Yakima Bull Trout Action Plan

Final
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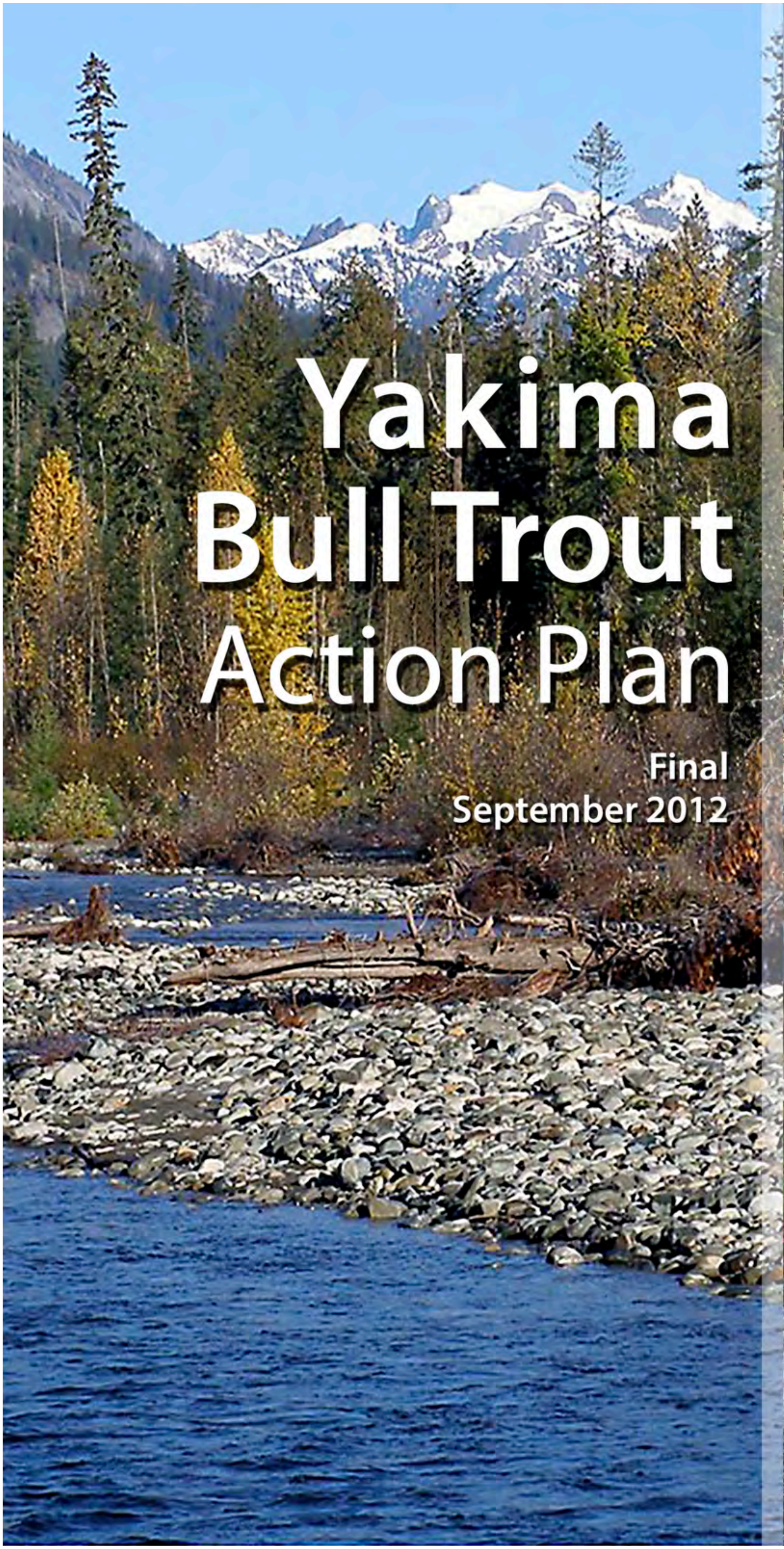

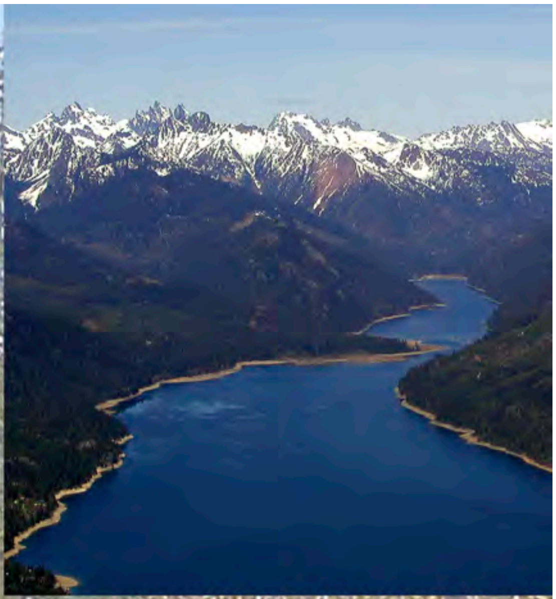

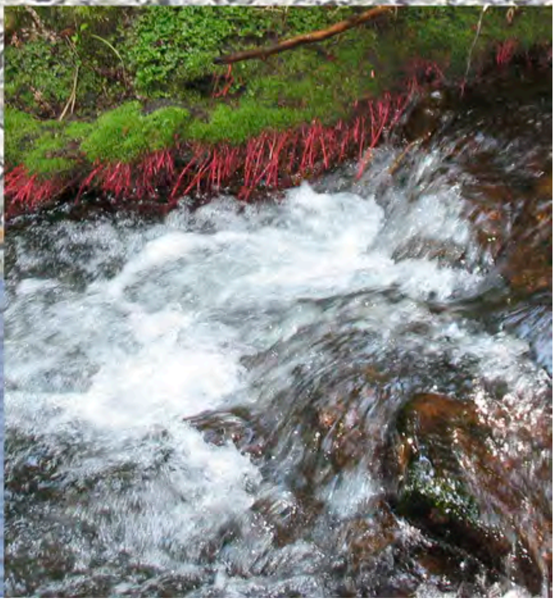

Yakima Bull Trout Action Plan (Draft Release, May 2012)

AUTHORS:

K. Yuki Reiss (Yakima Basin Fish and Wildlife Recovery Board)

Jeff Thomas (U.S. Fish and Wildlife Service)

Eric Anderson (Washington Department of Fish and Wildlife)

Jim Cummins (Washington Department of Fish and Wildlife)

Cover photo credits (clockwise from left): Teanaway River with mountains (J. Cummins); aerial view of Kachess Lake (W. Meyer); bull trout on spawning grounds (W. Meyer); exposed alder roots in the Middle Fork Ahtanum (Y. Reiss).

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EXECUTIVE SUMMARY

The Yakima Bull Trout Action Plan (YBTAP) is a locally developed, up-to-date summary of information on bull trout (*Salvelinus confluentus*) populations in the Yakima Basin. It includes information on population status, trend and distribution, habitat, a detailed analysis of threats by life stage for each population, and specific monitoring and restoration actions that address those threats. The main goal of this plan is to identify the specific actions that will most benefit bull trout populations in the Yakima Basin. This document is also meant to be a broadly accessible summary of information on bull trout populations and is linked to a document library of local bull trout documents (grey literature) as well as published documents, so that readers can easily access additional detail.

This action plan was developed by biologists from the Yakima Basin Fish and Wildlife Recovery Board (YBFWRB), Washington Department of Fish and Wildlife (WDFW), and the U.S. Fish and Wildlife Service (USFWS) Mid-Columbia Fishery Resource Office (collectively, the YBTAP Working Group), and was reviewed by a broader bull trout working group during its development.

There are currently 15 identified bull trout populations in the Yakima Basin, representing adfluvial, fluvial, and resident life history types. The Yakima Basin is considered a "Core Area" by the USFWS and is part of the Middle Columbia Recovery Unit. Bull trout across their range within the contiguous United States were listed as Threatened under the Endangered Species Act (ESA) in 1998. At this time, the USFWS is developing an ESA-mandated recovery plan for Bull Trout. It is our hope that the detailed information and analysis of the Yakima Core Area included in this document will inform development of the Yakima Core Area portion of the USFWS plan.

In the YBTAP, threats are analyzed by each life stage: spawning/egg incubation, juvenile rearing, adults and subadults in Foraging, Migratory and Overwintering (FMO) Habitat and during pre/post spawning migrations. For each threat, all possible effects and mechanisms were considered for each life stage, and severity was evaluated for all local populations. The YBTAP then identifies actions that address the most severe threats for each population, summarized in the table below.

The actions proposed are divided into several categories. Broad-scale actions are those that will benefit bull trout population in the long term (10-25+ years), but will require coordinated efforts across multiple entities in the basin or require congressional funding (e.g., passage at major storage dams). Actions that will directly benefit local populations and are implementable in a short- to mid-range time scale (1-10 years) were identified for multiple populations and for individual populations. In addition, actions to monitor bull trout populations and their habitat, implement project monitoring, and increase our understanding of key uncertainties are identified.

This plan identifies a suite of actions for each local population. However, acknowledging that funding is limited, an additional filter was used to help prioritize actions across populations. Five populations were categorized as "Action" populations, which have the highest priority for short-term action implementation (Tier I). These are areas where we anticipate significant improvements in population performance in response to proposed actions. The six "Protection" populations are ones where bull trout populations are relatively stable and where identified short-term actions, while important, are only expected to make incremental improvements in

population performance. For these populations, protecting the habitat conditions that have allowed them to perform well is the primary short-term focus. The four “Monitor” populations are the lowest priority for implementation of bull trout actions (Tier III), as there is significant uncertainty about the continued existence of these populations and what factors are limiting their performance. The tables presented below summarize the recommended actions for each of these population groups.

The analysis and information presented in this plan will help resource managers in the Yakima Basin best use limited resources to identify and implement on-the-ground actions that result in significant and sustainable improvements in bull trout viability. The goal is to work together with partners across the basin and the larger region to aid in recovering this often-forgotten native fish.

THREAT SEVERITY:	**Significant**	**Moderately Significant**	**Unknown But Believed to Be Significant**
POPULATION:			
Ahtanum Creek	Forest Management Low Abundance	Passage Barriers Altered Flows	Angling Development Entrainment Prey Base Recreation
Rattlesnake Creek		Low Abundance	Prey Base
Crow Creek	Low Abundance		Angling Prey Base Recreation Passage Barriers
American River		Low Abundance	Angling Prey Base Recreation
Indian Creek	Passage Barriers		Angling Entrainment Introduced Species Prey Base Recreation
S. F. Tieton River	Passage Barriers		Angling Entrainment Prey Base Recreation Grazing
N. F. Tieton River	Passage Barriers		Angling Entrainment Introduced Species Prey Base

THREAT SEVERITY:	**Significant**	**Moderately Significant**	**Unknown But Believed to Be Significant**
Deep Creek	Passage Barriers		Angling Dewatering Introduced Species Prey Base
Cle Elum/Waptus River	Introduced Species Low Abundance Passage Barriers		Entrainment Prey Base Recreation
Box Canyon Creek	Low Abundance Passage Barriers		Angling Entrainment Limited Extent of Habitat Prey Base Recreation
Kachess River	Low Abundance Passage Barriers	Dewatering	Angling Entrainment Prey Base
Gold Creek	Dewatering Low Abundance Passage Barriers		Angling Development Entrainment Prey Base
Teanaway River	Low Abundance		Altered Flows Angling Development Prey Base Recreation Passage Barriers
Upper Yakima River	Introduced Species Low Abundance		Altered Flows Angling Development Passage Barriers Prey Base

HIGHEST PRIORITY ACTION POPULATIONS ACTIONS (TIER I)

Population	Population Scale Actions	Monitoring Actions	Broad Scale Actions
Ahtanum Creek	Instream and floodplain restoration	Evaluate movement patterns between forks	Restore salmon populations
Ahtanum Creek	Address forest health	Monitor screens at diversions	
Ahtanum Creek	Relocate roads adjacent to streams	Monitor cattle exclusion fencing	
Ahtanum Creek	Increase instream flow in lower Ahtanum Creek	Habitat surveys	
Ahtanum Creek	Screen all diversions		
Ahtanum Creek	Close or relocate Tree Phones campground		
Ahtanum Creek	Close or relocate Snow Cabin campground		
Box Canyon Creek	Monitor/fix passage problems at mouth		Passage at Kachess Dam
Box Canyon Creek	Passage over Peekaboo Falls		
Box Canyon Creek	Carcass analog pilot study		
Crow Creek	Implement Little Naches River Action Plan	Periodic extended redd surveys	Restore salmon populations
Crow Creek	Relocate Crow Creek campground	Continue Little Naches River sediment monitoring	Passage at Rimrock Dam
Crow Creek	Land acquisitions in Little Naches watershed		Passage at Bumping Dam
Gold Creek	Hydrologic assessment	Monitor bank stabilization projects	Passage at Keechelus Dam
Gold Creek	Implement Forest Service Gold Creek floodplain restoration		
Gold Creek	Land acquisitions in lower Gold Creek		
Gold Creek	Monitor/fix passage problems at mouth		
N.F. Tieton R.	Clear Creek Dam assessment/improve passage		Passage at Tieton Dam
Multiple Pops #1	Outreach (Bull Trout Task Force)		
Multiple Pops #2		Redd surveys	

Population	Population Scale Actions	Monitoring Actions	Broad Scale Actions
Multiple Pops #3		Temperature monitoring	
Multiple Pops #4	Evaluate supplementation		
Multiple Pops #5	Carcass analog placement		
Multiple Pops #6	Floodplain protection in Naches River mainstem		
Multiple Pops #7		Monitor brook trout introgression	
Multiple Pops #8	Manage operations to reduce entrainment at Tieton Dam		
Multiple Pops #9		Periodic entrainment studies at dams	

PROTECTION POPULATION BULL TROUT ACTIONS (TIER II)

Population	Population Scale Actions	Monitoring Actions	Broad Scale Actions
American River	Protect and restore streambanks		Restore salmon populations
American River			Passage at Tieton Dam
Indian Creek	Reroute motorcycle race		
Rattlesnake Creek		Monitor effectiveness of screens on diversions	
S.F. Tieton River	Restrict streamside camping	Monitor cattle exclusions	
S.F. Tieton River	Address problem roads		
S.F. Tieton River	Implement Dry Forest Restoration Strategy		
S.F. Tieton River	Relocate river to natural mouth		
Deep Creek			Passage at Bumping Dam
NO POPULATION SCALE ACTIONS FOR DEEP OR KACHESS POPULATIONS			

MONITOR GROUP BULL TROUT ACTIONS (TIER III- lower short-term priority for bull trout)

Population	**Population Scale Actions**	**Monitoring Actions**	**Broad Scale Actions**
Cle Elum River	Lake trout assessment/removal	Extensive surveys for bull trout presence	Passage at Cle Elum Dam
Cle Elum River	Campsite restoration		
Teanaway River	Increase instream flows	Annual snorkel surveys for bull trout presence	Restore salmon populations
Teanaway River	Floodplain acquisitions	Habitat surveys	
Teanaway River	Reduce road densities		
Teanaway River	Implement cattle exclusions/riparian restoration		
Upper Yakima River	Improve flow conditions	Periodic surveys for bull trout presence	Restore salmon populations
Upper Yakima River	Floodplain acquisitions	Monitor/improve screens on diversions	Passage at Keechelus Dam
Upper Yakima River	Implement Forest Service Upper Yakima Restoration Plan		Passage at Kachess Dam
Upper Yakima River			Passage at Cle Elum Dam
Waptus River		Extensive surveys for bull trout presence	

INTRODUCTION

The Yakima Bull Trout Action Plan (YBTAP) is a locally developed, up-to-date summary of information on bull trout populations in the Yakima Basin. It includes information on population status, trend and distribution, habitat, detailed analyses of threats by life stage for each population, and specific monitoring and restoration actions that address identified threats. This document serves as an accessible repository for information on bull trout populations and is linked to a document library of local bull trout documents (grey literature) as well as published documents. This action plan was developed by biologists from the Yakima Basin Fish and Wildlife Recovery Board (YBFWRB), Washington Department of Fish and Wildlife (WDFW), and the U.S. Fish and Wildlife Service (USFWS) Mid-Columbia Fishery Resource Office (collectively, the YBTAP Working Group). The primary goal of this plan is to define actions that will benefit bull trout populations in the Yakima Basin.

Bull trout (*Salvelinus confluentus*) were listed as Threatened under the Endangered Species Act (ESA) in 1998. In the original listing (USFWS 1998), the Yakima Basin was part of the Columbia River Distinct Population Segment (DPS) and was one of 22 "Recovery Units" within that DPS. In 1999, the USFWS relisted the bull trout into one coterminous DPS and delineated the Columbia River basin as an interim Recovery Unit, until a final recovery plan is completed (USFWS 1999b). A Draft Bull Trout Recovery Plan, released in 2002, was never finalized (USFWS 2002). In 2010, the USFWS reinitiated the recovery planning process, with new geographic delineations. In this current planning process, the Yakima Basin is one of 34 Core Areas within the larger Middle Columbia Recovery Unit, and all recovery units are part of the range-wide DPS listing (see http://www.fws.gov/pacific/bulltrout/Recovery.html). Each of these bull trout core areas is expected to function as a metapopulation, a basic unit for ensuring long-term sustainability of an aggregate of local populations.

The development of this action plan is concurrent with the formal USFWS Bull Trout recovery planning process. The goal is to work together to ensure that the actions and information presented in this plan link with the strategies in the USFWS Final Bull Trout Recovery Plan. Building a crosswalk to the USFWS Recovery Plan will be an ongoing effort. This plan contains a much finer level of detail on population status, threats, and actions needed to address population threats than will be available in the larger-scale USFWS Recovery Plan.

Developing a locally driven plan has allowed us to work outside of the bounds of "regional templates" and create a document that will be immediately useful within the Yakima Basin for basinwide (e.g., Yakima River Basin Water Enhancement Program Integrated Plan and Yakima Project Biological Opinion) and reach-scale decision processes (project grant funding and watershed-level planning). As USFWS recovery planning progresses, it is expected that this document will also serve as a Core Area implementation plan guiding recovery of bull trout in the Yakima Basin.

In 1999, after bull trout were listed, USFWS convened recovery-planning groups around the region to help in developing local chapters for the 2002 Draft Bull Trout Recovery Plan. In the Yakima Basin a group of biologists from the original Yakima Basin bull trout recovery team has remained dedicated to working on bull trout issues during the last decade. This document is a way to formalize the discussions of this group and come to consensus on priority actions to benefit local bull trout populations. During the process of developing the content and writing the

YBTAP, several meetings were held to allow the team to review and comments on content (Appendix G).

What Is Included in This Plan

This document includes a wealth of information on bull trout in the Yakima Basin. The YBTAP includes detailed information specific to each local bull trout population, with links to relevant documents and literature. The description for each population is divided into sections on Population Distribution, Status and Trend, Habitat, Threats, and Actions.

The first section, Individual Population Information, describes population distribution, life history and status; genetic data; and redd count and population monitoring history. The document provides this information in one place and makes it available for anyone seeking information about bull trout in particular drainages within the Yakima Basin.

The next section, Habitat, is an overview of the general characteristics of spawning and rearing habitat and of foraging, migratory, and overwintering (FMO) habitat used by the population. It also describes past and present habitat monitoring in those areas. The Threats section, which follows the Habitat information, summarizes the key threats for the population (based on the life stages that are most severely affected) in both narrative and table forms. Also included in the Threats table for each population is an abbreviated list of actions that address all high and medium priority threats (See Methods below). These tables are included to display the critical results generated from the threats analysis. Full results of this analysis are presented in Appendix E. The analysis provides the rationale for the recommended actions.

The final section, Recovery Actions, includes actions from all categories. The strategy is an overall synopsis of what needs to be done for the population and lists the Broad Scale Actions that apply to the population. Next we list all the Completed Actions in the geographic area that benefit bull trout or address identified threats. Recommended Actions include specific Population Scale Actions and also a series of Monitoring Actions.

To compile this master list of actions, landowners and stakeholders from each of the local population areas were contacted to provide information on past and planned projects. Some actions are well developed and could be initiated immediately if funding were available. Others are more conceptual or describe long-term goals and would be implemented by a series of projects over time.

Within the Individual Population Information section of the document, actions are included as a bulleted list with a link to the Actions Detail section in the back of the document where more action-specific information is provided. In the individual population Actions subsections, we include actions from the Yakima Steelhead Recovery Plan that would also benefit bull trout. It will be critical to coordinate bull trout efforts in the basin with ongoing steelhead and salmon recovery efforts.

The individual population sections conclude with a map of the population area that show roads, trails, wilderness areas, and campgrounds in relation to bull trout spawning, rearing, and FMO habitat.

After the Individual Population Information sections, there is a section with Action Details that includes specific information necessary to implement each proposed action (description, partners, cost estimate, etc.). The Action Details will assist with the schedule of recovery actions and final inform the USFWS final Bull Trout Recovery Plan as well as the Yakima Basin Core Area implementation plan.

Relationship to Other Plans

The relationship of this YBTAP to the Draft Bull Trout Recovery Plan (USFWS 2002)and the Final Recovery Plan (USFWS, *in prep*) is described above. Additional information was drawn from the USFWS Five Year Status Review (USFWS 2008) and the USFWS Critical Habitat Listing Package (USFWS 2010). For each of these efforts, the USFWS, working with the local bull trout team, has summarized and updated the information and status of Yakima Basin bull trout populations. The YBTAP presents that information, plus additional analysis and actions, in a document that is specific to the Yakima Basin.

Other basinwide planning efforts include the Yakima Subbasin Plan (Yakima Basin Fish and Wildlife Planning Board 2005), the Salmon Recovery Plan (Yakima Basin Fish and Wildlife Planning Board 2005), the Limiting Factors Analysis (Haring 2001) and the Yakima Basin Integrated Water Resource Management Plan (Ecology 2012). Each of these includes summary information about bull trout populations and recovery needs but few comprehensive details. The YBTAP contains the most inclusive and current information about bull trout populations and will be maintained as a real-time document that is updated annually or as new information is available.

Steelhead are the other ESA-listed fish species in the basin, and the 2009 Yakima Steelhead Recovery Plan describes a suite of actions that would benefit steelhead populations (Yakima Basin Fish and Wildlife Recovery Board 2009). Many of these actions will also benefit other species, including bull trout. The bull trout populations that will most benefit from steelhead actions are those that utilize FMO habitat below the reservoirs. Implementing actions for bull trout where there is benefit to multiple species will increase funding opportunities, efficiency, and potential for success. However, bull trout are unique in that some populations reside in high elevation habitat that is currently inaccessible to anadromous species. An important role for the YBTAP is to highlight actions and projects in areas that are not currently priorities for broader salmon recovery efforts.

Overview of the Yakima Basin

The Yakima River basin is located in south central Washington and drains approximately 6,155 square miles. Almost all the basin lies within areas either ceded to the United States by the Yakama Nation or areas reserved for their use. The basin occupies most of Yakima and Kittitas counties, about half of Benton County, and a small portion of Klickitat County. The Yakima River basin is bounded on the west by the Cascade Range, on the north by the Wenatchee Mountains, on the east by the Rattlesnake Hills, and on the south by the Horse Heaven Hills. Altitudes range from 8,184 feet above mean sea level in the Cascades to 340 feet where the Yakima River enters the Columbia River at river mile (RM) 333 near the City of Richland, Washington. The Yakima River basin is a rich agricultural area almost totally dependent on irrigation. It contains about 500,000 acres of irrigated land with the water for most of this acreage supplied by the USBR's Yakima Project. Other major land uses include livestock production (ranching, feedlots, and dairies), timber production, and recreation.

The climate of the Yakima River basin ranges from alpine along the crest of the Cascade Range to arid in the lower valleys. Air temperatures are inversely related to altitude. Summer temperatures in the high elevation areas are warm, with a transition to hot temperatures in the lower elevation areas. Winters are generally cold throughout. Precipitation also varies considerably depending on altitude. Mean annual accumulations range from about 128 inches in the mountainous western and northern parts of the basin to about 8 inches in the eastern portion. Most of the precipitation occurs as snow at higher elevations, generally from November through March. While the valleys receive some snow, the majority of the precipitation falls as rain between October and March. If climate change predictions for the Northwest are realized, these patterns may shift over time, with potential to impact bull trout populations.

The Yakima River flows southeasterly for about 214 miles from its modern-day origin at Keechelus Dam to its confluence with the Columbia River. Located west of the Yakima River is its largest tributary, the Naches River, which flows 45 miles to join the Yakima River near the city of Yakima. The Naches River forms at the confluence of the Bumping, American, and Little Naches rivers. Its major tributaries are Rattlesnake Creek and the Tieton River. Other major tributaries of the upper Yakima River (above the Naches River confluence) include the Cle Elum and Teanaway rivers. Below this point the most significant tributaries include Ahtanum Creek, which enters just south of Yakima, and Toppenish and Satus creeks, which are on the Yakama Indian Reservation. Smaller tributary streams, too numerous to name here, also contribute to flows in the basin's rivers. The hydrographs of the basin's major rivers have been severely altered by the storage, release, and diversion of irrigation water. In many of the smaller streams, tributary diversions cause seasonal dewatering.

There are five major storage reservoirs in the Yakima River basin: Keechelus, Kachess, and Cle Elum reservoirs are located high in the upper Yakima basin. The dams forming these reservoirs were completed in 1917, 1912 and 1933, respectively. In the Naches River subbasin, Bumping Dam was constructed in 1910, while Tieton Dam (forming Rimrock reservoir) was completed in 1925. All of these dams except for Tieton were built at the outlets of natural lakes. Fish passage facilities were not constructed at any of them. Native sockeye salmon, which depend on the natural lakes and spawn in the streams above them, were extirpated; other anadromous salmonid species were excluded from the streams above these dams; and populations of resident fish species such as bull trout were isolated above the dams.

Bull Trout Life History

The range of bull trout in the contiguous United States includes populations in Montana, Idaho, Oregon and Washington. In Washington, bull trout occur sympatrically with Dolly Varden populations only on the west side of the Cascade mountain range. The two species were determined to be genetically and physically distinct in 1978 (Cavender 1978); however, confusion on this distinction continues amongst the general public. Bull trout have complex and highly variable life history patterns. Unlike salmon, which spawn once and die, bull trout are iteroparous, meaning they can spawn multiple times throughout their lives. Bull trout spawn in the fall, primarily in cold, high elevation headwater streams where water temperatures during spawning and incubation do not exceed 8 °C (Rieman and McIntyre 1993; Rieman and Chandler 1999; Dunham et al. 2003). Juveniles spend two to four years rearing in their natal streams and then migrate as subadults to a larger body of water. Fluvial populations migrate into mainstem rivers, adfluvial populations to lakes or reservoirs, and resident populations remain in their natal stream throughout their lives. As with other salmonid species, multiple life history strategies may occur within the same population, with some individuals adopting a migratory pattern and others residualizing for some portion of their adult lives (Rieman and Dunham 2000; Neraas 2001; Nelson 2002; Bahr and Shrimpton 2004; Al-Chokhachy et al. 2005). Some coastal populations have anadromous life history forms that utilize near-shore ocean habitat (Brenkman and Corbett 2005). These larger bodies of water are characterized as Foraging, Migratory and Overwintering (FMO) habitat, while smaller, natal streams are defined as spawning and rearing habitat.

Bull trout are piscivorous (fish eating) and past misconceptions about the role of bull trout as dangerous predators that are causing the decline of salmon has created negative public opinion about the species (Leary et al. 1993). At one time there were bounties on bull trout, and other attempts to eradicate the species. Now the focus has shifted to protecting and enhancing remaining bull trout populations.

YAKIMA BULL TROUT OVERVIEW

Population Designation

The number of recognized local populations in the Yakima Basin has shifted throughout the last decade. The 2002 Draft Recovery Plan for the Yakima Core Area recognized 13 local bull trout populations (USFWS 2002). These included four fluvial populations (mainstem Yakima River, American River, Crow Creek, and Rattlesnake Creek), two resident populations (North Fork Teanaway River and Ahtanum Creek), and seven adfluvial populations (Gold Creek, Box Canyon Creek, Kachess River, Cle Elum River, Deep Creek, Indian Creek, and the South Fork Tieton River) (Figure 1; Table 1). With the 2008 USFWS Status Update, three more populations were added—all adfluvial (North Fork Tieton River, Bumping River, and Waptus Lake) for a total of 16 local populations. The North Fork Tieton River was a newly discovered population, confirmed during surveys in 2004. The other two populations, Bumping River and Waptus Lake, were identified as populations in order to be consistent in applying the definition of a "population" (i.e., documented spawning within recent history and multiple life stages of bull trout present). Recent genetic analysis has identified 12 distinct bull trout populations in the Yakima Basin (Small et al. 2009), although this does not include genetic samples from three of the local population areas (Upper Yakima, Cle Elum, and Waptus rivers) due to a lack of available fish to sample.

For this action plan, we are working with USFWS on incorporating the newest information on the number of populations, which appears to be 15 (see Table 1). Results of genetic analyses (Small and Martinez 2011) conducted to date have shown that bull trout found in the upper Bumping River belong to the Deep Creek population. Questions about the status of several local populations remain. The upper Yakima River has confirmed bull trout spawning and rearing but in very low numbers due to the frequent difficulty in distinguishing between bull trout redds and sympatric spring Chinook salmon redds. Bull trout found in the upper Yakima River may be a distinct local population or also could represent bull trout that were entrained at one of the reservoirs and took refuge in this fluvial habitat. New information or an alternate interpretation of the definition of "local population" may result in more or fewer populations in the future.

Additionally, several areas in the basin have been identified as bull trout critical habitat (USFWS 2010) that may be candidates for bull trout reintroduction (or introduction) efforts. These areas include Cowiche Creek (South Fork), Nile Creek, the forks of Little Naches River and its tributaries, upper Taneum Creek, Cold Creek (tributary to Keechelus Lake), and the Middle Fork Teanaway River. Taneum Creek and the Little Naches River forks are specifically listed in the USFWS 2002 Draft Bull Trout Recovery Plan as potential local populations, as they are thought to be areas of historic distribution and/or have high quality habitat that could support a local population of bull trout. Threats and recovery actions that would benefit these potential populations will be identified as the USFWS Recovery Plan is further developed.

The 15 populations discussed above and listed in Table 1 have spawning areas in headwater streams and also use lower reaches of the stream and larger rivers and/or connected lakes as FMO areas (Figure 1). Known presence extends downstream to the confluence of the Yakima and Naches rivers, with presumed presence to the mouth of the Yakima River at the confluence with the mainstem Columbia River (McMichael 1997). As evidenced in the Wenatchee basin and other areas (Kelly Ringel and DeLaVerne 2008), there is no evidence of this migration pattern (Mizell and Anderson 2010). Large-scale genetic analysis of interior Columbia bull trout basins shows historical connectivity between the Snake River, Yakima River, and upper Columbia (Wenatchee, Methow, Chelan) basins (Ardren 2011).

Table 1. Local populations of bull trout in the Yakima Basin.

Geographic Area	Population	Life History Type	Status*	Year Spawning First Observed (10 year geomean)
Ahtanum Creek	Ahtanum	Resident**	Critical	1993 (6 redds)
Naches River	Rattlesnake	Fluvial	Critical	1990 (35 redds)
	Crow	Fluvial	Critical	1999 (6 redds)
	American	Fluvial	Critical	1996 (34 redds)
Rimrock Lake	Indian	Adfluvial	Healthy	1984 (101 redds)
	South Fork Tieton	Adfluvial	Healthy	1990 (192 redds)
	North Fork Tieton	Adfluvial	Not rated	2004 (insufficient data)
Bumping Lake	Deep	Adfluvial	Depressed	1990 (113 redds)
	Bumping River	Adfluvial	Not a population	1994 (NA)
Cle Elum Lake	Cle Elum	Adfluvial	Potentially Extirpated?	No confirmed redds
	Waptus	Adfluvial	Potentially Extirpated?	No confirmed redds
Kachess Lake	Box Canyon	Adfluvial	Critical	1984 (10 redds)
	Kachess	Adfluvial	Critical	1999 (8 redds)
Keechelus Lake	Gold	Adfluvial	Critical	1984 (15 redds)
Yakima River	Upper Yakima	Fluvial	Not rated	2000 (NA)
Teanaway River	Teanaway	Resident**	Potentially Extirpated?	1996 (NA)

*Status reported here is from the WDFW Salmonid Stock Inventory (SaSI) database.
**Currently appear to be resident populations, but were likely fluvial historically.

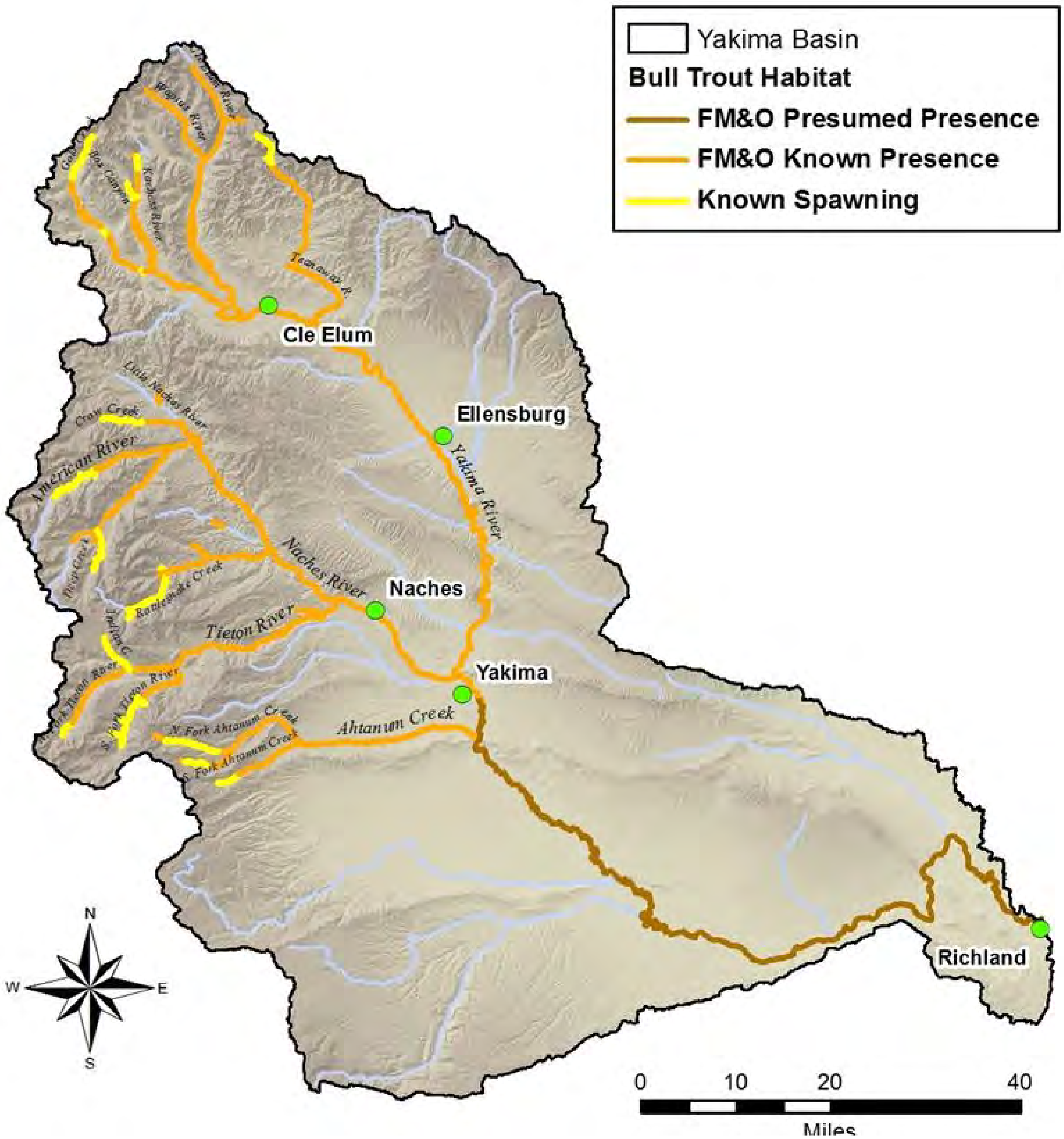

Figure 1. Overview map of spawning and FMO areas for bull trout populations in the Yakima Basin.
(Data provided by WDFW.)

Redd Surveys

Local biologists from multiple agencies began conducting redd surveys during the fall spawning period for populations throughout the Yakima Basin long before bull trout were listed under the ESA in 1998. WDFW began exploratory bull trout spawning surveys in 1984 to locate important spawning tributaries, establish spawning survey index areas, and monitor population trends. Indian Creek, Gold Creek, and Box Canyon Creek have been surveyed every year since 1984, although some of the earliest surveys did not cover the entire reaches that are in current index areas. Starting in 1990, a few additional streams were surveyed each year, and by 2000, index areas were established for most populations. The data are used to track trends in redd production and presumably relative abundance from year to year. Given the remote locations of most bull trout spawning reaches, their nocturnal nature, an affinity for substrate and cover, and the lack of monitoring infrastructure (i.e., dams and weirs) in bull trout areas, redd surveys are considered an effective and consistent way to monitor local populations. For more detail, see Appendix B: Redd Count Data and Methods.

For a species like bull trout, where we do not have dams for counting adults (as with many salmon species), redd counts are most often used to approximate adult population abundance. To directly correlate redd numbers to the number of adults requires data on spawners per redd, good spawning surveys conditions each year, and precise redd counts. The imprecision of redd counts is discussed in the literature as a potential problem (Rieman and McIntyre 1996; Rieman and Myers 1997; Maxell 1999; Dunham et al. 2001; Al-Chokhachy et al. 2005), although precision is likely improved by having the same surveyors cover index reaches year after year (Muhlfeld et al. 2006). Another complicating factor is that only a certain proportion of sexually mature adults spawn in any given year (Fraley and Shepard 1989; Rieman and Allendorf 2001; James 2002a). In the Yakima River basin, where redd surveys have been conducted consistently in the same index areas and often by the same biologists over many years, estimates are believed to provide accurate representations of population trends and relative abundance among populations.

Genetic Data

In the Yakima Basin there is a well-established genetic baseline for most local bull trout populations (see Appendix C). This began in 2001-2002 with Yuki Reiss's thesis project (Reiss 2003) for Central Washington University (CWU). Reiss collected and analyzed samples from 12 local bull trout populations. The two primary sources of tissue samples for this study were: 1) adults captured and sampled as part of a tagging study in the reservoirs (James 2002a), and 2) night snorkel surveys to capture juveniles in known spawning and rearing reaches. The results of this analysis showed a high level of differentiation among all populations, with some evidence of limited gene flow among the connected fluvial populations. However, above the reservoirs, even those with multiple local populations that use the same FMO reservoir habitat, there was no evidence of gene flow between populations. Two of the local populations that are currently considered "resident" life history type (Teanaway River and Ahtanum Creek) appeared quite distinct from all other populations, despite current connectivity to the fluvial system. Subsequent genetic analyses (Hawkins and Von Bargen 2006; Hawkins and Von Bargen 2007; Small et al. 2009; Small and Martinez 2011), using different genetic markers and including additional genetic samples, have shown similar patterns and provided information about newly sampled populations or areas (e.g., North Fork Tieton and Upper Bumping rivers).

As part of this Bull Trout Action Plan, a master list was compiled of all known bull trout samples that have been collected in the Yakima Basin (see Appendix C). This database (in Excel format) tracks collection data from the field through genetic analysis. In the future, this will be the central repository of information on bull trout genetic samples and will be updated as needed. In the Individual Population Information sections of this document, we present relevant results and the genetic sampling history for each population. We also identify future genetic monitoring needed to either: 1) improve the baseline for a population, 2) observe any temporal changes in genetic patterns, especially for population with low or highly fluctuating abundance, or 3) document the presence of any new populations or subpopulations within currently identified local populations.

Presence/Absence Surveys

Over the last 25 years, many exploratory surveys have been made to determine where bull trout are present. Many areas where we now have confirmed bull trout populations were discovered through these surveys. The details of the surveys are included below in the Population Monitoring subsection of the Individual Population Information summaries. However, a large number of surveys (listed below) did not detect bull trout. Although it is still prudent to continue to explore and to revisit areas where no bull trout have been detected, these surveys increase our confidence that there are unlikely to be "undiscovered" populations in the Yakima Basin. This is significant. In many basins across the Northwest, large unexplored areas remain where bull trout populations are suspected but not confirmed. Predictive models are often used to speculate on where such populations may exist. In the Yakima Basin, however, there is a strong empirical dataset of presence/absence data from many electrofishing and snorkel surveys.

In the early years of exploration, WDFW conducted electrofishing surveys on many miles of habitat. In addition to areas now confirmed as occupied by bull trout, surveys included Cowiche Creek and tributaries, Little Naches River and tributaries, Nile Creek, Oak Creek, and Little Rattlesnake Creek (Washington Dept of Game 1978b; WDFW 1991b; WDFW 1993; WDFW 1994b; Anderson 1998; WDFW 1998). Surveys have also been done above barrier falls in many of the streams that support bull trout in the lower reaches (i.e., Indian Creek, South Fork Tieton River, Deep Creek, and Box Canyon Creek).

Night snorkel surveys have also been widely used to determine bull trout presence/absence. The Forest Service completed night snorkel surveys on Middle Fork Teanaway River (Haskins 2003), Upper Bumping River above the falls (USFS 2003a), Oak Creek (USFS 2003b), Little Rattlesnake Creek (USFS 2002), Cooper River (Reiss and Wassell 2004), Clear Creek (Torretta 2005), two tributaries to the North Fork Teanaway River—Beverly Creek and Stafford Creek (Reiss 2006), North and South forks of the Little Naches River (Reiss 2008), Gale Creek (USFS 1991) and Silver Creek (USFS 1993). (The U.S. Forest Service is abbreviated in the text as Forest Service rather than USFS to more easily differentiate it from USFWS.)

WDFW completed night surveys in the upper forks of Cowiche Creek, following up on a sighting by a Yakama Nation (YN) biologist (Anderson 2002). Some of these surveys followed the Peterson et al. (2002) protocol for bull trout presence/absence surveys, which calls for randomized survey reaches and block nets and allows for efficiency estimates. Others used a modified protocol (no block nets) or a simple, non-randomized survey method designed to sample portions of all likely or suitable habitat. In addition, day snorkels were completed in Cold Creek and Meadow Creek (Craig 1996), tributaries to Keechelus Lake, and in Gale Creek (Craig 1994), a tributary to Kachess Lake. The Forest Service conducted day snorkel surveys in the South Fork Little Naches (USFS 1996a). During all of these surveys, no bull trout were detected.

Other Studies

Other bull trout studies in the Yakima Basin include radio telemetry, tagging, and entrainment studies. A three-year radio telemetry study (2003-6) tracked adults in the Naches River fluvial system, Rimrock Lake, and Bumping Lake (Mizell and Anderson 2010). Results confirmed overwintering areas for the Naches River fluvial and reservoir populations. A three-year tagging study (1996-1998) of adults in Rimrock and Bumping lakes (James 2002a) showed the high site fidelity of fish in these populations and provided some data on the proportion of the population that spawns in any given year. There have also been four separate entrainment studies on Rimrock Lake and on Keechelus Lake (Hiebert et al. 2002; James 2002b; Hiebert 2003; Underwood and Cramer 2007; Courter and Vaughan 2011). Rimrock Lake has the highest rate of entrainment of bull trout due to reservoir management and the location of outlet works. No bull trout were captured in the trap below Keechelus Lake during the sampling period in 2011. Six Master's theses focused on bull trout were completed through Central Washington University between 1980 and 2012 (Sexauer 1994; Craig 1997; James 1997; Meyer 2002; Reiss 2003; Lamperth 2012).

METHODS/ANALYSIS

Threat Definitions

The threats categories used in this document are based on those used by USFWS for recovery planning and status assessments. This was intentionally done to maintain consistency between this document and the USFWS Recovery Plan (*in prep*). However, for this document it was necessary to clearly define what was included or not included in each of the threats categories.

The following definitions are used:

Agriculture: Impacts associated with agricultural operation (excluding livestock grazing) on lands adjacent to bull trout bearing waters (includes riparian degradation, sedimentation, impaired water quality, and harassment of bull trout).

Altered flow: Impacts associated with flow regimes that are significantly altered in terms of magnitude, timing, and duration through water storage operations and/or water withdrawal.

Angling: Impacts associated with angling, legal and illegal.

Development: Impacts associated with residential development (urban, rural, or Forest Service cabins) along bull trout bearing waters (includes riparian degradation, erosion and sedimentation, channel disturbance, and harassment of bull trout).

Dewatering: A dewatering of stream reaches that restricts fish habitat access, quantity, and quality and can also result in stranding. Dewatering associated with irrigation withdrawal, reservoir management, etc. is categorized as altered flows or passage barriers.

Entrainment: Inadvertent passage of fish through the unscreened outlet works of storage dams or irrigations diversions, resulting in physical trauma, isolation from upstream habitats, and/or entrainment into irrigation systems.

