		FS 4225		Beaver Cr	9.93	NE	24	34N	22E	CO/CK/SH/CT/RB/DB/EB	On FS 4225, just next to intersection with Upper Beaver Creek Road.	culvert	US Forest Service crossing on the wildlife area.
980140		FS 4225.200		Volstead Cr	0.05	SE	13	34N	22E	CO/CK/SH/CT/RB/DB/EB	85 m upstream from confluence with Beaver Cr	culvert	
980141		FS 4225.200		Volstead Cr	0.25	SE	13	34N	22E	CO/CK/SH/CT/RB/DB/EB	400 m upstream from confluence with Beaver	culvert	
980142		FS 4225.200		Volstead Cr	0.54	NE	13	34N	22E	CO/CK/SH/CT/RB/DB/EB	865 m upstream from confluence with Beaver Cr	culvert	
980143		FS 4225.230		Volstead Cr	0.56	NE	13	34N	22E	SH/CT/RB/DB/EB	899 m upstream from confluece with Beaver Cr	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980144		FS 4225.200		Volstead Cr	0.88	NW	13	34N	22E	SH/CT/RB/DB/EB	1413 m upstream from confluence with Beaver Cr	culvert	
980145		FS 4225.200		Volstead Cr	1.05	NW	13	34N	22E	SH/CT/RB/DB/EB	1682 m upstream from the confluence with Beaver Cr	culvert	
980146		FS 4225.200		Volstead Cr	1.34	SW	12	34N	22E	SH/CT/RB/DB/EB	2159 m upstream from the confluence with Beaver Cr	culvert	
980147	Unknown	Unnamed		Frazer Cr	0.03	SE	14	33N	22E	CO/CK/SH/CT/RB/DB/EB	45 m upstream from the confluence with Beaver Cr	culvert	
980148		FS.4230		Beaver Cr	16.87	NW	28	35N	22E	CO/CK/SH/CT/RB/DB/EB	Furthest upstream crossing on mainstem Beaver Cr	culvert	
980149	Unknown	NA		Frazer Cr	0.52	NW	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	839 m upstream from confluence with Beaver Cr	dam	
980151	Unknown	Unnamed		Frazer Cr	1.16	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	1864 m upstream from confluence with Beaver Cr	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980152	Unknown	Unnamed		Frazer Cr	1.39	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2233 m upstream from confluence with Beaver Cr	culvert	
980153	Unknown	Unnamed		Frazer Cr	1.4	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2255 m upstream from confluence with Beaver Cr	culvert	
980154	Unknown	NA		Frazer Cr	1.45	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2341 m upstream from confluence with Beaver Cr	dam	
980157	Unknown	NA		Frazer Cr	1.57	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2530 m upstream from confluence with Beaver Cr	dam	
980158	Unknown	Unnamed		Frazer Cr	1.63	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2618 m upstream from confluence with Beaver Cr	culvert	
980159		FS 4225.200		Volstead Cr	1.38	SW	12	34N	22E	CT/RB/DB/EB	2230 m upstream from confluence with Beaver Cr; furthest upstream crossing on Volstead Cr.	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980163		FS 4225.400		Blue Buck Cr	2.32	SW	19	35N	23E	SH/CT/RB/DB/EB	Only road crossing on Blue Buck Creek. 3740 m upstream from confluence with Beaver Cr.	culvert	
980165		USFS Rd		Unnamed	0.8	SW	25	35N	22E	SH/CT/RB/DB/EB	On spur road, off FS 4225-400. 2nd of 3 crossings on Blue Buck trib #1. Fish bearing for only 65 m upstream of this point. Therefore, culvert has NO GAIN status.	culvert	Repair not required.
980166		USFS Rd		Unnamed	0.58	SE	25	35N	22E	SH/CT/RB/DB/EB	On spur road, off FS 4225-400. 1st of 3 crossings on Blue Buck trib #1.	culvert	Outfall drop over .8 feet
980167		FS 4225		MF Beaver Cr	0	SE	17	34N	23E	SH/CT/RB/DB/EB	MF Beaver Cr culvert. DS end of pipe dumps directly into SF Beaver Cr.	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980168		FS 4225		SF Beaver Cr	2.57	NE	21	34N	23E	SH/CT/RB/DB/EB	4162 m upstream of confluence with Beaver Cr.	culvert	
980169		FS 4225		SF Beaver Cr	2.58	NE	21	34N	23E	SH/CT/RB/DB/EB	4909 m upstream of confluence with Beaver Cr.	culvert	