Forest management: Negative impacts on stream condition including hydrology, sediment load, riparian health, and water temperature that result from current and/or past forest management practices (includes impacts from forest roads).

Grazing: Impacts associated with livestock grazing on lands adjacent to bull trout bearing waters (includes riparian degradation, sedimentation, impaired water quality, and harassment of bull trout.

Introduced species: Presence and potential impacts (e.g., introgression or competition) associated with the introduction of lake, brook, or brown trout.

Limited extent of habitat: Habitat quantity (i.e., stream distance accessible) that has been altered in streams whose lower reaches were inundated by reservoir construction.

Low abundance: A demographic threat resulting from a low population census size as estimated from annual redd counts. Populations receiving a significant threat level under this threat are believed to be at an elevated risk of extirpation.

Mining: Negative impacts on stream health resulting from mining operations (oil, natural gas, coal, precious metals, and gravel).

Passage barriers: Artificial barriers to fish passage, including storage dams, diversion dams, recreational dams constructed by the public, culverts, and passage problems associated with irrigation reservoir depletion that preclude passage into spawning tributaries (i.e., dewatering at the mouth of a stream on reservoir bed).

Prey base: Impacts that have negatively affected the availability of food (fish and macroinvertebrates).

Recreation: Impacts associated with recreational use of lands adjacent to bull trout bearing waters (includes riparian degradation, erosion and sedimentation, channel disturbance, and harassment of bull trout). Does not include impacts of associated forest roads or angling pressures on bull trout.

Transportation networks: Impacts associated with major roads or highways (paved) or rail lines.

Water Quality, which was included as a separate threat in the USFWS 2008 status review, was not viewed in this document as a stand-alone threat but is the effect of other threats such as forest management or agriculture.

For each threat we also created maps to represent the spatial distribution of the impact across populations and across the Yakima Basin (Appendix A: Threats Atlas). These maps will be updated as needed to reflect changes in Threats (e.g., increased urbanization or removal of passage barriers) or changes in our current knowledge base.

Threat Analysis

To better understand the way in which each of the threats listed above could effect a population, the mechanism for this effect, and what life stages would be impacted, the YBTAP Working Group (Yuki Reiss, Jeff Thomas, Eric Anderson, Jim Cummins, and Alex Conley) developed a Threats Analysis methodology. The analysis was a lengthy iterative process completed in close collaboration with Judy Neibauer, the USFWS Recovery Lead for the Yakima Core Area. This analysis linked threats directly to bull trout biology. As part of the analysis, the severity of each threat was also rated, as was the certainty regarding the effect on a specific life stage, and the justification/supporting data for the rating.

The analysis began with a list of all bull trout life stages and potential negative effects to that life stage. For each threat, the YBTAP Working Group, relying on expert opinion and relevant literature, considered whether or not a mechanism was present to create the negative effect and what that mechanism would be. Although Yakima bull trout populations were frequently used for calibration purposes, the goal was to think broadly of all possible effects and mechanisms. The following table (Table 2) gives an example of this process for two different threats—entrainment and forest management. These examples illustrate the nature of different threats, with one that impacts bull trout populations via direct mortality to fish (entrainment) and one with primarily indirect impacts via reductions in habitat quality (forest management). The same process was completed for all threats (see Appendix E: Threats Analysis). The advantage of this process over previous evaluations of population threats is the transparency and clear logic trail that allows for a better understanding of how a specific threat may limit a population.

Scale was an important factor in defining severity (Table 3). At a larger recovery-unit scale, the threat severity rating is based on the risk of extinction or on what percentage of a Core Area is affected. For the local population-scale used in this analysis, tying the severity rating to a percent of population affected was too arbitrary and difficult. Instead the threat severity rating was based on expected population response, using abundance (redd counts) as a response metric. Thus, for each threat/effect combination, the YBTAP Working Group considered whether the threat was limiting the population and whether a population-scale response could be expected (and at what level) if it were addressed. This puts the focus on current condition, future actions, and expected population response.

Table 2. Example of threat mechanisms and specific effect on bull trout life stages.

Life Stage	**THREAT** *Effect*	**ENTRAINMENT** *Mechanism*	**FOREST MANAGEMENT** *Mechanism*
Spawning/egg incubation			
	Reduced fertility	NA	NA
	Reduced population productivity	If many fish are entrained, could be reduced at population level	NA
	Increased spawning temperatures	NA	Loss of riparian/upland trees via logging or fire
	Habitat degradation (loss of riparian and/or instream complexity, increased sedimentation etc.)	NA	Loss of riparian/upland trees via logging or fire; forest roads
	Habitat availability/access	NA	NA
	Direct mortality (eggs)	NA	Sediment input while eggs in gravel
Juvenile rearing			
	Summer temperatures	NA	Loss of riparian/upland trees via logging or fire
	Habitat availability/access	NA	NA
	Habitat degradation (loss of riparian, increased sedimentation, soil compaction etc.)	NA	Loss of riparian/upland trees via logging or fire; forest roads
	Reduced growth/condition	NA	If habitat quality is lower (loss of benthic productivity)
	Direct mortality	Entrainment into irrigation systems	NA

Life Stage	**THREAT** *Effect*	**ENTRAINMENT** *Mechanism*	**FOREST MANAGEMENT** *Mechanism*
Subadults/adults in FMO habitat			
	Direct mortality	Entrainment into irrigation systems; mortality during passage through reservoir outlet works	NA
	Isolated from natal population	Adults cannot return to reservoirs	NA
	Reduced growth/condition	NA	If habitat quality is lower (loss of benthic productivity)
	Habitat availability/access/quality	NA	NA
Pre/post spawning migrations			
	Increased temperatures	NA	Loss of riparian/upland trees via logging or fire
	Reduced habitat availability/access	NA	NA
	Increase stress/reduced condition/possible direct mortality	NA	NA

Once this step was completed for all threats, all "Not Applicable" (NA) boxes were taken out, and a table was completed with only potential threat/effect combinations. For each possible Threats/Life Stage/Effect combination, we evaluated the severity for each local bull trout population based on criteria determining significance and certainty (Table 3).

Table 3. Criteria used to assign severity ratings.

Threat Severity	Color	Abbreviation
Present, significant impacts	Red	SIGNIFICANT
Present, moderately significant impacts	Yellow	MODERATE
Impacts unknown but could be significant or moderately significant	Orange	UNKNOWN SIGNIFICANT
Impacts unknown. No judgment as to potential significance	Dark Blue	UNKNOWN
Impacts unknown but not believed to be significant	Light Blue	UNKNOWN LOW
Present, not thought to be significant at reach or population level	Green	LOW
Mechanism not present or extremely rare	Gray	NOT PRESENT

In addition to the severity rating, the YBTAP Working Group provided justification and/or supporting data for each rating with links to relevant literature and reports. Certainty (confidence regarding severity ratings) was built into the severity definitions via incorporation of "unknown" impacts. Table 4 provides an example of a High, a Moderate, a Low, and a Not Present threat/effect combination for Ahtanum Creek. The entire analysis for each threat/effect combination, for Ahtanum, and for all other populations is presented in Appendix E.

Table 4. Example of a threats analysis for Ahtanum Creek.

Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data	Future Monitoring/ Data Needs	Future Actions
Low abundance (high risk of extirpation	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low effective population size	SIGNIFICANT	Effective population size estimated based on annual red counts. Adult spawner numbers are low in all three forks and have been for years.	Annual spawning surveys, collect any data required before supplementation can be implemented	Population supple-mentation
Forest management	Spawning/ egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction	SIGNIFICANT	High road density in spawning habitat. Clearcut upstream. Risk of catastrophic wildfire due to overstocked stands in watershed. Questions about future management (status of DNR staff)	Determine if forest practice rules are adequate, applied and enforced. On the ground monitoring of sediment, riparian condition and habitat quality	Relocate road NF Ahtanum Creek near Shellneck Creek (EIS 2011). SF Aht road? Road density-1m/sq m
Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture	MODERATE	Legal angling for other species does occur in migration for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take, but could	Creel surveys (Bull Trout Task Force-BTTF)	Public education, field contact (BTTF) and enforcement
Altered flows	Pre/post spawning migrations	Habitat availability/ access	Regulated flows (too high of low) restrict fish movement	LOW	Low flows in early fall in lower reaches due to irrigation withdrawal, but minimum flows are likely sufficient to allow migrations	Track flow measurement data in FMO habitat during migration period	If needed, acquire additional instream water
Introduced Species	Pre/post spawning migrations	Reduced growth/ condition	Competition for food and space	NOT PRESENT	No introduced species are present based on snorkel and electrofishing data	Periodic fish surveys to ensure no brook trout are established	If needed, brook trout removal efforts

Prioritization of Actions

After completion of the Threats Analysis, the next step was to crosswalk threats to future restoration actions (the heart of this plan). For each threat a list of possible actions was created. Actions that address threats identified as significant or moderate severity become the highest priority for that population. Threats with unknown severity, especially those that are thought to be significant, became the highest priority for future monitoring actions. Using the severity categories from Table 2 significant and moderate threats (red and yellow) were identified as the highest priority; unknown but potentially significant or simply unknown (orange and dark blue) were assigned a medium priority. The lowest priority was assigned to threats of unknown consequence but not believed to be significant (light blue), threats deemed insignificant (green), and threats which were not present (gray). This resulted in a list for each population of associated monitoring and population-scale actions in order of priority, with the prioritization based on expected population response.

This approach is useful for looking at potential actions within a particular population but it is also important to be able to look across all bull trout populations within the Yakima Basin and understand overall priorities. Funding for bull trout recovery actions and monitoring is limited. Under ideal circumstances all actions in this plan could be completed. Under the current funding scenario, however, it will be critical to be able to first implement actions with immediate benefit to populations in peril. To be used as the next "filter" for prioritization populations were divided into three categories. The categories are as follows:

TIER I: "ACTION" populations: These are populations where recovery actions would provide an immediate benefit to habitat conditions and population levels, and thus are the highest priority across all populations (Ahtanum Creek, Crow Creek, Gold Creek, North Fork Tieton River, and Box Canyon Creek).

TIER II: "PROTECTION" populations: These are populations to protect and continue monitoring but where actions are expected to elicit a limited population level response (Deep Creek, Indian Creek, South Fork Tieton River, Kachess River, American River, and Rattlesnake Creek). These populations are the next priority tier for implementing recommended actions.

TIER III: "MONITOR" populations: These are populations where the priority action is to determine if bull trout are currently present, because the number of individuals in these populations is low or unknown. Implementation of recovery actions is a low priority. If an extant, self-sustaining population of bull trout is discovered, or when supplementation/reintroduction efforts are initiated, these would be re-evaluated (Cle Elum River, Waptus River, Teanaway River, and Upper Yakima River).

As the method described above was applied, we created a comprehensive list of actions, prioritized among and within populations. The recommended actions may be Broad Scale Actions, Population Scale Actions, or Monitoring Actions. The scale varies temporally and spatially.

Broad Scale Actions

Broad-scale actions apply across multiple populations and require dedicated programs, funding, and authorities to implement (see section below).

Population Scale Actions

Population-scale actions are mostly specific to individual populations, or a group of populations, and are mainly addressed in the Individual Population Information section. The focus is on-the-ground actions, many of them ready to be implemented if funding becomes available.

Monitoring Actions

Monitoring actions encompass a wide variety of on-the-ground activities. Monitoring is an important way to track progress towards goals, document trends, and test hypotheses. It is often difficult to find funding for monitoring projects, thus making it critical to prioritize and clearly define the questions being asked. Ideally, many of the proposed monitoring actions will direct us towards broad-scale or population-scale recovery actions and increase our confidence that these actions will address true limiting factors for Yakima bull trout populations.

Monitoring Actions can be divided into:

Population Monitoring: Snorkel or redd surveys to detect presence of bull trout and to monitor trends in abundance, juvenile densities, etc.

Baseline Habitat Monitoring: Gathering data on trends in habitat over time, such as temperature, flow, sediment, etc.

Implementation Monitoring of Completed and Recommended Actions: Effectiveness monitoring to determine longevity of actions (e.g., cattle or camping exclusions) or intended habitat response (e.g., "Did the riparian restoration result in increased stream shade?").

Threats Research & Monitoring: These actions address uncertainties regarding the threats severity ratings and effects on populations. For example, through the Threats Analysis, angling was identified as a threat that may be significant for most bull trout populations. Data collected during creel surveys could substantiate this and direct attention to problem areas.

Monitoring actions specific to individual populations are listed in the Individual Population Information section, and are described in detail in the Actions Detail section.

BROAD SCALE ACTIONS

Broad-scale actions are crucial to the recovery of bull trout populations and require wide-ranging coordination among entities across the basin. These actions are described separately to draw attention to this distinction. The implementation of these actions will benefit bull trout over a long period of time.

Restore Healthy Salmon Populations

This action primarily addresses the threat identified as a "limited prey base." Although we have no specific historic data on bull trout utilization of salmon resources in the Yakima Basin, one can assume that bull trout thrived as a result of the abundance of numerous species of anadromous salmonids that historically returned to the Yakima Basin to spawn. It is estimated that between 500,000 to 800,000 adults historically returned annually including runs of spring, summer, and fall chinook salmon, coho salmon, sockeye salmon, and steelhead (Tuck 1995; Yakima Basin Fish and Wildlife Planning Board 2005). As a result of the intense development of the Yakima and Columbia River basins since the late 1800s these runs have been reduced to a small fraction of those historical numbers and several species (summer chinook, sockeye, and coho) were in fact extirpated (coho have been reintroduced and efforts to reintroduce sockeye and summer chinook are in beginning stages).

The impact on the basin's aquatic ecosystem from over a century of development has been profound and the abundance and productivity of bull trout populations have likely suffered as a result. The juvenile offspring of anadromous salmonids are no longer an abundant prey base for subadult and adult bull trout. Perhaps more significantly, juvenile bull trout, especially those rearing in tributaries above barrier dams, have likely experienced a decline in prey availability as well. These fish feed on aquatic invertebrates whose populations were historically sustained by marine derived nutrients obtained annually from the decaying carcasses of hundreds of thousands of salmon.

Although there are population-scale actions that address prey base and/or productivity of lake and river systems (e.g., pilot study of carcass analog disbursement), or that may contribute to our knowledge of the impacts on bull trout populations (e.g., monitoring condition factor), the broad-scale action identified here is the need to maintain and enhance existing efforts to recover salmon and steelhead in the Yakima Basin to improve the prey base for bull trout.

There are many programs making progress towards this goal. The Yakima-Klickitat Fisheries Project (www.ykfp.org) is dedicated to enhancing stocks of salmon currently present in the basin (spring and fall Chinook) and reintroducing extirpated stocks (coho and summer chinook). The Yakama Nation has also initiated a program to reintroduce sockeye salmon into Cle Elum Lake, in anticipation of re-establishment of fish passage at this reservoir. Steelhead recovery is being implemented with habitat improvement projects throughout the basin, in addition to a Yakama Nation steelhead kelt reconditioning program.

Passage at Major Storage Dams

Fish Passage Priorities for Yakima Basin Bull Trout

The five Yakima Project storage dams constructed between 1910 and 1933 do not have any fish passage facilities (see Appendix A: Atlas of Threats). They act as barriers that exclude anadromous fish from the watersheds above these dams and prevent resident fishes that spawn above the dams, including bull trout, from regularly using downstream habitats. Bull trout that move downstream of these dams cannot return to spawn in their natal streams. This disruption of natural migration routes has had significant negative effects on Yakima Basin bull trout populations by:

1. Creating small isolated populations at risk of inbreeding depression and loss of genetic diversity.

2. Reducing or eliminating the likelihood that stray fish will recolonize areas after isolated catastrophic events reduce or eliminate local populations.

3. Reducing the productivity of juvenile and adult bull trout by limiting access to foraging habitat and eliminating the input of anadromous nutrients from downstream areas.

The effects of the loss of connectivity on isolated bull trout populations are rooted in the tenets of conservation biology and negatively affect the ability of a population to persist on a long-term basis. Each of these factors is reviewed and applied to bull trout in the Yakima Basin below.

1. Genetic Integrity and Effective Population Size

Because of the inherent unpredictability of nature, the conservation of species depends on protecting their genetic diversity. When diversity is lost, genetic combinations that ensure survival in variable environments may be lost as well (Rieman and McIntyre 1993; Rieman and Allendorf 2001). Genetic variation will be lost through time in isolated populations, and this loss will occur more quickly in small populations than in large ones. Loss of genetic variation can influence the dynamics and persistence of populations through at least three mechanisms: inbreeding depression, loss of phenotypic variation and plasticity, and loss of evolutionary potential (Allendorf 2002). Both theory and empirical evidence clearly indicate the populations that are small and isolated will eventually lose genetic variation and have an increased probability of extirpation (Frankham 1996; Wofford et al. 2005; Whiteley et al. 2010)

The implication is that some minimum number of organisms and effective interactions are necessary to maintain genetic diversity and ensure the persistence of a population. Soulé (1987) asserted that the scientific community should provide guidance for the public so conservation programs could proceed. In 1980, he proposed the "50/500" rule (Soule 1980). That is, in a completely closed population, an effective population size ($N_{e)}$ of 50 is needed to prevent excessive rates of inbreeding and 500 are needed to maintain genetic variation.

Following the "50/500" rule, Rieman and Allendorf (2001) used VORTEX (Miller and Lacy 1999), a generalized, age-structured, simulations model, to relate N_e to adult numbers under a range of life histories and other conditions characteristic of bull trout populations. Their most realistic estimates of N_e were between 0.5 and 1.0 times the mean number of adults spawning annually. Therefore, a cautious interpretation of their results would be that an average of 100 (i.e., 100 x 0.5 = 50) adults spawning each year would be required to minimize risks of inbreeding in a population and 1,000 (i.e., 1,000 x 0.5 = 500) would be necessary to maintain genetic variation indefinitely. Based on published literature, two spawners per redd is average (Dunham et al. 2001; Al-Chokhachy et al. 2005). Thus, the geometric mean from annual redd counts can be translated into number of adults spawning annually (Table 5).

Few local bull trout populations are known to support 1,000 or more spawners. However, the aggregation of local populations in a geographic area may exceed this number. These populations must, of course, have access to one another for the criteria to be met. Maintaining natural connections and potential for gene flow is critical (Rieman and Allendorf 2001). Dispersal and the full expression of life histories require free movement of migratory fish. Where local populations cannot support the minimum N_e necessary to maintain genetic variation, managers should seek to conserve a collection of interconnected populations (i.e., metapopulation) at least large enough to meet the minimum of 1,000 annual spawners.

Application to the Yakima Basin

Of the local bull trout populations in the Yakima Basin, only three (South Fork Tieton River and Indian and Deep creeks) currently meet the minimum requirements for N_e. The Naches River fluvial populations meet this minimum if taken as an aggregate. No local populations or aggregate of currently connected local populations meet the 1,000 mean annual spawners threshold although the Rimrock aggregate is close. The Upper Yakima River populations are currently not connected as a functional aggregate of local populations. As demonstrated in Table 5, even with connectivity, this aggregate would not total 1000 mean annual spawners given extremely low abundance in the Upper Yakima River local populations.

Table 5: Number of annual spawning adults for bull trout local populations and population aggregates.

	10 Geometric mean Redd Count	If 2 Spawners Per Redd	If 2.5 Spawners Per Redd
Ahtanum	6	12	15
American	34	68	85
Rattlesnake	35	70	88
Crow	6	12	15
Naches Fluvial Aggregate Total		**162**	**203**
N.F. Tieton	INSUFF DATA		
Indian	101	202	253
S.F. Tieton	192	384	480
Rimrock Aggregate Total		**586**	**733**
Deep	113	**226**	**283**
Box	10	20	25
Kachess	8	16	20
Gold	15	30	38
Cle Elum	0	0	0
Waptus	0	0	0
Teanaway	0	0	0
Upper Yakima	0	0	0
Upper Yakima Total (not connected)		**66**	**83**

2. Metapopulation Structure and Recolonization

Groups of subpopulations or local populations form larger regional metapopulations (Hanski and Simberloff 1997). The interaction of populations in a metapopulation reduces extinction risk for a species because the loss of all populations at any one time is unlikely, and dispersal among local populations provides a mechanism for supporting weaker populations or re-establishing those that become extirpated (Rieman and McIntyre 1993). The study of metapopulation dynamics suggests that such mechanisms may strongly influence the probability of persistence for a species (Gilpin 1987; Fahrig 1990; Stacey 1992). At any given time, some populations may act as “sources” and others as “sinks” (Pulliam 1988; Stacey 1992) with all contributing, over time, to the stability, persistence, and diversity of the whole (Poff and Ward 1990).

The concept that regional populations of a species may persist in variable environments as collections of local populations interacting through dispersal (Hanski and Simberloff 1997) has been widely accepted by biologists and managers. The theory has been repeatedly invoked in recent discussions regarding conservation and land management relevant to threatened or sensitive populations of salmonids in the Pacific Northwest (Rieman and McIntyre 1993; Reeves et al. 1995; Schlosser and Angermeier 1995; Independent Scientific 1996; National Research Council . Committee on et al. 1996; Lee et al. 1997; Policansky and Magnuson 1998). Salmonids, including bull trout, appear to have a metapopulation structure because spawning and rearing habitats are usually spatially discrete. Also dispersal patterns, local environmental variability and disturbance regimes often create a patch dynamic described by metapopulation models (Rieman and McIntyre 1993; Reeves et al. 1995; Rieman and McIntyre 1995; Schlosser and Angermeier 1995; Dunham and Rieman 1999).

However, the results of genetic studies suggest that strong natal site fidelity in bull trout translates to limited dispersal. Strong population structure is shown in almost all genetic studies of bull trout local populations, including the Yakima Basin (Spruell et al. 1999; Costello et al. 2003; Dehaan et al. 2011; Small and Martinez 2011). In the short-term, this may limit "source-sink" metapopulation dynamics or successful recolonization from "frequent" extinction-recolonization events. Over many decades or centuries, however, dispersal rates are likely high enough to re-establish extirpated populations or provide an important influx of genes. There is good evidence that an extinction-recolonization event occurred in the Pend Oreille River system in Idaho about 30 years ago (B. Rieman, pers comm, 2002). Given enough time and a source of colonists, expansion of populations into suitable habitats seems almost certain for most salmonid species (Rieman and Dunham 2000)

Application to the Yakima Basin

For successful dispersal, even over a long timeframe, there must be populations large enough to support some degree of straying. In the Naches River subbasin there are currently multiple fluvial populations with steady abundance trends (American River and Rattlesnake Creek); the three strongest local populations in the basin (South Fork Tieton River, Indian and Deep creeks) exist above two storage dams (Tieton and Bumping). If fish passage were restored at either of these dams, it would be reasonable to assume that the current fluvial metapopulation structure and recolonization potential would be strengthened, as would individual population resilience.

In the upper Yakima River basin, however, the remaining bull trout populations have poor abundance trends (Gold and Box Canyon creeks and Kachess River), and several populations are clinging to existence (Cle Elum, Waptus, Teanaway and Upper Yakima rivers). Given current conditions, even with restored fish passage at the upper basin storage dams, there may not be enough individual bull trout to ensure dispersal and recolonization without significant improvements in the size of the local populations. Restoration actions proposed in this Action Plan may help increase abundance of the Upper Yakima River populations, which would in turn increase the chances of a functional metapopulation when fish passage is obtained. Without significant abundance improvements in individual populations, metapopulation benefits from passage reconnection in the Upper Yakima subbasin may be limited.

3. Passage, Salmon Reintroduction and Bull Trout Productivity

Restoration of passage at the reservoir dams will be important to bull trout for dispersal and genetic connectivity. In many areas, salmon and steelhead co-evolved with bull trout and provided an important prey base for bull trout and other native trout. Passage restoration will be largely driven by the desire to reintroduce salmon and steelhead to suitable headwater habitat above the dams.

Discussed above were the effects on the bull trout prey base resulting from the steep decline of anadromous salmonid populations in the Yakima Basin. Restoring salmon populations below impassable dams will not benefit local bull trout populations above them. Providing passage at the dams and restoring anadromous fish runs above them would increase prey availability for subadult and adult bull trout in the reservoirs as well as juveniles inhabiting their tributary streams. However, in some areas reintroduced anadromous species may also compete directly with bull trout.

Interference competition via redd superimposition can have a major effect on spawning success for a species. For example, in New Zealand interference competition for spawning space between brown trout and rainbow trout was studied by Hayes (1987). He found that redd superimposition by later spawning rainbow trout caused a 94% reduction in spawning success for brown trout. Negative effects from interspecific competition between salmon and bull trout fry and juveniles for space and food might also be anticipated. Underwood et al. (1995) studied competitive interactions between hatchery-reared steelhead and spring chinook salmon and bull trout in four streams in southeastern Washington. They found that in the streams most heavily supplemented with anadromous salmonids, bull trout displayed the slowest growth.

Application to the Yakima Basin

Historically, there were certainly overlaps in spawn timing for various species of salmon and local populations of bull trout. Currently, there are few population areas across the basin with spatial overlap. They are the American River, Rattlesnake Creek and potentially the Upper Yakima River. Chinook salmon, which generally spawn earlier in the fall than bull trout, are present in all three areas; steelhead are present as well but are spring spawners. In the upper watersheds above the reservoirs, it is probable that salmon and bull trout were spatially segregated to some degree. For example, in lake systems bull trout likely migrated higher into headwater habitats to spawn while sockeye salmon utilized spawning habitat lower in the stream (J. Neibauer, USFWS, pers comm).

After the construction of storage dams at the outlets of four natural lakes in the basin these lakes were substantially enlarged and significant amounts of tributary habitat were inundated, reducing the amount of spawning and rearing habitat available. If large-scale programs are undertaken to reintroduce salmon above the dams the result may be significant levels of redd superimposition and interspecific competition among juveniles. This is primarily a concern in areas where extent of spawning habitat is limited (Bumping and Kachess lakes).

Current Status of Fish Passage at Dams:

Establishing volitional, two-way fish passage at each of the storage dams in the Yakima Basin is identified as a priority by multiple agencies, for multiple fish species. In 2002, the Bureau of Reclamation began an assessment process to evaluate passage possibilities at each of the dams.

Based on this process, Cle Elum and Bumping reservoirs were selected to move forward to feasibility studies, and a Final Cle Elum Fish Passage Environmental Impact Statement (EIS) was released in 2011 (see: http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/index.html). Funding to construct the fish passage facilities would require congressional action, which is being pursued by USBR and other partners. Meanwhile, interim downstream fish passage was constructed at Cle Elum Dam in 2005 and the Yakama Nation has been working to re-establish a sockeye salmon run into this watershed by transporting adult sockeye from the Columbia River to Cle Elum Lake.

INDIVIDUAL POPULATION INFORMATION

Ahtanum Creek

Ahtanum Creek is a tributary of the Yakima River that enters the river just south of the city of Yakima at RM 107. The stream is composed primarily of a North and a South Fork, which merge at around RM 23 to form a single main channel. The North Fork is approximately 23 miles in length while the South Fork is approximately 15 miles. Another fork, the Middle Fork, enters the North Fork at about its halfway point.

Population Distribution and Life History

The Ahtanum Creek drainage supports what is currently treated as a single local population of bull trout. There are known spawning areas in the upper reaches in all three forks and Shellneck Creek, a tributary to the North Fork (Figure 3). However, there is a falls at RM 2.5 on the South Fork Ahtanum Creek that is believed to be a barrier to upstream migration. Juvenile rearing occurs in the upper reaches and may extend all the way to the confluence of the forks. Adults are assumed to utilize the entire drainage as FMO habitat. It is possible that some adults migrate seasonally into the mainstem Yakima River when conditions (i.e., water temperatures) are suitable (see below), but timing of migration from FMO areas to spawning reaches is unknown.

Currently this population is considered a resident/fluvial life history type. Low stream flows due to irrigation withdrawals, thermal barriers, and habitat conditions in lower Ahtanum Creek limited migratory access to the mainstem Yakima River as early as 1880 with the construction of numerous irrigation diversions. These conditions persisted through the 1900s and beyond. Migratory conditions have improved in the last decade but there is very limited evidence of fluvial connectivity. A smolt trap has been operated by the Yakama Nation at the mouth of Ahtanum Creek since 2000 to enumerate juvenile steelhead and coho leaving the drainage (Anderson 2010). Only one out-migrating adult bull trout has been caught in the trap during its operation.

Population Status

The USFWS considers the Ahtanum Creek population to be depressed, decreasing, and at risk of stochastic extirpation (USFWS 1998); the WDFW rates the status of this population as critical (WDFW 2004). If future genetic analysis determines that each of the forks represents a distinct, isolated population, each of these populations would warrant a depressed or critical status.

Genetic analysis concurs with this lack of connectivity to the larger fluvial system (Yakima or Naches rivers). Genetic samples were collected from all tributaries in the Ahtanum Creek drainage and were analyzed as one population. The population was unique when compared to all the other Yakima Basin populations and did not cluster with the Naches River fluvial populations (Reiss 2003; Small et al. 2009).

Population Trend

The Ahtanum Creek population spawns primarily during the month of September. Complete redd counts were first recorded in established index areas on the North Fork Ahtanum Creek in

1993, the South Fork Ahtanum Creek in 2001, and the Middle Fork Ahtanum Creek in 2002. The index area on the North Fork is 1.9 miles long with the lower 0.5 miles of Shellneck Creek (a high elevation tributary) also surveyed. The length of the index areas for the Middle Fork and South Fork are 2.0 and 2.7 miles, respectively. Annual redd counts are presented graphically in Figure 2. Considering the last 10 years (when data are available for all three forks), this population appears small and generally getting smaller. Redd numbers steadily declined over the first four years of that period from a high of 36 in 2002 down to 14 in 2005. With the exception of 2008 (seven redds), counts have held between 16 and 18 since 2005. Noteworthy is the steady decline in the number of redds observed in the North Fork over the last decade. In contrast, the Middle Fork has experienced an increase in spawning activity over the last four years.

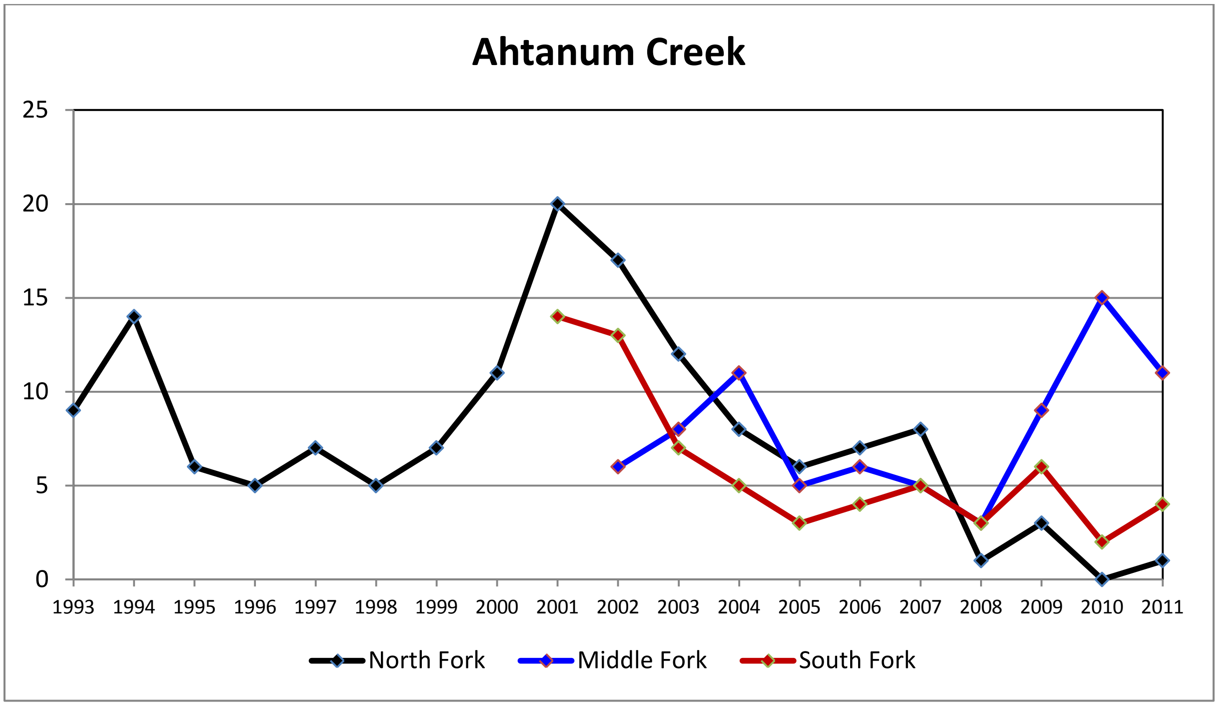

Figure 2. Bull trout redd counts in the three forks of Ahtanum Creek.

Population Monitoring

WDFW electrofishing surveys documented the presence of bull trout in the North and Middle forks of Ahtanum Creek in 1993 (Anderson 1993). During that same year redd surveys within established index areas began in the North Fork Ahtanum Creek (including Shellneck Creek). The Yakama Nation documented bull trout in the South Fork Ahtanum Creek in 1998 and 2000 (Gullett 2001). Redd surveys were initiated on the Middle Fork Ahtanum Creek in 1996 and on the South Fork Ahtanum Creek in 2000; however, index areas were not fully established and complete surveys were not conducted on these forks until 2002 and 2001, respectively (Appendix B). The Yakama Nation conducts the surveys on the South Fork Ahtanum Creek and WDFW is the lead on the other forks.

Snorkel surveys were conducted in 2000 as part of a statewide project to predict how habitat variables affect juvenile bull trout (Dunham and Chandler 2001). There were also snorkel surveys in 2001 in association with collection of genetic samples for Reiss (2003). In 2002 genetic samples were collected during electrofishing surveys as part of a statewide WDFW bull trout genetics baseline (Small and Martinez 2011). WDFW day and night snorkeled and electroshocked the North Fork and Shellneck Creek in 2003 as part of a project to develop a bull trout presence/absence sampling protocol (Hoffman et al. 2005). Larsen et al. (2003) examined these data in more detail with Peterson et al. (2005) providing final analysis.

Adult bull trout have been captured in two fish salvage efforts. WDFW collected 5-6 resident bull trout at the Bachelor-Hatton construction site on mainstem Ahtanum Creek in 1994 (WDFW 1996) and Scott (2010) captured two bull trout during the removal of a low dam at the North Fork Ahtanum Creek USGS gage site.

Mizell and Anderson (2010) investigated the migratory behavior of adult bull trout in the Middle and North forks of Ahtanum Creek. None of the radio tagged fish migrated outside of the Ahtanum Creek drainage. Only one fish moved below the confluence of the North and Middle forks of Ahtanum Creek.

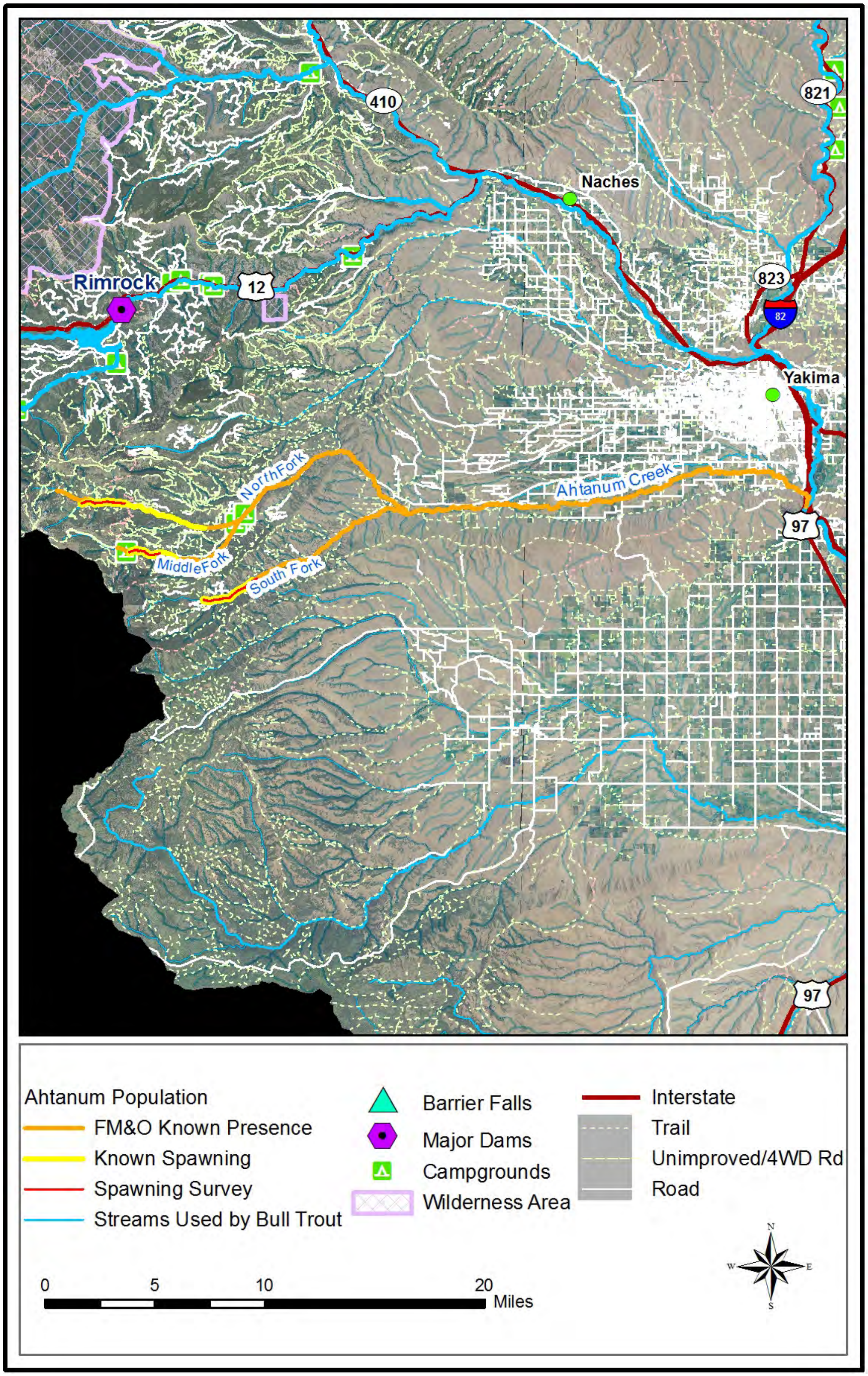

Figure 3. Ahtanum Creek subwatershed

Habitat

Habitat Overview

The area inhabited by bull trout on Ahtanum Creek ranges in elevation from 960 feet at the mouth to about 5,000 feet at the upstream end of the spawning area in the North fork (all elevations provided in this document are above mean sea level). The known spawning, and presumably primary juvenile rearing, habitat in all three forks occurs in reaches at higher elevations (4,200-5,000 feet) although it is probable that rearing habitat extends downstream to the confluence of the forks (elevation ~2,100 feet). Above the forks, land ownership consists primarily of Washington Department of Natural Resources (DNR) lands and commercial timber company holdings; Yakama Reservation lands occur south of the South fork for its entire length. Habitat conditions in the Ahtanum Creek watershed were described in detail in the Salmonid Habitat Limiting Factors Analysis for the Yakima River watershed conducted by the Washington State Conservation Commission (Haring 2001).

In the upper watershed, timber harvest (and associated roads), livestock grazing and heavy recreational use have degraded habitat conditions. Negative impacts on channel condition (pool frequency and depth, LWD presence), substrate condition (resulting from increased fine sediment load) and riparian condition have all occurred. Impacts from livestock grazing have lessened considerably over the last decade but forest practices, road density and recreational impacts remain a concern. The latter is primarily associated with two DNR campgrounds located on the banks of the North Fork, which contribute to bank erosion and riparian damage, and the construction of recreational dams that impede or prevent fish passage.

In addition to the FMO habitat available in the three forks of the Ahtanum Creek, the 23 miles of the mainstem below the confluence of the North and South forks are utilized as well. Lands along the mainstem are almost entirely privately owned to the north of the creek with the Yakama Reservation to the south. The primary land use is agriculture with rural residential housing and some industrial development in the lower part of the creek. Irrigation development began in the mid-1800s and by the early 1900s there were over 100 diversions, primarily on the mainstem Ahtanum Creek. Most, if not all, were unscreened. Today there are two main irrigation projects on the creek: Ahtanum Irrigation District (AID) which serves the agricultural lands north of the creek, and the Wapato Irrigation Project (WIP) which serves the Yakama Reservation lands to the south. In addition, there are numerous smaller pump and gravity diversions, which are private. The effects of agricultural development on fish populations and habitat have been profound. Haring (2001) provided extensive detail regarding these effects. Since the document was published there have been significant improvements with respect to screening diversions although a small number remain unscreened. There have also been improvements regarding instream flow, the most significant being the agreement with the WIP to provide a minimum flow of 10 cubic feet per second (cfs) in a 7-8 mile reach that was annually dried up between mid-July and mid-October. These improvements notwithstanding, the mainstem remains flow depleted in the summer and early fall and other problems exist as well. The creeks floodplain has been disconnected by dikes; channel condition is poor due to extensive bank erosion and the lack of LWD; riparian condition is poor due to livestock grazing, residential development and flow depletion; and summer water temperatures are unsuitable for bull trout due to riparian disturbance, floodplain disconnection, and flow depletion.

Habitat Monitoring

USGS reported the effects of Mount St. Helens eruptions on several watersheds, including Ahtanum Creek (Lee 1996). Chesney (1998; 2000) monitored channel condition and functioning of wood for a long-term habitat monitoring program on DNR lands. For the Dunham and Chandler (2001) study referenced above, temperature, large wood, gradient, wetted channel width, mean depth, maximum depth, undercut banks, and substrate were measured within designated reaches.

The WDFW, through Fish Restoration and Irrigation Mitigation Program (FRIMA) funding, conducted an extensive fish passage and diversion screening survey on Ahtanum Creek from March-August 2003. This survey consisted of an inventory of all fish passage barriers and water diversions encountered within the watershed (Kohr et al. 2004).

The Department of Ecology facilitated the Ahtanum Creek Watershed Restoration Program (ACWRP) which was intended to resolve water resource problems in the watershed by providing a unified program to restore stream flows and fish habitat and to improve water supply for irrigation (Ecology 2005). This resulted in a detailed plan for habitat work in the watershed but dedicated funding has not been secured.

The Washington Department of Ecology (DOE) monitored water quality at the mouth of Ahtanum Creek (Fulbright Park) in 2009. Temperature and fecal coliform exceeded state water quality standards for several months during the summer irrigation period (Ecology 2009). The U.S. Geologic Survey (USGS) has also collected water quality data from 1973-2000 at five sites on Ahtanum Creek, from the mouth to Tampico (USGS website). The Yakama Nation has collected other temperature monitoring data in the Ahtanum Creek drainage (G. Morris, YN, pers comm). Nine sites along the Middle, South and North forks of Ahtanum Creek, as well as several tributaries were monitored as year-round sites from 2003-2006. There has been no water temperature data collected in Ahtanum Creek since 2006; this is identified as a data gap.

Threats

The highest severity threats to this population, forest management and low abundance, as shown in Table 6, result from land ownership patterns—private and DNR forest lands that have degraded habitat conditions and presumably lowered population viability (Table 5). Passage barriers, resulting from low flow conditions in the lower reaches (i.e., altered flows) and recreation dams in the upper spawning reaches, also appear to be limiting bull trout productivity in this system. There are multiple threats of unknown but potentially significant severity including: angling, entrainment, prey base and recreation. Further monitoring work is necessary to confirm the severity of each of these threats.

Certain threats, which are commonly associated with the Ahtanum Creek system (agriculture and grazing) were rated as unknown in the analysis but were not considered significant. Agriculture, though present in the lower FMO reaches, was not found to have direct mechanisms for affecting the bull trout population. Instead the potential effect is indirect via water quality issues or riparian degradation, although neither is considered significant. Grazing allotments are present in the spawning and rearing reaches. However, riparian fencing has reduced the severity of this threat to insignificant. A road along the length of the mainstem Ahtanum Creek in the FMO habitat is believed not to present a significant threat. There are no known areas of natural dewatering, or introduced brook trout, or mining, and the extent of habitat is not limiting.

Table 6. Ahtanum Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREAT	Rating	ACTIONS	Priority
Forest management	SIGNIFICANT	Restoration; address forest health; road closures; sediment monitoring	HIGH
Low abundance	SIGNIFICANT	Monitor; evaluate supplementation; evaluate movement patterns	HIGH
Passage barriers	MOD SIGNIFICANT	Remove recreation dams	HIGH
Altered flows	MOD SIGNIFICANT	Increase instream flow	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Development	UNKNOWN SIGNIFICANT	Habitat surveys/projects	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Screen all diversions	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Relocate Tree Phones and Snow Cabin campgrounds; Outreach	MEDIUM
Agriculture	UNKNOWN	Temperature monitoring	MEDIUM
Grazing	UNKNOWN	Monitor exclusion fencing	MEDIUM
Transportation	UNKNOWN LOW	—	LOW
Dewatering	NOT PRESENT	—	NA
Introduced species	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

ACTIONS

Strategy

This population has been identified as a high priority "Action" population (see Prioritization of Actions). The highest priority recovery actions are those that improve habitat and access to habitat in the upper spawning and rearing reaches and those that restore instream flow and reduce entrainment in the lower FMO reaches. To address threats to the Ahtanum Creek bull trout population, it will be critical to work with staff at the DNR to implement road closures and habitat restoration projects in important bull trout rearing areas. Protection and restoration of downstream FMO habitat will involve partnerships with private landowners. This is an area where habitat improvements are currently being completed based on their importance for anadromous species. Addressing the current Low Abundance threat by continued population monitoring will be critical, as will understanding the movement patterns between forks. This is a candidate population for evaluating the feasibility of supplementation (see Appendix D). Outreach is a priority in order to document angling pressures and to educate anglers, recreationists, and landowners throughout the watershed. The Broad Scale actions that apply to the Ahtanum Creek populations include: Restore Healthy Salmon Populations.

Completed Actions

- Screened nine unscreened gravity diversions and side channel construction (2001-2008).
- Riparian exclusion fence constructed within grazing allotment in spawning areas of the North Fork Ahtanum Creek in 2004.
- Cattle grazing allotment in Middle Fork Ahtanum Creek not renewed in 2008.
- Passage barrier removed at North Fork Gaging Station in 2010 (YTAHP).
- Herke fish screen (SRFB project 10-1764). (Project was funded in 2010 and should be completed in Fall 2012.)
- The North Yakima Conservation District screened three unscreened (non-compliant) pump diversions in 2005.
- Agreement between Yakama Nation and principle irrigators to maintain a minimum of 10 cubic feet per second (cfs) instream flows.
- Fishing regulations have been implemented to protect bull trout in Ahtanum Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164)

Population Scale

- Ahtanum Creek #1: Instream and floodplain restoration.

- Ahtanum Creek #2: Address forest health in Ahtanum Creek watershed.
- Ahtanum Creek #3: Relocate road adjacent to Shellneck Creek and reduce road densities throughout the forested area of the drainage.
- Multiple Populations #4: Evaluate supplementation (see Appendix D).
- Ahtanum #5: Increase instream flows via water conservation and diversion consolidation in the mainstem Ahtanum Creek.
- Multiple Populations #1: Monitor for recreational dams on an annual basis and remove as necessary.
- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Ahtanum Creek #7: Ensure all pump and gravity diversions are adequately screened including all three Herke Ranch diversions (the last unscreened open ditches).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Ahtanum Creek #8: Close or relocate Tree Phones Campground.
- Ahtanum Creek #9: Close Snow Cabin Campground and restore the site.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas of all forks to monitor long-term abundance trends.
- Ahtanum Creek #4: Evaluate movement patterns and genetic connectivity between forks.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring throughout Ahtanum Creek drainage, expanding as necessary.

Implementation Monitoring of Completed and Recommended Actions

- Ahtanum Creek #10: Monitor effectiveness of cattle exclusion fencing in the North and South forks.
- Ahtanum Creek #7: Monitor condition and effectiveness of fish screens on irrigation diversions.

Threats Research & Monitoring

- Ahtanum Creek #6: Habitat surveys in areas affected by grazing, forest management, agriculture, or residential development.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Naches River Action #24: Protect instream flow improvements in Ahtanum Creek
Naches River Action #25: Develop off-channel storage in Ahtanum Creek
Naches River Action #26: Minimize irrigation conveyance loss in Ahtanum Creek
Naches River Action #27: Ahtanum Creek floodplain and side channel restoration
Naches River Action #28: Protect Ahtanum Creek riparian areas to lessen developmental impacts
Naches River Action #29: Reduce livestock impacts on Ahtanum Creek riparian areas

Naches River Fluvial Populations Overview

The Naches River is the main tributary of the Yakima River entering just north of the city of Yakima. It begins approximately 45 miles upstream at the confluence of the Bumping and Little Naches rivers (the American River flows into the Bumping River about 3.5 miles above this point). Major tributaries of the Naches River include the Tieton River and Rattlesnake Creek. With the exception of storage dams, which block upstream migration on the Bumping and Tieton rivers, bull trout are able to migrate freely within the system. Below these dams there are 16.5 miles of habitat available to fish on the Bumping River and 21 miles on the Tieton River. Numerous smaller tributary streams also flow into the Naches River.

At this time three local bull trout populations comprise the Naches River fluvial populations. These populations spawn in the American River, Rattlesnake Creek, and Crow Creek (tributary to the Little Naches River) and all use the mainstem Naches River as FMO habitat, as well as possibly the mainstem Yakima River upstream and downstream of the confluence with the Naches River. There is limited evidence of movement outside of the Naches River although one fish tagged during the WDFW radio telemetry study (Mizell and Anderson 2010) moved into the Yakima River and one bull trout sampled at Roza Dam (RM 205.9) genetically assigned back to Rattlesnake Creek (Small and Martinez 2011). The contribution to the Naches River fluvial populations from fish entrained out of Rimrock and Bumping reservoirs is largely unknown but appears to occur to some limited extent; two of 13 adult bull trout trapped in 2003 after spawning in Rattlesnake Creek assigned to the South Fork Tieton River population, evidence that entrained fish may be contributing to Naches River fluvial bull trout populations (Small and Martinez 2011). These populations, however, remain distinct from populations above the reservoirs, indicating that one-way gene flow since the time of dam construction (~100 years) is not homogenizing populations (Small et al. 2009).

Naches River Fluvial Populations FMO Habitat Overview

An overview of spawning and rearing habitat for each Naches River fluvial population is described below in the individual population sections. The shared FMO habitat for all of these populations is considered to be primarily located in the Naches River although there is some evidence that the Tieton River and mainstem Yakima River are used as well. It is difficult to summarize habitat conditions in the Naches River given the length of the river (45 miles). Generally, the upper 27 miles (above the Tieton River confluence) flows through forested lands of mixed ownership. Much of this is National Forest but there are also areas that are privately owned; residences and groups of residences are ubiquitous with a few small farms present lower in the reach. There is also considerable recreational access and use. State Route (SR) 410 runs adjacent to the river for the entire length of this segment and has impacted floodplain function. Below the Tieton River confluence land use along the Naches River converts to predominantly agricultural (orchards, irrigated pasture, and hay production) and there are numerous water diversions. U.S. Highway 12 runs adjacent to the river from the Tieton River confluence downstream to the mouth impairing floodplain function. Haring (2001) describes numerous positive habitat attributes such as good riparian condition (in the upper portion of the river), good pool frequency and depth, good LWD and substantial amounts of off-channel habitat. These positive attributes combined with the length of river available for bull trout habitation suggest that FMO habitat conditions in the mainstem Naches River are not limiting population productivity for Naches River fluvial bull trout populations.

The significance of the Tieton River as FMO habitat for the Naches River fluvial populations is unknown. However, adult bull trout have been captured in the Tieton River (in the stilling basin directly below Tieton Dam) that genetically assigned to the Rattlesnake Creek and American River populations (Small et al. 2009). The Tieton River flows for just over 23 miles from the base of the dam to its confluence with the Naches River. U.S. Highway 12 parallels the river on the left bank for much of this length, which has altered the riparian corridor. However, this road has little effect on floodplain function as the river is naturally confined in this section. Other roads, structures, several developed campgrounds, and the Yakima-Tieton diversion dam contribute to the rivers disturbed condition. The channel is in poor condition due to structural restrictions and an almost complete absence of LWD (Haring 2001). The most significant negative impact on fish habitat in the Tieton River is the regulated flow regime, which also contributes to the lack of LWD and channel complexity. The timing and magnitude of stream discharge in the river is the most highly altered of any in the Yakima Basin. Winter flows are 60-80% less than would occur under unregulated conditions and flow variability is extremely low. At a time when overwintering bull trout would be seeking pool habitat with cover, relatively none exists. During the first week of September an extreme, managed hydrologic event ("flip-flop") occurs when dam releases are rapidly increased and average river flows often exceed by an order of magnitude what would be a natural base flow, sometimes exceeding 2,000 cfs. This condition persists to varying degrees for over a month.

Rattlesnake Creek

Rattlesnake Creek is a right-bank tributary of the Naches River, which originates in the William O. Douglas Wilderness Area and is approximately 20 miles in length from its origin to its confluence with the Naches River at RM 28. The north fork is much shorter and appears impassable for fish a short distance upstream of the confluence of the two forks. Several small tributaries enter the south fork along its course, including Little Wildcat, Shell, Dog and Hindoo creeks. Little Rattlesnake Creek enters well below the forks about a mile above the mouth of Rattlesnake Creek.

Population Distribution and Life History

Rattlesnake Creek supports a single local population of bull trout, which displays a fluvial life history type; a resident component may exist as well but this has not been confirmed. The primary spawning area for this population is located in the south fork above the wilderness boundary at RM 14 and extends about seven miles upstream; it includes Little Wildcat and Shell creeks (Figure 5). Juvenile bull trout are assumed to rear in Rattlesnake Creek all the way down to the mouth; adult FMO habitat is primarily the Naches River below the Rattlesnake confluence but some adults also utilize FMO habitat upstream (Mizell and Anderson 2010). An unknown but assumed small number of adult bull trout evidently migrate up the Tieton River and the mainstem Yakima River as well (see Population Monitoring below). Adult bull trout migrate into Rattlesnake Creek in late June and July and are in close proximity to their spawning grounds by mid-August.

Status

The USFWS (1998) did not consider the Rattlesnake Creek population singularly but considered the Naches River "subpopulation" (i.e., all three Naches River fluvial populations) to be depressed with an unknown trend. WDFW similarly lumped the Naches River fluvial populations and rated the status of this stock as critical (WDFW 2004).

Results of genetic analyses show this population is genetically distinct from all other Yakima Basin populations but did cluster with the other Naches River fluvial populations, indicating some degree of gene flow either currently or historically (Reiss 2003; Small et al. 2009). Juvenile samples for the genetic baseline were collected in spawning and rearing areas above the wilderness boundary on Rattlesnake Creek, and adults were collected in a box trap post-spawning during the radio telemetry studies (Mizell and Anderson 2010). No samples were collected in the smaller tributaries.

Trends

The Rattlesnake Creek population spawns primarily during the month of September. Complete redd surveys have been conducted for this population since 1996 in an index area beginning about 2.8 river miles above the wilderness boundary and extending upstream 7.1 miles; also surveyed are 0.1 mile of Shell Creek and 0.5 mile of Little Wildcat Creek. This index area is believed to cover the entirety of the spawning habitat currently utilized. Annual redd counts have been highly variable with counts ranging from 13 to 69 (Figure 4).

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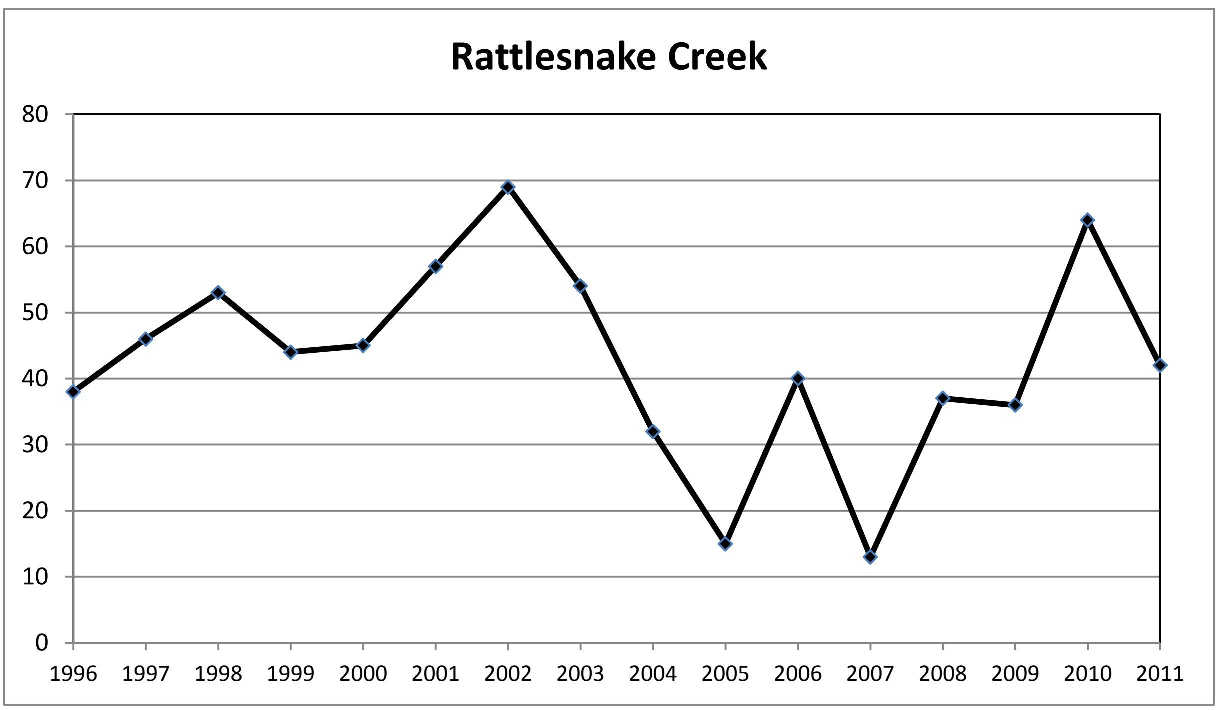


Figure 4. Bull trout redd counts in Rattlesnake Creek.

Population Monitoring

The USFWS first documented the presence of bull trout (although they called them Dolly Varden) during habitat and fish barrier surveys conducted during 1935-1936 (McIntosh 1990). A survey by the Washington Department of Game Fisheries Research Team in 1975 also documented bull trout (Dolly Varden) (Washington Dept of Game 1975). The population was not investigated again until WDFW captured several juvenile bull trout in Rattlesnake Creek during electroshocking surveys (Anderson 1991). Exploratory spawning surveys were first conducted in 1994 with complete surveys initiated in 1996. In 2001 juvenile bull trout were captured in the creek during snorkel surveys conducted in association with the collection of genetic samples (Reiss 2003).

Mizell and Anderson (2010) investigated the migratory behavior of bull trout in the Naches River and its tributaries. They reported on migration timing and overwintering habitat. In October after spawning, adults migrate back to the Naches River to over-winter. Although not observed during this radio telemetry study, a few Rattlesnake Creek adults appear to make their way up the Tieton River. Small et al. (2009) reported that six of 34 adult bull trout captured in the stilling basin directly below Tieton dam, most during a fish salvage operation in December 2005, genetically assigned to the Rattlesnake Creek population. Evidence that Naches River fluvial bull trout may use FMO habitat in the mainstem Yakima River comes from a single bull trout that was sampled at Roza Dam in 2005, which also genetically assigned to the American River population (see Appendix C).

Attempting to determine the complete distribution of bull trout in the Rattlesnake Creek watershed, WDFW also conducted electroshocking surveys on the North Fork Rattlesnake Creek and Little Rattlesnake Creek in 1990 and 1994, finding no bull trout (WDFW 1990). In addition the Forest Service completed night snorkel surveys on this tributary in 2002 using the bull trout presence/absence protocols developed by Peterson et al. (2002). No bull trout were found during these surveys (USFS 2002). Technicians with YN Coho Program documented subadult bull trout in the lower portion of Little Rattlesnake Creek in 2006 and 2011 (T. Newsome, YN, pers comm.). Due to the absence of bull trout found in the previous surveys, it is assumed this fish belonged to the Rattlesnake Creek population.

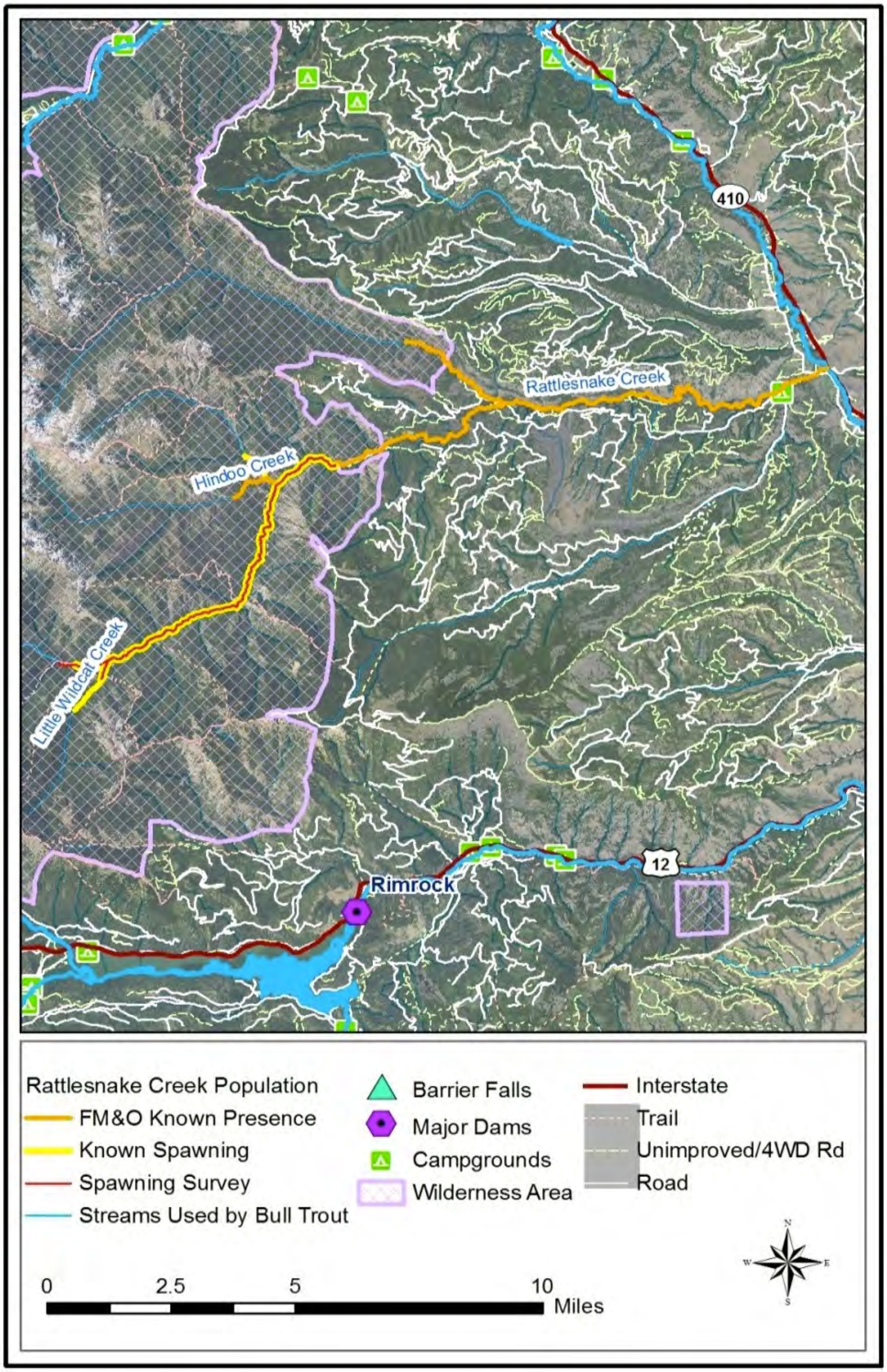


Figure 5. Rattlesnake Creek subwatershed.

Habitat

Habitat Overview

Rattlesnake Creek is a high gradient stream with elevations ranging from 1,960 feet at its mouth to over 3,500 feet at the upstream extent of the spawning area. Approximately 56% of the watershed, including the entire portion where bull trout spawn, is in the wilderness. Habitat conditions in the spawning area are excellent considering all rating parameters—channel condition (pool frequency and depth, LWD presence); substrate condition (suitable spawning gravels, sedimentation); riparian condition; water quality (temperature, chemicals/minerals); and water quantity (Haring 2001). Bull trout juveniles rear above and below the wilderness boundary. Below the boundary the creek flows primarily through National Forest land with the exception of some private holdings in the lower mile of the stream corridor. There are a small number of private residences (less than 10) located on Forest Service land 5-6 miles upstream of the mouth and several on the private land nearer the mouth. The upstream residences are not believed to significantly affect habitat quality in the creek. Haring (2001) described habitat condition in the non-wilderness section of Rattlesnake Creek as good above the Little Rattlesnake Creek confluence (RM 1.0). Below this point, the channel has been constrained by a bridge and by diversion structures, limiting the area available for sediment deposition in the floodplain and resulting in chronic aggradation at the confluence with the Naches River. There have been concerns in the past that in dry years adult bull trout migration into the creek may be impeded. The span of the bridge was lengthened in 2008, which should, over time, reduce aggradation; the most significant diversion was removed in 2009.

Habitat Monitoring

The Forest Service has conducted habitat surveys on Rattlesnake Creek and its tributaries using a Hankin and Reeves protocol (Hankin and Reeves 1988). On the mainstem Rattlesnake Creek, 7.2 miles were surveyed in 1996, Little Rattlesnake Creek survey was completed in 2002, and all tributaries were surveyed in 1994, including Little Wildcat and Shell creeks (USFS 2003c). During these surveys, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature. Sediment samples were collected and analyzed in a reach of Rattlesnake Creek below the wilderness boundary in 1997 and 2002 (Matthews 2006). In 2009, the Forest Service completed a road condition survey on major roads within the Rattlesnake drainage (USFS 2009).

Temperature monitoring via thermographs deployed during the summer low flow period has been sporadic, but some degree of monitoring occurred in 11 out of 17 years between 1991 and 2007 (USFS 2011a). Monitoring sites were located in Rattlesnake, NF Rattlesnake and Little Rattlesnake creeks. Collection of temperature data since 2007 is a monitoring gap.

Threats

With a geometric mean of <50 redds annually (see Appendix B) low abundance is identified as a moderate threat but this population is not considered a candidate for supplementation due to a stable population trend. The next highest threat to this population (prey base) is unknown but believed to be of significant severity. Currently steelhead, spring chinook, and coho spawn in the lower reaches of Rattlesnake Creek but at much lower numbers than historically. Angling is another potential threat to this population. However, because of difficult recreational access, this is not likely a limiting factor. The potential for entrainment into irrigation diversions is present in the lower reaches, and the impact to migrating or rearing juvenile bull trout is unknown.

Brook trout (an introduced species) are present in lower reaches of Rattlesnake Creek and in the Naches River, but no evidence of hybridization was found during genetic sampling. Dewatering, altered flows, development, forest management issues, roads, passage barriers (potential) and recreational impacts are all present in the FMO habitat and lower rearing reaches of Rattlesnake Creek but are not believed to be significantly impacting the population. There is a sheep grazing allotment in the Rattlesnake drainage but this has never been documented to damage riparian areas. Altered flows have been an issue in the past in lower Rattlesnake Creek but recent improvements appear to have adequately mitigated this threat. Threats that are not present for this population include: agriculture, limited extent of habitat, and mining.

Table 7. Rattlesnake Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low Abundance	MODERATE	Monitor	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Angling	UNKNOWN	Outreach	MEDIUM
Entrainment	UNKNOWN	Improve screening on diversions	MEDIUM
Introduced species	UNKNOWN LOW	—	LOW
Transportation	LOW	—	LOW
Altered Flows	LOW	—	LOW
Development	LOW	—	LOW
Forest management	LOW	—	LOW
Recreation	LOW	—	LOW
Dewatering	LOW	—	LOW
Passage Barriers	LOW	—	LOW
Grazing	LOW	—	LOW
Limited extent habitat	NOT PRESENT	—	NA
Agriculture	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a "Protection" population with a priority for continued population monitoring but with limited restoration actions recommended. Spawning and rearing occurs in the wilderness where no threats are present and threats are limited in the reach outside of the wilderness where rearing also occurs. In the lower reaches of Rattlesnake Creek and in the Naches River, implementing restoration actions would benefit this population. Current conditions in these reaches, however, are not thought to be limiting. Outreach is a priority in order to document angling pressures and educate anglers, recreationists, and landowners throughout the watershed. The Broad Scale Actions that apply to the Rattlesnake Creek population include: Restore Healthy Salmon Populations and Passage at Major Storage Dams (Bumping and Rimrock). Revitalizing salmon and steelhead runs in the Yakima Basin would significantly improve the prey base for all bull trout life stages. Providing passage at the two storage dams in the Naches subbasin would benefit the Naches River fluvial bull trout populations in general.

Completed Actions

- The Boyd Brown diversion (associated with altered flows) near the Nile Road Bridge was removed in 2009.
- WDFW in 2001 manually modified multiple channels at the mouth of Rattlesnake Creek into a single channel to provide fish passage in 2001 drought year.
- One unscreened (non-compliant) pump diversion was screened in 2011 by the North Yakima Conservation District.
- The Nile Road Bridge over Rattlesnake Creek was replaced in 2008.
- Fishing regulations have been implemented to protect bull trout in Rattlesnake Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164)

Population Scale

- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Multiple Populations #6: Floodplain acquisition/easements along the mainstem Naches River to benefit FMO habitat quality.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas to monitor long-term abundance trends.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

- Rattlesnake #1: Monitor effectiveness of fish screens on irrigation diversions.

Threats Research & Monitoring

None recommended

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Naches River Action #5: Restore lower Naches River floodplain
Naches River Action #7: Protect habitats in Naches River mainstem above Tieton River confluence
Naches River Action #9: Provide passage at Bumping Lake Dam
Naches River Action #17: Increase instream flows in lower Rattlesnake Creek
Naches River Action #18: Improve sediment transport at Rattlesnake Creek/Naches River confluence

Crow Creek

Crow Creek is tributary of the Little Naches River, which originates in the Norse Peak Wilderness Area. The creek flows for approximately 20 miles to its confluence with the Little Naches River about four river miles above its confluence with the Bumping River. All but the lower 6.2 miles of Crow Creek are in the wilderness and its only tributaries are very small and tend to dry up seasonally.

Population Distribution and Life History

Crow Creek supports a single local population of bull trout that displays a fluvial life history; a resident component may occur as well but this is unconfirmed. The creek is the only known bull trout spawning stream in the Little Naches drainage despite its large size and the presence of suitable habitat elsewhere. The spawning area for this local bull trout population extends from about a mile below the wilderness boundary (RM 5.2) to about 4.5 miles above with most spawning concentrated in the upper end of this reach (Figure 7). There is no known spawning activity in the smaller tributaries.

Juvenile bull trout rearing likely occurs throughout the length of Crow Creek. Adult FMO habitat includes the Little Naches River, the mainstem Naches River, and likely the Bumping and American rivers although this is unconfirmed. Timing of spawning migration is unknown but likely occurs in the late summer, similar to other Naches fluvial populations.

Population Status

The USFWS (1998) did not consider the Crow Creek population singularly but considered the Naches River "subpopulation" (i.e., all three Naches River fluvial populations) to be depressed with an unknown trend. WDFW similarly lumped the Naches fluvial populations and rated the status of this stock as critical (WDFW 2004).

Results of genetic analyses show this population is genetically distinct from all other Yakima Basin populations but clusters with the other Naches River fluvial populations, indicating some degree of gene flow (Reiss 2003; Small et al. 2009). Juvenile samples for the baseline were collected in spawning and rearing areas above the wilderness boundary (Reiss 2003).

Population Trend

The Crow Creek population spawns primarily during the month of September. Complete redd surveys have been conducted for this population since 1999. They are conducted in an index area, which extends from the wilderness boundary (RM 6.2) to about 4.3 miles above it. In 2008 and 2009, the index area was shortened to exclude the lower 1.8 miles of this reach as redds are rarely observed in this stretch. However, surveying of the full index area resumed in 2010 and is expected to continue in the foreseeable future.

This population appears to be quite small. After relatively high counts the first two years of surveying, the number of observed redds plummeted and has not bounced back (Figure 6). Since 2001 an average of only seven redds has been counted annually in Crow Creek.

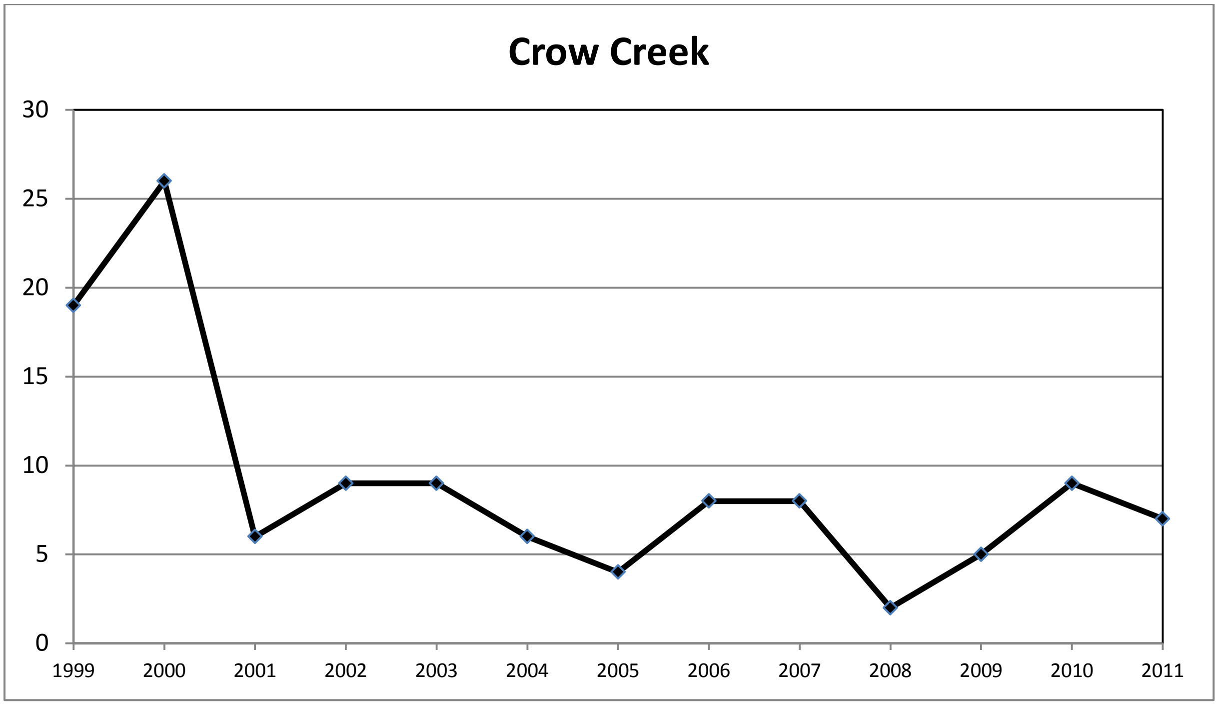


Figure 6. Bull trout redd counts in Crow Creek.

Population Monitoring

WDFW captured one bull trout while electroshocking in Crow Creek in September 1990 (Anderson 1990). Seven bull trout were observed during snorkel surveys to determine presence/absence in 1993 (Plum Creek TImber Company 1993; Plum Creek Timber Company 1995). Westslope cutthroat trout and rainbow/steelhead trout were observed during both of these monitoring efforts but it is important to note that no brook trout were observed. Juvenile bull trout samples were collected during snorkel surveys in 2001 (Reiss 2003).

Spawning surveys have been conducted annually since 1999 in the index area mentioned above. In addition, exploratory spawning surveys have been conducted in the Crow Creek basin above and below the index area. In 1999, the USFS surveyed from the top of the current index area to Crow Creek Lake (an additional 4 miles), and also ~1 mile of habitat on Crow Creek above the lake. In 2001 and 2009 WDFW repeated the extended survey to Crow Creek Lake. In 2000, WDFW surveyed from the lower end of the index area to the mouth of Crow Creek. No redds were found outside of the index area during any of these surveys.

Mizell and Anderson (2010) investigated the migratory behavior of bull trout in the Naches River and tributaries using radio telemetry. Overwintering bull trout in the Naches River were captured and tagged in 2003 and subsequently tracked to spawning grounds the following fall. Only one of these tagged bull trout was tracked into Crow Creek. This fish was genetically assigned to the Crow Creek population using the genetics baseline. One juvenile bull trout was captured in a trap near the mouth during the radio telemetry study, but was too small to radio tag. Some juvenile bull trout were observed in Crow Creek below the spawning grounds during snorkel surveys in 2005. None were of a size that allowed them to be radio tagged.

As mentioned above the Little Naches River watershed is large and contains apparently suitable bull trout habitat in streams other than Crow Creek. Many surveys have been conducted in the Little Naches River and various tributaries over the years (see Presence/Absence Survey); no bull trout have been found. There have been individual bull trout sightings reported throughout the Little Naches stream network but their origin is unknown (Anderson 2010).

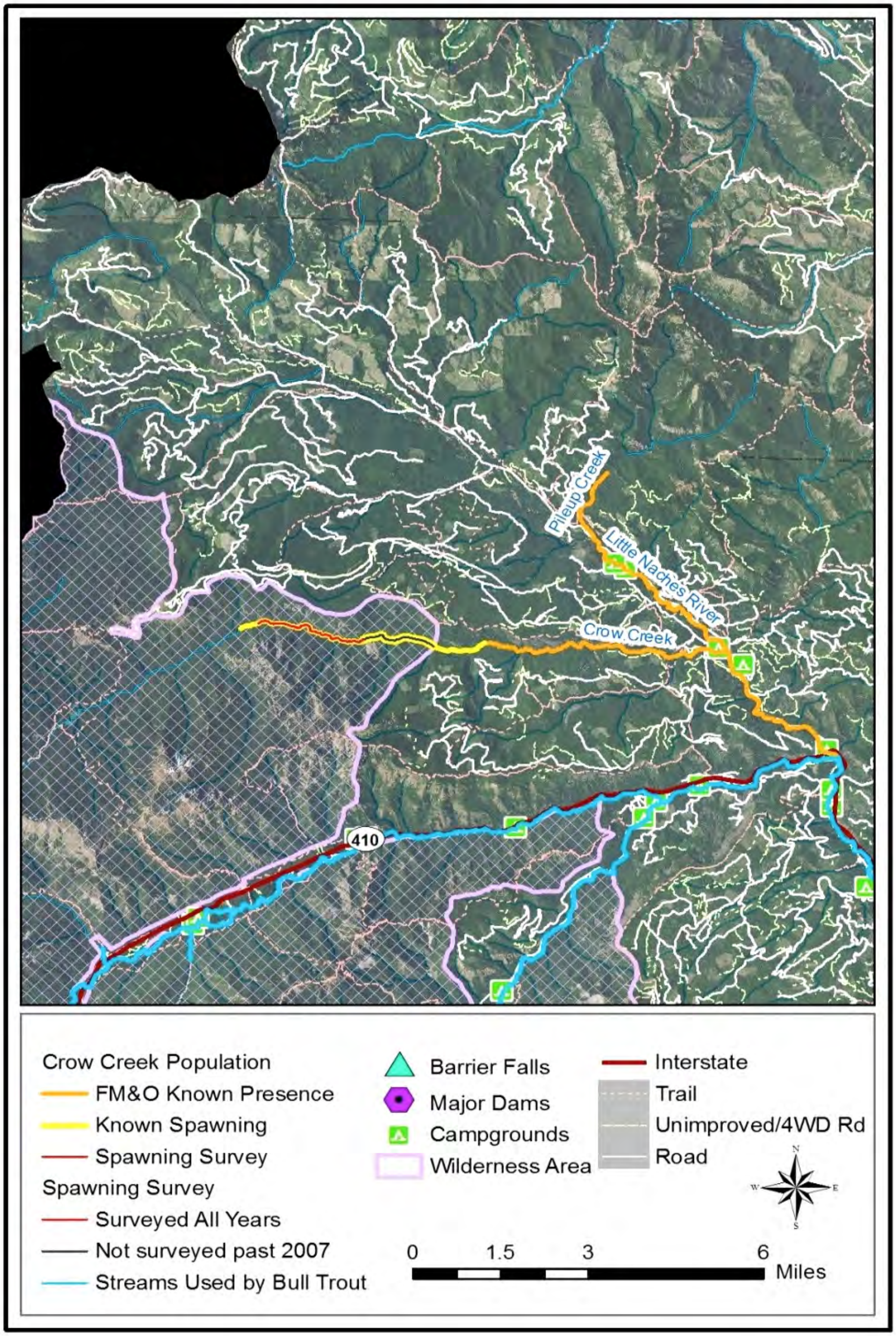


Figure 7. **Crow Creek subwatershed**

Habitat

Habitat Overview

Crow Creek is a high gradient, high elevation stream with elevations ranging from 2,700 feet at its mouth to about 3,700 feet at the upstream extent of the known spawning area. Approximately 60% of the Crow Creek watershed, including the primary bull trout spawning area, is in the wilderness. The creek flows through National Forest land below the wilderness boundary to its confluence with the Little Naches River. Limited timber harvest outside of the riparian corridor occurred in the past but the area has regrown. As a result spawning and rearing habitat for bull trout is generally considered to be in good to excellent condition as is water quality and quantity. An exception is the area immediately upstream of the creek's mouth where a popular Forest Service campground is located along the left stream bank along with a few off-road vehicle trails. Bank erosion and degraded of riparian vegetation are evident in this area.

FMO habitat for this population includes the Little Naches River, the mainstem Naches River, and perhaps the Bumping and American Rivers, although this has not been confirmed. The Little Naches River originates in the Norse Peak Wilderness but the river flows mostly through National Forest and private timberlands. The Little Naches watershed has a long history of human disturbance. Intense grazing of sheep and cattle occurred from the late 1880s through the 1950s. The watershed has been logged heavily with most of the private timberlands in the lower river valley completely harvested by the mid-1940s. Beginning in the mid-1970s and extending through the 1990s the upper watershed was heavily harvested. Primarily as a result of timber harvest operations, road densities in the watershed are extremely high. The watershed is one of the most popular recreational areas in the Yakima Basin, particularly for off-road vehicle enthusiasts. As a result, off-road trails are almost too numerous to count and the impacts on the stream and its tributaries have been significant. The major habitat concerns in the Little Naches watershed are excessive amounts of fine sediments, lack of deep pools, loss of habitat complexity, an absence of LWD, increased frequency and magnitude of peak stream flows, and high water temperatures (Haring 2001). Bull trout FMO habitat in the river is in extremely poor condition.

Habitat Monitoring

The Forest Service conducted habitat surveys on Crow Creek in 1990 (12.6 miles) and in 2000 (5.0 miles) using the Hankin and Reeves protocol (1988). In these surveys data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature. Many habitat surveys have been conducted in the mainstem Little Naches River and associated tributaries from 1988-2010. The 2001 data were used in a thesis project comparing the American and Little Naches rivers (Muir 2003).

In 2001, the Forest Service contracted aerial thermal infrared remote sensing surveys on the Little Naches River from the mouth to the confluence of the North and South forks (Watershed Sciences 2002). Accuracy of temperatures was confirmed with instream sensors. The flights were completed in early September and stream temperatures ranged from 12.8-15.5 °C. Crow Creek was measured at the confluence with the Little Naches River, and the temperature was 13.1 °C, providing a cooling influence.

The Forest Service and the Yakama Nation Timber Fish & Wildlife Program (TFW) have worked cooperatively to maintain a long-term data set of sediment monitoring data in the Little Naches drainage, although Crow Creek itself is not monitored (Matthews 2011). There are 10 reaches in the mainstem Little Naches River and tributaries (South and North forks, Bear and Pyramid creeks) that have been sampled every year from 1992 to present. This monitoring effort demonstrates an overall trend of reduced fine sediments in the substrate; monitoring will continue for the foreseeable future.

Temperature monitoring via thermographs deployed during the summer low flow period at two locations on Crow Creek has been sporadic, but some degree of monitoring occurred in 11 out of 15 years between 1991 and 2005 (USFS 2011a). Other thermographs were deployed throughout the Little Naches drainage at a variety of monitoring sites, primarily in the time period from 1998-2005. Temperature data since 2005 is a monitoring gap.

Threats

The most immediate threat to the Crow Creek population is an extremely low abundance of spawners (10 year geometric mean = 6 redds). This population is at high risk of extirpation. Threats that have contributed to the severe reduction in population viability include angling, lack of prey base, recreation, forest management, and passage barriers (i.e., recreational dams). Angling is open in Crow Creek as well as the Little Naches and Naches rivers; however due to difficult access into Crow Creek, it likely does not receive much fishing pressure. The extent of illegal angling of bull trout is unknown. Given the small population size, however, removing any adults could potentially have a significant effect. Currently there are steelhead, spring chinook and coho salmon spawning in the mainstem Little Naches River and lower reaches of Crow Creek, but in much lower numbers than historically. The primary spawning and rearing area for bull trout is above the wilderness boundary, but in the lower reaches of Crow Creek and in the Little Naches River (FMO habitat), recreation and forest management have caused habitat degradation and sedimentation issues. It is unknown to what extent the condition of habitat in the Little Naches River affects the Crow Creek population. Introduced brook trout are present in the Little Naches River but not in Crow Creek. The brook trout are not believed to present a significant threat to the population.

Altered flows, development, and transportation (paved roads) are present in the FMO habitat for this population but are not believed to be negatively affecting it. There is a grazing allotment in the Crow Creek drainage, but due to local topography, there are no effects on the creek or riparian corridor. The following threats are not present: agriculture, dewatering, entrainment, mining, and limited extent of habitat.

Table 8. Crow Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low abundance	SIGNIFICANT	Monitor; evaluate supplementation	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM

THREATS	Rating	ACTIONS	Priority
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Outreach; restoration; relocate Crow Creek campground	MEDIUM
Passage barriers	UNKNOWN SIGNIFICANT	Remove recreation dams	MEDIUM
Forest management	UNKNOWN	Little Naches habitat projects; land acquisitions	MEDIUM
Introduced species	UNKNOWN LOW	—	LOW
Altered flows	UNKNOWN LOW	—	LOW
Transportation	UNKNOWN LOW	—	LOW
Development	LOW	—	LOW
Grazing	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Entrainment	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as an "Action" population. The most significant threat to the population (Low Abundance) will require continued, and preferably expanded, monitoring to confirm that all spawning activity is being documented. This is a high priority. If the extremely low abundance of spawning adults observed in recent years is confirmed the Crow Creek population is a candidate for evaluating the feasibility of supplementation (see Appendix D). Outreach to document angling pressures and to educate anglers and recreationists is a medium priority as are reducing recreational impacts and insuring no passage barriers exist near the mouth of the creek. There are few concerns relating to spawning and rearing habitat quality upstream of the mouth. Although restoration actions implemented in the Naches River would benefit this population, current conditions are not thought to be limiting. FMO habitat degradation is present in the Little Naches River (USFS 2011c). Actions to restore and protect habitat in the Little Naches River are a moderate priority for this population. The Broad Scale Actions that apply to the Crow Creek population include: Restore Healthy Salmon Populations and Passage at Major Storage Dams (Bumping and Rimrock). Revitalizing salmon and steelhead runs in the Yakima Basin would significantly improve the prey base for all bull trout life stages. Providing passage at the two storage dams in the Naches subbasin would benefit the Naches River fluvial bull trout populations in general.

Completed Actions

- Fishing regulations have been implemented to protect bull trout in Crow Creek (see Appendix F).
- In lower Crow Creek, restoration actions implemented include instream restoration to diversify habitat, and riparian fencing (USFS 2011c).
- In the Little Naches drainage (FMO habitat), restoration actions implemented in the last 20 years include: instream work, riparian fencing, motorized trail and campsite relocations, streambank restoration, road restoration, and placement of an engineered log jam (USFS 2011c).
- From 2003-2008 the Forest Service hired a "river ranger" to educate recreationists on fish and riparian habitat issues and to remove recreation dams.

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p.164).

Population Scale

- Crow Creek #2: Implement restoration actions in the Forest Service Little Naches River Action Plan including: floodplain road relocation/removal, channel complexity restoration, transportation management (road improvement, storage, retention, or obliteration), floodplain recreation management, upsizing culverts to improve capacity and aquatic organism passage, floodplain large wood supplementation, and removal of non-native plant species within riparian areas.
- Crow Creek #3: Relocate (set back) Crow Creek campground at mouth away from current location directly on the creek.
- Crow Creek #4: Acquisition of private land holdings in the Little Naches watershed.
- Multiple Populations #6: Floodplain acquisition/easements along the mainstem Naches River to benefit FMO habitat quality.
- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #1: Monitor for recreational dams on an annual basis and remove as necessary.
- Multiple Populations #4: Evaluate supplementation (see Appendix D).
- Multiple Populations #5: Carcass analog placements if pilot studies demonstrate success.

Population Monitoring

- Crow Creek #1: Periodic expanded spawning surveys above and below current index area.
- Multiple Populations #2: Continue redd surveys within the established index area.
- Continue to collect tissue samples from any bull trout captured within the Little Naches watershed and compare to the Crow Creek genetics baseline. Samples that do not assign back to this population or to one of the other Naches River populations may indicate unknown spawning areas in this watershed.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring throughout the Little Naches drainage.
- Crow Creek #5: Continue sediment-monitoring program in Little Naches drainage.