980170		FS 4225		SF Beaver Cr	6.66	SW	24	34N	23E	SH/CT/RB/DB/EB	Under FS 4225, near intersection with FS 42	culvert	
980171		FS 4235		SF Beaver Cr	7.33	NE	24	34N	23E	SH/CT/RB/DB/EB	Under FS 4235, near the intersection with FS 42	culvert	
980177		FS 4225.030		SF Beaver Cr	5.91	SE	23	34N	23E	SH/CT/RB/DB/EB	Spur rd, approx. 0.25 off of FS 4225	culvert	
980179		NA		SF Beaver Cr	6.14	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.
980183		NA		SF Beaver Cr	6.18	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.
980188		NA		SF Beaver Cr	6.22	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.
980190		NA		SF Beaver Cr	6.24	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980191		NA		SF Beaver Cr	6.25	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.
980192		NA		SF Beaver Cr	6.27	SE	23	34N	23E	SH/CT/RB/DB/EB	South Fork Meadows	dam	Log control.
980194		USFS Rd		SF Beaver Cr	8.34	NE	19	34N	24E	SH/CT/RB/DB/EB	Under spur rd (spur of FS 4235)	culvert	Forest Service road.
980195		FS 4230		MF Beaver Cr	3.11	SW	11	34N	23E	SH/CT/RB/DB/EB	2nd culvert on Middle Fork	culvert	
980197		FS 4235.100		MF Beaver Cr	5.97	NW	7	34N	24E	SH/CT/RB/DB/EB	Furthest upstream crossing on Middle Fork Beaver Cr.	culvert	Huge outfall drop (3')
980198	Unknown	NA		Frazer Cr	1.66	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	50 m off SR-20. Site is 2673 m upstream from confluence with Beaver Cr	dam	
980199	Unknown	Unnamed		Frazer Cr	1.66	NE	13	33N	22E	CO/CK/SH/CT/RB/DB/EB	2677 upstream from confluence with Beaver Cr.	culvert	
980203	Unknown	Unnamed		Frazer Cr	1.9	NW	18	33N	23E	CO/CK/SH/CT/RB/DB/EB	3059 m upstream from confluence with Beaver Cr	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980205	Unknown	Unnamed		Frazer Cr	2.46	SE	7	33N	23E	CO/CK/SH/CT/RB/DB/EB	25 m off SR-20 on private rd.	culvert	
980206	Unknown	Unnamed		Frazer Cr	2.73	SE	7	33N	23E	CO/CK/SH/CT/RB/DB/EB	4398 m upstream from confluence with Beaver Cr	culvert	
980208	Unknown	NA		Frazer Cr	3.1	SW	8	33N	23E	CO/CK/SH/CT/RB/DB/EB	4983 m upstream from confluence with Beaver Cr	dam	Dam slightly breached, partial barrier.
980210	Unknown	NA		Frazer Cr	3.8	SE	8	33N	23E	SH/CT/RB/DB/EB	6121 m upstream from confluence with Beaver Cr	dam	
980211	Unknown	Unnamed		Frazer Cr	3.97	SE	8	33N	23E	SH/CT/RB/DB/EB	6387 m upstream from confluence with Beaver Cr	culvert	
980215		USFS Rd		Frazer Cr	5.11	SE	9	33N	23E	SH/CT/RB/DB/EB	USFS Rd, no apparent number. Next to campground, just off SR-20. 8227 m up Frazer from confluence with Beaver Cr	culvert	
980216		FS 4225.200		Volstead Cr	0.31	SE	13	34N	22E	CO/CK/SH/CT/RB/DB/EB	3rd culvert on Volstead Cr	culvert	
980217		FS 4225.200		Volstead Cr	0.41	SE	13	34N	22E	CO/CK/SH/CT/RB/DB/EB	4th culvert on Volstead Cr	culvert	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWN SHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980218		FS 4225		Unnamed	0.02	SW	23	34N	23E	SH/CT/RB/DB/EB	Culvert on 1st reach of an unnamed trib of SF Beaver Cr (approx. RM on SF: 5.05)	culvert	
980219	Unknown	Balky Hill Rd		Wolf Canyon Cr	0.06	NW	2	33N	22E	CO/CK/SH/CT/RB/DB/EB	Under Balky Hill Rd, just off of Beaver Cr Rd	culvert	
980222	Unknown	Beaver Creek Rd		Wolf Canyon Cr	0.12	NW	2	33N	22E	CO/CK/SH/CT/RB/DB/EB	Culvert under Beaver Creek Rd (212 m upstream from confluence with Beaver Cr).	culvert	
980223	Unknown	Unnamed		Wolf Canyon Cr	0.39	NE	2	33N	22E	CO/CK/SH/CT/RB/DB/EB	Private road; crossing is 636 m upstream from confluence with Beaver Cr.	culvert	
980224	Unknown	Unnamed		Wolf Canyon Cr	0.78	SE	35	34N	22E	SH/CT/RB/DB/EB	Brand new driveway; house 50 up LB sideslope.	culvert	
980225	Unknown	NA		Wolf Canyon Cr	0.83	SE	35	34N	22E	SH/CT/RB/DB/EB	90 m upstream from 980224 (culvert, private driveway).	dam	