Implementation Monitoring of Completed and Recommended Actions

None at this time

Threats Research & Monitoring

None at this time

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Naches River Action #5: Restore lower Naches River floodplain
Naches River Action #7: Protect habitats in Naches River mainstem above Tieton confluence
Naches River Action #8: Maintain, upgrade or abandon forest roads
Naches River Action #9: Provide passage at Bumping Lake Dam
Naches River Action #11: Restore side channels and floodplain of the Little Naches River
Naches River Action #13: Reduce dispersed recreation impacts in key tributaries
Naches River Action #14: Protect habitat in the Little Naches River

American River

The American River originates in the William O. Douglas Wilderness Area and flows unimpeded for over 25 miles before converging with the Bumping River about 3.5 miles upstream of the latter's convergence with the Little Naches River. For much of its length it is bordered by wilderness; however, SR 410 runs parallel to the river for a significant portion. The American River is fed by numerous tributary streams, three of the most significant being Union, Kettle, and Timber creeks. In addition to supporting bull trout, the American River is the most productive spring chinook spawning stream in the Naches River watershed.

Population Distribution and Life History

The American River supports what is believed to be a single local population of bull trout that displays a fluvial life history type; there may be a resident component as well but this has not been confirmed. The known spawning area for the American River bull trout population includes the American River beginning just below where Kettle Creek enters the stream (~RM 9) and extending about 8.5 miles upstream (Figure 9). It also includes Union Creek, which enters the river at RM 11.5, and the lower reaches of Kettle Creek.

Juvenile bull trout most likely rear throughout the length of the river but presumably most remain within the spawning areas. Adult FMO habitat includes the Bumping, Little Naches, and mainstem Naches rivers. An unknown but assumed small number of adult bull trout evidently migrate up the Tieton River as well (see Population Monitoring below). Adults migrate upstream on the Naches River throughout the summer and into the American River in August.

Population Status

The USFWS (1998) did not consider the American River population singularly. The agency considered the Naches River "subpopulation" (i.e., all three Naches River fluvial populations) to be depressed with an unknown trend. WDFW similarly lumps the Naches fluvial populations and rates the status of this stock as critical (WDFW 2004).

The American River population, while genetically distinct from all other populations, clustered with the other Naches River fluvial populations, indicating some degree of gene flow. Juvenile samples for the genetics baseline were collected in spawning and rearing areas, and adults were collected in a box trap after spawning during the radio telemetry studies in Union Creek (Mizell and Anderson 2010). Samples from the American River and Union Creek were run separately to determine whether bull trout spawning there were genetically distinct from one another and they were found to be genetically identical (Reiss 2003; Hawkins and Von Bargen 2007). Kettle Creek was not sampled separately; it is believed to be part of the same population group because of its proximity to the other spawning locations and relatively small number of redds.

Population Trend

The American River population spawns primarily during the month of September. Complete redd surveys have been conducted for this population since 1996 in two American River index reaches and in Kettle and Union creeks. The lower mainstem index reach covers 0.4 mile below the Union Creek confluence, and the upper covers 2.8 miles at the upstream end of the known spawning area. The length of the reaches surveyed in Kettle and Union creeks are 0.7 and 0.4

miles, respectively. Both reaches begin at the mouth of the creek and end at natural fish passage barriers. Annual redd counts for the American River bull trout population has remained relatively stable over the period of record (Figure 8).

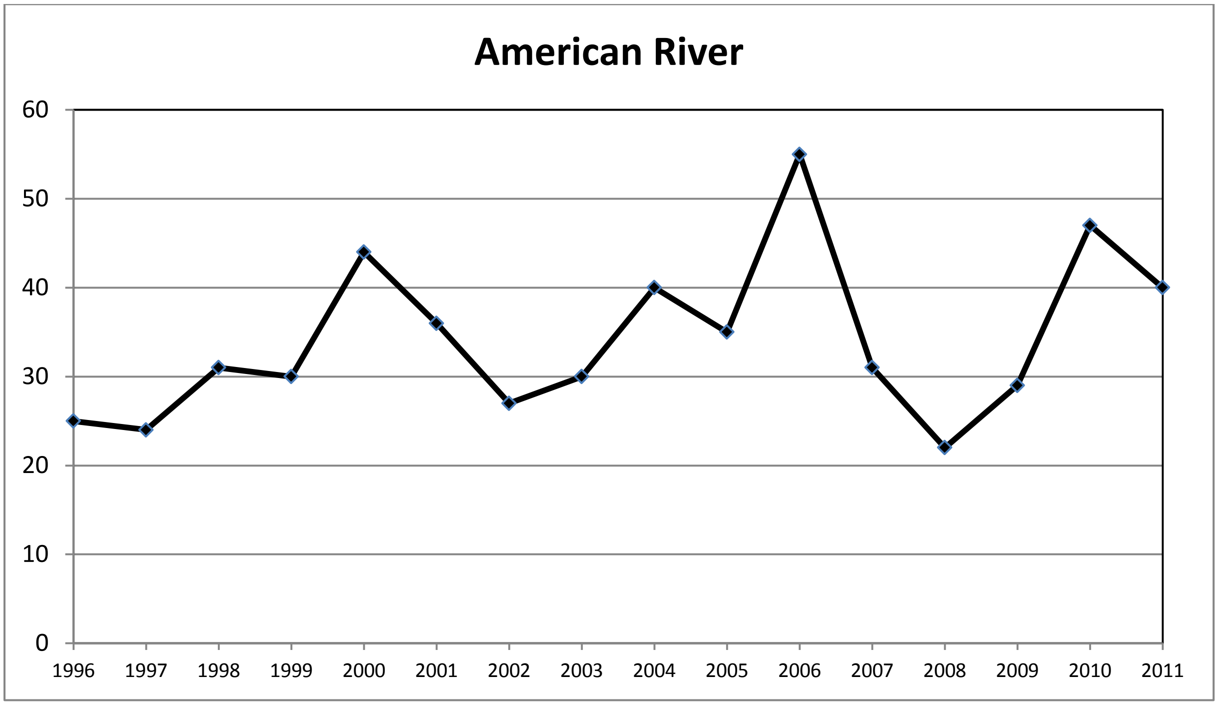


Figure 8. Bull trout redd counts in the American River.

Population Monitoring

The USFWS first documented the presence of bull trout (although they called them Dolly Varden) in the American River during habitat and fish barrier surveys conducted during 1935 and 1936 (McIntosh 1990). The population was not investigated again until WDFW captured several bull trout during electroshocking surveys in 1978 and 1985 (Washington Dept of Game 1978; WDFW 1985). Returning to conduct presence/absence electroshocking surveys in 1993, they reconfirmed the presence of bull trout in the American River and also documented the species' presence in Union, Timber, and Kettle creeks (Anderson 1993b). Also present were cutthroat trout and brook trout. The Forest Service in 1993 also caught juvenile bull trout in minnow traps in Timber, Kettle and Union creeks (USFS 1993b). As mentioned above, annual spawning surveys have been conducted since 1996.

Mizell and Anderson (2010) investigated the migratory behavior of bull trout in the Naches River and tributaries. Bull trout that spawn in the American River and tributaries overwinter in the Naches River, generally downstream from Rattlesnake Creek. Their presence staging in pools in the American from Union Creek to the mouth in early fall has been documented on numerous occasions. The study revealed that adult bull trout leave the American River immediately after spawning, spending a short time in the Bumping River before moving downstream into the Naches River to overwinter.

In 2005, a hydroelectric project was constructed on Tieton Dam, at the head of the Tieton River. Thirty seven bull trout were captured in the stilling basin directly below Tieton Dam during a fish salvage effort (Ackerman 2005). Genetic samples were collected from these fish, and six were genetically assigned to the American River population (Small et al. 2009).

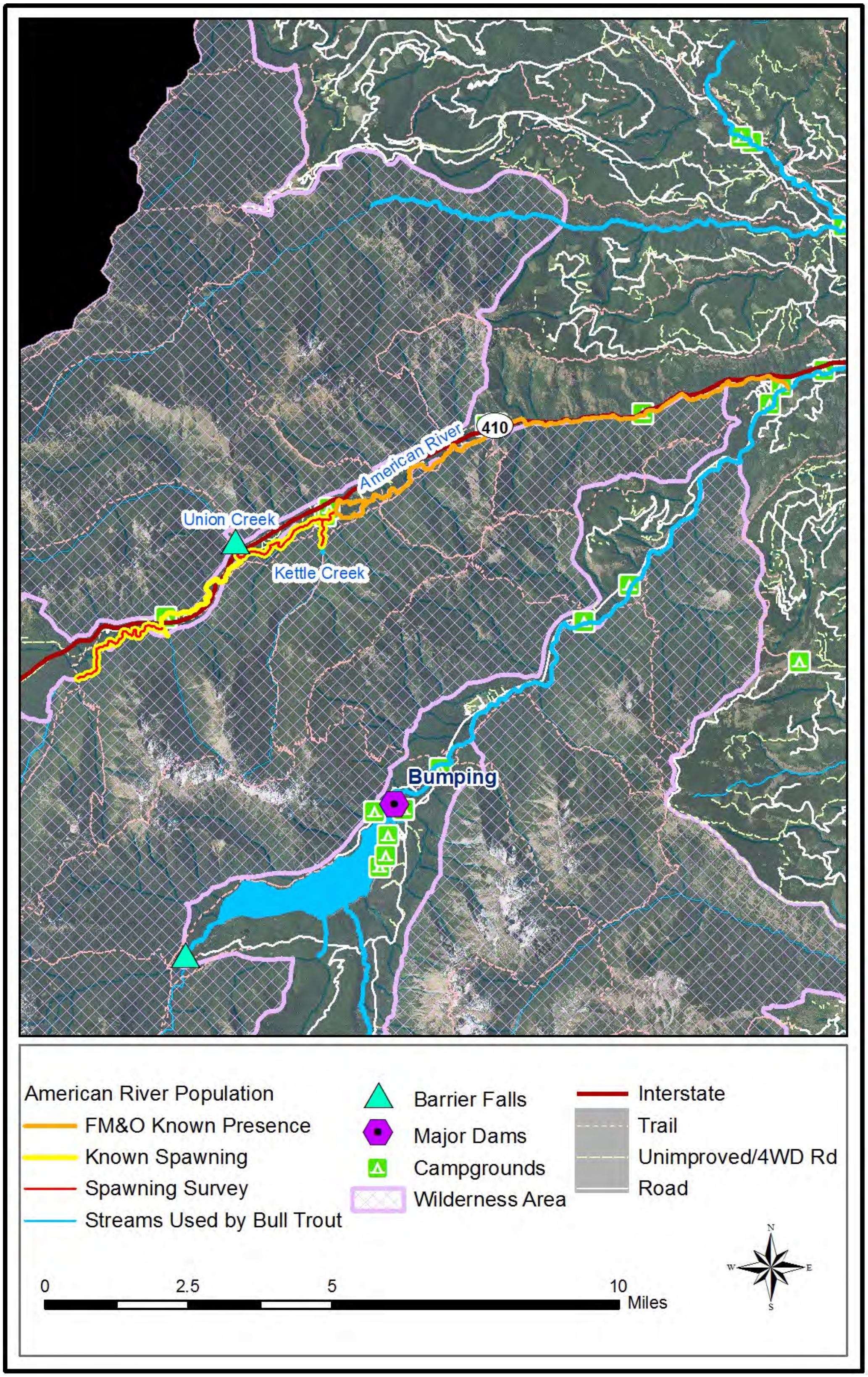


Figure 9. American River subwatershed.

Habitat

Habitat Overview

The American River is a relatively high elevation river ranging from 2,750 feet to 3,600 feet within the area inhabited by bull trout. The known spawning area for bull trout is located along the boundary of the Norse Peak Wilderness Area to the north and the William O. Douglas Wilderness Area to the south. As was noted above this is also considered the primary juvenile rearing area. SR 410 parallels the river along this boundary, but the road's effects on floodplain confinement are minimal as the river is naturally confined for the most part (USFS 1998). Habitat conditions in the American River were described in detail in the Limiting Factors Analysis (Haring 2001). Good to excellent conditions were noted for channel condition, substrate condition, riparian condition, water quality, and water quantity. Concerning riparian condition, some degradation leading to bank erosion was noted in areas where Forest Service campgrounds (Pleasant Valley, Hells Crossing, Lodgepole) are located. Spawning and rearing habitat in the two important tributaries (Union and Kettle creeks) were not addressed in the analysis but are considered to be highly suitable by local bull trout experts.

The Naches River is believed to provide the primary FMO habitat for American River adult and subadult bull trout but it is probable that habitat in the Bumping and Little Naches rivers is also used to some extent. Habitat conditions in the Naches and Little Naches rivers were described previously (see Naches Fluvial Populations FMO Habitat Overview; Crow Creek Habitat Overview). Below Bumping Dam the river flows for over 16 miles through National Forest land and is in close proximity to the William O. Douglas Wilderness Area. Like the American River, a road parallels the Bumping for much of its length. Four Forest Service campgrounds are located along its banks as well as a numerous private residences. None of this recreational development is believed to have a significant impact on FMO habitat quality in the Bumping River.

Habitat Monitoring

The Forest Service completed habitat surveys on the American River in 1992 (22.4 miles) and again in 2001 (9.8 miles) using Hankin and Reeves protocol (USFS 2003c). The 2001 data were used in a thesis project comparing the American and Little Naches rivers (Muir 2003). Kettle Creek (1.5 miles) was surveyed in 1993 (USFS 2003c). In all of these surveys, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

In 2001, the Forest Service contracted aerial thermal infrared remote sensing surveys on the American River from the mouth to the confluence with Rainier Fork (Watershed Sciences 2002). Accuracy of temperatures was confirmed with instream sensors. The flights were completed in early September and stream temperatures ranged from 8.8-12.8 °C. Kettle Creek and Union Creek were measured at their confluences with the American River, and the temperatures were 10.1 °C and 9.7 °C respectively.

In addition, the Forest Service completed a watershed analysis of the American River system in 1998. Banish (2003) measured bull trout microhabitat and mesohabitat in 10 Eastern Washington and Oregon streams. Banish conducted day and night snorkeling in Kettle Creek; however, he pooled his data and did not report results for individual steams.

Temperature monitoring in the American River system is primarily from Forest Service thermographs deployed during the summer low flow period. One thermograph on the American River at the USGS gage was deployed in most years from 1991-2007. Other thermographs were deployed in five other locations on the American River and on associated tributaries, including Union and Kettle creeks, during the years from 1995-2007, although not consistently (USFS 2011a). Temperature data since 2007 is a monitoring gap.

Threats

With a geometric mean of <50 redds annually (see Appendix B) low abundance is identified as a moderate threat but this population is not considered a candidate for supplementation due to a stable population trend. The next highest threats to this population are those of unknown severity. Likely significant are angling, prey base, and recreation. The American River, Union Creek, and Kettle Creek spawning reaches are closed to fishing but rearing and FMO areas downstream are currently open. Illegal and/or incidental catch of bull trout can cause direct mortality of adults and reduce overall population productivity. There are dispersed and developed campsites as well as trails and trailheads along the spawning and rearing reaches on the American River and Union Creek. These may affect the bull trout population via habitat degradation and direct harassment. Introduced brook trout are present within the spawning area, but no hybrids have been documented thus far during genetic sampling.

Altered flows, development, transportation, and forest management issues are present within the population area (spawning and rearing or FMO) but are not considered significant threats. The following threats are absent: agriculture, dewatering, entrainment, grazing, limited extent of habitat, mining, and passage barriers.

Table 9. American River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low Abundance	MODERATE	Monitor	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Manage developed & dispersed campsites	MEDIUM
Introduced species	UNKNOWN	Monitor introgression	MEDIUM
Altered flows	UNKNOWN LOW	—	LOW
Transportation	UNKNOWN LOW	—	LOW
Development	LOW	—	LOW
Forest management	LOW	—	LOW

THREATS	Rating	ACTIONS	Priority
Agriculture	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Entrainment	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Passage barriers	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a "Protection" population with a priority for continuation of population monitoring but with limited restoration actions recommended. Although spawning and rearing occurs outside of the wilderness, the American River and associated spawning tributaries (Union and Kettle creeks) have generally excellent habitat. Recreation sites along the river are the source of some habitat degradation and actions to minimize and prevent riparian damage are a moderate priority. Outreach is a priority in order to document angling pressures and to educate anglers and recreationists throughout the watershed. Although restoration actions implemented in the Naches River would benefit this population, current conditions are not thought to be limiting. The Broad Scale Actions that apply to the American River population include: Restore Healthy Salmon Populations and Passage at Major Storage Dams (Bumping and Rimrock). Revitalizing salmon and steelhead runs in the Yakima Basin would significantly improve the prey base for all bull trout life stages. Providing passage at the two storage dams in the Naches subbasin would benefit the Naches River fluvial bull trout populations in general.

Completed Actions

- Approximately 2.8 miles of dispersed camp roads were closed between 2003 and 2006.
- Between Pinus Creek and Timber Creek over 27 acres of riparian/valley floor acres habitat have been protected with 6.5 acres replanted with native grass and shrubs between 2003 and 2006.
- Fish harassment issues at Forest Service stream-adjacent campgrounds (Lodgepole, Hells Crossing, and Pleasant Valley) have been addressed through public contact and interpretive signing between 2003 and 2006.
- Fishing regulations have been implemented to protect American River bull trout (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #6: Floodplain acquisition/easements along the mainstem Naches River to benefit FMO habitat quality.
- American River #1: Protect and restore stream banks by relocating and restoring campsites.
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas to monitor long-term abundance trends.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

- Forest Service to continue monitoring of restored riparian areas to ensure compliance with camping exclusions.

Research, Monitoring, and Evaluation

None recommended at this time.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Naches River Action #5: Restore lower Naches River floodplain
Naches River Action #7: Protect habitats in Naches River mainstem above Tieton River confluence
Naches River Action #9: Provide passage at Bumping Lake Dam
Naches River Action #13: Reduce dispersed recreation impacts in key tributaries

Rimrock Lake Adfluvial Populations

Rimrock Lake is the only one of the five major storage reservoirs in the Yakima Basin that was not a natural lake prior to impoundment. The reservoir holds 198,000 acre-feet of water at full pool with a surface area of 2,562 acres. Tieton Dam was constructed on the Tieton River in 1925 about 21 miles upstream of the confluence with the Naches River. The dam is a complete barrier to migration, isolating three local populations of bull trout that now reside in the lake and spawn in upstream tributaries. One of these populations spawns in Indian Creek, one spawns in the South Fork Tieton River, and the third spawns in the North Fork Tieton River above Clear Lake, which was impounded with the construction of Clear Creek Dam in 1914. All three populations use Rimrock Lake as primary FMO habitat and all undoubtedly benefit from the abundance of kokanee salmon and relatively high lake productivity. The Indian Creek and South Fork Tieton River populations are the healthiest in the Yakima Basin. The demographics of the North Fork Tieton River population are still unknown but this population is likely impacted by marginal passage at Clear Creek Dam.

In addition to blocking upstream passage, Tieton Dam entrains fish through its outlet works. Adults and subadults residing in the reservoir are entrained annually through the outlet works of the dam as Rimrock Lake is rapidly drawn down to provide for irrigation demands downstream in the late summer and early fall. Bull trout mortality as a result of entrainment has been documented. Although some survive entrainment, they are permanently displaced from the lake and their natal streams. The fate of most of these fish remains unknown. There is some evidence of entrained fish spawning with Naches River fluvial bull trout populations, but genetic distinctions between populations do not indicate a high level of gene flow.

Rimrock Lake FMO Habitat Overview

FMO habitat for the following bull trout populations is in Rimrock Lake. Shoreline development is low density, thus it is not believed to influence habitat quality; water sports activities on the surface of the reservoir are not likely an issue either given the preference of bull trout for deep water. Like all of the storage reservoirs in the Yakima Basin, Rimrock Lake is drafted heavily during the irrigation season and the reservoir pool remains depleted for much of the winter. Unlike the other impoundments, Rimrock Lake can be nearly emptied as it was in 1979 when just 30 acre-feet of water remained. The effects of extremely low carryover storage on Rimrock Lake bull trout have not been quantified but have been a concern for many years. In the midst of the 2001 drought year SOAC, WDFW, the USFWS and the Yakama Nation submitted recommendations to USBR to maintain at least 30,000 acre-feet in the reservoir based on the work of (Mongillo 1982). Although the Rimrock pool ultimately declined below this level in 2001 it has not since.

Indian Creek

Indian Creek flows into the northwest end of Rimrock Reservoir, which inundated an extensive meadow complex known as McAllister Meadows after impoundment in 1925. Before impoundment Indian Creek was a tributary of the North Fork Tieton River. It becomes one again each year when the reservoir is drawn down and the North Fork Tieton River flows across the dry bed of the reservoir, usually between late September and mid-October. Fish passage conditions at the mouth of Indian Creek can deteriorate during this time period in dry years, although bull trout access was precluded only in 2001. Indian Creek originates in the William O. Douglas Wilderness Area, and approximately five miles of the stream is accessible to bull trout below a waterfall that is a total barrier to upstream passage. The lower four miles of this reach is on the Okanogan-Wenatchee National Forest, with the upper mile in the wilderness area. Several springs contribute flow to Indian Creek in the accessible reach; other than these no perennial tributaries enter the Indian Creek below the barrier waterfall. Short reaches of the creek can experience dewatering in extremely dry years.

Population Distribution and Life History

Indian Creek supports a single local population of bull trout, which displays an adfluvial life history type. It is possible that a resident component exists although this has not been confirmed. The primary spawning area for this population extends from the U.S. Highway 12 bridge to the barrier waterfall 4.3 miles upstream although occasionally a few fish have been observed spawning a short distance below the bridge, usually within about a tenth of a mile (the distance from the bridge to the mouth of the creek is about a half mile). Between 2.0 and 2.5 miles above the bridge several springs enter the creek. Two of these in particular contribute significant flow and are utilized for spawning. Juvenile bull trout use the entire length of Indian Creek for rearing. Rimrock Lake provides FMO habitat for subadult and adult fish (Figure 11). Adult bull trout enter the creek in late August/early September just prior to commencement of spawning (James 2002a).

Population Status

The USFWS (USFWS 1998) did not consider the Indian Creek population singularly, but considered the Rimrock “subpopulation” to be stable and increasing. WDFW similarly lumps the Rimrock adfluvial populations and rates the status of this stock as healthy (WDFW 2004).

The Indian Creek population is genetically distinct from all other populations in the Yakima Basin including the other adfluvial populations residing in Rimrock Lake to which it is physically connected (South and North Fork Tieton rivers). All genetic samples that have been analyzed to date were collected from post-spawn adults captured in 1996 in a box trap deployed in the creek, although additional juvenile samples were collected in 2011. Connectivity and thus the potential for genetic exchange with downstream populations in the Naches River fluvial system was eliminated by the construction of Tieton Dam in 1925.

Population Trend

The spawning period for the Indian Creek population occurs primarily during the month of September but can extend through mid-October. Complete redd surveys have been conducted on Indian Creek since 1988 from the U.S. Highway 12 bridge upstream to the barrier waterfall, a distance of 4.3 river miles. The index area includes a spring (South Spring) contributing single-channel flow, which enters the creek on the right bank at about the half-way point of the reach and another spring (North Spring) which enters from the left bank about a little further upstream. The latter is a spring complex with multiple channels of significant length, together totaling an estimated 0.25 mile of spawning habitat. The surveyed index area covers nearly the entire length of the stream currently utilized for spawning.

The number of redds observed in Indian Creek rose steadily over the first eight years of surveys to average over 200 between 1995 and 2000 (Figure 10). At the time the Indian Creek population was considered the strongest in the Yakima Basin. In 2001, redd numbers declined to an average of 94 redds with two particularly depressed years. It is speculated that this may have been the result of the large winter flood in 1996 that scoured the primary spawning and rearing area for multiple age classes. This could have affected adult recruitment five years later. Redd counts have increased since 2009, although not quite to the level observed during the peak period. Given the pattern evident over the last 11 years it is difficult to determine a distinct trend for this population. To a great extent it appears to have recovered from the eight-year depression. Counts obtained over the next few years may confirm this trend. At this point the population can still be considered one of the healthiest in the basin.

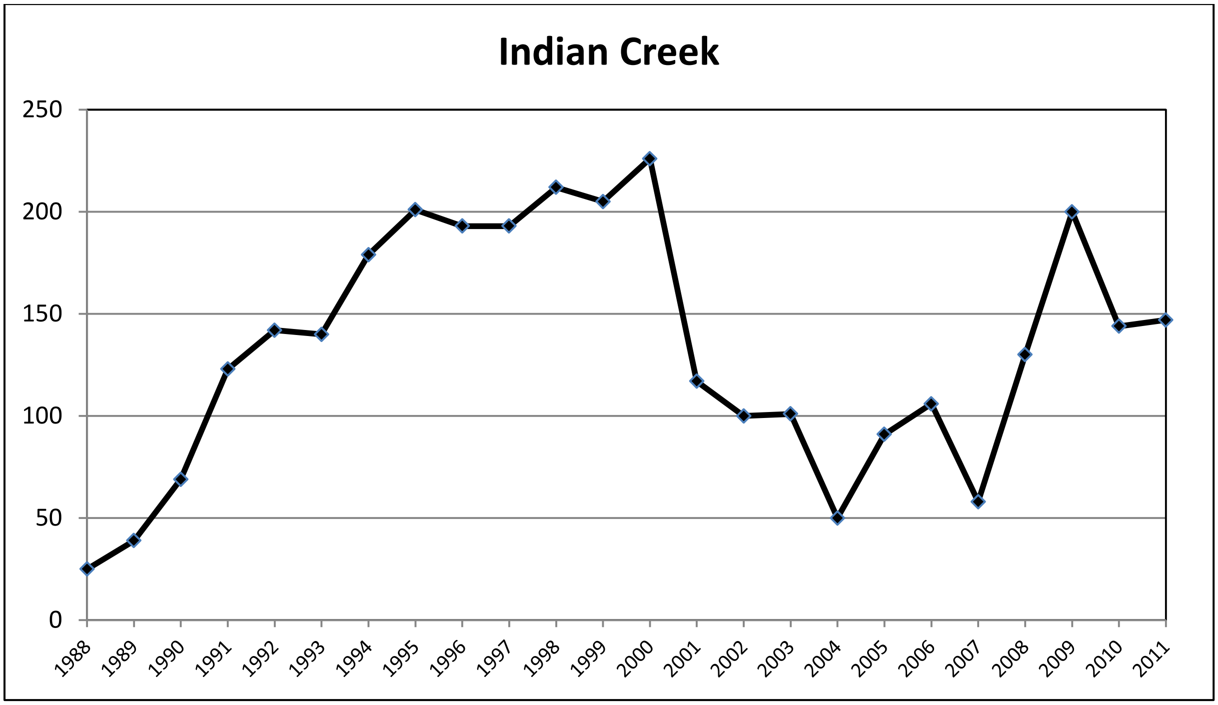


Figure 10. Bull trout redd counts in Indian Creek.

Population Monitoring

In 1982 a snorkel survey was conducted on Indian Creek and found bull trout and cutthroat trout but no brook trout (Plum Creek TImber Company 1993). Shortly thereafter in 1984, exploratory spawning surveys began with complete surveys conducted since 1988. The Indian Creek bull trout population has received considerable attention since. In 1994, when Plum Creek Timber Company returned and conducted night surveys, only bull trout and whitefish were observed (Plum Creek Timber Company 1995). In work for her CWU Master's degree, Sexauer studied life history aspects of bull trout in several Okanogan-Wenatchee National Forest streams including Indian Creek, reporting on juvenile bull trout population densities and habitat use (Sexauer 1994; James and Sexauer 1997; Sexauer and James 1997). A CWU graduate student, Brenda James studied the feeding ecology of juvenile bull trout in the stream (James 1997). Paul James (2002a) studied the population status and life history characteristics of the Indian Creek population. To determine genetic variability within bull trout populations in the Yakima River basin, Reiss (2003) analyzed genetic samples collected from post-spawn adults in Indian Creek in 1996. WDFW snorkeled and electroshocked Indian Creek in 2003 as part of a project to develop a bull trout presence/absence sampling protocol (Hoffman et al. 2005). Larsen et al. (2003) examined these data in more detail with Peterson et al. (2005) providing final analysis.

Although no brook trout were observed in the initial 1982 snorkel survey of Indian Creek the species' presence has since been confirmed by the Hoffman study cited above and by Polacek and James (2003) who reported that bull trout were the predominant species in the creek but brook trout were also present at much lower densities (along with cutthroat trout, mountain whitefish, and sculpin). It has also been confirmed that hybridization between bull and brook trout has occurred, although this confirmation comes from the analysis of just one genetic sample collected from a juvenile fish in 1998 (Small et al. 2009).

As was noted above, Rimrock Lake bull trout are entrained in the outlet works of Tieton Dam. The population-scale impact of entrainment on the Indian Creek population or either of the other two adfluvial populations residing in the lake has not been quantified. Estimates have been derived on the number of fish entrained. Three years of entrainment monitoring occurred in the early 2000s. James (2002b) estimated that the number of bull trout entrained ranged from 46–87 in 2001 and Hiebert et al. (2002; 2003) estimated the entrainment loss to be 145 bull trout in 2002 and 140 in 2003. Underwood and Cramer (2007) used data from these entrainment studies, as well as James' population data to create a life cycle model that was used to simulate effect of entrainment on long-term population dynamics.

During the 2005 construction of the Tieton hydroelectric project a fish salvage effort was conducted; 37 bull trout were captured in the stilling basin directly below Tieton Dam (Ackerman 2005). Genetic samples were collected from these fish, and 11 were assigned to the Indian Creek population (Small et al. 2009). Additional evidence of entrained bull trout surviving and migrating within the Yakima Basin comes from a single fish that was captured and sampled at Roza Dam in 2004. This fish genetically assigned to the Indian Creek population (see Genetics Baseline). Courter and Cramer subsequently reported on higher survival estimates for entrained bull trout post-construction of the hydroelectric project, with estimated mortality reduced from 85% to 45% (Courter and Vaughan 2011).

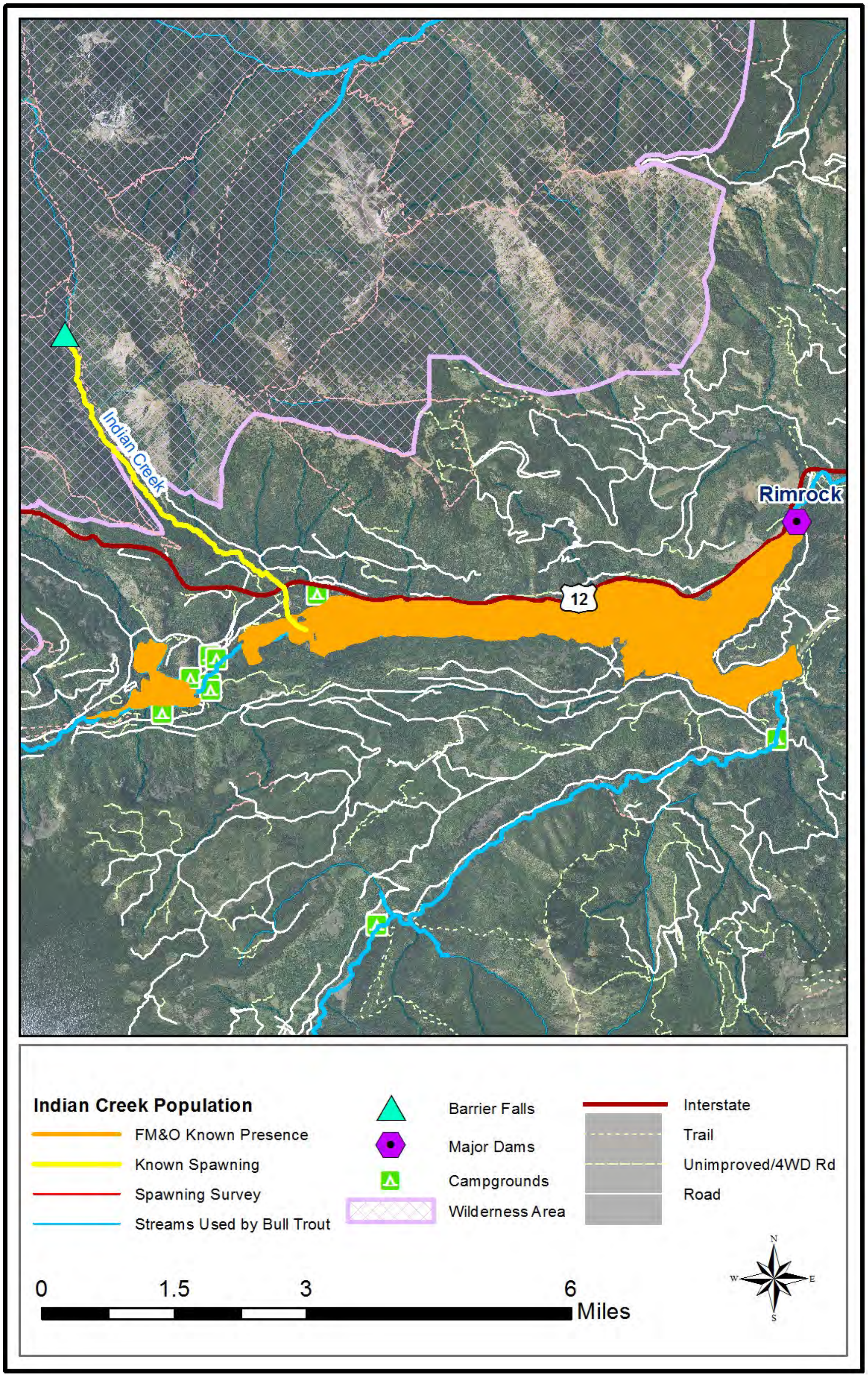


Figure 11. Indian Creek subwatershed.

Habitat

Habitat Overview

Indian Creek is a relatively high elevation stream ranging from 2,900 feet at its mouth to about 3,700 feet at the upstream end of the spawning area. As mentioned previously, the upper mile (approximate) of the reach accessible to migratory bull trout is located in the wilderness. The remainder of the creek flows through the Okanogan-Wenatchee National Forest and, with the exception of the half-mile reach extending from the US Highway 12 Bridge to Rimrock Reservoir, is also relatively undisturbed. There are several reasons for this: the lower section of the creek is paralleled by a Forest Service road (1308) for about three miles but its average distance from the stream is approximately 1,000 feet with a minimum distance of 300 feet (overall road density in the watershed is low); the most recent timber harvest in the vicinity occurred over 20 years ago and no harvesting occurred near the riparian corridor; livestock grazing has not occurred in the area to any significant degree for over a century; and residential development is non-existent. Habitat conditions in this reach were most recently reported in a 1999 stream survey report (USFS 1999). This report describes a stream with multiple channels occurring in 15% of the length surveyed (3.5 miles) having an active floodplain of variable width. The riparian corridor was healthy but often set back some distance from the active channel. Partly because of this, Indian Creek fell well below Forest Plan standards for LWD. Since the presence of LWD is closely correlated with pool formation, the creek also fell well short of the standards for pool frequency and depth. In considering these observations it should be noted that well over a mile of the creek's mainstem at the upstream end was not surveyed nor apparently were the two springs previously mentioned (see Population Distribution and Life History, Trend). The quality of spawning and rearing habitat in these areas is considered excellent by local biologists.

Habitat quality in the reach below the bridge is not nearly as good as above it and diminishes appreciably closer to the mouth of the creek. Not far below the bridge a few summer homes are located on the banks of the creek and Indian Creek Campground is situated close to the stream at the mouth. The bridge itself does not appear to restrict floodplain function, as it is located at a natural bedrock constriction of the channel. The riparian disturbance from the homes is minimal; some bank erosion occurs during snowmelt runoff in the spring. The campground does not significantly contribute to habitat degradation, but the activities of campers sometimes do. Wood, presumably for campfires, is often removed from the creek, but the larger issue is the construction of recreational dams that impede upstream fish passage. These obstructions are found and dismantled on an annual basis by biologists conducting redd surveys in September. A motorcycle race held annually in September on the dry bed of the depleted reservoir adjacent to Indian Creek is a concern. While efforts are made to avoid direct impacts on the channel the race undoubtedly disturbs the behavior of bull trout ascending the creek to spawn. A final issue of moderate concern is passage conditions at the mouth of Indian Creek in late summer. Passage for pre-spawn bull trout may be impeded when flows and the reservoir volume are low such as occurred in 2001 when remedial measures had to be taken to reestablish connectivity.

Habitat Monitoring

Mongillo (1982) measured water quality parameters and zooplankton densities for Rimrock Reservoir. Sexauer (1994) surveyed habitat use by juvenile and pre-spawning adult bull trout.

James (1997) measured and summarized habitat parameters and water temperature in Indian Creek and the North Spring of Indian Creek. The Forest Service did a stream survey on Indian Creek in 1999, using Hankin and Reeves survey protocol (Hankin and Reeves 1988; USFS 1999). In these surveys, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature. Croci (2001) and Harvester (2007) summarized temporary measures that were implemented to alleviate upstream adult bull trout passage impediments due to drought conditions, resulting low flows, low reservoir levels, and a wide, shallow steam channel.

During annual spawning surveys, the following observations have been made: low flows and split channels occasionally impede upstream migration, generally near Trail 1147 crossing at the end of the Indian Creek Road. In 2010, a high intensity rain event caused a delivery of high sediment from upland areas into the spawning and rearing area adjacent to the North Spring area of Indian Creek.

Banish (2003) measured bull trout microhabitat and mesohabitat in 10 Eastern Washington and Oregon streams. Banish conducted day- and night-time snorkeling in Indian Creek. He pooled his data, however, and did not report results for individual steams. Polacek and James (2003) studied diel microhabitat use of age-0 bull trout in Indian Creek. Microhabitat variables included water depth and velocity, distance from the stream bottom, habitat and refuge use, substrate type, and substrate embeddedness.

Indian Creek at the Highway 12 crossing was monitored for temperature via thermographs deployed during the summer low flow period in 10 out of 11 years from 1997-2007 (USFS 2011a). Other thermographs were deployed in and around the spring tributaries in 2000. Temperature data since 2007 is a monitoring gap.

Threats

Several of the highest severity threats to this population result from the presence of Tieton Dam (passage barriers, entrainment and prey base). The dam precludes gene flow with downstream Naches River fluvial populations, entrains adult and subadult fish during irrigation withdrawal, and has eliminated anadromy in Indian Creek. Other high and medium severity threats include passage barriers caused by recreational dams, illegal angling in Rimrock Lake, documented introgression with brook trout, and recreation activities, particularly the annual Rimrock Motocross event. Dewatering within the upper spawning reaches has been occasionally observed but is not believed to be a significant threat.

Forest management issues are present in the form of forest roads and potential future timber harvest but are currently not affecting habitat conditions in Indian Creek. Low abundance is identified as a potential threat due to unstable abundance trends in this population, although recent redd counts have been high. The only potential transportation issue is the U.S. Highway 12 Bridge, which is not believed to present a threat. The following threats are not present in this population area: agriculture, altered flows, development, grazing, mining, and limited extent of habitat.

Table 10. Indian Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Passage barriers	SIGNIFICANT	Passage at Tieton Dam; recreation dam removal	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Tieton Dam	MEDIUM
Introduced species	UNKNOWN SIGNIFICANT	Monitor introgression	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Outreach; re-route motocross event	MEDIUM
Dewatering	UNKNOWN LOW	—	LOW
Forest management	LOW	—	LOW
Low abundance	LOW	—	LOW
Transportation	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a "Protection" population with a priority for continuation of population monitoring but with limited immediate restoration actions recommended. Spawning and rearing habitat is excellent and fed by very cold spring water. Highest priority actions include outreach to document angling pressures and educate anglers and recreationists; annual removal of recreation dams and monitoring of passage conditions at the mouth; and rerouting of the Rimrock Motocross event. Certain threats will require additional monitoring prior to developing and implementing actions. Brook trout introgression has been documented but eradication of brook trout will be a difficult if not impossible task. Similarly, implementing carcass analog placement to address lack of marine derived nutrients will likely only happen after a successful pilot study is implemented elsewhere in the basin and the measure is deemed necessary. The reservoir contains a healthy population of reproducing kokanee salmon providing an abundant food source for Indian Creek bull trout. Passage at Tieton Dam is a Broad Scale Action that will be implemented on a different time schedule than the other actions listed above. Nonetheless passage is critical to the long-term genetic health of the population.

Completed Actions

- Fishing regulations implemented to protect bull trout in Indian Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #1: Outreach on bull trout conservation issues (cabin owners, recreationists, anglers, school groups, and others).
- Multiple Populations #1: Identify recreational dams annually and remove as necessary.
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Multiple Populations #8: Manage Tieton Dam operations to reduce entrainment.
- Indian Creek #1: Reroute annual Rimrock Motocross race to a location that directs traffic away from Indian Creek.
- Multiple Populations #9: Periodic entrainment studies at storage dams.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas to monitor long-term abundance trends.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

None

Threats Research & Monitoring

- Multiple Populations #7: Continue to screen all collected genetic samples for evidence of genetic introgression with brook trout.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

South Fork Tieton River

The South Fork Tieton River is the largest tributary of Rimrock Lake, entering the reservoir from the south at its eastern end. Prior to impoundment the South Fork joined the North Fork in McAllister Meadows to form the mainstem Tieton River. The South Fork Tieton River originates in the Goat Rocks Wilderness Area, and most of the stream is contained within the Okanogan-Wenatchee National Forest. A waterfall 14.2 miles upstream of the reservoir represents an impassable barrier for migratory fish. Numerous small tributary streams enter the South Fork Tieton River below this waterfall, including Bear, Short and Dirty, Grey, Spruce, and Corral creeks. Bear Creek, which enters the stream 1.6 mile below the barrier falls, is the largest of these.

Population Distribution and Life History

The South Fork Tieton River supports a single local population of bull trout, which displays an adfluvial life history type. It is possible that a resident component exists as well although this has not been confirmed. The known spawning area for this population is located entirely within the National Forest, extending from about RM 5.0 to the waterfall (Figure 13). It also includes Bear Creek but none of the other tributaries.

Juvenile bull trout primarily rear within the spawning area and have also been found in several of the creeks in which spawning activity has not been documented. Rimrock Lake provides FMO habitat for subadult and adult fish. It appears that adult bull trout enter the South Fork Tieton River prior to spawning earlier than other populations in the Yakima Basin. A copy of a local angler's fishing journal provided to Eric Anderson documented his catch from 1987-1994 and included bull trout caught in June. Snorkel surveys in 2000 to document spawning migration timing found adult bull trout moving into the river in late July (James 2002a).

Population Status

The USFWS (1998) did not consider the South Fork Tieton River population singularly. The agency considered the Rimrock "subpopulation" to be stable and increasing. WDFW similarly lumps the Rimrock adfluvial populations and rates the status of this stock as healthy (WDFW 2004).

Results of genetic analyses show that this population is genetically distinct from all other populations in the Yakima Basin including the other adfluvial populations residing in Rimrock Lake to which it is physically connected (Indian Creek and North Fork Tieton River). The population did cluster with the other Naches River fluvial populations, indicating some degree of gene flow (Reiss 2003; Small et al. 2009). This likely reflects a pre-dam exchange of genetic material or a more recent one-way genetic contribution from entrained fish. All genetic samples were collected from post-spawn adults captured in 1996 and 2000 in a box trap deployed in the river. Connectivity and thus the potential for genetic exchange with downstream populations in the Naches River fluvial system was eliminated by the construction of Tieton Dam in 1925.

Population Trend

The spawning period for the South Fork Tieton River population occurs primarily during the month of September but can extend through mid-October. Complete bull trout redd surveys have been conducted in an index area on the South Fork Tieton River since 1994. This index area begins at river mile 8.4 in an area locally referred to as "Blue Slide" and extends 5.8 miles upstream to the barrier waterfall. Also included in the annual survey is 0.6 mile of Bear Creek from the mouth to an impassable barrier. This creek annually hosts large numbers of spawners despite its relatively small size and limited accessible length. Many years, especially over the last decade, additional surveying has been done in a 3.5-mile reach directly below the mainstem index area with as many as 30 additional redds found. Despite these observations there are currently no plans to expand the South Fork Tieton River index area to include this reach. To do so would make population trend comparisons across all years difficult. The redd counts presented below in Figure 12 do not include redds observed in this additional reach.

Excluding 1995 (an incomplete survey year), an average of 187 redds has been counted annually. The highest counts during the period of record have been observed in three of the last four years (surveys were hampered in 2010 by high flows). The South Fork Tieton River population has been the most stable bull trout population over time in the Yakima Basin and is currently considered the strongest in terms of abundance.

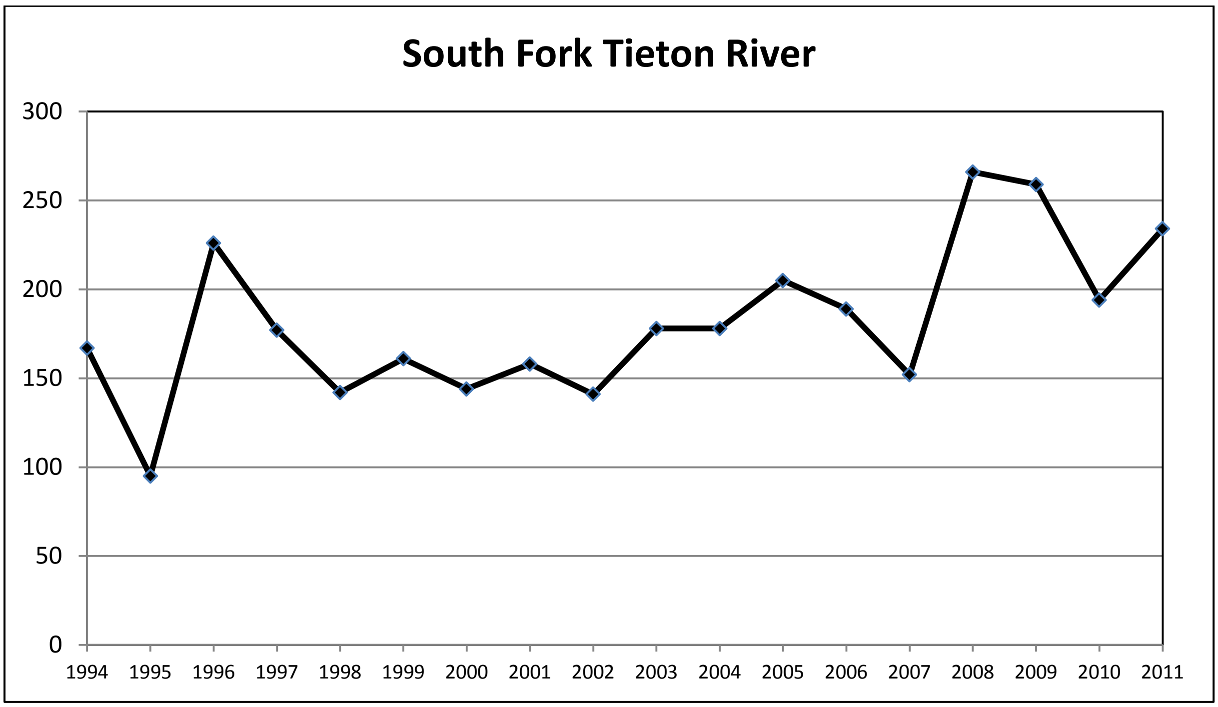


Figure 12. Bull trout redd counts in the South Fork Tieton River.

Population Monitoring

WDFW began exploratory spawning surveys in the South Fork Tieton River in 1990 with a mainstem index area established and complete surveys started in 1994. Bear Creek was included in the survey after WDFW found numerous bull trout in the lower end of Bear Creek during electroshocking surveys that same year. Short and Dirty Creek was also electrofished in 1994, and juvenile bull trout were observed (Anderson 1994). In 1993 the Forest Service captured juvenile bull trout in minnow traps in several South Fork Tieton tributaries (Milk, Bear, Spruce and Corral creeks) (USFS 1993b). Sexauer (1994) estimated juvenile bull trout population density and derived length frequencies for both juveniles and adults in the South Fork Tieton

River in 1992. The author also studied life history aspects of the species in the river and documented habitat use. James (2002a) trapped and tagged bull trout annually from 1995-2000 and conducted snorkel surveys in 1992, 1996, and 2000 while studying the population status and life history characteristics of the South Fork Tieton population. WDFW snorkeled and electroshocked Bear Creek in 2003 as part of a project to develop a bull trout presence/absence sampling protocol (Hoffman et al. 2005). Larsen et al. (2003) examined these data in more detail, and Peterson et al. (2005) provided final analysis.

The results of studies investigating the entrainment of Rimrock Lake bull trout through the outlet works of Tieton Dam were discussed previously in the Population Monitoring section for Indian Creek. Also discussed was the collection of 37 bull trout from the stilling basin directly below Tieton Dam during a fish salvage effort in 2005 and the subsequent analysis of genetic samples taken from these fish. This analysis revealed that eight of the bull trout captured in the stilling basin below the dam assigned to the South Fork Tieton River population (Small et al. 2009).

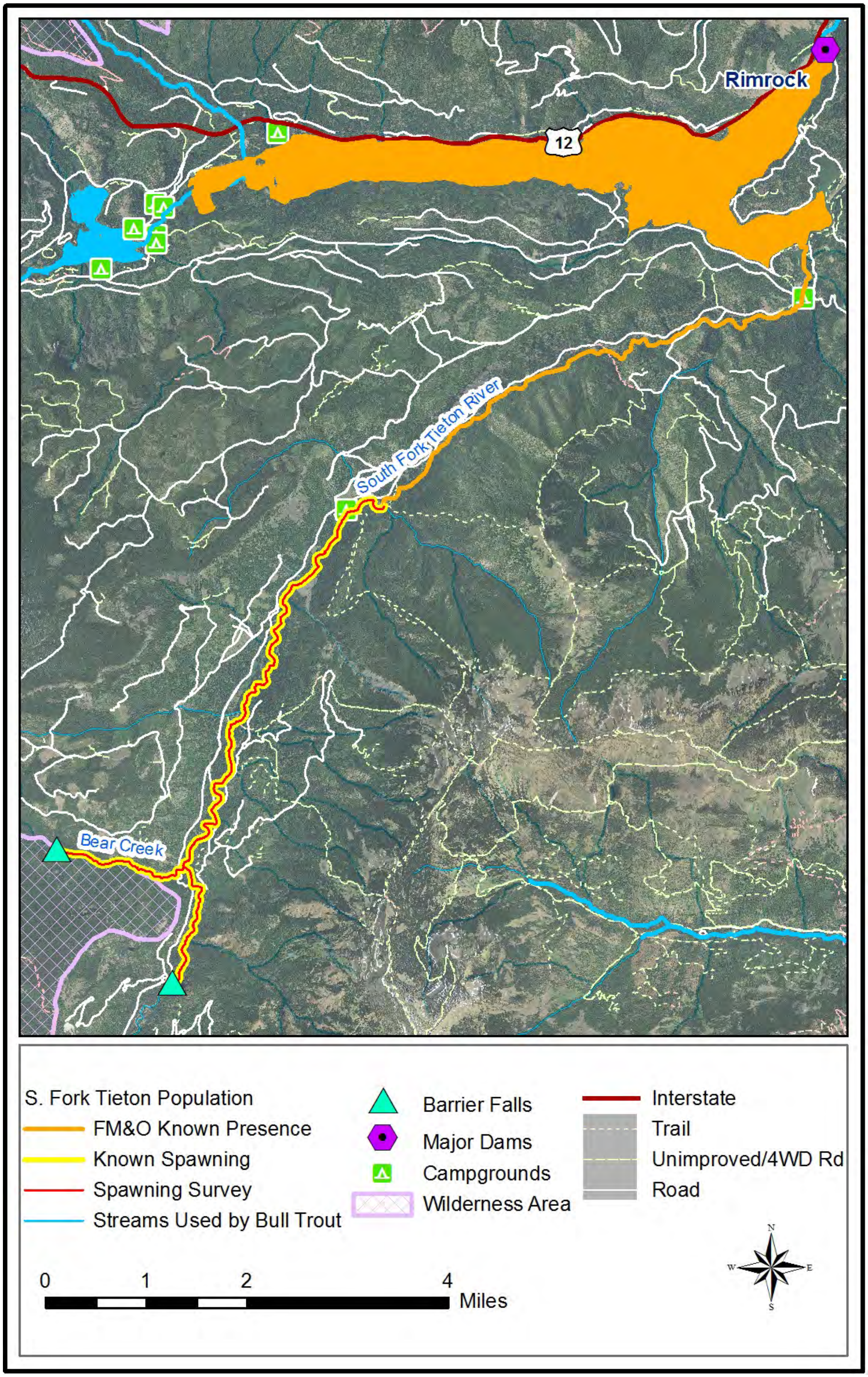


Figure 13. South Fork Tieton River subwatershed.

Habitat

Habitat Overview

South Fork Tieton River elevations range from 2,900 feet at the mouth to 3,850 feet at the base of the impassable waterfall located just over 14 miles upstream. As mentioned previously this entire reach is located in the Okanogan-Wenatchee National Forest. The primary land use activities in the watershed are recreation and livestock grazing. Bank erosion and riparian damage has occurred in areas where two established campgrounds and scattered dispersed campsites are located. These same impacts have resulted from off-road vehicle use near the stream. The Forest Service has actively addressed these issues over the last decade. Livestock grazing (and direct access to the river) has also impacted bank stability and riparian condition, most likely to a greater extent than recreation, as it has been more widespread. While significant measures have been recently implemented to address grazing impacts, they are an ongoing issue. Timber harvest has been heavy in the past but is now limited. However, the associated roads remain and road density in the watershed is relatively high. Except at crossings these roads are generally not close to the river, but a relatively high percentage of them (30%) are within high erosion hazard landforms (Haring 2001). Forest health in the South Fork Tieton watershed is a definite concern. A growing fear is that extensive beetle kill combined with high tree density could fuel a catastrophic wildfire.

Despite the impacts described above spawning and rearing habitat conditions in the South Fork Tieton River are considered very good. Channel and riparian condition, LWD, pool frequency and quality, and water temperatures all rate high (Haring 2001). The river appears to receive considerable sediment input from various sources, particularly in the area known as “Blue Slide” (RM 8.4), which is a natural landform. One potential concern derives from hydraulic conditions at the mouth of the river.

The issue is one of habitat access and was created when a bridge on Forest Service Road 1200 was constructed years ago. The natural channel of the river was relocated to flow under the bridge through a notch blasted out of bedrock. A waterfall begins to form at this location when the reservoir is drafted below 131,000 acre-feet. It is believed to become impassable for bull trout attempting to migrate upstream when the pool volume drops below 127,000 acre-feet (Thomas 2001). An informal agreement is in place with the USBR to maintain at least this minimum pool through August 10 of each year, the date Yakima basin biologists agree bull trout have likely concluded their spawning migration into the South Fork Tieton River. Under current operations heavy drafting of Rimrock Lake does not begin until early September and the reservoir has held more than 127,000 acre-feet on August 10 (average 177,155) for the 32 years since modern-day operations (i.e., flip-flop) were initiated in 1981. Previous to this at least part of the spawning migration may have been blocked from entering the South Fork Tieton; should a proposal to change current reservoir operations occur in the future it could resurface as an issue.

Habitat Monitoring

Sexauer (1994) surveyed habitat use by juvenile and pre-spawning adult bull trout. Thomas (2001) assessed the potential impact of the waterfall at the confluence with Rimrock Lake on bull trout passage. Two glaciers, Mead and Conrad, are in the headwaters of South Fork Tieton River. USGS (Josberger et al. 2007) have photographic evidence and density measurement showing that Conrad Glacier is receding. Flows may decrease as these glaciers recede.

Mongillo (1982) measured water quality parameters and zooplankton densities for Rimrock Lake. The Forest Service completed habitat surveys on the South Fork Tieton River in 1991 (15.8 miles) and again in 2000 (6.0 miles) using Hankin and Reeves protocol (USFS 2003c). Bear Creek and other associated tributaries were surveyed between 1991-1998. In all of these surveys, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

The Forest Service and the Yakama Nation Timber Fish & Wildlife Program (TFW) have worked cooperatively to maintain a long-term data set of sediment monitoring data in the South Fork Tieton River (Matthews 2011). There are three reaches that have been sampled every year from 1999 to present. This monitoring effort demonstrates an overall relatively high level of fine sediments in the substrate within the spawning reach (~12-14%), which would qualify as "functioning at risk" (USFWS 1999) and may indicate a need to address sediment sources in the drainage.

The South Fork Tieton River was monitored for temperature via thermographs deployed at three sites on the mainstem during the summer low flow period in the majority of years from 1995-2007 (USFS 2011a). Other thermographs were deployed in associated tributaries, including Bear Creek during that same time period, primarily in 1995. Temperature data since 2007 is a monitoring gap.

Threats

Similar to the Indian Creek population, several of the highest severity threats to the South Fork Tieton population result from the presence of Tieton Dam are (passage barriers, entrainment, and prey base). The dam precludes upstream gene flow from Naches River fluvial populations, entrains adult and subadult fish through the outlet works, and has eliminated anadromous fish access to the South Fork Tieton River. Other high and medium severity threats include illegal angling in Rimrock Lake, potential introgression with brook trout, recreation activities (campsites adjacent to spawning areas), extensive forest health issues (forest management), and grazing. There is a grazing allotment within the spawning and rearing area but an agreement stipulates that cattle are to be excluded during the spawning period. However, cows were observed in Bear Creek in 2011 during spawning, which may constitute a significant threat. Agriculture, altered flows, development, dewatering, limited extent of habitat, transportation, and mining are not threats present for this population.

Table 11. South Fork Tieton River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Passage barriers	SIGNIFICANT	Passage at Tieton Dam & SFT Falls	HIGH
Angling	UKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UKNOWN SIGNIFICANT	Passage at Tieton Dam	MEDIUM
Prey base	UKNOWN	Carcass analogs	MEDIUM

THREATS	Rating	ACTIONS	Priority
	SIGNIFICANT		
Recreation	UKNOWN SIGNIFICANT	Close streamside campsites	MEDIUM
Grazing	UKNOWN SIGNIFICANT	Maintain cattle exclusion	MEDIUM
Forest management	UNKNOWN	Dry Forest Restoration Strategy; address problem roads	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Low abundance	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Transportation	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a "Protection" population with a priority for continuation of population monitoring but with limited immediate restoration actions recommended. The highest priority actions involved improving passage conditions, both at a metapopulation scale (i.e., passage at Tieton Dam) and at a local population scale (i.e., relocate river to natural mouth). Other recommended actions include outreach to document angling pressures and educate anglers, closing streamside campsites along the spawning and rearing reaches, implementing Forest Service Dry Forest Restoration Strategy, addressing problem roads, and ensuring that cattle are excluded during the spawning period. Brook trout introgression should continue to be monitored as genetic samples are taken. No specific brook trout removal efforts are recommended at this time. Implementing carcass analog placement to address lack of marine derived nutrients will likely only happen after a successful pilot study is implemented elsewhere in the basin, and the measure is deemed necessary. The reservoir contains a healthy population of reproducing kokanee salmon providing an abundant food source for South Fork Tieton River bull trout.

Completed Actions

- Tieton Allotment Management Plan (USFS 2006c) changed regulations to not allow grazing after August 15 in pastures adjacent to the South Fork Tieton River.
- As of 2010 the number of permitted livestock was reduced (prior to August 15) from 398 cow/calf pairs to 248 cow/calf pairs.
- Fencing (300 feet total) was constructed along South Fork Tieton River in 2002 and 2003 at a dispersed campsite and at Minnie Meadows Campground, protecting four acres of riparian habitat.
- Fencing (600 feet) was constructed in 2009 along lower Corral Creek protecting two acres of riparian habitat and eliminating motorized access.
- A Forest Service watershed restoration project in 2010 decommissioned 1.1 miles of system roads, decommissioned 0.3 miles of unauthorized jeep road, removed 4 impassible stream culverts on minor tributaries of South Fork Tieton River, and closed 2 jeep trail fords in bull trout spawning habitat (lower Spruce Creek and South Fork Tieton River at Grey Creek Campground).
- Fishing regulations have been implemented to protect bull trout in South Fork Tieton River (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- South Fork Tieton River #1: Limit access to camping areas (dispersed and developed) immediately adjacent to bull trout holding/spawning areas when adult bull trout are present.
- South Fork Tieton River #2: Address problem roads.
- South Fork Tieton River #3: Implement Dry Forest Restoration Strategy
- South Fork Tieton River #4: Relocate river channel at current mouth to eliminate bull trout migration problems associated with the waterfall that forms as lake levels drop.
- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Multiple Populations #8: Manage Rimrock Dam operations to reduce entrainment.
- Multiple Populations #9: Periodic entrainment studies at storage dams.

Population Monitoring

- Multiple Populations #2: Continue annual spawning surveys in established index areas.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

- South Fork Tieton River #5: Monitor compliance of cattle exclusions and timing restrictions during spawning period.

Threats Research & Monitoring

None at this time

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

North Fork Tieton River

The North Fork Tieton River flows into Rimrock Lake at its western end. The river originates in the Goat Rocks Wilderness Area and flows for an undetermined distance before entering Clear Lake, a small (5500 acre-foot) impoundment formed when Clear Creek Dam was constructed in 1914. A waterfall exists about nine miles upstream of Clear Lake representing an impassable barrier for migratory fish. The wilderness boundary is approximately four miles below this waterfall with the remaining length of the river located in the Okanogan-Wenatchee National Forest. Several small tributary streams enter the North Fork Tieton River above Clear Lake, the largest being Scatter Creek. Clear Creek, once the most significant tributary of the North Fork Tieton River, now flows into Clear Lake from the west. Below Clear Creek Dam, the North Fork Tieton River flows for about 0.7 mile before entering Rimrock Lake.

Population Distribution and Life History

The North Fork Tieton River population was recently "discovered" although catch records from the 1950s documented the presence of adult bull trout (referred to at the time as Dolly Varden) in Clear Lake and biologists from CWU found a single adult bull trout above the lake in 1996 (Craig 1996). However, there was no clear indication that a spawning population inhabited the North Fork Tieton River until 2004. During the fall of that year a fish census was conducted in the river that documented the presence of 14 bull trout including seven juveniles (<199 mm TL), five that were considered subadults (200-299 mm TL), and two large (>500 mm TL) adults (USFWS 2004). In addition spawning activity was confirmed with the discovery of a single redd and a couple of large adults observed about 0.6 mile below the waterfall. As a result of the data collected and observations made in 2004, a local population of bull trout was officially recognized in the North Fork Tieton River. This population appears to be adfluvial, based on the large size of the fish. A resident component may exist, but this has not been confirmed.

Although data are limited it appears that all spawning activity occurs above the wilderness boundary located about five miles upstream of Clear Lake with most of that occurring in the reach extending from the waterfall downstream for approximately two miles (Figure 14). Over the last four years bull trout have also been observed spawning in a very small, unnamed tributary which enters the river from the west in this two-mile reach. Juvenile rearing likely occurs throughout the reach above Clear Lake, but all juvenile observations to date have been above the wilderness boundary.

At this time it is assumed that the primary FMO habitat for adults and subadults is Rimrock Lake (see discussion under Population Monitoring). It is possible, perhaps probable, that these life stages utilize FMO habitat in Clear Lake for some limited period of time, but is considered unlikely that they remain there over the winter. Timing of migration into the North Fork Tieton River for spawning is unknown but will be addressed in a multi-year study beginning in 2012. Passage conditions at Clear Creek Dam will also be comprehensively evaluated. This dam was originally constructed without fish ladders. In 1992, the USBR constructed two ladders in the steep bedrock spillway channel adjacent to the dam; the upper ladder is a pool and weir that appears to be functional but the lower one (a denil ladder) was poorly engineered and has persistent problems with bedload accumulation. Without the benefit of an effective ladder, passage conditions up the channel for bull trout are rigorous at best and most likely impossible at higher flows. The data acquired during this study will be critical to determine the extent to which passage conditions at Clear Creek Dam are impeding successful migration and what can be done to alleviate the problem.

Population Status

Due to its very recent recognition the status of this population has not been rated by either the WDFW or the USFWS. Based on redd counts to date, it appears to be depressed.

Six genetic samples were collected from bull trout juveniles during the 2004 study (USFWS 2004). Efforts to collect additional samples were constrained by turbidity issues until 2010 when enough genetic samples (30+) were collected to analyze the uniqueness of this population. Results indicate that this population is genetically distinct from all other populations in the Yakima Basin including the other adfluvial populations residing in Rimrock Lake (Indian Creek and South Fork Tieton River) to which it is physically connected (Small and Martinez 2011). Of the genetic samples analyzed to date, three have been identified as brook trout x bull trout hybrids. Connectivity and thus the potential for genetic exchange with downstream populations in the Naches River fluvial system was eliminated by the construction of Tieton Dam in 1925.

Population Trend

The spawning period for the North Fork Tieton River population occurs primarily during the month of September but can extend through mid-October. Problems have been encountered in attempting to annually conduct complete redd surveys in the North Fork Tieton River. The river is glacial-fed and is usually milky with glacial flower until late in the summer. Its hydrology is “flashy” and river discharge quickly changes from stable and clear to high and turbid after fall rains or high daytime temperatures, both of which are common during the bull trout spawning period. This results not only in difficult survey conditions but also in conditions in which redds become undetectable if an event occurs before or between surveys. Although the first redd was observed in the North Fork in 2004, a complete survey was not accomplished until 2007 for the reasons just described. The surveys conducted in 2009 and 2010 were incomplete.

Surveys are conducted in an index reach approximately 2.3 miles in length, which ends at the barrier waterfall. Included in this index area since 2008 is a small, unnamed tributary—its mouth is barely detectable from the main channel—that has contained a surprising number of bull trout redds. For logistical reasons (i.e., access and hydrologic timing), just two survey passes are attempted annually. During the first year of redd surveys 37 redds were observed and the unnamed tributary was not included. The count was 28 redds in 2008 and included 5 redds found in the tributary. As mentioned above, the surveys in the two subsequent years were not complete and thus counts were lower with 15 and 18 redds observed in 2009 and 2010, respectively. Favorable survey conditions prevailed in 2011 however and just 11 redds were counted. With these limited data it is difficult to determine a trend for this population.

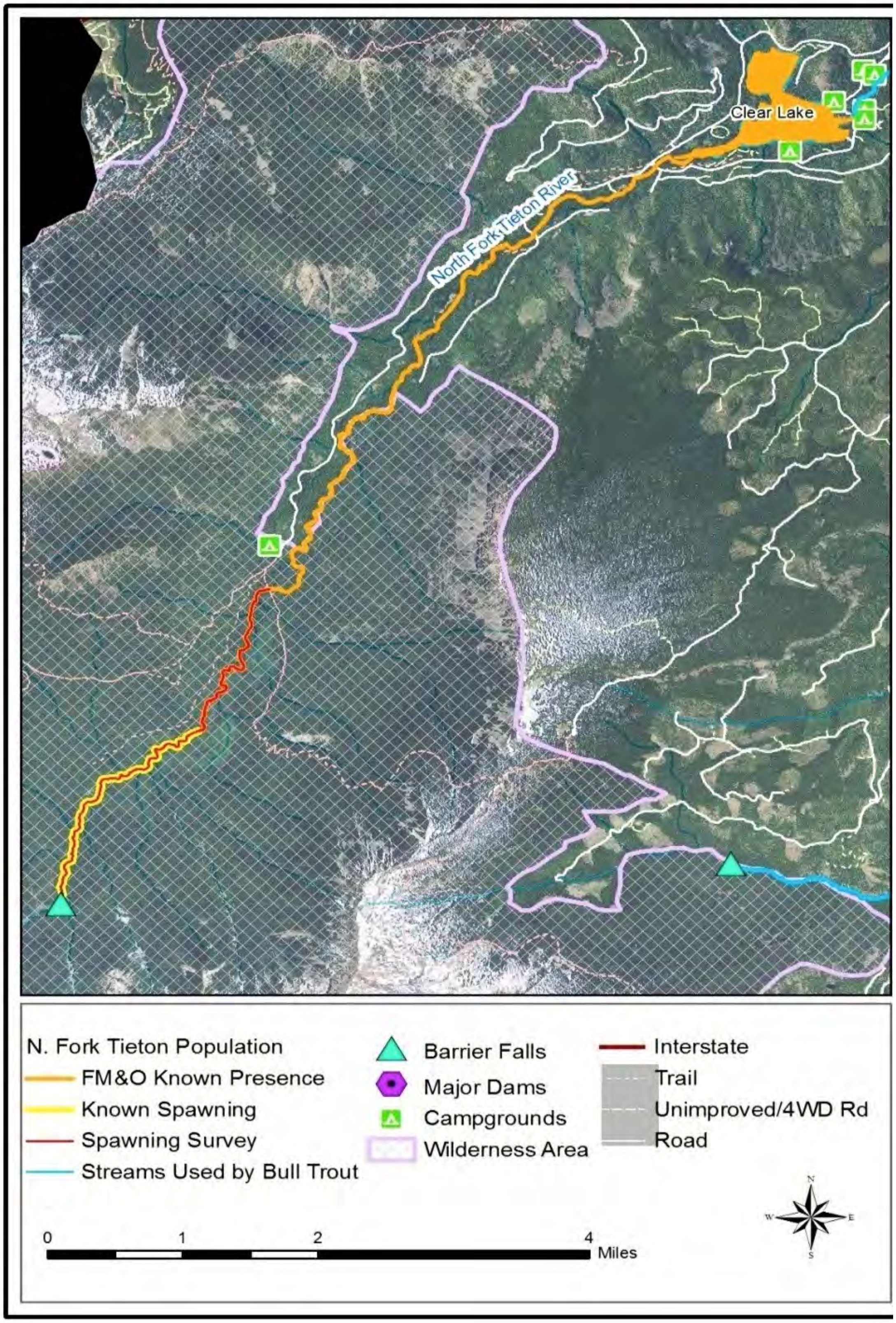


Figure 14. North Fork Tieton River subwatershed.

Population Monitoring

The monitoring history for the North Fork Tieton River population is fairly recent. In 1993, the Forest Service captured a juvenile bull trout in a minnow trap on the margins of Clear Lake (USFS 1993b). The first organized investigation of bull trout in the North Fork Tieton River appears to have occurred in 1994 when Central Washington University coordinated with WDFW to monitor the effectiveness of the fish ladders constructed in the spillway channel of Clear Creek Dam two years previous. No bull trout were observed in the ladders but nine adult bull trout were captured and tagged below the base of the dam. It is assumed that these fish were attempting to find a migration route upstream and would thus have belonged to the North Fork Tieton River population. Two years later an adult bull trout was observed in the North Fork Tieton River about six miles above Clear Lake during a snorkel survey (Craig 1996). Presence of a spawning population existed in the North Fork Tieton River was confirmed in a 2004 fish census survey conducted cooperatively by the USFWS and the Forest Service (USFWS 2004). The details of this monitoring effort were discussed above in the Population Distribution and Life History section.

WDFW radio-tracked five adult bull trout captured and tagged in the North Fork Tieton River below Clear Creek Dam in July 2005. These fish all migrated downstream to Rimrock Lake by late fall to overwinter and returned to the area near the mouth of the North Fork by early June the next year. Only one eventually entered the river and did not attempt to ascend the ladders in the spillway channel (Mizell and Anderson 2008). However, one fish that was collected below Clear Creek Dam in 2005 did genetically assign to the North Fork Tieton River population (Small and Martinez 2011). Apparently the reach below the dam is used by all Rimrock Lake populations, not just North Fork Tieton River adults intending to migrate above the dam to spawn.

As with the other two Rimrock Lake populations, North Fork Tieton River bull trout are subject to entrainment through the outlet works of Tieton Dam. The results of studies investigating the entrainment of Rimrock Lake bull trout through the outlet works of Tieton Dam were discussed previously in the Population Monitoring section for Indian Creek. Also discussed was the collection of 37 bull trout from the stilling basin directly below Tieton Dam during a fish salvage effort in 2005 and the subsequent analysis of genetic samples taken from those fish. This analysis revealed that two of the bull trout captured in the stilling basin below the dam assigned to the North Fork Tieton River population (Small et al. 2009). This provides further evidence that the North Fork Tieton River population uses Rimrock Lake as FMO habitat.

In 2010, snorkel surveys coordinated by the USFWS were successful in collecting enough genetic samples from juvenile bull trout to supplement those collected previously and enable an analysis of the genetic uniqueness of the North Fork Tieton River bull trout population (Small and Martinez 2011).

In 2011, the Bull Trout Task Force conducted creel surveys in Clear Lake during the summer months. Fifty five anglers were interviewed and no bull trout were caught by any of these anglers (WDFW 2011). Previous creel surveys and observations by WDFW biologists during annual fishing derbies support this evidence that bull trout are not commonly caught in Clear Lake, despite heavy fishing pressure throughout the summer season (E. Anderson, WDFW, pers comm).

Habitat

Habitat Overview

The North Fork Tieton River is one of the higher elevation streams inhabited by bull trout in the Yakima Basin. Elevations range from 3,000 feet where it enters Clear Lake to about 4,000 feet at the impassable waterfall located just over nine miles upstream. As mentioned previously, approximately four miles of the river is in the Goat Rocks Wilderness with the lower five miles flowing through the Okanogan-Wenatchee National Forest. A Forest Service road (1207) parallels the river for these five miles but is rarely close to it with thick forest separating the two. The main human activity in the watershed is recreation—primarily hiking and horseback riding on trails that are not directly on the river. There are no established campgrounds; dispersed campsites are limited and generally not in close proximity to the riverbanks. Timber harvest occurred in the past but well upslope of the river. The area is now designated as Late Successional Reserve and will receive very little future harvest. Road density in the drainage is low, and livestock grazing does not occur. In short, the North Fork Tieton River is undisturbed above the wilderness boundary and for the most part below it as well. The floodplain is connected and properly functioning, the riparian corridor is healthy, LWD is plentiful, and water quality is excellent (USFS 1998a). Pool frequency did not meet Forest Plan standards but it was noted that the evaluation was limited to full channel pools and that smaller pools (not evaluated) were prevalent in riffle habitat. The North Fork Tieton River is a relatively sediment-rich river. This is likely due to the fact that it received a great deal of fine volcanic material during the 1980 eruption of Mount St. Helens and because its waters are of glacial origin. Much less fine sediment is present in the upstream reaches, which may explain why all of the spawning activity and juvenile fish observed to date have occurred above the wilderness boundary.

Habitat Monitoring

A number of documents explore preliminary designs and options for fish passage facilities at Clear Creek Dam (WDFW 2003; WDFW 2007; USBR 2008b). Fish passage is considered potentially problematic for bull trout during the presumed spawning migration period (July-September).

The Forest Service completed a habitat survey using Hankin and Reeves protocol on the North Fork Tieton River (Hankin and Reeves 1988; USFS 1998a). In this survey, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

The North Fork Tieton River was monitored for temperature via thermographs deployed at the FS 1200 road crossing during the summer low flow period in 7 out of 11 years from 1997-2007 (USFS 2011a). A thermograph was also deployed at the confluence of Scatter Creek in 1997. Temperature data since 2007 is a monitoring gap.

Threats

The highest severity threats to the North Fork Tieton River population are associated with passage issues both at Tieton Dam, which is complete passage barrier, and at Clear Creek Dam, which appears to be problematic for passage under certain conditions. Also resulting from lack of passage at Tieton Dam are the threats of entrainment and lack of prey base. Other threats to this population include illegal angling in Rimrock Lake and possibly Clear Lake, and introgression with brook trout. Low abundance and unstable redd numbers are possibly the result of passage problems at Clear Creek Dam.

While forest management and recreation issues—both dispersed and managed forest roads and campsites—are present in the North Fork Tieton River population area, they are not believed to be significant threats. Agriculture, altered flows, development, dewatering, grazing, limited extent of habitat, transportation issues, and mining are not present in this population area.

Table 11. North Fork Tieton River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Passage barriers	SIGNIFICANT	Passage at Clear Creek and Tieton dams	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Clear Creek and Tieton dams	MEDIUM
Introduced species	UNKNOWN SIGNIFICANT	Monitor brook trout introgression	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Low abundance	UNKNOWN	Monitor; improve passage at Clear Creek Dam	MEDIUM
Forest management	LOW	—	LOW
Recreation	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Transportation	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a high priority "Action" population. The highest priority actions are the broad-scale action of Passage at Tieton Dam and the immediate population-scale action of improving passage at Clear Creek Dam. Adults from this population appear to use Rimrock Lake for FMO habitat and are targeted by anglers. Continued outreach to educate anglers is a priority. Brook trout introgression has been documented in this population and should continue to be monitored, although no brook trout removal efforts are recommended at this time. Implementing carcass analog placement to address lack of marine derived nutrients will likely only happen after a successful pilot study is implemented elsewhere in the basin and deemed necessary. Rimrock Lake contains a healthy population of reproducing kokanee salmon while Clear Lake is heavily planted with rainbow trout. Both provide an abundant food source for North Fork Tieton River bull trout.

Completed Actions

- Fish ladders were installed in the spillway channel in 1992. Only one of these, the pool and weir at the upper end, is functional at all flows. The denil ladder at the lower end is poorly designed and does not function to pass bull trout.
- Fishing regulations were implemented to protect bull trout in North Fork Tieton River (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- North Fork Tieton River #1: Evaluate passage at Clear Creek Dam and implement subsequent action to ensure effective adult bull trout passage.
- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Multiple Populations #8: Manage Tieton Dam operations to reduce entrainment.
- Multiple Populations #9: Periodic entrainment studies at storage dams.

Population Monitoring

- Multiple Populations #2: Continue annual spawning surveys to monitor trends in population abundance.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

None at this time

Threats Research & Monitoring

- Multiple Populations #7: Current genetic samples indicate that this population may have a high level of introgression with brook trout. Continue to monitor, targeting fish that show phenotypic hybrid characteristics.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

Bumping Lake Adfluvial Population

Bumping Dam was constructed on the Bumping River in 1910 about 16.5 miles above its confluence with the Little Naches River. The dam was constructed on the outlet to a natural lake and formed a reservoir holding 33,700 acre-feet of water with a surface area of 1,303 acres at full pool. The dam was constructed without fish passage facilities and is a complete barrier to migration, isolating fish residing above it. Under certain infrequent operating conditions, strong swimmers may be able to return to the lake from downstream through the outlet gates. A single adfluvial population of bull trout resides in Bumping Lake, spawning and rearing in Deep Creek. The upper Bumping River is the other major tributary to the lake. Limited bull trout spawning and rearing have been observed in the approximate one-mile reach of this stream accessible below a barrier waterfall (the stream is extensively braided approximately doubling the length of its accessible habitat). As a result of these observations, a Bumping River local population was designated during the 2008 USFWS Status Review. However, because subsequent genetic analysis of juveniles collected in the upper Bumping River showed them to be indistinct from Deep Creek bull trout, this designation will be dropped. The upper Bumping River will continue to be considered important rearing and FMO habitat.

Bumping Dam represents another potential threat aside from the passage issue. Some adults and/or subadults residing in the reservoir are probably entrained annually through the outlet works of the dam, although data are not available to confirm this. While bull trout mortality as a result of entrainment would be less likely due to the dam's low elevation, entrained bull trout would likely be permanently displaced.

Deep Creek

Deep Creek is the larger of two main tributaries to Bumping Lake. Deep Creek originates in the William O. Douglas Wilderness Area and the reach accessible to migratory fish is entirely within the Okanogan-Wenatchee National Forest. A waterfall that is a complete barrier to upstream migration exists approximately 5.6 miles above the lake. It is not uncommon even in years that are just moderately dry for the creek to experience severely diminished flows and/or complete dewatering in some reaches. The only significant tributary in the reach below the barrier waterfall is Copper Creek, which enters at about the halfway point (RM 2.9)

Population Distribution and Life History

Deep Creek supports a single local population of bull trout, which displays an adfluvial life history type. It is possible, although unconfirmed, that a resident component exists as well. The spawning and rearing area for the population extends from the mouth to the waterfall with some limited spawning also taking place in the lower portion (~0.25 mile) of Copper Creek. (A bedrock cascade directly above this point is believed to be impassable.) Bumping Lake and the upper Bumping River provide FMO habitat for subadult and adult fish (Figure 16). Adult bull trout generally enter Deep Creek in late July to mid-August.

As mentioned above, Deep Creek adults occasionally stray into the upper Bumping River to spawn. A few bull trout redds have been observed in the upper Bumping over the years and juveniles have been observed during snorkel surveys. Genetic samples analyzed from 30+ juveniles collected in 2002 and 2010 revealed that these fish were not genetically distinct from Deep Creek bull trout. These data support the hypothesis that adults spawning in the upper

Bumping River are strays from Deep Creek and indicate that the stream does not support a separate, genetically distinct population.

Population Status

The USFWS (1998) considered the Deep Creek population to be depressed, decreasing, and at risk of stochastic extirpation. The WDFW rates the status of this stock as depressed (WDFW 2004). Both of these ratings warrant reconsideration (see Population Trend below).

Results of genetic analyses show this population is genetically distinct from all other populations in the Yakima Basin (Reiss 2003; Small et al. 2009). Genetic samples for the baseline were collected from post-spawn adults during a tagging study begun in 1997 (James 2002a). Interestingly, this population had a lower level of genetic diversity than would be expected based on abundance estimates. It may have experienced a genetic bottleneck when rotenone was applied to Bumping Lake in 1950 to eliminate suckers (*Catostomus spp.*) and Northern pikeminnow (WDFW 1991). Connectivity and thus the potential for genetic exchange with downstream populations in the Naches River fluvial system was eliminated by the construction of Bumping Dam in 1910.

Population Trend

The spawning period for the Deep Creek population begins earlier than any other local population in the Yakima Basin. Spawning begins in late August is usually completed by mid-September. Complete bull trout redd surveys have been conducted on Deep Creek since 1991. These surveys cover the entire length of the mainstem spawning area (see above) and approximately the lower quarter-mile of Copper Creek.

Redd counts over the period of record have been highly variable. Yet there has been a steadily increasing trend over the last five years (Figure 15). Through 2006 (16 years) an average of 84 redds were observed in Deep Creek; since that time the average has more than doubled to 169 with over 190 redds observed in 2010 and 2011. At this time it is one of the strongest in the Yakima Basin.

Another extrapolation from the data is the effect dry years, and thus the occurrence of reach dewatering, have on this population’s reproductive success. The effect is evident in the redd counts obtained during particularly dry years (e.g., 1993, 1994, 1996, 2001, 2003, and 2005) when the number of redds observed ranged from 12 to 73. In contrast, the last five years have been good-to-excellent water years in the Yakima Basin.

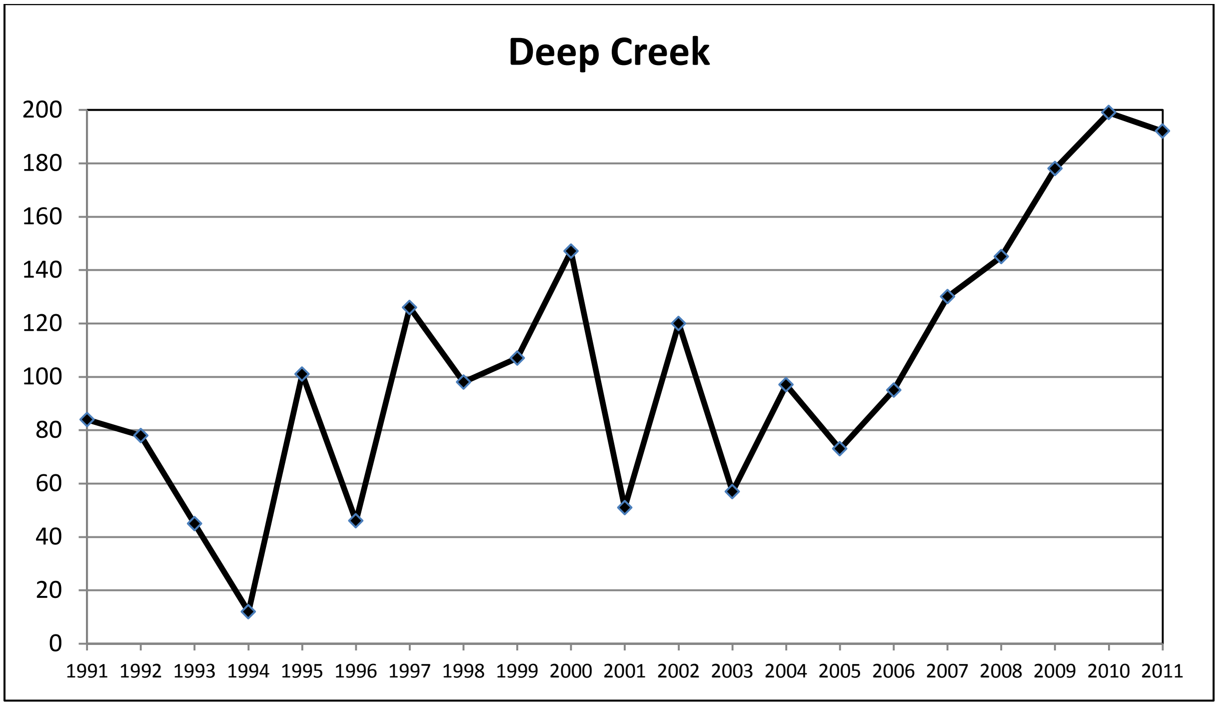


Figure 15. Bull trout redd counts in Deep Creek.

Population Monitoring

After the 1950 rotenone application Dolly Varden (i.e., bull trout) began to show up in WDFW creel surveys in 1953 and continued to do so until legal angling for the species was prohibited in the 1990s (WDFW file data). The first official monitoring of Bumping Lake's fish assemblage appears to have been done by Mongillo and Faulconer (1982) who gillnetted the lake and captured five bull trout. A number of other salmonid species were also captured including brook trout, which continue to maintain a presence in the stream. Exploratory spawning surveys were begun in Deep Creek in 1989 with complete surveys conducted annually since 1991.

The first Deep Creek genetic samples were collected from juvenile bull trout in 1997 with the subsequent analysis reported by Reiss (2003). James (2002a) trapped and tagged adult bull trout in Deep Creek from 1997 through 2000 while studying the population status and life history characteristics of the population. In 2000, snorkel surveys were conducted in the creek to determine the migration timing of pre-spawn adults. WDFW snorkeled and electroshocked Deep Creek in 2003 as part of a project to develop a bull trout presence/absence sampling protocol (Hoffman et al. 2005). Larsen et al. (2003) examined these data in more detail with Peterson et al. (2005) providing final analysis.

Seventeen post-spawn bull trout were captured in 2005 and implanted with radio tags to track their movements after they returned to Bumping Lake (Mizell and Anderson 2008). Included in these were five implanted with archival tags to monitor preferred water temperatures and depths, but only two of these tags were recovered. All 17 of the tagged bull trout remained in Bumping Lake, which was of interest because, as is the case for the other storage dams in the Yakima Basin, the outlet works of Bumping Dam are unscreened.

The upper Bumping River has also received monitoring attention. Beginning in 1999, sporadic snorkel surveys have been conducted in the stream. No bull trout were observed by Craig (Craig 1999). Subsequent snorkel surveys (2002, 2003, and 2010) documented the presence of bull trout juveniles although not in large numbers (Reiss 2011). Exploratory spawning surveys, also sporadic, have resulted in one bull trout redd observed in 1994 and two in 2009 (Reiss 2011). In six other years none were found and none of the fish tracked by Mizell and Anderson (2008) entered the upper Bumping River.

It is possible for Deep Creek bull trout to become displaced downstream if entrained through the unscreened outlet works of Bumping Dam. About a half-mile of the Bumping River below the dam was snorkeled in 2001 and six bull trout, all greater than 12 inches in total length, were observed (Kalin and Ackerman 2002). However, none of these fish were confirmed to have originated in Bumping Lake.

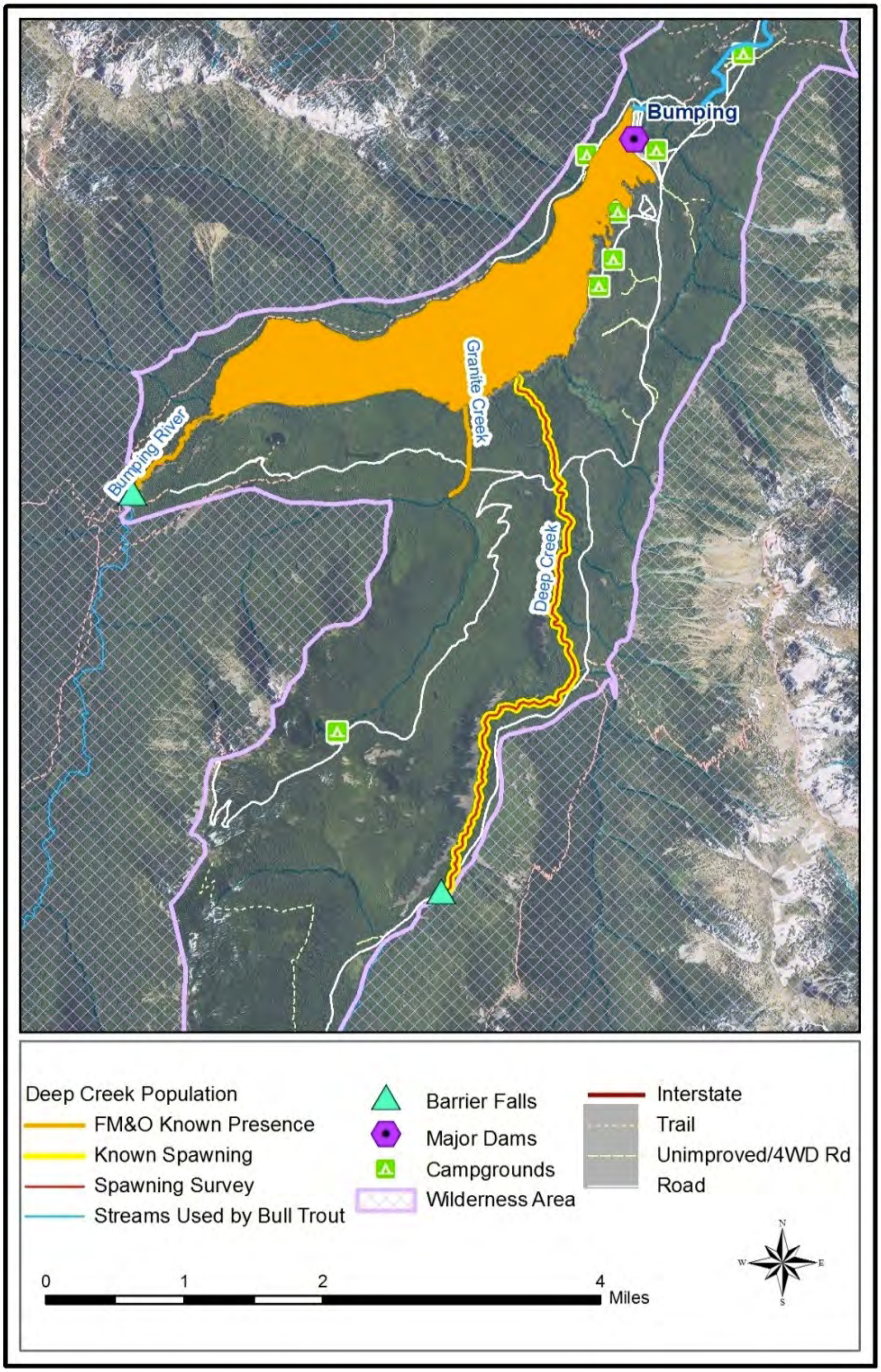


Figure 16. Deep Creek subwatershed.