SITEID	CONTACT	ROAD NAME	MILE POST	STREAM	River Mile	1/4 SEC	SEC	TOWNSHIP	RANGE	SPECIES	LOCATION	FEATURE TYPE	BARRIERCOM
980226		FS 4235.100		Unnamed	0.62	SW	6	34N	24E	SH/CT/RB/DB/EB	1004 m upstream from confluence with Middle Fork.	culvert	
980227		USFS Rd		Unnamed	0.19	NE	11	34N	23E	SH/CT/RB/DB/EB	Lower of two crossings on MF Beaver trib # 2. On spur road off of FS 4235.	culvert	
980228		FS 4235.100		Unnamed	1.63	SW	36	35N	23E	SH/CT/RB/DB/EB	Higher of two road crossings on MF Beaver, trib #1. Culvert has NO GAIN status (usable habitat stops here).	culvert	

APPENDIX D - SALMONID HABITAT CONDITION RATING STANDARDS FOR IDENTIFYING LIMITING FACTORS

Under the Salmon Recovery Act (passed by the legislature as House Bill 2496, and later revised by Senate Bill 5595), the Washington Conservation Commission (WCC) is charged with identifying the habitat factors limiting the production of salmonids throughout most of the state. This information should guide lead entity groups and the Salmon Recovery Funding Board in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Identifying habitat limiting factors requires a set of standards that can be used to compare the significance of different factors and consistently evaluate habitat conditions in each WRIA throughout the state.

In order to develop a set of standards to rate salmonid habitat conditions, several tribal, state, and federal documents that use some type of habitat rating system (Table 1) were reviewed. The goal was to identify appropriate rating standards for as many types of habitat limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the accepted standard was adopted by the WCC. For factors that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed by WCC, with the expectation that it will be modified or replaced as better data become available.

Table D- 1 Source documents

Code	Document	Organization
Hood Canal	Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Habitat Recovery Plan, Final Draft (1999)	Point No Point Treaty Council, Skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Washington Department of Fish and Wildlife
ManTech	An Ecosystem Approach to Salmnoid Conservation, vol. 1 (1995)	ManTech Environmental Research Services for the National Marine Fisheries Service, the US Environmental Protection Agency, and the US Fish and Wildlife Service
NMFS	Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast (1996)	National Marine Fisheries Service
PHS	Priority Habitat Management Recommendations: Riparian (1995)	Washington Department of Fish and Wildlife
Skagit	Skagit Watershed Council Habitat Protection and Restoration Strategy (1998)	Skagit Watershed Council
WSA	Watershed Analysis Manual, v4.0 (1997)	Washington Forest Practices Board
USFWS Guidelines	A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed	Fish and Wildlife Service

	Scale	
TAG	The assessment of conditions are based on data from USFS stream surveys, comparison of data with the Interagency Aquatic Database and GIS, and professional knowledge of the system	2496 Methow Habitat Limiting Factors Technical Advisory Group
WSP	Wild Salmonid Policy (1997)	Washington Department of Fish and Wildlife

The ratings adopted by the WCC are presented in Table 2. These ratings are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in a WRIA. They will provide a level of consistency between WRIAs that allows habitat conditions to be compared across the state. However, where data is unavailble or where analysis of data has not been conducted, the professional expertise of the TAG is used. In some cases there may be local conditions that warrant deviation from the rating standards presented here. Additional rating standards will be included as they become available and will supercede the standards used in this report.