Habitat

Habitat Overview

Deep Creek ranges in elevation from 3,435 feet at its mouth to 3,840 feet at the barrier waterfall. This reach is entirely within the National Forest with the primary land use being recreation, mostly hiking and horseback riding. There are numerous dispersed campsites in the drainage. These are close to the two roads in the watershed but only a couple of them are close to the creek's banks; most are located on elevated terraces well away from the channel. One of the two roads (FS 1800) is not near Deep Creek until it crosses it about a mile above Bumping Lake. A new bridge was constructed in 2011 to replace two perched culverts that were a barrier to juvenile fish passage under certain flow conditions. There were also habitat impacts from dispersed camping at this site. The passage problem has been remedied; it remains to be seen if the camping impact resurfaces but for the time being the area has been restored. The other road (FS 1808) runs adjacent but not in close proximity to Deep Creek for several miles. This road used to cross the stream over a problematic undersized culvert about a half-mile below the upstream barrier before a flood in 2006 washed it out. A new bridge was constructed at this site in 2011 and the road continues on the other side of the creek. Overall, habitat conditions in Deep Creek are good to excellent for all rating parameters. There is abundant LWD, a low percentage of fine sediments, abundant spawning gravels, a healthy riparian corridor, and excellent water quality (USFS 2006a). Although technically Deep Creek did not meet Forest Plan standards for pool frequency, the percentage of the stream classified as pool habitat was large (44%) so this standard is somewhat deceiving.

Undoubtedly the most significant habitat issue in Deep Creek is the dewatering mentioned in the paragraph introducing this population. Between the FS 1800 bridge (RM 0.9) and the Copper Creek confluence (RM 2.6), it is not uncommon, even in years that are just moderately dry, for a portion of Deep Creek to experience severely diminished flows and/or complete dewatering during the late summer. The dewatering is typically first observed about a half-mile above the bridge and can extend as much as a half-mile upstream, often continuous. This is a low-energy reach with a broad floodplain to the east. The west side of the valley is controlled by a steep talus slope preventing the lateral movement of the stream and contributing loose unarmored substrate. Subsurface flow appears to move laterally to the east; just downstream of the area an extensive side-channel complex occurs in thick forest. This complex is heavily utilized by spawning bull trout.

FMO habitat for the Deep Creek bull trout population is in Bumping Lake. Neither the sparse shoreline development or water sports activities on the lake are believed to influence habitat quality. Bumping Lake is the smallest storage reservoir in the Yakima Basin and does experience extreme drawdown in the summer (avg. 80%). A 14,000 acre-foot conservation pool (i.e., dead storage), however, cannot be accessed. As a result, Bumping Lake reservoir, which has the highest refill ratio in the basin, recovers quickly when irrigation releases cease. The effects of reservoir depletion on FMO habitat quality and quantity are unknown but not believed to be significant.

Habitat Monitoring

Flooding in 2006 damaged Forest Service Roads 1800 and 1808 where Deep Creek flowed through culverts. Both culverts were considered impediments to upstream passage of juvenile fish at some flows although adults passed upstream through both culverts. A number of documents and emails have been written regarding the replacement/repair of these culverts and roads (Gonzales 2007; Krupka 2007; McCoy 2008). Both culverts were replaced with bridges in 2011.

Banish (2003) measured bull trout microhabitat and mesohabitat in 10 Eastern Washington and Oregon streams. He conducted day and night snorkeling in Copper Creek, a tributary of Deep Creek. He pooled his data, however, and did not report results for individual steams.

USBR examined Bumping Lake limnology from 1998-2001, and data are reported in Ackerman et al (2002). Lieberman and Grabowski (2007) conducted limnological studies in Bumping Reservoir from 2003-2005. They concluded that zooplankton densities may limit the lake’s capacity to support resident fish as well as introduced salmonids and suggested the nutrient enrichment may be one method to increase both algal and zooplankton production.

The Forest Service completed habitat surveys on Deep Creek in 1993 (4.9 miles) and again in 2005 using Hankin and Reeves protocol (Hankin and Reeves 1988; USFS 2006a). The upper Bumping River was surveyed in 1994-95 (9.5 miles) and 2003 (10.0 miles) (USFS 2003a). In all of these surveys, data was collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

Deep Creek at the 1800 Road crossing was monitored for temperature via thermographs deployed during the summer low flow period in 9 out of 10 years from 1996-2005 (USFS 2011a). A thermograph was deployed on the upper Bumping River in 1996 and again from 2000-2004. Temperature data since 2005 is a monitoring gap.

Threats

The highest severity threat to the Deep Creek population is Bumping Dam, which is a complete barrier to passage and isolates this population from the Naches River fluvial populations. Entrainment through the dam may also reduce population productivity, as individuals are lost from the population. Other threats to this population include illegal angling in Bumping Lake, dewatering in spawning and rearing reaches, introgression with brook trout, and lack of anadromous prey base and marine derived nutrients. A potential threat that is not rated here, but could have a very significant impact on this population, is the proposal in the Yakima Basin Integrated Water Resource Plan (Ecology 2012) to expand the storage capacity of Bumping Lake. This would elevate the threat of limited habitat by inundating .75 miles of spawning and rearing habitat and also potentially exacerbate the effect of dewatering.

While forest management issues, the potential for low abundance (large annual fluctuations in abundance), and recreation are all present in the population area, they are not considered significant threats. Agriculture, altered flows, development, grazing, limited extent of habitat, transportation issues, and mining are not present in this population area.

Table 12. Deep Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Passage barriers	SIGNIFICANT	Passage at Bumping Dam	HIGH

THREATS	Rating	ACTIONS	Priority
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Dewatering	UNKNOWN SIGNIFICANT	Natural–no actions	MEDIUM
Introduced species	UNKNOWN SIGNIFICANT	Monitor brook trout introgression	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Entrainment	UNKNOWN	Passage at Bumping Dam	MEDIUM
Forest management	LOW	—	LOW
Low abundance	LOW	—	LOW
Recreation	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Transportation	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a "Protection" population with a priority for continuation of population monitoring but with limited restoration actions recommended. The highest priority action is Passage at Bumping Dam. Bumping Lake is a popular fishing location; a priority recommended action is outreach to educate anglers and recreationists. Brook trout introgression has been documented in this population and should be monitored with future genetic sampling, but no specific brook trout removal actions are recommended at this time. Implementing carcass analog placement to address lack of marine derived nutrients will likely only happen after a successful pilot study is implemented elsewhere in the basin and is deemed necessary. Bumping Lake contains a healthy population of reproducing kokanee salmon providing an abundant food source for Deep Creek bull trout. There is currently a proposal to expand the capacity of Bumping Lake by 170 acre-feet, which would inundate the lower portion of Deep Creek. It will be critical to ensure that the proposed reservoir expansion does not compromise the viability of the Deep Creek population.

Completed Actions

- Culverts (partial passage barriers) on forest roads 1800 and 1808 were replaced with bridges in 2011.
- Fishing regulations have been implemented to protect bull trout in Deep Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Multiple Populations #9: Periodic entrainment studies at storage dams.
- Ensure impacts to bull trout from the proposed reservoir enlargement are minimized.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas to monitor long-term abundance trends.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring in Deep Creek.

Implementation Monitoring of Completed and Recommended Actions

None

Threats Research & Monitoring

- Multiple Populations #7: Continue to screen all collected genetic samples for evidence of genetic introgression with brook trout.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

Cle Elum/Waptus River Population Overviews

Cle Elum Dam was constructed in 1933 on the Cle Elum River just over eight miles upstream of its confluence with the Yakima River (at RM 186.5). The dam was built on the outlet of a natural lake and its storage reservoir is the largest in the Yakima Basin. The reservoir holds 437,000 acre-feet of water at full pool and covers 4,812 surface acres. Like the other storage dams in the basin, Cle Elum Dam was not constructed with fish passage, although interim downstream passage has been provided during a limited period in the spring for reintroduced anadromous salmonids in most years since 2006,. Because upstream fish passage remains impossible, bull trout that leave the reservoir volitionally or are entrained on the unscreened outlet works of the dam become permanently isolated from their natal populations.

The Cle Elum Lake watershed is extremely large and diverse. The upper Cle Elum River is the primary tributary to the reservoir. The river's headwaters feed a sizeable natural lake, Hyas, about 18.7 river miles upstream of Cle Elum Lake. Numerous small creeks enter the upper Cle Elum River along its course along with two major tributaries, the Waptus and Cooper rivers. Natural lakes are also present on both of these with Cooper and Waptus lakes located about 4.6 and 8.5 river miles upstream of their respective confluences with the upper Cle Elum River.

Relatively little is known about the bull trout that inhabit the Cle Elum Lake watershed and its associated subwatersheds. In 1998, WDFW recognized a single Cle Elum/Waptus Lakes stock speculating that it may have originated from a pre-dam adfluvial life history form with the possibility that fluvial forms may have been present in the area as well (WDFW 2004). Just a decade ago the USFWS in the draft Recovery Plan for the Middle Columbia River Recovery Unit (i.e., the Yakima Basin) identified one local adfluvial population above Cle Elum Dam (USFWS 2002). Based on fish observations made since, and the fact that physical barriers to migration separate the spawning areas of bull trout populations in the Cle Elum and Waptus systems, the two will be considered separate populations in this document. The Cle Elum River population is defined as bull trout that may be present in Cle Elum Lake and the mainstem upper Cle Elum River (including tributary creeks). The Waptus Lake population includes bull trout present in Waptus Lake, the Waptus River above the lake, and the river below the lake (but above a barrier waterfall occurring at about river mile 2.5). This is consistent with the conclusions reached in the USFWS 2008 Status Review.

Although an angler reportedly caught a bull trout in Cooper Lake in 2007, several subsequent hook-and-line and snorkel surveys in the Cooper River produced none. Therefore, a separate Cooper River bull trout population is not recognized in this plan. It should also be noted that any adfluvial bull trout seeking to migrate up the Cooper River would likely be precluded by a steep series of cascades which begins just over a half-mile upstream of the river mouth.

Cle Elum River

The upper Cle Elum River originates in the Alpine Lakes Wilderness and is the primary tributary to the reservoir, entering at its extreme northern end. As mentioned above, the river flows for about 19 miles from the outlet of Hyas Lake (Figure 17), with less than a mile of potential habitat in the headwater reach above the lake. About a mile below Hyas Lake, the upper Cle Elum River leaves the wilderness and enters lands owned and managed by the Forest Service. Approximately one mile further downstream, it enters a low gradient valley where it spreads out over a marshy floodplain (Tucquala Lake) for a distance of about 2.75 miles before the channel once again is confined. Three miles above Cle Elum Lake the Cooper River enters the upper Cle Elum River, while the Waptus River comes in 2.5 miles further upstream. Several smaller tributaries enter the upper Cle Elum River along its course; the largest of these are Fortune and Boulder creeks. A series of steep cascades is present about ten miles upstream of the lake (locally known as China Falls). These present a potential barrier to fish migrating upstream.

Population Distribution and Life History

Both adult and juvenile bull trout have been found in the upper Cle Elum River (see Population Monitoring section below) but not a single confirmed bull trout redd has ever been documented in the river or any of its tributaries. Redd surveys have been sporadic and incomplete (a detailed description of the survey efforts is presented in Population Monitoring section below). It is probable that adfluvial bull trout were present in Cle Elum Lake following construction of the dam, however confirmation of this has been elusive. The National Marine Fisheries Service (NMFS) reportedly captured 17 bull trout in floating Merwin traps set in the lake during a 1990-91 Cle Elum Lake sockeye restoration feasibility study (Pasley 1993). Some believe that these fish may have been misidentified lake trout, which are relatively abundant (Eric Anderson, WDFW, pers comm).

Since that time no attempts have been made to capture bull trout in the lake and no anglers have reported encountering them (Eric Anderson, WDFW, pers comm). In 1996, biologists from Central Washington University observed several adult bull trout during a snorkel survey below Salmon la Sac bridge (Craig 1996). Due to their size (reported as “large”), the observers speculated that they might be migrating adfluvial fish (Paul James, CWU, pers comm). In 2002, two adult bull trout were observed by USFWS snorkelers just below the potential barrier mentioned above (Mallas 2003), however these fish were not of the size characteristic of adfluvial adults. In summary, it is uncertain if a viable adfluvial bull trout population still inhabits Cle Elum Lake; it is also unknown if a resident component exists in the upper Cle Elum River, although that is possible. Further investigation is warranted.

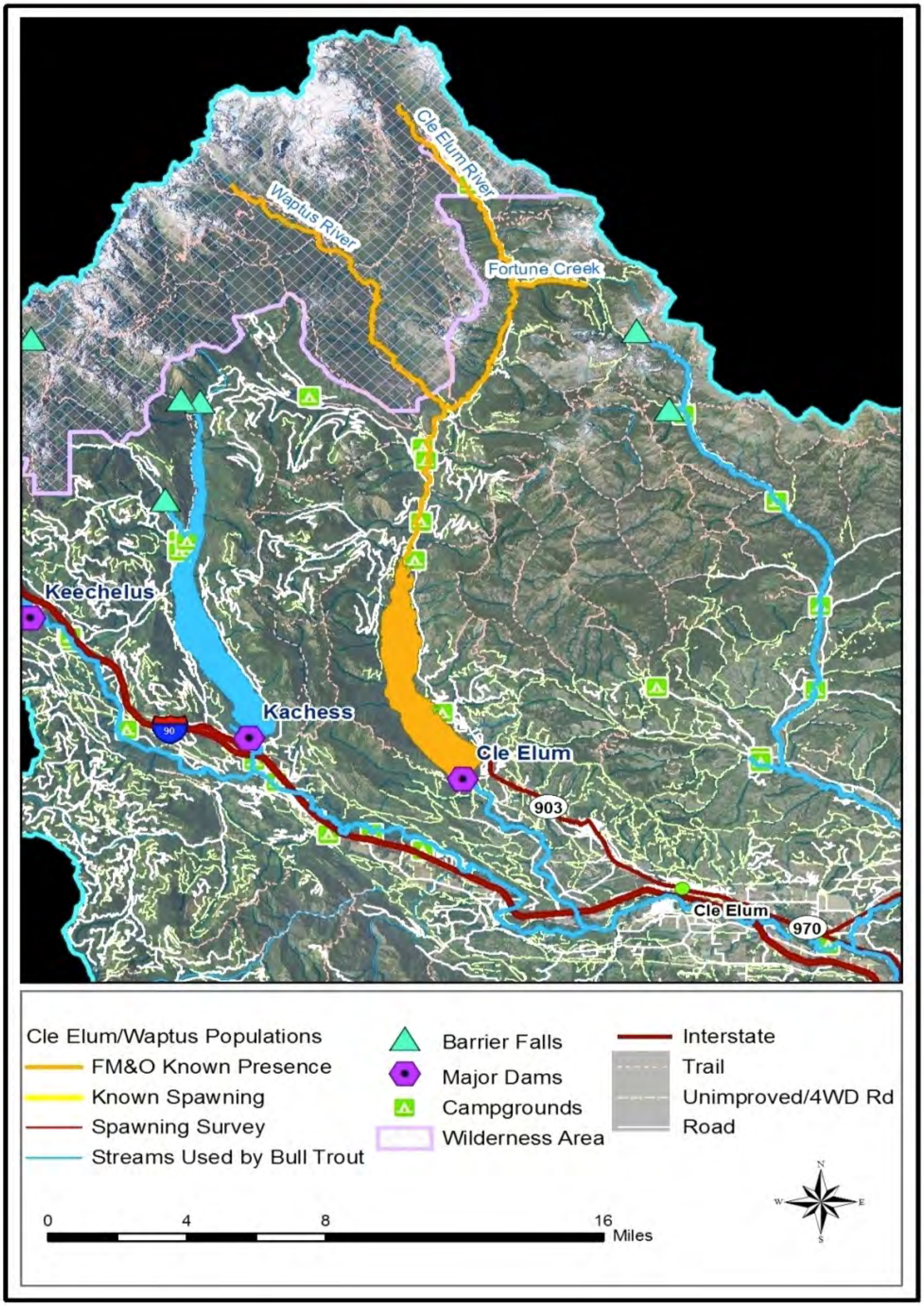


Figure 17**. Cle Elum River/Waptus River subwatersheds.**

Population Status

This population was last officially rated while combined with Waptus Lake. The USFWS (USFWS 1998) considered the Cle Elum/Waptus population depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of this stock as unknown (WDFW 2004). For the purposes of this document the status of the Cle Elum River population should be considered unknown.

No genetic samples have been taken from this population to date. Connectivity and thus the potential for genetic exchange with downstream populations in the Yakima River fluvial system was eliminated by the construction of Cle Elum Dam in 1933.

Population Trend

It is not possible to determine a trend for this population. The history of conducting spawning surveys in the upper Cle Elum River is presented in the section below.

Population Monitoring

Prior to the 1990-91, NMFS study mentioned above, Cle Elum Lake was sampled with gillnets by WDFW in 1978-79. Among other species captured was lake trout. No bull trout were included in the catch (Mongillo and Faulconer 1980). Although not targeting bull trout, none were collected in gillnets set by WDFW in a mid-1990s assessment of the pygmy whitefish population in the lake (Eric Anderson, WDFW, pers comm).

The upper Cle Elum River has received considerable attention over the last two decades by biologists conducting day and night snorkel surveys and electrofishing surveys. In 1992, the Forest Service conducted night snorkel surveys at several locations throughout the Cle Elum drainage and found no bull trout (USFS 1992). In 1996, the Forest Service conducted stream surveys, which appear to have employed electrofishing as the primary method, finding mostly rainbow and brook trout but no bull trout (USFS 1996). As mentioned above, biologists from Central Washington University observed two adult bull trout in the upper Cle Elum River in the fall of 1996 (Craig 1996). WDFW biologists snorkeled the upper Cle Elum River in September 1997 and observed rainbow trout and brook trout (Anderson 2001).

In the most concentrated effort to date, in 2002 the USFWS surveyed 19 randomly selected sampling units using the presence/absence protocols established by Peterson et al. (Peterson et al. 2002). Fourteen additional opportunistic sampling units were also snorkeled and limited hook-and-line sampling was conducted in Hyas and Tucquala lakes. In all 4.9 miles of the river was snorkeled between the Waptus River confluence (~RM 5.5) and Hyas Lake (~RM 19). Twenty-four juvenile (<150 mm) bull trout observations were documented although it was acknowledged that some might have been brook trout (or hybrids). Juvenile brook trout, often difficult to differentiate from bull trout while snorkeling, were abundant and no genetic samples were obtained to confirm field identifications. Two larger bull trout (>220 mm) were observed and identified with certainty (Mallas 2003). Survey crews coordinated by the Forest Service in the fall of 2008 revisited the area where the juvenile observations were made. Working at night, snorkelers surveyed approximately two miles of the river. No bull trout were found, although brook trout and introduced coho salmon juveniles were abundant (Reiss 2008).

Fortune Creek, which enters the river at about RM 12, has also been the focus of fish surveys. The Forest Service conducted employed various methods in 1991 and reported the presence of rainbow and brook trout only. In 2000, the Forest Service snorkeled a portion of the creek and reported the presence of three bull trout (life stage unavailable but assumed juvenile). They also observed brook and rainbow trout. Returning in the fall of 2008, snorkelers working at night surveyed about 0.5 miles of Fortune Creek and did not observe any bull trout (Reiss 2008). About 0.7 miles of the creek was snorkeled by the USFWS in their 2002 effort. This surveying was done during the day and produced no bull trout observations.

Spawning surveys have been conducted sporadically in the upper Cle Elum River since 1996. With 19 miles to cover, the task is difficult. An index area has not been established, and none of the surveys can be described as complete. Habitat reconnaissance since 1999 has revealed that the most suitable spawning habitat exists above the Fortune Creek confluence (excluding the Tucquala Lake area) where the river has less gradient and the most suitable gravels. Nevertheless, no confirmed redds have been found in eight redd surveys conducted since 2000 (2000-2003, 2006-2009). The most promising "redds" observed were found by biologists from the USFWS and WDFW in September 2002 in the short (<0.7 mile), very low gradient reach directly below Hyas Lake (Jeff Thomas, USFWS, pers comm). Possible bull trout redds had been reported in this reach the two previous years. Seven large excavations that appeared to be redds (i.e., well defined pit and tailspill) were present in close proximity to each other but no fish were observed in the vicinity. The site was visited three additional times over the next month and subsequent investigation revealed no eggs present in the tailspill gravels of any of the redds. It was hypothesized that the redds might be those of spring spawners, possibly large rainbow or cutthroat trout, that had dropped down from Hyas Lake to spawn (fry emergence would have occurred several months previous). It is also possible that the excavations were not redds at all. It remains unknown what species produced these redds. The area was revisited the following two years and nothing similar was found (Reiss 2009).

The USFWS conducted a single redd survey in Fortune Creek in early October 2000. Thirteen redds were observed but the species responsible for the excavations is unknown since no fish were present on or near any of them (Judy Neibauer, USFWS, pers comm). There are strong brook trout populations throughout the Cle Elum drainage, and they are also fall spawning fish. In the fall of 2002 the USFWS conducted bull trout redd surveys (single-pass) in Fortune, Paris, Camp, and Big Boulder creeks. No redds were found in any of them.

Habitat

Habitat Overview

Elevations in the upper Cle Elum River range from 2,240 feet at its mouth (Cle Elum Lake) to 3,460 feet at the outlet of Hyas Lake about 19 miles upstream. For all but the upper mile the river flows through the Okanogan-Wenatchee National Forest. For almost all of this distance, the river is easily accessible by a Forest Service road, which is paved for the lower four miles. The watershed has a long history of grazing, timber harvest, and mining (Haring 2001). Some scattered small-scale gold mining still occurs in a couple of tributary creeks but grazing and logging are no longer significant activities at this time. The watershed is a very popular recreation area. Four heavily used Forest Service campgrounds exist next to the river in the lower five miles, and road densities are high (3-4 miles/sq. mi.). There are numerous dispersed campsites upstream. Most of these are between Fortune Creek and Tucquala Lake. Many are located on the banks of the river, although the Forest Service has been working over the last decade to relocate and/or restrict access to some of the more problematic of them. There are just a few private residences located on land leased from the Forest Service; most in a small cluster near Big Boulder Creek (~RM 8).

Much of the upper Cle Elum River is confined in a canyon reach about eight miles in length beginning near RM 4.0. Large substrate materials dominated by boulders, high stream gradients and high water velocities characterize this reach. A series of steep bedrock cascades at RM 9.7 present a potential barrier for fish migrating upstream. Below the canyon reach the river channel displays alluvial characteristics, which could provide good spawning conditions for bull trout. Above Fortune Creek (~RM 12), the channel is also alluvial and physical habitat conditions for spawning and rearing are much better than were available in the canyon reach. This was the only portion of the river that approached meeting Forest Plan standards for pool quantity and LWD (USFS 1996). The riparian corridor is basically healthy except in areas where concentrations of dispersed campsites are present. In the mid-1990s fine sediment levels (in riffles) met standards, but concerns were raised that increased delivery of fine sediments was likely from dispersed recreational activity. Forest roads are not considered to be a leading contributor of fine sediment in the watershed (Haring 2001). Elevated water temperatures in the upper Cle Elum River could be a problem for bull trout. The river is on the CWA 303(d) impaired water quality list for water temperature and investigators have recorded maximum temperatures exceeding 15^{o} C for extended periods in the summer (Mallas 2003). This is most likely a natural condition probably due to the presence of Hyas and Tucquala lakes as well as the fact that there are large segments of the river where the riparian canopy is naturally sparse.

Detailed habitat information is not available for smaller tributaries of the upper Cle Elum River. Redd survey notes compiled by the USFWS in 2002 provide some general descriptions of habitat conditions in several of these creeks (Fortune, Camp, Big Boulder, Paris). All of them had very steep gradients (>5%) and substrate materials dominated by small and large boulders; suitable spawning gravels were limited and found primarily in small pockets. Steep cascades and small waterfalls were prevalent, many of them at least potential barriers to fish migration. Fortune Creek has the longest stream length available above its mouth, approximately 2.5 miles, before a definite passage barrier is encountered. The distance from the mouth to a barrier waterfall in Big Boulder Creek is approximately a half-mile, but the creek is essentially a continuous steep cascade for this entire distance. The other two creeks have barrier waterfalls located within 100-200 yards upstream of their mouths. All four of these streams are subject to extremely low flows in late summer and early autumn.

If a viable adfluvial bull trout population still exists in Cle Elum Lake, FMO habitat for that population is provided by the lake. Neither the sparse shoreline development or water sports activities on the lake are believed to impact habitat quality. Cle Elum Lake is the largest storage reservoir in the Yakima Basin. Although it does experience extreme drawdown in the summer, a 265,000 acre-foot conservation pool (i.e., dead storage) cannot be accessed. This is the only lake in the Yakima Basin with a strong population of lake trout, which has been identified as a major limiting factor for bull trout populations in Montana (Donald and Alger 1993; Martinez et al. 2009).

Habitat Monitoring

Mongillo (1982) measured water quality parameters and zooplankton densities for Cle Elum Reservoir. Mongillo and Faulconer (1980) conducted limnological studies in Cle Elum Reservoir in 1978 and 1979. They recommended lake fertilization as one method to increase productivity. Mongillo proposed a Cle Elum Lake fertilization implementation and monitoring study. Flagg et al. (2000) reviewed Cle Elum Lake productivity and fertilization potential. Lieberman and Grabowski (2007) conducted limnological studies in Cle Elum Reservoir from 2003-2005. They concluded that zooplankton densities may limit the lakes capacity to support resident fish as well as introduced salmonids and suggested the nutrient enrichment may be one method to increase both algal and zooplankton production.

Sediment samples were collected and analyzed for the Cle Elum River and Cooper River in 1990 (Mayo 1998). Cle Elum River samples were collected between the reservoir and Fortune Creek. This monitoring effort demonstrated a level of fine sediments in the substrate within the spawning reach (~3-9%), which would qualify as “functioning appropriately” (USFWS 1999) although this data are from only one year.

The Forest Service completed habitat surveys on the Cle Elum River in 2000 (lower reach) and in 2005 (upper reach) using Hankin and Reeves protocol (Hankin and Reeves 1988; USFS 1996). In these surveys, data was collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature. In 2006 an Aquatic Species Environmental Baseline was completed for the Cle Elum watershed (USFS 2006d). In 2004, a Federal Roads Analysis was completed for the Cle Elum watershed, including an aquatic rating.

In 2001, the Forest Service contracted aerial thermal infrared remote sensing surveys on the Cle Elum River from Cle Elum Lake upstream to the outlet of Hyas Lake (Watershed Sciences 2002). Accuracy of temperatures was confirmed with instream sensors. The flights were completed in early September and stream temperatures ranged from 13.9-17.4 °C.

There are three long-term monitoring sites in the Cle Elum River drainage where thermographs have been deployed during the summer low flow period for numerous years: Cle Elum River above French Cabin Creek (2000-2011), Cooper River (1994-2011) and Waptus River (1994-2006) (USFS 2011b). There are a number of other sites throughout the system that have been monitored by the Forest Service for a period of time, mostly between the years of 2000-2005.

Threats

The highest severity threat to this population appears to be low abundance. It is uncertain whether bull trout are still present anywhere in the Cle Elum drainage as their presence was last documented in 2002. A high severity threat that appears to have contributed to this possible extirpation is the presence of strong populations of introduced species (brook trout, lake trout, and brown trout). Passage barriers have also likely contributed, both Cle Elum Dam, which has limited connectivity to other bull trout populations and precluded anadromy, and recreation dams that may limit migrations within the system. Other threats to the population include lack of marine derived nutrients, habitat degradation due to recreation and forest management and illegal angling.

Transportation issues associated with the paved road along the mainstem Cle Elum River and active mining claims are present in this population area, but are not thought to be significant threats. Agriculture, altered flows, development, dewatering, grazing, and limited habitat are not present in this population area.

Table 13. Cle Elum River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority

THREATS	Rating	ACTIONS	Priority
Introduced species	SIGNIFICANT	Lake trout removal; Monitor brook trout introgression	HIGH
Low abundance	SIGNIFICANT	Monitor; Evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Cle Elum Dam; Remove recreation dams	HIGH
Entrainment	UNKNOWN SIGNIFICANT	Passage at Cle Elum Dam	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Support reintroduction effort	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Outreach; Riparian restoration	MEDIUM
Angling	UNKNOWN	Outreach	MEDIUM
Forest management	UNKNOWN	Riparian restoration	MEDIUM
Transportation	UNKNOWN LOW	—	LOW
Mining	UNKNOWN LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA

Actions

Strategy

The Cle Elum River population has been identified as a “Monitor” population with a low priority for implementing bull trout actions beyond population monitoring actions used to determine whether there are extant bull trout remaining. If bull trout are found in this basin, the highest priority to recover this population would be to reduce the populations of brook trout, lake trout, and brown trout (to a lesser extent) which dominant this system. There is currently work being done to restore passage and reintroduce anadromous species including sockeye into the Cle Elum system. However, actions to provide passage (Passage at Major Storage Dams) recover salmon populations (Restore Healthy Salmon Populations), address riparian health, extend outreach to anglers and remove recreational dams will do little to benefit bull trout if there are none present. Supplementation will likely be necessary to recover viable populations of bull trout in this system in the future but issues with introduced species would need to mitigated first.

Completed Actions

- Cle Elum Dam fish passage facility final design and DEIS, which includes reintroduction of anadromous species, was completed in 2010.
- Dispersed campsites near confluence of Cooper and Cle Elum rivers were closed or relocated by USFS in 2007 and 2008.
- Numerous dispersed campsites along the river from the northwest end of Cle Elum Lake to the Fortune Creek area were relocated and/or had vehicle access restricted by USFS in 1996.
- Roads in the watershed that were acquired over the last ten years by the Forest Service in land exchanges were decommissioned between 2006 and 2008 (most of these roads were in the upper headwaters of the Cooper River and Thorp and French Cabin creeks).
- Three segments of Forest Service Road 4330 (totaling one mile) located in the active floodplain of the Cle Elum River that are chronic sediment sources are scheduled to be relocated; old road prisms were decommissioned in 2012.
- Drainage and hydraulic improvements were completed along Forest Service Road 4330 in 2011 (1,000 feet of road treated).
- Motor vehicle use on the lakebed was restricted to a limited number of access points and for ingress and egress to shoreline only; off-road vehicle activity on the lakebed was prohibited by USFS in 1999.
- Fishing regulations have been implemented to protect bull trout in the Cle Elum and Waptus rivers (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Cle Elum River #1: Lake trout assessment and removal.

- Cle Elum River #3: Restoration of dispersed campsites located along 12 miles of FS (Forest Service) Road 4330 from Salmon la Sac Campground up to the Deception Pass Trailhead.

- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, other).

- Multiple Populations #4: Evaluate supplementation (see Appendix D).

- Multiple Populations #1: Monitor for recreational dams on an annual basis and remove as necessary.

- ***Population Monitoring***

- ***Cle Elum River #2***: Conduct additional snorkel surveys in the Cle Elum River and tributaries and extensively sample Cle Elum Lake for bull trout using hook-and-line and possibly short-set gill nets.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue to monitor temperature.

Implementation Monitoring of Completed and Recommended Actions

None

Threats Research & Monitoring

- Multiple Populations #7: Monitor introgression with brook trout in any genetic samples collected.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

- Upper Yakima #8: Provide passage at Cle Elum Dam

Waptus River

The Waptus River is the larger of the two major tributaries of the upper Cle Elum River, entering the river about 5.5 miles above Cle Elum Lake. The Waptus originates as the outflow from several lakes high in the Alpine Lakes Wilderness about two miles upstream of Waptus Lake. From the outlet of Waptus Lake the river flows for approximately 8.5 miles to its confluence with the upper Cle Elum River. Most of the river is in the wilderness, with the last mile or so flowing through the Okanogan-Wenatchee National Forest (Figure 17). Numerous high-gradient creeks are tributaries to the river, all of them subject to seasonal flow depletion and all providing limited access for fish. A waterfall located on the lower Waptus River approximately 2.5 river miles above the mouth (near the Hour Creek confluence) is believed to be a complete barrier to upstream fish migration.

Population Distribution and Life History

There have been very few bull trout redd surveys conducted in the Waptus River. These include incomplete surveys conducted by WDFW in 1997-98 and a single survey in the reach below the barrier waterfall conducted by the USFWS in 2003. Also in 2003, the USFWS conducted a redd survey in a reach extending from Waptus Lake upstream approximately 0.6 mile. No bull trout redds were observed in any of these surveys (USFWS 2004b). Bull trout were present historically in Waptus Lake. Catch records compiled by WDFW documented bull trout presence in the 1940s and early 1950s when they were evidently abundant according to anecdotal accounts. The species presence in the lake was further documented by WDFW in 1996 when a single juvenile was captured in a gill net and again the next year when an adult was caught by hook-and-line (Anderson 2001). In 2003, the USFWS sampled the lake via angling for 6-8 hours and captured numerous brook trout but no bull trout. Juvenile bull trout were reportedly observed in the Waptus River (specific location unknown) during snorkel surveys conducted by the Forest Service in 1990, but an extensive presence/absence survey conducted by the USFWS in 2003 throughout the length of the river produced only one potential bull trout observation, which was made above the lake (USFWS 2004b). A subsequent genetic analysis of a tissue sample taken from this juvenile fish revealed it to be an F_2 hybrid (see Population Status section below).

It is believed that Waptus Lake once supported a healthy and likely distinct population of adfluvial bull trout. At this point, the evidence suggests that while some bull trout may persist in Waptus Lake, a viable population may not. It is also possible that a resident component exists in the Waptus subwatershed but this has not been confirmed. Further investigation is warranted.

Population Status

This population was last officially rated while combined with Cle Elum Lake. The USFWS (1998) considered the Cle Elum/Waptus River population to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of this stock as unknown (WDFW 1994). For the purposes of this document the status of the Waptus population should be considered unknown.

There has only been one genetic sample collected from this population. A fin clip was taken from a juvenile fish observed and captured above the lake in 2003. The results of the genetic analysis for this fish indicated it was an F_2 hybrid, a cross between a brook trout and a bull trout/brook trout hybrid (Paul Spruell, University of Montana, pers comm).

Population Trend

It is not possible to determine a trend for this population. The history of spawning surveys in the Waptus River was presented above in the Population Distribution and Life History section.

Population Monitoring

The first documentation of bull trout presence in Waptus Lake occurred during creel surveys conducted in 1940, 1948, and 1957 (Washington Dept of Game 1967). Introduced brook trout also entered the creel as early as 1940. A 1951 Washington Department of Game High Lake Survey Report states that “dollies,” eastern brook, rainbow, and cutthroat trout were found in Waptus Lake (Washington Dept of Game 1951). It appears that the lake and river were not investigated again until 1995 when the Forest Service conducted stream surveys in the Waptus River below the lake (USFS 1995). They reported that bull trout were observed while snorkeling, but data are lacking concerning the size of the fish observed and where specifically they were found.

WDFW conducted hook-and-line surveys in Waptus Lake in 1995 and no bull trout were detected (Anderson 1995).WDFW conducted snorkel and hook-and-line surveys in the Waptus River above and below Waptus Lake in 1996 and 1997 (Anderson 2001). In 1996 one juvenile bull trout was captured in a gillnet in Waptus Lake and in 1997 an adult fish (462 mm TL) was caught. No bull trout were caught in the river. Also in 1997, gillnets in Waptus Lake caught a few rainbow and brook trout and possibly a bull trout or bull trout/brook trout hybrid (Mongillo 1997).

The most concentrated effort to date occurred in 2003 when the USFWS night-snorkeled 19 randomly selected sampling units using the presence/absence protocols established by (Peterson et al. 2002; USFWS 2004b). The sampling units were located both above and below Waptus Lake; in the river below the lake, units were sampled both above and below the barrier waterfall. A total of 1.2 miles of the river were surveyed in approximately 25 person-hours of effort. Opportunistic snorkel surveys were also conducted in various reaches of the Waptus River that appeared to contain suitable bull trout habitat, including several of its tributaries, Hour, Spinola, and Spade creeks. An additional 20-to-24 person hours of effort were expended on this effort. The predominant species observed during the course of the study was rainbow trout (63%) followed by brook trout (23%). No pure bull trout were found but one F_2 hybrid was observed and captured.

Habitat

Habitat Overview

Below Waptus Lake, elevations in the Waptus River range from 2,970 feet at the lake outlet to 2,510 feet at its mouth. The alpine lakes from which the river originates are at elevations greater than 4,000 feet. The entire watershed is relatively undisturbed by human activities, the only access to it being foot and horse trails that do not impact the river. Riverine habitat and the riparian corridor are in a natural condition. The most complete description of habitat in the river can be found in a final report on bull trout presence/absence surveys conducted in 2003 (USFWS 2004b).

A variety of habitat conditions exist in the Waptus River. Below Waptus Lake a habitat transition zone is evident around RM 4.2 (about the half-way point). Below this the river has an average gradient of 1.5% and the channel displays a low degree of sinuosity. The riverbed is composed primarily of large colluvial material (boulders and large cobbles) and spawning-size gravel is scarce; pool frequency and depth are low and LWD is infrequently encountered. Above this point the average gradient drops to 0.9%, and the channel meanders much more. Here a shift towards smaller bed materials and spawning-size gravel occurs; pool frequency and depth increases significantly; and LWD (both individual pieces and extensive aggregates) abounds. Water temperatures in the lower Waptus River were suitable for bull trout in 2003, generally remaining below the threshold thought to limit the species' distribution (15 ^{0}C) during the first two weeks of September. Readings slightly warmer than this were recorded directly below Waptus Lake but these warmer water temperatures only persisted for a short distance (<0.3 mile).

Upstream of Waptus Lake the river is significantly smaller than below it in terms of both flow and average wetted width. For a distance of approximately a half-mile directly above the lake habitat conditions are exceptionally suitable for bull trout. The channel is extensively braided, disappearing frequently under massive logjams. The stream gradient was low (0.25- 0.5%), the riparian canopy was thick, undercut banks were prevalent, and LWD was abundant. Spawning-size gravels were abundant and completely free of fine sediment. Above this reach the stream gradient increases significantly, averaging 1.9%. Despite the high gradient, habitat conditions for juvenile bull trout are very good considering available pool habitat, the abundance of LWD, riparian shading and water temperature, which was much colder than below the lake. However, spawning conditions are marginal due to a shortage of suitable gravel. Given its location in the wilderness, Waptus Lake provides excellent FMO habitat for adult and subadult bull trout.

Habitat Monitoring

The Forest Service completed habitat surveys on the Waptus River in 1995 and 2003 using Hankin and Reeves protocol (Hankin and Reeves 1988; USFS 1995). In these surveys, data was collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

During the aerial thermal infrared remote sensing surveys on the Cle Elum River in 2001 (Watershed Sciences 2002), temperature in Waptus River at the confluence with the mainstem Cle Elum River was recorded as 15.8 °C, one of the few tributaries with a warmer temperature than the mainstem. A long-term monitoring site on the Waptus River recorded temperature via thermographs deployed during the summer low flow period from 1994-2005 (USFS 2011b). Two other sites on the Waptus River were monitored just during the summer of 2003. Temperature data since 2005 is a monitoring gap.

Threats

A separate Threats Analysis was not completed for the Waptus population; instead it was combined with the Cle Elum River population. The highest severity threat to this population appears to be low abundance. It is uncertain whether bull trout are still present in the Waptus River drainage. A high severity threat that has likely impacted this population is the abundance of introduced brook trout. The Waptus population spawning, rearing, and FMO habitat is all contained with the Alpine Lakes Wilderness, thus limiting other possible threats.

Actions

Strategy

The Waptus populations has been identified as a “Monitor” population with a low priority for implementing bull trout actions beyond population monitoring actions used to determine whether there are extant populations of bull trout remaining. The Waptus River is within the wilderness area and the only future actions that might be recommended would be brook trout eradication and bull trout supplementation. Brook trout eradication would be an extremely difficult undertaking, however supplementation would not likely be successful without it.

Completed Actions

- Fishing regulations have been implemented to protect bull trout in the Waptus River (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, other).

- Multiple Populations #4: Evaluate supplementation (see Appendix D).

Population Monitoring

- Waptus Lake #1: Conduct additional snorkel surveys in Waptus Rivers and tributaries and Waptus Lake for bull trout using hook-and-line and possibly short-set gill nets.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue to monitor temperature.

Implementation Monitoring of Completed and Recommended Actions

None

Threats Research & Monitoring

- Multiple Populations #7: Monitor introgression with brook trout in any genetic samples collected.

Actions Identified in YSRP that would benefit bull trout:

None

Kachess Lake Adfluvial Populations Overview

Kachess Lake was a natural lake prior to the construction Kachess Dam on its outlet in 1912. At full pool the lake holds 239,000 acre-feet of water with a surface area of 4535 acres. The dam is a complete barrier to migration, isolating two local populations of bull trout, which now reside in the lake and spawn in upstream tributaries. One spawns in Box Canyon Creek and the other, in the upper Kachess River. Both of these populations are relatively small with each having a limited amount of spawning and rearing habitat available below waterfalls that block further upstream access. Several other smaller tributaries also flow into Kachess Lake. None are known to support bull trout.

As is the case for the other adfluvial populations in the Yakima Basin, the potential exists for individuals to be entrained through the unscreened outlet works of the dam and permanently displaced downstream. The likelihood of this occurring is reduced because of dead storage in the reservoir (432,000 acre-feet), and the location of the dam's outlet works.

Box Canyon Creek

Box Creek originates in the Alpine Lakes Wilderness Area and flows into Kachess Lake from the northwest near its northern end. The reach accessible to migratory fish is about three miles downstream of the wilderness boundary and entirely within the Okanogan-Wenatchee National Forest. This reach is relatively short with an impassable waterfall (Peekaboo Falls) located at its upstream end approximately 1.6 miles above the lake. No significant tributaries enter the creek in the accessible reach. Complete dewatering at the mouth of Box Canyon Creek has been known to occur in late summer during dry years when streamflow is low and the reservoir level has dropped significantly due to irrigation demands.

Population Distribution and Life History

The Box Canyon Creek population displays an adfluvial life history type. It is possible that a resident component exists as well although this has not been confirmed. The spawning area extends from Peekaboo Falls downstream, generally ending a short distance (~0.1 mile) above Kachess Lake. Juvenile rearing occurs in the entire 1.6-mile accessible reach. The lake provides FMO habitat for subadult and adult fish (Figure 19). Adult bull trout move into Box Canyon Creek in mid-July to mid-August, prior to spawning, and numerous fish migrate to and hold in the large pool directly below Peekaboo Falls.

Population Status

The USFWS (1998) considered the Kachess subpopulation to be depressed, decreasing, and at risk of stochastic extirpation. At the time this subpopulation included only the Box Canyon Creek local population, as bull trout spawning had not been observed yet in the upper Kachess River nor was a local population recognized. WDFW rates the status of the Kachess Lake stock (which included the upper Kachess River population) as critical, further stating that it was very near extirpation (WDFW 2004).

Results of genetic analyses show the Box Canyon Creek population is genetically distinct from all other populations in the Yakima Basin (Reiss 2003; Small et al. 2009). Genetic samples for the baseline were collected from juveniles during a snorkel survey in 2001 (Reiss 2003; Small et al. 2009). Connectivity and thus the potential for genetic exchange with downstream populations in the Yakima River fluvial system was eliminated by the construction of Kachess Dam in 1912.