Table D- 2 WCC salmonid habitat condition ratings

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Access						
Artificial Barriers	% known/potential habitat blocked by artificial barriers	All	>20%	10-20%	<10%	WCC
Floodplains						
Floodplain Connectivity	Stream and off-channel habitat length with lost floodplain connectivity due to incision, roads, dikes, flood protection, or other	<1% gradient	>50%	10-50%	<10%	WCC

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Riparian Condition						
Riparian Condition	Within 300' of the Ordinary High Water Line (OHWL)	All – Eastside	riparian areas are fragmented, poorly connected, or provide inadequate protection of habitats for sensitive aquatic species (<70% intact, refugia does not occur), and adequately buffer impacts on rangelands; percent similarity of riparian vegetation to the potential natural community/composition is <25%.	moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian areas, or incomplete protection of habitats and refugia for sensitive aquatic species (≈ 70-80% intact) and adequately buffers impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/composition is 25-50% or better.	the riparian areas provide adequate shade, LWD recruitment, and habitat protection and connectivity in subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact) and adequately buffers impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/composition is >50%.	USFWS Guidelines

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Large Woody Debris						
Large Woody Debris	comparison of USFS stream survey data with the Interagency Aquatic Database and GIS.	All – forests eastside of the North Cascades crest	ranked in the <25 percentile category of streams with like gradient and width	ranked in the 25 – 75 percentile category of streams with like gradient and width	ranked in the >75 percentile category of streams with like gradient and width	TAG
Channel Conditions and Streambed Sediment						
Sediment	fines <0.85mm in spawning gravel	All – Eastside	>17%	12 – 17	<12%	USFWS Guidelines
Substrate Embeddedness	Degree of reach embeddedness	All – Eastside	>30%	20 – 30%	<20%	USFWS Guidelines
Channel Conditions and Streambed Sediment continued						
Sediment Delivery	chronic and catastrophic delivery from bank erosion, mass wasting and surface erosion	All – Eastside	high delivery of sediment to the watercourse and the system is in a highly unstable condition	moderate delivery of sediment to the watercourse and a downward trend in condition	low delivery of sediment to the watercourse and the system is in a stable condition	TAG

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Pools	channel spanning pools/mile longer than they are wide and >3 feet deep	All – Eastside	no pools present	few pools present	many pools present	TAG
Width/Depth Ratio		All – Eastside	streambed has aggraded or degraded	there is a mild trend toward aggrading or degrading of the streambed	streambed appears to be managing the bedload and is in a stable condition	TAG
Water Quality						
Toxics	Varies	All – Eastside	high levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one CWA 303(d) designated reach	moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients one CWA 303(d) designated reach	low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no CWA 303(d) designated reaches	USFWS Guidelines

Habitat Factor	Parameter/Unit	Channel Type	**Poor** **(Not Properly Functioning)**	**Fair** **(At Risk)**	**Good** **(Properly Functioning)**	Source
Temperature	degrees Celsius/ degrees Fahrenheit	All	>15.6° C/ 60°F (spawning) >17.8° C/ 64°F (migration and rearing)	14-15.6°C/59-60°F (spawning) 14-17.8° C/57.2°-64°F (migration and rearing)	10-14°C/50°-59°F	NMFS
			For bull trout, 7-day average maximum temperature in a reach during the following life history stages: >15°C/ 59°F (rearing) <4°C or > 10°C/ <39°F or >50°F (spawning) <1°C or >6°C/ 34°F or 43ºF (incubation) also temperatures in areas used by adults during migration regularly exceed 15ºC (59ºF) (thermal barriers present)	For bull trout, 7-day average maximum temperature in a reach during the following life history stages: <4°C or >13-15ºC/ <39°F or >55º-59ºF (rearing) <4°C or >10°C/ <39°F or 50°F (spawning) <2°C or >6°C/ 36°F or 43ºF (incubation) also temperatures in areas used by adults during migration sometimes exceed 15ºC (59ºF)	For bull trout, 7-day average maximum temperature in a reach during the following life history stages: 4°-12ºC/ 39°-54ºF (rearing) 4° - 9ºC/ 39°-48°F (spawning) 2°-5°C/ 36°-41ºF (incubation) also temperatures do not exceed 15ºC (59ºF) in areas used by adults during migration (no thermal barriers)	USFWS Guidelines

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Water Quantity						
Flow	Change in Peak/Base Flows	All	Pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	USFWS Guidelines
Dewatering	presence/absence	All	No flows during some portion of the year	-	Flows present year-round	TAG

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Biological Processes						
Brook Trout	presence/ absence	All - Eastside	Brook trout present in the drainage.	Brook trout recorded in an adjacent drainage and have access to the drainage.	Brook trout absent in the drainage and there is not opportunity for access to the drainage	TAG