Population Trend

The spawning period for the Box Canyon Creek population begins in early September and can extend through mid-October. Complete bull trout redd surveys have been conducted since 1984 and cover the entire spawning area from just upstream of Kachess Lake to Peekaboo Falls. Redd counts have been highly variable (Figure 18). Over the first ten years of surveys, the counts were very low including three years when none were observed. This was probably due in large part to limited adult access to the creek as several years from the late 1980s through the mid-1990s were drought years in the Yakima Basin. The chronic passage problems that occur at the mouth were not yet fully recognized or monitored at that time. Since 1996 the average number of bull trout redds found in Box Canyon Creek has been 15 (excluding 2007 when surveys were curtailed due to high flows). Considerable variability is still evident, and the average is skewed by the counts the last three years, which were progressively the highest recorded. The population trend looks positive considering the last three years. Basin biologists, however, remain skeptical until this is sustained for a longer period of time.

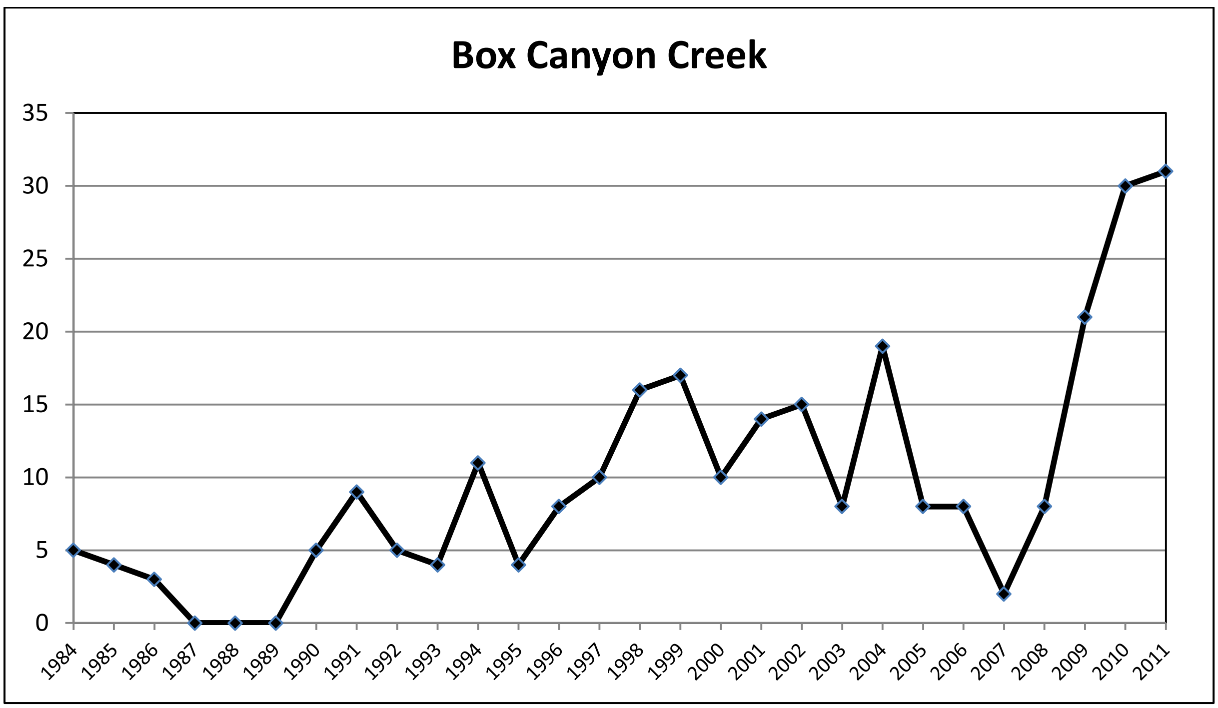


Figure 18. Bull trout redd counts in Box Canyon Creek.

Population Monitoring

The first known documentation of bull trout inhabiting Kachess Lake came in 1941 from creel data collected by WDFW (then known as the Washington Department of Game) between 1937 and 1966. Interestingly, very few bull trout (referred to as Dolly Varden) entered the creel during that time period. In 1982, four bull trout were captured by the agency in gillnets set in the lake (Mongillo 1982), and that same year the species was observed, apparently for the first time, by snorkelers in Box Canyon Creek. As noted above, spawning surveys were initiated two years later, beginning the period of consistent monitoring of the Box Canyon Creek bull trout population that continues today. In 1994, Plum Creek Timber Company conducted night snorkel surveys, observing cutthroat and bull trout (Plum Creek Timber Company 1995).

The Forest Service conducted snorkel surveys in Box Canyon Creek in 1991 and 1993, observing relatively small numbers of bull trout. CWU researcher Paul James unsuccessfully attempted to trap post-spawn bull trout near the mouth of the creek in 1999; the next year he observed adults while snorkeling in the summer to determine spawn migration timing (James 2002a).

CWU graduate students Yuki Reiss and William Meyer both spent time snorkeling Box Canyon Creek. Reiss captured 31 juvenile bull trout and collected genetic samples in 2001 (Reiss 2003), and Meyer observed both juveniles and adults in 2000 and 2001, ultimately electing not to use these data in his thesis work (William Meyer, WDFW, pers comm).

In 2011, the USBR conducted an entrainment study directly below Kachess Dam. A screw trap and a fyke net were deployed in the river channel to capture fish entrained through the outlet works of the dam and passed to the river below. The sampling was done over a range of flow releases from mid-June through mid-October. Nearly 2,700 fish were captured during the course of the study representing 16 species but no bull trout were collected (Arden Thomas, USBR, pers comm).

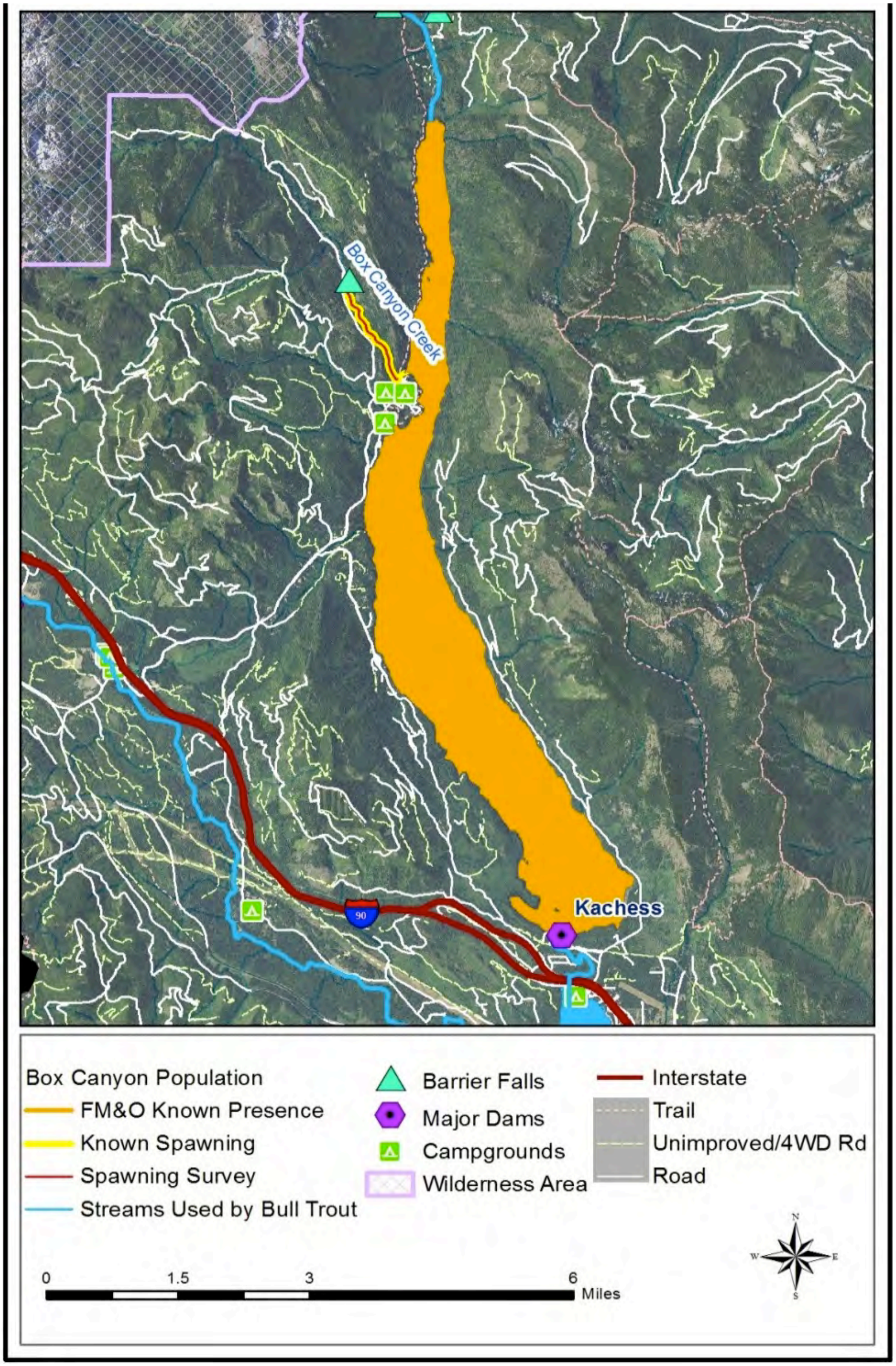


Figure 19. Box Canyon Creek subwatershed.

HABITAT

Habitat Overview

Elevations on Box Canyon Creek range from 2,270 feet at its mouth to 2,540 feet at the barrier waterfall. This reach is entirely within the Okanogan-Wenatchee National Forest although there are scattered private timber company holdings in the watershed. The current primary land use in the watershed is recreation. Logging has occurred in the past and timber harvest is possible in the future. FS Road 4930 runs parallel and fairly close (<100 yards) to the spawning reach for about two-thirds of its distance. In the past a lengthy section of this road (~600 feet) was a chronic source of sediment in the creek but this section was relocated and stabilized in 2006. Road density in the watershed increases further upstream but these former logging roads are not particularly close to the creek and do not appear to be problematic in terms of sediment contribution. Areas along the riparian corridor of Box Canyon Creek were negatively impacted by past timber harvest; these areas have regrown for the most part. Riparian disturbance also resulted from the presence of numerous dispersed campsites. The Forest Service has re-engineered or closed and rehabilitated many of these areas. A large campground is located near the mouth of Box Canyon Creek but is not believed to present significant habitat-related issues.

Overall, habitat conditions in Box Canyon Creek are generally considered good although they do not meet Forest Plan standards in some areas (i.e., LWD and pool depth). Bed and bank stability are good, sediment levels are low, and water temperatures are suitable for bull trout (Haring 2001). The area of the creek containing suitable gravels for spawning is adequate for the current population but might not be if the population increased in size.

The other major concern for this population is the dewatering that sometimes occurs in dry years directly upstream of the creek's mouth. The time period this occurs coincides with the immigration of pre-spawn bull trout. With the reservoir level significantly lowered from irrigation water withdrawal, the mouth is located on the lakebed. Above this point the creek spreads out over unconsolidated sediments on the bed and can go dry up to several hundred yards upstream. These conditions were observed in three of the first six years of the last decade (2001, 2003, and 2005) and required implementation of remedial passage projects to allow pre-spawn bull trout to enter Box Canyon Creek.

FMO habitat for the Box Canyon Creek bull trout population is in Kachess Lake. Neither the sparse shoreline development or water sports activities on the lake are believed to influence habitat quality. The effects of reservoir depletion during the summer and early fall are less concerning in Kachess Lake than in any of the other Yakima basin impoundments. The reservoir has a conservation pool (i.e., dead storage) of well over 400,000 acre-feet that cannot be accessed for irrigation withdrawal.

Habitat Monitoring

Some level of monitoring before or during spawning surveys is done to determine if there is an opportunity for pre-spawn adult bull trout to migrate upstream from the reservoir into Box Canyon Creek. A combination of low flows, low reservoir levels, percolation within the large alluvial fan on the reservoir floor, and channel configuration have historically impeded or blocked upstream bull trout migration. Thomas (2007) summarized dates, flows, and reservoir elevations when Box Canyon Creek was not passable to upstream migrating adult bull trout. USBR (2008) wrote an appraisal report on potential options for constructing permanent passage.

Sediment samples were collected and analyzed for Box Canyon Creek in 1990. The percent average fine sediment level was found to be 8.2% (Mayo 1998), which would qualify as "functioning appropriately" (USFWS 1999), although this data are from only one year. The Forest Service completed a stream survey on Box Canyon Creek in 2002 (USFS 2002b) using Hankin and Reeves protocol (Hankin and Reeves 1988). In this survey, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature. In 2004, a Federal Roads Analysis was completed for the Box Canyon watershed, including an aquatic rating. Mongillo (1982) measured water quality parameters and zooplankton densities for Kachess Lake.

There is a long-term monitoring site on Box Canyon Creek and temperature has been recorded via a thermograph deployed during the summer low flow period for most years from 1994-2011 (USFS 2011b).

Threats

The highest severity threats to this population are passage barriers in the form of Kachess Dam at the outlet of the lake and from low water conditions at the mouth of the spawning tributary during the migratory period. This population also has a low population abundance, which increases the risk of extirpation. Other threats include illegal angling in Kachess Lake, entrainment at Kachess Dam, limited habitat due to inundation of lower reaches of Box Canyon Creek when the reservoir was created, lack of marine derived nutrients, recreation (large campsite at mouth of spawning reach), forest management (road densities), and the presence of brook trout.

Agriculture, altered flows, development, dewatering, grazing, transportation issues, and mining are not present in this population.

Table 14. Box Canyon Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low abundance	SIGNIFICANT	Monitor; evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Kachess Dam, monitor passage at mouth	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Kachess Dam	MEDIUM
Limited extent habitat	UNKNOWN SIGNIFICANT	Passage at Peekaboo Falls	MEDIUM
Prey base	UNKNOWN	Carcass analog pilot study	MEDIUM

THREATS	Rating	ACTIONS	Priority
	SIGNIFICANT		
Recreation	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Forest management	UNKNOWN	Riparian restoration	MEDIUM
Introduced species	UNKNOWN	—	MEDIUM
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Dewatering	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Transportation	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a high priority "Action" population (see Prioritization of Actions). The highest priority threats involve creating passage at the broad scale (passage at Kachess Dam) and at the local scale through monitoring and ensuring passage at the creek's mouth. Other actions that are identified as a priority are outreach to anglers and recreationists, riparian restoration as needed at campsites, and evaluating the feasibility of passage at Peekaboo Falls to provide additional spawning and rearing habitat. Available habitat was reduced when the reservoir was constructed and lower reaches were inundated. Addressing the threat of limited habitat should be considered with this population because it is physically possible and good quality habitat is available above the falls. This population is a good candidate for a pilot project that would place carcass analogs to address lack of marine derived nutrients. Salmon have been excluded from this system for ~100 years, there is suitable access for delivering carcasses, and the stream is short enough to allow for extensive data monitoring.

Completed Actions

- Campsite next to Peekaboo Falls was closed to overnight camping by USFS in 2002.
- Approximately 15 dispersed campsites along the creek were either re-engineered or closed and rehabilitated to protect sensitive riparian areas by USFS in 1996. There has been ongoing maintenance at the sites.
- With no flow at the mouth on August 23, 1996, USBR made channel modifications to provide passage.

- A 623-foot segment of Box Canyon Road (FS Road 4930), which was a chronic source of sediment, was relocated upslope and stabilized by USFS in 2006.
- Construction of a temporary straw bale and plastic flume near the confluence of Box Canyon Creek and Kachess Reservoir was required in 2001, 2003, and 2005 (Harvester 2001; Meyer 2001; Meyer 2005) to provide upstream bull trout passage.
- Fishing regulations have been implemented to protect bull trout in Box Canyon Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #4: Evaluate supplementation (see Appendix D).
- Box Canyon Creek #1: Monitor and fix as necessary passage impediments into stream for pre-spawn adfluvial adults migrating from Kachess Lake.
- Multiple Populations #1: Provide outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Box Canyon Creek #4: Conduct assessment and pilot study on feasibility of carcass analogs to enhance prey base for juveniles.
- Multiple Populations #9: Periodic entrainment studies at storage dams.
- Box Canyon Creek #2: Provide passage past Peekaboo Falls (and the second barrier immediately upstream) if habitat is determined to be suitable for bull trout spawning and rearing and if density dependent effects are found to be limiting juvenile production in accessible habitat.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within the established index areas to monitor long-term abundance trends.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring throughout the Box Canyon Creek drainage including above Peek-a-Boo Falls.

Implementation Monitoring of Completed and Recommended Actions

- Forest Service continues monitoring of restored riparian areas to ensure compliance with camping exclusions.

Threats Research & Monitoring

- Multiple Populations #7: Monitor for brook trout introgression when collecting genetic samples.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

Upper Kachess River

The upper Kachess River is the smaller of two streams in what is locally known as the Kachess/Mineral system. Mineral Creek joins the river approximately 1.2 miles above the reservoir (at full pool) and contributes an estimated 75% of the combined flow of the two streams (Meyer 2002). Despite this flow discrepancy the stream is referred to as the Kachess River below this confluence, a fact that has caused some confusion in the past. It is referred to as the *upper* Kachess River in this document to differentiate it from the short reach remaining below Kachess Dam before it flows into Lake Easton the Yakima River.

Mineral Creek originates in the Alpine Lakes Wilderness Area and the headwaters of the upper Kachess River originate on other lands managed by the Forest Service. The river flows into Kachess Lake at its northern end. Barrier waterfalls, which prohibit further upstream fish migration on Mineral Creek and the upper Kachess River, are located about 0.6 and 0.9 miles upstream of the confluence of the two streams, respectively. All accessible fish habitat in the two streams is in the Okanogan-Wenatchee National Forest. The upper Kachess River almost always goes dry for a considerable distance above the lake during late summer and early fall. Typically the river also experiences intermittent subsurface flows even further upstream in dry years (up to about a mile).

Population Distribution and Life History

The upper Kachess River population displays an adfluvial life history type. It is possible that a resident component exists as well although this has not been confirmed. The population spawns primarily in the upper Kachess River above the Mineral Creek confluence although a few redds are sometimes found below this point. While Mineral Creek contains some suitable spawning habitat bull trout do not appear to spawn there. Brown (1992) reported that three redds were found in the creek in 1980 but no bull trout redds or adult bull trout have been observed since. However, the surveys done in Mineral Creek are mostly spot checks and not part of the established index area so it is possible that some undetected spawning activity takes place. Juvenile bull trout are known to use both Mineral Creek and the upper Kachess River for rearing with their distribution extending to the lake. Kachess Lake provides FMO habitat for subadult and adult fish (Figure 21). Adults have been observed to migrate into the upper Kachess River in October, after fall rains have re-watered the reach above the lake (W. Meyer, WDFW, pers comm, 2012).

Population Status

The USFWS (1998) considered the Kachess River subpopulation to be depressed, decreasing, and at risk of stochastic extirpation. At the time this subpopulation did not include the upper Kachess River local population as bull trout spawning had not been observed yet in the upper Kachess River and a local population was not recognized. WDFW rates the status of the Kachess Lake stock (which included the upper Kachess River population) as critical, further stating that it was very near extirpation (WDFW 2004).

Results of genetic analyses show this population is genetically distinct from all other populations in the Yakima Basin (Reiss 2003; Small et al. 2009). Genetic samples for the baseline were collected from juveniles during a snorkel survey conducted in 1997 by CWU researchers assisted by WDFW biologists (Reiss 2003). Connectivity and thus the potential for genetic exchange with downstream populations in the Yakima River fluvial system was eliminated by the construction of Kachess Dam in 1912.

Population Trend

The spawning period for this population totally depends on fall precipitation rewatering the stream channel and allowing access to the stream. In a typical year, this period extends from mid-October thru mid-November, at least a full month later than for other bull trout populations in the Yakima Basin. While the rains provide necessary access for fish, they also can hamper the ability to monitor this population. The upper Kachess River responds quickly to rainfall, and high flows have often severely reduced or eliminated the ability to conduct complete redd surveys. There has been an attempt to conduct complete redd surveys in the river since 2000. These surveys cover the entire upper Kachess River from Kachess Lake (which is at low pool at that time) to the barrier waterfall, a distance of approximately 2.5 miles. The annual count has been highly variable (Figure 20). High flows in three years (2005, 2006, and 2009) resulted in incomplete surveys and very low counts. In 2008, high flows between survey passes are suspected of obscuring redds established between surveys. These conditions are not conducive to determining a trend for this population. Nonetheless the population is clearly small. Despite the upper Kachess River population's obvious obstacles (i.e., access and limited habitat area), it continues to persist. The highest redd count on record (33) was documented in 2011.

Population Monitoring

The documentation of bull trout in Kachess Lake was described above in the Box Canyon Creek population section. Adult bull trout (four) were first observed in October 1980 in the upper Kachess River by a WDFW (then Washington Department of Wildlife) electrofishing crew (USFS 1980). Brown also reported that adults were found in Mineral Creek and that bull trout redds (three in Mineral Creek and two in the Kachess River) were observed. Returning in 1993 on four separate dates between late August and mid-October, no adult bull trout were found, though juveniles were. A CWU graduate student reported the presence of "small" adult bull trout in the Kachess/Mineral system in July 1996, but found no redds when he returned in October (Craig 1996). In 1998, WDFW conducted an exploratory redd survey finding no redds and observing no adult bull trout. It was not until two years later that adult presence was once again documented,when 17 adults were observed in 11 snorkel surveys conducted from July thru November 2000 (Meyer 2002; James 2002a). That same year 15 bull trout redds were found in the first complete redd survey conducted.

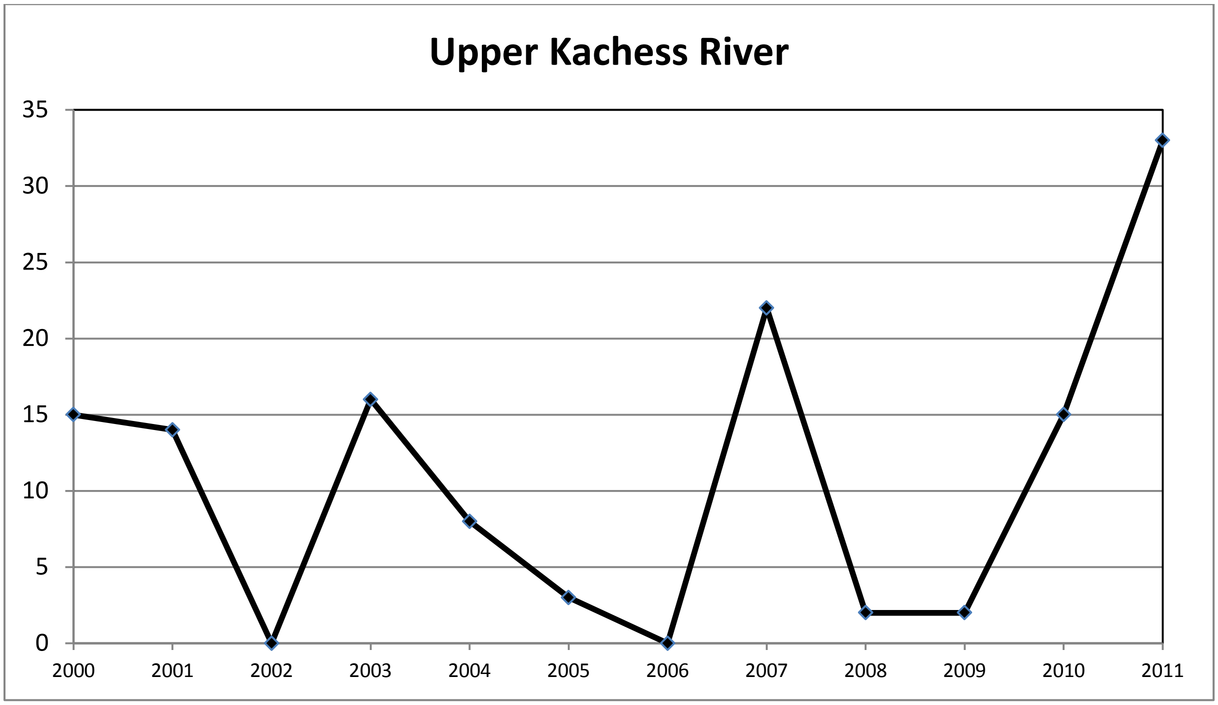


Figure 20. Bull trout redd counts in the upper Kachess River.

Through these efforts, it became clear that the timing of adult bull trout presence in the upper Kachess River was dependent on fall precipitation reconnecting the river with the lake and that the population was thus adfluvial. The redd surveys conducted since 2000 support this.

Juvenile bull trout presence in the Kachess/Mineral system was first documented in 1980 when WDFW conducted the electrofishing described above; bull trout were found in both streams. The Forest Service observed juveniles in snorkel surveys conducted in Mineral Creek in 1990 and 1991. Craig observed juvenile bull trout in the system in 1996 (Craig 1996). CWU researchers Paul and Brenda James, with assistance from WDFW, snorkeled about 0.7 mile in the Kachess/Mineral system in 1997 starting about a tenth of a mile below the confluence of the two streams and continuing up Mineral Creek to the barrier waterfall. They obtained genetic samples from 30 juvenile bull trout (Reiss 2003). In 2000 CWU graduate student William Meyer conducted snorkel surveys from late July through mid-November from the mouth of the upper Kachess River up to the barrier waterfall on the river. He observed both juvenile and adult bull trout. For his thesis work investigating the effects of seasonal dewatering on different age classes of bull trout, he calculated juvenile densities, determined adult migration and spawn timing, monitored stream discharge and channel condition, and documented life-stage specific mortalities resulting from channel dewatering (Meyer 2002).

In 2011, the USBR conducted an entrainment study directly below Kachess Dam. A screw trap and a fyke net were deployed in the river channel to capture fish entrained through the outlet works of the dam and passed to the river below. The sampling was done over a range of flow releases from mid-June through mid-October. Nearly 2,700 fish were captured during the course of the study representing 16 species, but no bull trout were collected (Arden Thomas, USBR, pers comm).

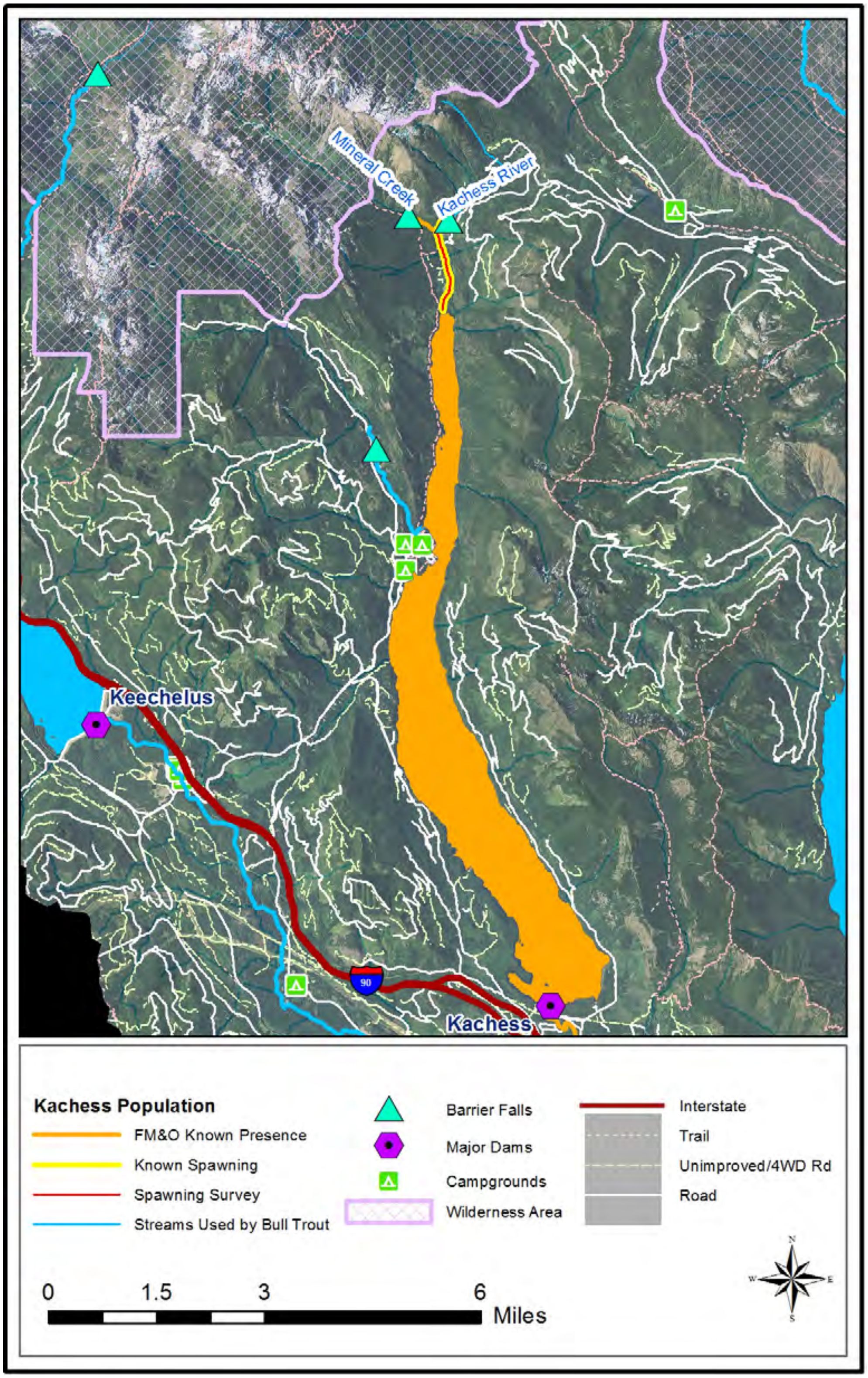


Figure 21. Kachess River subwatershed.

Habitat

Habitat Overview

Elevations on the upper Kachess River range from 2,270 feet at its mouth to about 2,500 feet at the barrier waterfall, a similar elevation as the base of the barrier falls on Mineral Creek. All of reaches accessible to bull trout in both streams are located in the Okanogan-Wenatchee National Forest. The upper Kachess River has a varied history of resource extraction (Meyer 2002). Copper deposits were discovered on Mineral Creek in the late 1800s. A wagon road was built shortly thereafter to extract ore mined from the hillsides adjacent to the creek. The tailings of the mining operation are still visible as are the remains of the mining operations, even though they ended long ago. The watershed was heavily logged from 1968 through 1987 with some harvest occurring directly adjacent to the lower segment of the upper Kachess River. The roads that were built to accommodate timber harvest have been decommissioned except for FS 4600, which does not impact the upper Kachess River and ends a short distance from the lower portion of it. Currently the main human activity in the watershed is recreation, which is limited to a hiking trail that crosses the lower river near where FS 4600 ends.

Habitat conditions in the upper Kachess system vary (except for water temperatures which are suitable throughout). Above the confluence of Mineral Creek and the Kachess River, the stream gradient of both streams is between 2 and 7% with channel widths ranging between 15 and 25 feet. Pools are frequent, LWD is prevalent and the availability of spawning-size gravels, at least in the upper Kachess River, is good. The riparian corridor on both streams is composed of typical old-growth understory species and is healthy. Below the confluence for a distance of about 0.5 mile, high alluvial banks frequently confine the river. The channel widens, stream gradient decreases to about 1%, and pool frequency and depth decreases. The riparian corridor shows some signs of past disturbance but can still be described as healthy. Below this reach habitat conditions change dramatically. The channel width often exceeds 150 feet; LWD is scarce. The segment contains mostly riffle habitat and few pools. It is within this reach, often beginning near its upstream end, that the upper Kachess River goes completely dry almost every year in the late summer and early fall. There may be short intermittent sections of flowing water, but for the most part the water in the river goes subsurface. These conditions are believed to result from the deposition of massive amounts of alluvial material, most likely tailings left from past copper mining activities, which washed down during flood events (Meyer 2002). The river generally remains disconnected from its upstream reaches until fall rains reconnect it, typically sometime in October.

FMO habitat for the upper Kachess River bull trout population is in Kachess Lake. Neither the sparse shoreline development or water sports activities on the lake are believed to influence habitat quality. The effects of reservoir depletion during the summer and early fall are less concerning in Kachess Lake than in any of the other Yakima basin impoundments. The reservoir has a conservation pool (i.e., dead storage) of well over 400,000 acre-feet that cannot be accessed for irrigation withdrawal.

Habitat Monitoring

Meyer (2002) studied the effects of dewatering on juvenile bull trout and adult migration. The lower reach of the upper Kachess River is generally dewatered from mid-summer until heavy precipitation waters the channel in late fall. Flows have been monitored during annual spawning surveys since 2000.

Mongillo (1982) measured water quality parameters and zooplankton densities in Kachess Reservoir. There has been limited Forest Service monitoring in this reach of the Kachess River. To date no habitat surveys, sediment monitoring efforts, road inventories, or even temperature monitoring have been conducted. This is identified as a monitoring gap.

Threats

The highest severity threats to this population are passage barriers (Kachess Dam) and low population abundance. Dewatering in the lower reaches of the spawning tributary also appears to be limiting the population, although this is likely natural or the legacy effect of logging and/or mining operations. Other threats include illegal angling in Kachess Lake, entrainment at Kachess Dam, lack of marine derived nutrients, presence of brook trout, and the limited habitat due to the inundation of lower reaches of the upper Kachess River when the dam was completed and the reservoir filled.

While forest management and recreation issues are present, they not considered a significant threat. Agriculture, altered flows, development, grazing, transportation issues, and mining are not present in this population area.

Table 15. Kachess River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low abundance	SIGNIFICANT	Monitor; evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Kachess Dam	HIGH
Dewatering	MOD SIGNIFICANT	Natural: no actions	HIGH
Angling	UNKNOWN SIGNIFICANT	Monitor; outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Kachess Dam	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Limited extent habitat	UNKNOWN	No action	MEDIUM
Forest management	LOW	—	LOW
Recreation	LOW	—	LOW

THREATS	Rating	ACTIONS	Priority
Agriculture	NOT PRESENT	—	NA
Altered flows	NOT PRESENT	—	NA
Development	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Transportation	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a “Protection” population with a priority for continuation of population monitoring, but with limited restoration actions recommended. The highest priority actions involve passage at the broad scale (passage at Kachess Dam) and potentially addressing low abundance via supplementation. Other recommended actions are outreach to educate anglers and recreationists and carcass analog placement if pilot study results from Box Canyon Creek are positive.

Completed Actions

- Fishing regulations have been implemented to protect bull trout in Kachess River (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #4: Conduct supplementation feasibility.
- Multiple Populations #1: Provide outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #9: Periodic entrainments surveys at storage dams.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within established index areas to monitor long-term trends in abundance.

Baseline Habitat Monitoring Actions

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

None

Threats Research & Monitoring

- Multiple Populations #7: Monitor any genetic samples for introgression with brook trout.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

Gold Creek

Gold Creek is one of several tributaries of Keechelus Lake, the uppermost storage reservoir in the Yakima Basin. Keechelus was a natural lake prior to the construction of Keechelus Dam on its outlet in 1917. The dam is the upstream terminus of the Yakima River, which continues 214 river miles downstream to the Columbia River. At full pool the reservoir holds 158,000 acre-feet of water with a surface area of 2562 acres. The dam is a complete barrier to migration isolating the only population of bull trout residing in Keechelus Lake, which spawns in Gold Creek. As is the case for the other adfluvial populations in the Yakima Basin the potential exists for individuals to be entrained through the unscreened outlet works of the dam and permanently displaced downstream.

Gold Creek originates in the Alpine Lakes Wilderness Area and flows into Keechelus Lake at its northern end. About 6.8 miles of Gold Creek is accessible to migratory fish up to a barrier waterfall. A bedrock cascade about a half-mile below this barrier may also impede upstream migration (Craig 1997). A little less than half of the stream's length below the waterfall is in the wilderness. Once Gold Creek exits the wilderness land use is a mix of National Forest, State and private. In this reach the channel typically dewaters intermittently during August and September in a section beginning just above the outlet of Gold Creek Pond at RM 0.6. The length of stream which dewaters varies, but the affected reach has been observed to extend for up to two miles upstream (Craig 1997).

Population Distribution and Life History

The Gold Creek population displays an adfluvial life history type. It is possible that a resident component exists as well although this has not been confirmed. The spawning area extends from the barrier waterfall downstream to the lake but bull trout usually spawn above the wilderness boundary if migration is possible through the reach below. Spawning is infrequently observed between the bedrock cascade and the waterfall. A major avalanche occurred sometime during the early spring of 2008 completely covering about a quarter-mile section of Gold Creek with large wood and rock debris, earth, snow, and ice. The affected reach was in the wilderness 3.75 miles above Keechelus Lake. It was feared that passage would be blocked to spawning habitat above it. This has fortunately not proven true as redds were found in and above the avalanche zone the following fall and in the two years following that. Rearing juveniles are present throughout the length of the stream. Keechelus Lake provides FMO habitat for subadult and adult fish (Figure 23). Timing of migration into Gold Creek is dependent on continuous stream flow during the late summer period. Some adult fish begin to move into the stream in late July to mid-August; in years when dewatering occurs there is a subset of adults that migrate after the stream rewaters with fall rains (James 2002a).

Population Status

The USFWS (USFWS 1998) considers the Keechelus subpopulation (i.e., Gold Creek) to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of the Keechelus Lake stock as critical (WDFW 2004).

Results of genetic analyses show the Gold Creek population is genetically distinct from all other populations in the Yakima Basin (Reiss 2003; Small et al. 2009). Initial genetic samples for the baseline were collected from juvenile bull trout during a snorkel surveys conducted in 2001

(Reiss 2003). Additional samples were collected in 2010 by the USFWS. Connectivity and thus the potential for genetic exchange with downstream populations in the Yakima River fluvial system was eliminated by the construction of Keechelus Dam in 1917.

Population Trend

The spawning period for the Gold Creek population begins in early September and can extend through mid-October. Complete bull trout redd surveys have been conducted since 1984 and cover the entire spawning area from the FS Road 4832 bridge up to the barrier waterfall. Redd counts have been highly variable (Figure 22). This probably reflects, at least in part, the migration difficulties that spawners frequently encounter as a result of the near annual dewatering of the channel. Years of low, medium, or high counts generally do not cluster. This makes it impossible to identify a population trend but it would be accurate to classify the Gold Creek population as small and vulnerable.

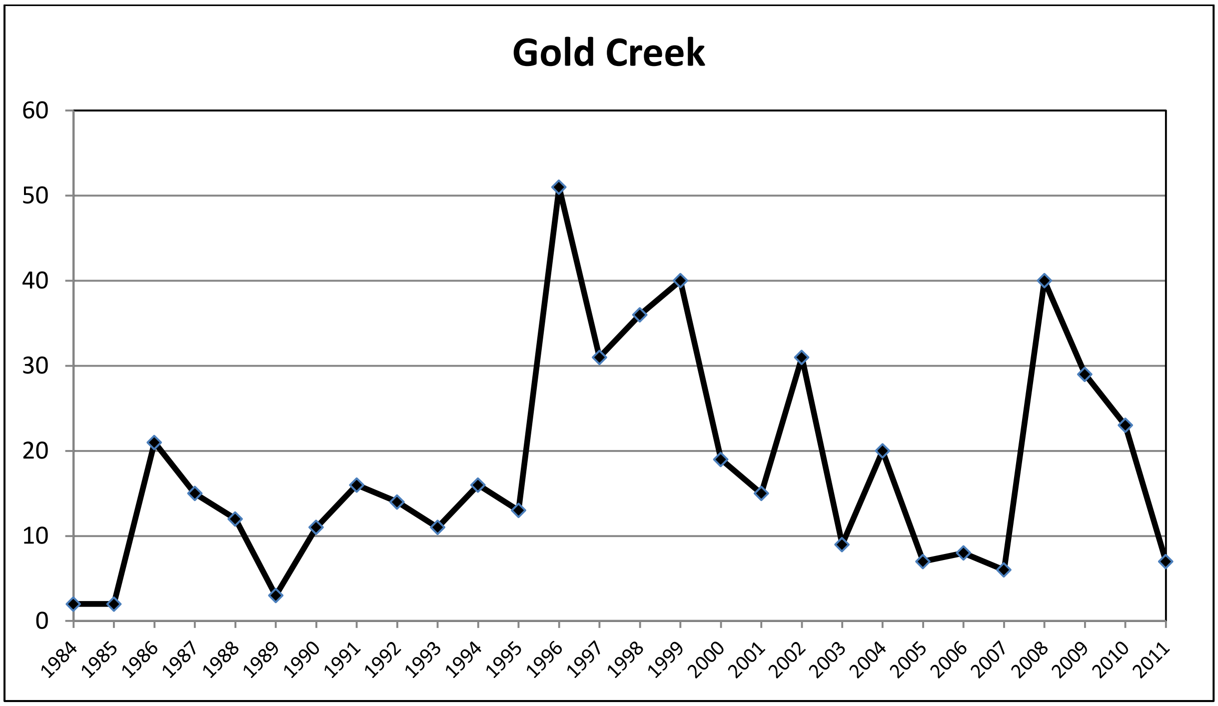


Figure 22. Bull trout redd counts in Gold Creek.

Population Monitoring

The first official documentation of the presence of bull trout in Keechelus Lake comes from 1982 when WDFW captured five adults in gill nets (Mongillo 1982). As noted above, spawning surveys in Gold Creek were initiated two years later and consistent monitoring of the Gold Creek bull trout population began. Other than these spawning surveys Gold Creek did not receive much attention until 1996 when CWU graduate student Scott Craig investigated habitat conditions affecting bull trout spawning areas in the creek (Craig 1997). To do so he used the redd count data collected during the annual spawning surveys.

CWU researcher Paul James studied the population status and life history characteristics of the Gold Creek population (James 2002a). To determine outmigration timing he attempted to trap post-spawn bull trout in the channel adjacent to Gold Creek Pond in 1999 without success. They did manage to trap three adults (and one juvenile) in 2000. That same year his crew conducted four daytime snorkel surveys to determine migration timing, observing 16 adults in the creek by the end of July. The stream became intermittently dewatered in late August, and he documented a few adults unable to migrate upstream of the Gold Creek Pond. Also in 2000, William Meyer conducted nine nighttime snorkel surveys in Gold Creek between 19 July and 9 November. He observed both adults and juvenile bull trout and reported juvenile densities lower than those observed in the upper Kachess River by 25-50% (Meyer 2002).

In 2001, snorkel surveys were conducted in Gold Creek by Yuki Reiss to capture juvenile bull trout and obtain genetic samples. Twenty samples were obtained, less than the number generally desired (30) to establish a genetic baseline Reiss (2003). The USFWS and WDFW returned to the creek in 2010 to collect additional genetic samples to supplement this baseline (See genetics baseline).

WDFW day and night snorkeled and electroshocked Gold Creek in 2003 as part of a project to develop a bull trout presence/absence sampling protocol (Hoffman et al. 2005). Larsen et al. (2003) examined these data in more detail with Peterson et al. (2005) providing final analysis.

In 2010, the USBR conducted an entrainment study directly below Keechelus dam. A screw trap was deployed in the river channel to capture fish entrained through the outlet works of the dam and passed to the river below. The sampling was done over a range of flow releases from mid-May through August. A total of 526 fish were captured during the course of the study, representing at least 11 species but no bull trout were collected (USBR 2010).

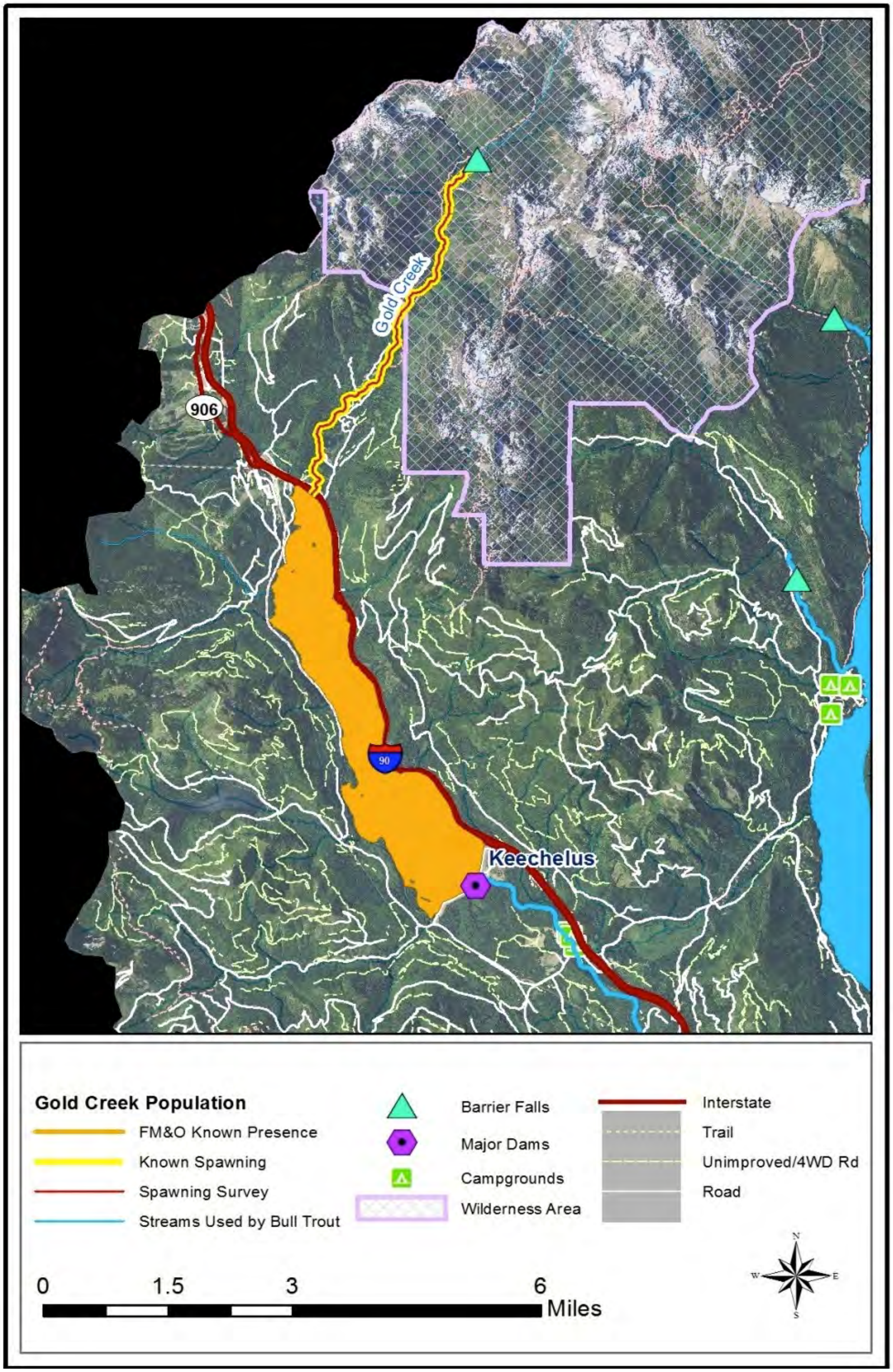


Figure 23. Gold Creek subwatershed.

HABITAT

Habitat Overview

Elevations on Gold Creek range from 2,530 feet at its mouth to around 3,500 feet at the barrier waterfall. Approximately 3.2 miles of the stream is in the Alpine Lakes Wilderness; the remainder flows mostly through National Forest lands with some State (former Plum Creek Timber Company) and private ownership in the lower 1.5 miles. Gold mining occurred in the upper part of the watershed in the late 1800s and early 1900s (prior to wilderness designation). It is unknown what impact these operations may have had on Gold Creek. From 1968 thru the mid-1980s extensive commercial logging of old growth occurred adjacent to the creek in the lower mile. Some of the logged lands were subsequently sold by Plum Creek and subdivided; a large number of seasonal-use private cabins are now present on the east side of Gold Creek between RM 1.5 and 1.8. The lower mile of the creek sustained a major impact in the late-1970s when gravel was mined from the floodplain for the construction of Interstate 90. The major current land use activity in the watershed is recreation. No campgrounds are present in the watershed, and dispersed campsites are not an issue.

The upper portion of Gold Creek from the barrier waterfall to about two miles below the wilderness boundary contains excellent habitat conditions for bull trout. For about a quarter-mile mile below this point several of the cabins mentioned above are located close to the stream's banks; mature riparian vegetation has been removed and the banks have become unstable. As a result property owners have made efforts to stabilize them to the detriment of instream habitat quality. Heavy equipment has operated in the channel, fine sediment has been mobilized, LWD has been removed, and the channel has been redirected in places. Downstream of the development the stream channel becomes progressively wider and more braided. Riffle habitat containing coarse substrate materials (cobbles and boulders) is predominant, and LWD is less prevalent; what is present is often isolated on cobble bars. The active base-flow channel is primarily located a significant distance from any riparian influence and intermittent dewatering frequently occurs in the reach.

The most serious effects of past land use practices on Gold Creek are in the lower mile of the creek. As a result of past old-growth harvest, almost no key pieces of LWD (i.e., large and immobile) are present to stabilize the channel and stream banks (Haring 2001). The creek has essentially "mined" those banks, increasing bed load and creating a channel that is extensively braided with widths frequently exceeding 200 feet (Meyer 2002). The channel dewatering prevents migrating adult bull trout from reaching spawning habitat upstream and can strand adult and juveniles present in the reach. Wissmar and Craig (1997) documented stranding mortality in Gold Creek in 1993 and 1994, estimating that 63% and 24%, respectively, of adult post-spawn bull trout died in these years. The loss of continuous surface flow is practically an annual event, which typically occurs in parts of August and September (Thomas 2001b; Meyer 2002). A dry streambed is usually first encountered just above RM 0.6 where the outlet of Gold Creek Pond enters the creek. The affected reach extends upstream a variable distance, which has been observed to be as much as two miles (Craig 1997). It characteristically has very short sections of flowing water and isolated pools indicating the stream is flowing not far below the surface of its bed. The causal mechanisms for this phenomenon have not been formally investigated but it is suspected that, in addition to channel condition, excavation of the 22-acre gravel pit (Gold Creek Pond) as well as other anthropomorphic hydrologic disturbances have occurred on the lower east side of the Gold Creek valley and are contributing factors. Often overlooked because of the problems upstream are potential passage problems on the reservoir bed. By late summer Keechelus Lake is depleted, and Gold Creek flows for a considerable distance (0.50-0.75 mile) across the exposed reservoir bed. The channel becomes extensively braided, and the main channel is poorly defined.

FMO habitat for the Gold Creek bull trout population is in Keechelus Lake. There is no shoreline development and water sports activities on the lake are believed to influence habitat quality. While the active pool of reservoir is significantly depleted over the course of the irrigation season (up to 94%), a conservation pool of over 156,000 acre-feet remains which cannot be accessed.

Habitat Monitoring

The Forest Service constructed a spawning channel between Gold Creek Pond and Gold Creek in 1972 and 1992. Goetz (1997) monitored the relationship between habitat and bull trout juvenile rearing. Mongillo (1982) measured water quality parameters and zooplankton densities for Keechelus Reservoir. USBR examined Keechelus Lake limnology from 1998-2001, and data are reported in Ackerman et al. (2002).

Sediment samples were collected in 1990. Fine sediment levels averaged 4.7-13.2% across the three reaches that were sampled (Mayo 1998). The Forest Service completed a stream survey of seven 100 meter sections of Gold Creek in 1998, using Timber, Fish and Wildlife protocol (USFS 1998b). Channel type, LWD, flow, temperature, bankfull width, and pool/riffle ratios were measured during this survey. In 2004, a Federal Roads Analysis was completed for the Gold Creek watershed, including an aquatic rating.

Craig (1997) monitored habitat conditions that affect bull trout spawning in several Yakima Basin spawning tributaries including Gold Creek. Dewatering often prevents upstream and downstream migration of adult bull trout in Gold Creek. Thomas (Thomas 2001b) summarized dates, years, flows, and reservoir elevations when Gold Creek was not passable to upstream migrating adult bull trout. Similar data for Coal, Cold, and Meadow creeks, and Keechelus Lake tributaries was summarized.

Willey (2007) collected 2005-2007 temperature data in Gold Creek. Gold Creek was monitored for temperature via thermographs deployed during the summer low flow period at three sites in 2007 and two other sites in 2010 (USFS 2011b). Consistent temperature data are a monitoring gap.

Threats

One of the highest severity threats to this population is the frequent channel dewatering within the spawning reach that results in direct mortality and limits access to spawning habitat upstream. Other high severity threats include low population abundance and the passage barrier at Keechelus Dam. Other threats include illegal angling in Keechelus Lake, development in the lower reaches of Gold Creek, entrainment at Keechelus Dam, lack of marine derived nutrients, and documented introgression with brook trout.

While forest management and recreation issues are present, they are not thought to be significant. Interstate-90 crosses Gold Creek at its mouth (when the reservoir is at full pool) significantly impacting floodplain function; however effects on bull trout are unknown. Agriculture, altered flows, grazing, limited habitat, and mining are not present in this population area.

Table 16. Gold Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Dewatering	SIGNIFICANT	Hydrological assessment; floodplain restoration	HIGH
Low abundance	SIGNIFICANT	Evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Keechelus Dam	HIGH
Angling	UNKNOWN SIGNIFICANT	Monitor; outreach	MEDIUM
Development	UNKNOWN SIGNIFICANT	Land acquisition; monitor bank stabilization projects	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Keechelus Dam	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Transportation	UNKNOWN LOW	—	LOW
Forest management	LOW	—	LOW
Recreation	LOW	—	LOW
Agriculture	NOT PRESENT	—	NA
Altered Flows	NOT PRESENT	—	NA
Grazing	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA
Mining	NOT PRESENT	—	NA

Actions

Strategy

This population has been identified as a high priority "Action" population (see Prioritization of Actions). The highest priority action for this population is a hydrologic assessment and subsequent restoration project to connect dewatered sections in the stream, which strand fish and prevent access to spawning grounds. Other high priority actions include passage at Keechelus

Dam and an evaluation of supplementation to address low abundance. Other actions to address threats include outreach, protection from future development and carcass analog placement if a pilot study conducted elsewhere in the basin is successful. There have been documented hybrids in the system, and introgression with brook trout should continue to be monitored, although no large-scale removal actions are recommended at this time.

Completed Actions

- WSDOT purchased 550 acres on west side of lower Gold Creek around 2008 (ownership has since been transferred to the Forest Service).
- The Cascade Land Conservancy has purchased a total of 221 acres on the east side of lower Gold Creek since 2008.
- Length expansion of the Interstate-90 bridge over lower Gold Creek, a WSDOT project benefitting the lower Gold Creek floodplain, is scheduled to be completed in 2012.
- Fishing regulations have been implemented to protect bull trout in Gold Creek (see Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Gold Creek #1: Conduct comprehensive hydrogeomorphic evaluation in lower Gold Creek to determine the causal mechanisms (and possible solutions) for annual dewatering. Implement solutions if determined to be feasible.
- Gold Creek #2: Gold Creek Floodplain Restoration would include the removal of legacy dikes and road fill from the gravel pit operation, relocation of an ADA-accessible trail away from Gold Creek, relocation of the footbridge out of the floodplain, restoration of hydraulic connectivity through the parking area, and installation of an engineered logjam in Gold Creek (USFS).
- Multiple Populations #4: Evaluate supplementation (see Appendix D).
- Multiple Populations #1: Provide outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).
- Multiple Populations #5: Carcass analog placement if pilot studies demonstrate success.
- Gold Creek #4: Floodplain acquisition/easements in lower creek corridor.
- Gold Creek #5: Monitor, document, and fix (where possible) passage problems due to dewatering on the reservoir bed on an annual basis.
- Multiple Populations #9: Periodic entrainment studies at dams.

Population Monitoring

- Multiple Populations #2: Continue redd surveys within established index areas to monitor long-term trends in abundance.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

- If instream work is completed to address the dewatering issues, monitoring of flows post-treatment will be critical.

Research, Monitoring, and Evaluation

- Gold Creek #3: Monitor all bank stabilization projects that include instream work.

- Multiple Populations #7: Continue to screen all collected genetic samples for evidence of genetic introgression with brook trout.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

None

Teanaway River

The Teanaway River is a tributary to the Yakima River, entering the river at RM 176. The river system consists of three forks: The North Fork is 16 miles long, the Middle Fork is 12, and West Fork is 8 miles long. Below the confluence of the three forks the mainstem Teanaway River flows for another 11.7 miles before entering the Yakima River. In the North Fork numerous small tributaries enter the stream, DeRoux, Jungle, Jack, Beverly and Stafford creeks being the most significant. All of the lands in the Teanaway watershed are owned and managed by the Forest Service, the State of Washington, timber companies, or are classified as rural residential.

The Teanaway system was historically one of the top producers of spring Chinook salmon, steelhead, and coho salmon in the Yakima Basin (Bryant and Parkhurst 1950). These stocks were essentially eliminated from the Teanaway River by the middle of 20th century if not earlier. They are rebounding somewhat as a result of recent restoration efforts.

Population Distribution and Life History

Little is known about the bull trout that inhabit the Teanaway River system. It is speculated that a fluvial population existed historically, but evidence suggests it may no longer. It is also possible that there was a resident component but this has not been confirmed. Currently only a single population is recognized in the Teanaway system, and it is classified as fluvial/resident (USFWS 1998; WDFW 2004). In this document, the population is referred to as the North Fork Teanaway River population based on the fact that bull trout redds have only been observed in the upper 1.5 miles of this fork, and in DeRoux Creek, a tributary entering at RM 14.5. A few bull trout have been observed in the Teanaway River below the forks by the Yakima Species Interaction Study (YSIS) team, whose members snorkeled and electro-fished throughout the Teanaway drainage from 1991 to 2010. They did not find bull trout (any life stage) in either the Teanaway's west or middle forks.

Population Status

The USFWS (1998) considers the North Fork Teanaway River subpopulation to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of the North Fork Teanaway River stock as critical (WDFW 2004).

Results of genetic analyses show the North Fork Teanaway River population is genetically distinct from all other populations in the Yakima Basin (Reiss 2003; Small et al. 2009). Genetic samples for the baseline were collected from juvenile bull trout during a snorkel surveys conducted in 2001; however, only 11 samples were obtained, not the 30+ that is considered optimal for genetic analysis (Reiss 2003).

Population Trend

There is some question as to whether a viable population still exists in the North Fork Teanaway River. Only six redds have been observed since the first exploratory spawning survey was conducted in 1996 including the two found that year. Although all six of these redds were unoccupied, they were presumably bull trout redds as no other fall-spawning salmonids utilize the area. Four were found between the mouth of DeRoux Creek at RM 14.5 and a barrier waterfall at RM 16, and two were observed in DeRoux Creek (Figure 24). Between 1996 and

2005, no redd surveys were conducted in the North Fork Teanaway River. Since 2005 complete surveys have been conducted in only three years (2007, 2009, 2011). These surveys covered the 1.5-mile long reach described above and also about a mile of DeRoux Creek from the mouth to a barrier waterfall. No more than two redds have been found in any year and the last observed, a single redd, was in 2009. Extensive efforts to locate fish in the North Fork Teanaway River have also had limited success. The last bull trout sighting in the North Fork Teanaway River, its tributaries, or in the mainstem Teanaway River below the forks was in 2006. A detailed description of all documented bull trout observations in the Teanaway River appears below in the Population Monitoring section.

A viable population may no longer exist in the North Fork Teanaway River. If it does, it appears to be on the brink of extirpation.

Population Monitoring

The earliest known reference to bull trout presence in the Teanaway subbasin comes from a 1936 Washington Bureau of Fisheries report that lists them as present in the North Fork Teanaway River, the mainstem Teanaway River, and Beverly Creek (McIntosh 1990). It is not well documented if fish populations in the system received any significant monitoring attention again until the 1990s when Forest Service and WDFW Ecological Interactions Team (EIT) biologists became active.

In 1992, the Forest Service conducted night snorkel surveys at several locations throughout the Teanaway drainage (north, west, and middle forks) and found no bull trout (USFS 1992). In 1993 and 1994, the Forest Service conducted snorkel surveys in the North Fork Teanaway and West Fork Teanaway rivers and Stafford Creek. During these surveys, four juveniles were observed in the North Fork in 1993; none were observed elsewhere. The Forest Service returned to the North Fork to snorkel in 1996, Stafford Creek in 1998 and 1999, and DeRoux Creek in 1998. No bull trout were observed during any of these surveys. The Forest Service conducted extensive snorkel surveys in the Middle Fork Teanaway River in 2003 and encountered no bull trout (Haskins 2003). The USFWS conducted snorkel surveys in 2005 in the North Fork Teanaway River and DeRoux Creek with the same result (Morgan 2005). Bull trout were once again located in the North Fork Teanaway River in 2006 when five were seen by snorkelers (Reiss 2006). During that same snorkeling effort none were observed in De Roux, Jack, or Stafford creeks. These five juvenile fish were the last confirmed bull trout sightings in the Teanaway system. Night snorkel surveys conducted in the North Fork in 2009, 2010, and 2011 produced no bull trout observations (USFWS 2009; Reiss 2010; Reiss 2011).

The most consistent information about bull trout in the North Fork Teanaway system is available from EIT surveys. EIT crews tagged 6 bull trout in the North Fork Teanaway River in 1990 and 1992, and captured 17 bull trout in traps from 1991-1995, including 2 juveniles in Jungle Creek in 1994 and 1 in Jack Creek in 1995. The EIT team observed 4 juvenile bull trout while snorkeling the North Fork Teanaway River in 1994, including an adult 500+ mm in length. From 1997-2008, crews surveyed designated reaches on the mainstem North Fork Teanaway in August or September and recorded information about all species seen. A summary of bull trout sighted during these snorkel surveys is in the table below. When bull trout were not found in the three years after 2005, this survey was subsequently dropped from the EIT sampling scheme in 2009 (G. Temple, WDFW, pers comm 2012).

In 2001, Reiss and crew collected 11 bull trout fin clip genetic samples in one night of snorkeling (Reiss 2003). This snorkel effort was for a thesis project, and covered approximately 3,000 meters of the mainstem North Fork Teanaway River in the reach between Johnson and Eldorado creeks.

Bull trout sightings recorded by EIT snorkel teams in the North Fork Teanaway.

Year	Total # of bull trout seen (night snorkel surveys)	Size Range
1997	4	Not taken
1998	12	225-700 mm
1999	20	61-660 mm
2000	13	63-720 mm
2001	20	100-650 mm
2002	13	Young of year-440
2003	16	45-280
2004	0	NA
2005	2	180, 220
2006	0	NA
2007	0	NA
2008	0	NA

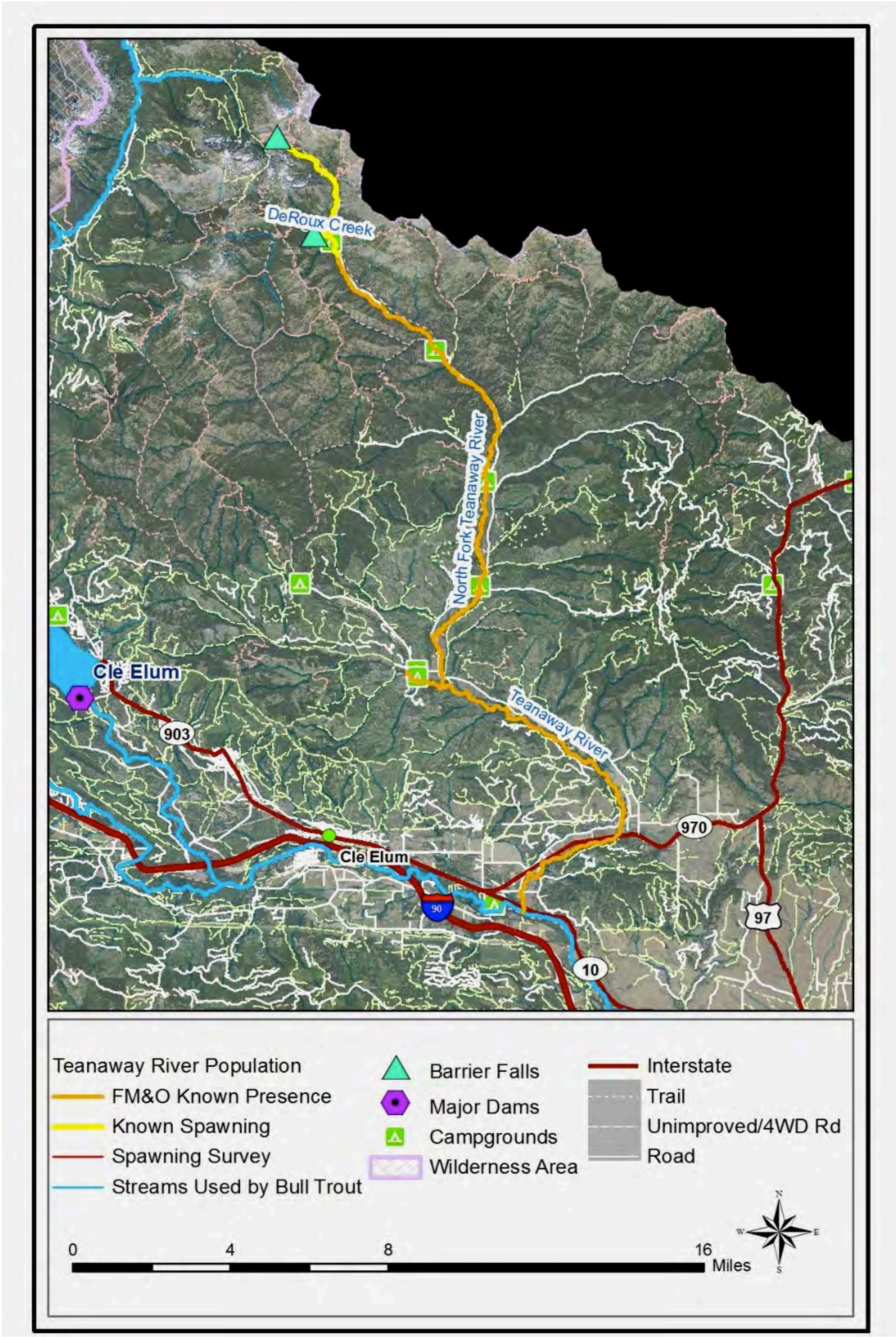


Figure 24. Teanaway River subwatershed.

Habitat

Habitat Overview

The upper 1.5 miles of the North Fork Teanaway River (below a barrier waterfall) and the lower mile of DeRoux Creek are the only areas in the Teanaway system where presumed bull trout redds have been observed. These areas are located in the Okanogan-Wenatchee National Forest. Elevations in these areas range from 3,800-4,300 feet. Mining occurred in the early 1900s in the headwaters of the North Fork Teanaway River and a Forest Service road parallels the river along the entire reach. The impact the mining activities may have had on the creek is unknown but is not evident today; the road generally runs along a terrace above and away from the stream and is not believed to impact habitat quality. Habitat conditions for bull trout spawning and rearing are considered good in both this reach of the North Fork Teanaway River and DeRoux Creek.

Lower in the North Fork Teanaway River, land ownership is a mix of State, private timber company, and rural residential holdings. The impacts of human occupation on the river and its tributaries are greater in the lower reaches than they are in the spawning area. Historic disturbances include intensive sheep grazing, logging, splash dam log drives, stream cleanout (to accommodate the log drives), water diversion, and road and rail construction. Cattle have since replaced sheep and grazing practices have improved and water withdrawals are better managed. However, more recent activities affecting habitat in the North Fork Teanaway River have emerged. These include increased recreational use and rapidly accelerating residential development. The result of these past and current activities is a loss of habitat quantity and quality for all salmonids in the North Fork Teanaway River. Riparian vegetation has been removed, bank stability has been compromised, LWD is lacking, and pool frequency and depth ratings are below Forest Plan standards, and the stream is currently listed on the State's 303d list as "water quality impaired" for water temperatures (USFS 2009b). While considerable success has been achieved over the last decade in containing and shrinking the footprint of watershed disturbance, the Forest Service concludes that the Teanaway watershed is currently not functioning properly.

The effects identified above can be repeated and magnified for the mainstem Teanaway River below the forks. Impacts from agricultural development are much greater in the mainstem then in the North Fork Teanaway River. The river flows through a broad valley consisting mainly of irrigated hayfields although rural residential home sites are rapidly being developed. Much of the channel has been rerouted to the edge of the valley and confined by dikes; riparian vegetation is sparse. LWD has generally been removed from this reach to minimize the potential for bank erosion or channel change. In addition, State Route 970 functions as a levee in the lower four miles, constraining floodplain function and natural channel migration during peak flow events (Haring 2001). Historically, flow depletion resulting from water diversions has been a huge problem in the mainstem and complete dewatering has occurred. While various water conservation projects have improved instream flows in the river over the last 10-15 years, flow depletion in the lower mainstem still occurs to some degree. This may impede bull trout migration at certain times of the year, not just physically but as a result of thermal barriers as well. Most of the diversions on the Teanaway River were unscreened in the past, causing direct mortality for fish entrained in them. This problem has been addressed through the efforts of numerous entities and is no longer an issue.

Habitat Monitoring

The USFWS conducted a habitat and fish barrier survey on the North Fork Teanaway River, DeRoux Creek, and Teanaway River in 1935-1936 (McIntosh 1990). In addition to other salmonids, Dolly Varden (bull trout) were reported to be present but scarce. From the late 1800's through the early 1900's, the streambed was scoured during log drives (1996; April 23, 1891).

In 2001, the Forest Service contracted aerial thermal infrared remote sensing surveys on the mainstem Teanaway River (mouth to forks), the North Fork Teanaway River (mouth to DeRoux Creek), the Middle Fork Teanaway River (mouth to Jolly Creek), and on the West Fork Teanaway River (mouth to Tumble Creek) (Watershed Sciences 2002). Accuracy of temperatures was confirmed with instream sensors. The flights were completed in early September. Stream temperatures on the mainstem Teanaway River ranged from 16.9-20.4 °C. In the North Fork Teanaway, temperatures ranged from 19.4 °C at the mouth to 9.4 °C at the upstream end where bull trout are generally found. In the Middle Fork and West Fork Teanaway rivers the range was 11.0-12.7 °C and 10.9-20.9 °C, respectively.

The Forest Service collected and analyzed sediment samples for three reaches in the North Fork Teanaway River in 1990 and 1995 and from 2000-2011 (W. Ehinger, USFS, pers comm). In 2009, an Aquatic Species Environmental Baseline was completed for the Teanaway watershed (USFS 2009b). In 2004, a Federal Roads Analysis was completed for the Teanaway watershed, including an aquatic rating.

The Forest Service completed a stream surveys in 1992, 1997, 1998, and 2006. Cle Elum Ranger District (USFS 2006b) conducted habitat surveys on the following tributaries to the North Fork Teanaway: Jungle, Stafford, Beverly, Johnson and DeRoux creeks. In these surveys, data were collected on pool/riffle frequency, riparian and channel condition, substrate, LWD, and temperature.

The North Fork Teanaway River (above Stafford Creek confluence) was monitored for temperature via a thermograph deployed during the summer low flow period from 1994-2011(no data from 1999) (USFS 2011b). Four other sites in the North Fork Teanaway and all tributaries (DeRoux, Johnson, Beverly, Stafford, Bear, Standup, Miller, Jack, Jungle creeks) have been monitored periodically during the same time period. Temperature data on DeRoux Creek since 2004 is a monitoring gap.

Morgan (2005) observed recreational dams during snorkel surveys.

Threats

The highest severity threat to the Teanaway River population is low abundance given that no bull trout have been positively identified in this system since 2006. Other threats include altered flows in the lower reaches of the mainstem (which may impede migration), illegal angling in the open or closed sections of the river, passage barriers in the form of recreation dams, habitat degradation and harassment due to development, recreation, agriculture and/or forest management. Cattle grazing along the mainstem and North Fork Teanaway rivers also appears to be degrading the stream banks and riparian zones.

Unlike many of the streams in the Yakima Basin, brook trout are not found within the presumed spawning and rearing areas for bull trout. However, the species is found in tributaries. This threat (introduced species) is not currently considered significant but should be monitored. Transportation issues (associated with the paved road along the mainstem Teanaway River) and mining are not believed to be significant. Entrainment due to irrigation withdrawals in the lower reaches of the Teanaway River have been, and continue to be, addressed through ongoing diversion screening efforts. Natural dewatering and limited extent of habitat are not present.

Table 17. Teanaway River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Low abundance	SIGNIFICANT	Snorkel surveys; evaluate supplementation	HIGH
Altered flows	UNKNOWN SIGNIFICANT	Increase instream flows	MEDIUM
Angling	UNKNOWN SIGNIFICANT	Monitoring; outreach	MEDIUM
Development	UNKNOWN SIGNIFICANT	Land acquisition	MEDIUM
Prey Base	UNKNOWN SIGNIFICANT	Carcass analogs	MEDIUM
Recreation	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Passage barriers	UNKNOWN SIGNIFICANT	Remove recreation dams	MEDIUM
Agriculture	UNKNOWN	Habitat surveys	MEDIUM
Forest management	UNKNOWN	Reduce road densities	MEDIUM
Grazing	UNKNOWN	Maintain cattle exclusion	MEDIUM
Introduced species	UNKNOWN LOW	—	LOW
Transportation	UNKNOWN LOW	—	LOW
Mining	UNKNOWN LOW	—	LOW
Entrainment	LOW	—	LOW
Dewatering	NOT PRESENT	—	NA
Limited extent habitat	NOT PRESENT	—	NA

Actions

Strategy

Currently this is identified as a "Monitor" population with a low priority to implement actions specifically to benefit bull trout. However, this population has been identified as a candidate for supplementation/reintroduction (see Appendix D). For this to proceed addressing the identified threats would be essential and the Teanaway River population would shift to an "Action" population. Land in the Teanaway drainage is primarily owned and managed by the Forest Service, American Forestry Resources (AFR), and private interests. Addressing threats would require working cooperatively with all landowners to address habitat and floodplain restoration, increasing instream flows, and protecting large parcels from development and fragmentation. This work is currently a high priority of broader salmon recovery efforts. A Broad Scale Action that would be beneficial to bull trout in the Teanaway system is to Restore Healthy Salmon Populations.

Completed Actions

- Culvert replacements on Indian and Jack creeks (North Fork tributaries) were completed in 2009. (See SRFB project 07-1517).
- The decommissioning of a gravity diversion and removal of a push-up berm on the mainstem Teanaway River is scheduled for completion in 2012. (See SRFB project 09-1612, 3M Ditch Project.)
- Several large gravity fed diversions were replaced with pump stations (at Lambert and Red Bridge roads) in the late 1990s, removing passage barriers allowing water to be left instream several miles to the new diversions, and reducing overall irrigation diversions. Flooding in 2010 damaged the new pump stations; the Lambert Road diversion was replaced in 2011 by USBR, and the Red Bridge Road diversion is scheduled for completion in 2012-13 (see SRFB project 10-1847).
- Numerous projects to augment instream flows have been completed (WDOE/YRBWEP).
- Numerous dispersed campsites have been closed and rehabilitated by the Forest Service along the North Fork Teanaway River and Stafford Creek over the last 10 years.
- Jack Creek channel and floodplain restoration along lower two miles of creek will be completed in 2012 (see SRFB project 10-1786).
- Relocation of FS Road 9738 out of the active floodplain of Jack Creek was completed in 2011.
- Fishing regulations have been implemented to protect bull trout in the Teanaway River system (See Appendix F).

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Multiple Populations #4: Evaluate supplementation (see Appendix D).
- Teanaway River #2: Continue to pursue water conservation projects and water lease/purchase agreements to enhance summer instream flows.
- Multiple Populations #1: Provide outreach on bull trout conservation issues to landowners, recreationists, anglers, school groups, and others.
- Teanaway River #4: Acquire floodplain areas or obtain easements.
- Teanaway River #5: Reduce road densities.
- Teanaway River #6: Implement cattle exclusion from and restoration of riparian areas.

Population Monitoring

- Teanaway River #1: Continue snorkel surveys on an annual basis to document presence of any bull trout in the North Fork Teanaway River or DeRoux Creek. Capture any bull trout found and insert a PIT tag to help determine movement patterns (using fixed sites that have already been established for steelhead monitoring).

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

None

Research, Monitoring, and Evaluation

- Teanaway River #3: Conduct habitat surveys to determine the extent of habitat degradation from recreational impacts, development, agriculture, and grazing. Develop habitat improvement projects as warranted.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Upper Yakima #4: Improve instream flows in Swauk Creek and Teanaway River watersheds
Upper Yakima #13: Protect and restore floodplain, riparian, and in-channel habitats in Upper Yakima, Kittitas and Easton/Cle Elum reaches
Upper Yakima #14: Restore instream and floodplain habitat complexity in Swauk and Taneum creeks and Teanaway and lower Cle Elum rivers
Upper Yakima #15: Restore tributary riparian areas
Upper Yakima #16: Build conservation easements and other habitat protections into development plans
Upper Yakima #17: Protect Teanaway watershed from negative impacts of development
Upper Yakima #18: Relocate forest roads and campsites and revegetate clearcuts in the Teanaway watershed

Upper Yakima River

The Yakima River begins at the outlet of Keechelus Dam and flows southeasterly for about 214 miles to its confluence with the Columbia River. The rivers major tributaries include the Naches River at RM 117.2, the Teanaway River at RM 176, and the Cle Elum River at RM 186.6. The Yakima River also has many smaller tributaries too numerous to mention. The river flows through both public (Federal and State) and private lands with the former more prevalent in the upper reaches of the river and the latter more prevalent in the lower reaches. The Yakima River is heavily regulated. The flow regime is significantly affected by water storage operations at the reservoirs—three of them are in close proximity to one another in the upper Yakima basin—and by irrigation water withdrawal at six major diversion dams located along the course of the river. With so many points of inflow and outflow, the river has many different reach-specific flow regimes. All of them are characterized by stream discharges that are lower in the winter and spring than would occur under unregulated conditions. In the upper half of the river, summer flows are significantly higher than unregulated flows would be. In the lower half of the river, major diversions reduce summer flows below what would occur naturally.

About 12 miles below Keechelus Dam, the river is diverted for the first time at Easton Diversion Dam. This dam forms Lake Easton, a 237-acre impoundment (at full pool) that also captures the outflow from Kachess Dam located slightly less than a mile upstream of the lake. Easton Diversion Dam is equipped with upstream and downstream fish passage facilities as are the other diversion dams in the Yakima Basin. The river reach extending from the dam down to the Teanaway River confluence is the most productive spring chinook salmon spawning area in the Yakima Basin. These fish also spawn in significant numbers in the 11-mile reach between Lake Easton and Keechelus Dam. It is in this reach that the only documented bull trout spawning activity in the Yakima River has been observed.

Population Distribution and Life History

At the time of listing the USFWS found no evidence that a subpopulation of bull trout remained in the mainstem Yakima River (USFWS 1998). The WDFW, however, did recognize a mainstem Yakima stock (WDFW 2004). The assignment of stock status was based on old catch records, anecdotal accounts, and a relative few adult bull trout captures occurring in the 1990s. One of these fish was captured just 28 miles above the mouth of the Yakima River, one was illegally harvested by an angler in Lake Easton, and four were collected between Cle Elum and Ellensburg. Until 2000, no bull trout redds had been found in the Yakima River and no bull trout had been observed in the upper river between Keechelus Dam and Lake Easton. In that year, bull trout redds (two) were found in the reach, with adults observed in close proximity. Six additional redds and a few adults have been observed in the reach between 2001-2007 (see the Population Trends and Populations Monitoring sections below for more detailed information concerning redd and fish observations).

In the 2000s, Yakama Nation (YN) biologists have routinely captured bull trout during spring Chinook brood stock collection at the Roza Dam facility located at RM 128. Twenty bull trout were captured (and released) in 1999. In the years since between one and five bull trout have been documented annually. These fish have all been in the 200-400 mm size range (Mark Johnston, YN, pers comm). Scale, genetic samples and biological data (size, weight, sex) have been collected on bull trout captured since the mid-2000s.

Considering this information it is difficult to ascertain the demographics and life history of the bull trout population in the mainstem Yakima River. The bull trout that have been observed could belong to a single population group that spawns above Lake Easton but will migrate long distances when conditions (e.g., water temperatures) are favorable. It is also possible that some are fluvial fish belonging to an undiscovered spawning population. There are also questions about the origin of this population. Although no bull trout were captured in USBR's 2010 Keechelus Dam entrainment study (USBR 2010), bull trout from Keechelus Lake have been entrained through the dam's outlet works in the past. A very large (>750 mm) adult bull trout, which probably came from the lake, was found dead by YN biologists conducting a spring chinook redd survey in 2001. Two adult bull trout, one dead and the other close to it, were retrieved from the outlet tunnel of Keechelus Dam during a maintenance inspection in the winter of 2004. In 2005, an adult bull trout was caught directly below Kachess Dam. A subsequent genetic analysis linked this fish to the Gold Creek population in Keechelus Lake. Whatever their origin, there now appears to be a group of bull trout, apparently small, that spawns in the upper Yakima River and displays a fluvial life history type.

Population Status

At the time of listing the USFWS found no evidence that a subpopulation of bull trout remained in the mainstem Yakima River (USFWS 1998). WDFW rates the status of the Yakima River stock as critical (WDFW 2004).

Very few genetic samples have been collected from bull trout in the Upper Yakima River. As mentioned above, an analysis done on a genetic sample taken from an adult bull trout caught at the base of Kachess Dam in 2005 genetically assigned the fish to the Gold Creek population. In 2011, Ecological Interactions Team (EIT) crews captured one juvenile bull trout near Lake Easton, but the genetic sample taken from this fish has not yet been analyzed. There are eight genetics samples available from fish captured at Roza Dam. Two of these samples have been analyzed and the fish genetically assigned to the Rattlesnake and Indian Creek populations (see Genetics Baseline). Analysis of the remaining samples and of those collected in the future should provide information that will help to determine the origin and status of this population.

Population Trend

A bull trout redd survey was first conducted in the 11-mile reach between Keechelus Dam and Lake Easton in 2000 when two redds were found near Crystal Springs less than a mile below the dam. Surveys were conducted in 6 of the next 11 years (2001-2003, 2006-2007, and 2011) with 6 additional redds found. A defined index area has not been established and most of these surveys cannot be described as complete. A single redd was found in 2001 and in 2003. The most extensive effort to completely survey the reach was undertaken from mid-September through late October 2002. Four passes were made in the upper three miles of the reach, three passes in a six-mile section directly below it, and one pass in the lower two miles of the reach where a redd had been found at the mouth of Cabin Creek the previous year. Despite the effort no confirmed bull trout redds were documented. Three redds were observed in 2006 with one reported in 2007; no redds were observed in an incomplete survey done in 2011. One of the pitfalls of surveying this reach is the presence of spring chinook salmon that spawn in mid-September and an abundant population of brook trout that spawn shortly thereafter. Only a few of the bull trout redds observed over the period of record had fish associated with them. This leaves some question as to whether the unoccupied redds were actually those of bull trout. This was the case in 2002 when four suspected bull trout redds were observed, but were recorded as “possible” because no bull trout were observed on or near them.

A population trend cannot be derived from these data. This population, if it can actually be considered distinct, appears to be very small.

Population Monitoring

Most of the monitoring history for this population has been covered above to describe distribution and trend. Details on other monitoring work are provided below.

The YKFP Ecological Interactions Team (EIT) has established fish monitoring sites in the Upper Yakima River and electrofishing surveys have been conducted annually during the fall period (1991-present). There are five 2.8-mile long index reaches between the confluence with the Cle Elum River (~RM 195) and the Roza Diversion Dam (RM 128). Only four bull trout have been captured at these sites: 1992 (474 mm), 1994 (205 mm), 1995 (433 mm) and 2011 (153 mm). Three of these fish were caught near Cle Elum and one near Ellensburg (G. Temple, WDFW, pers comm 2012).

The EIT also has used minnow traps in tributaries for monitoring, and an adult bull trout was caught in a trap about 0.1 mile up Swauk Creek (an upper Yakima River tributary) in 1993. It was assumed to have migrated up the creek from the Yakima River but the population of origin is unknown (WDFW 2004). Other bull trout sightings in the 1990s included an adult bull trout illegally caught in 1996 by an angler in Lake Easton and an adult fish captured by WDFW biologists in 1997 near Benton City at about RM 28 (Anderson 2008).

Redd surveys conducted since 2000 in the reach between Keechelus Dam and Lake Easton were described above. As noted, only a small number of adult bull trout have been observed in the reach since surveys began. Four of these were seen in the immediate vicinity of the redds found in 2000 during a snorkel survey, and another was observed on a redd at the mouth of Cabin Creek in 2001 by a Forest Service biologist (Tina Mayo, USFS, pers comm). In addition to these observations, two adult bull trout, one subadult, and an adult that was possibly a bull trout/brook hybrid were observed during snorkel surveys conducted in the upper mile of the reach in 2006.

Habitat

Habitat Overview

This uppermost reach of the Yakima River is approximately 11 miles in length from the outlet of Keechelus Dam to Lake Easton. It is the only documented spawning area for the local bull trout population inhabiting the mainstem Yakima River. Elevations range from 2,440 feet at the outlet to 2,190 feet at Lake Easton, the lowest for any bull trout spawning area in the Yakima Basin. The overall gradient of the reach is low at about 0.4%. The lands surrounding the reach are of mixed ownership and have been significantly disturbed. Extensive logging has occurred and road densities are very high (>4 mi./sq. mi.). Several active gravel-mining operations are located close to the river near the upper end of the reach. Interstate 90 runs adjacent to the river to the east, a reasonable distance away on average (>0.3 mile) but coming within 0.1 mile in some locations. Nevertheless, many of the constituent habitat elements in most of the reach are good.

The reach can be subdivided into three fairly distinct sections based primarily on channel type. From the outlet downstream for approximately a half-mile the river is channelized with berms confining it. There is no channel complexity, pools are non-existent, and LWD is absent for the most part. From the end of this section and extending downstream for approximately 1.5 miles, channel complexity improves. There are a few side-channels, LWD is present (although not abundant), and some pool habitat is available. Gravels of suitable size for spawning bull trout, essentially absent from the section upstream, are also present but mostly in scattered patches. About a half-mile above the downstream end of this section, a subsurface spring (Crystal) contributes around 8-10 cfs to river discharge. The lowest section of the reach is nine miles long and distinctly different from those upstream. The channel is extensively braided, LWD (including several huge logjams) is abundant, pool frequency and depth are good, and spawning gravels are abundant. Two significant tributaries enter the lower section, Cabin Creek about 1.3 miles above Lake Easton and Stampede Creek at around RM 5.5. Riparian condition is described as excellent in all three sections of the upper Yakima River (Haring 2001).

It is likely that the most serious habitat problems facing bull trout in the upper Yakima River are related to the flow regime and water temperatures. The regulated flow regime is highly altered from a natural condition. The most extreme alteration occurs in July, August and September when the average daily discharge for the respective months are 408%, 873%, and 386% higher than those that would occur under unregulated conditions. In contrast, fall and winter flows are significantly lower. During the winter months of November through March average daily flows are just 16-50% of those that would occur naturally. In October, when bull trout would be spawning, the average daily flow declines 67% from September's daily average (data source: USBR, Yakima Field Office, Hydromet database, 1981-2010). The situation with water temperatures may be worse considering the stringent requirements for bull trout at all life stages. Examining water temperature data from 2006-2011, the average daily temperature of water released from the reservoir in August was 16.5 ^{0}C; the average daily temperature exceeded 15 ^{0}C for periods lasting from 11-31 days in those years, four of them the entire month or just one or two days short of it. In September and October, the average daily temperature was 14.5 ^{0}C and 11.5 ^{0}C with four periods during September exceeding 15 ^{0}C for 9-10 days (data source: USBR, Yakima Field Office, Hydromet database, 2006-2011).

Whether or not a distinct bull trout population exists in the upper Yakima River the fish that have been observed spawning there presumably use the mainstem Yakima River for FMO habitat. Since over 200 miles of the river extend below Lake Easton and because the Yakima changes drastically from reach to reach over this length, it is not practical to describe the habitat conditions of the mainstem river in this document. This information is available in numerous documents published over the years including the Yakima Subbasin Plan (Yakima Basin Fish and Wildlife Planning Board 2005), Comprehensive Basin Operating Plan for the Yakima Project (USBR 2002), and the Yakima Steelhead Recovery Plan (Yakima Basin Fish and Wildlife Recovery Board 2009).

There is speculation that Upper Yakima River bull trout may descend to Lake Easton to overwinter and never actually leave the upper Yakima River. This has not been confirmed. If the fish stayed in Lake Easton, there would likely be habitat quality issues as the lake is annually drawn down to very low levels for much of the winter.

Habitat Monitoring

USBR temperature data summary indicates that water temperatures are higher than those found in other Yakima Basin habitats utilized by bull trout for spawning (McKenzie 2008). The Forest Service has monitored temperature at one site on the Yakima River (above Cabin Creek) via a thermograph deployed during the summer period from 2000-2011 (no data from 2008) (USFS 2011b).

In 2005, the Forest Service completed an Aquatic Species Environmental Baseline for the Upper Yakima Watershed (USFS 2005). In 2004, the Forest Service completed a Federal Roads Analysis for the upper Yakima watershed, including an aquatic rating.

In a collaborative project between students at the University of Washington School of Forest Resources, USGS, and the NOAA Northwest Fisheries Science Center, 60 miles of habitat on the mainstem upper Yakima River (Ellensburg to the base of Keechelus Dam) were surveyed in 2007 (Cram et al. 2012). Individual habitat units (e.g., pools, riffles, etc.) were identified and bankfull channel widths, depth, cover, and substrate data were collected from each one.

Threats

The highest severity threat to the Upper Yakima River population is low abundance. Other threats include the presence of a strong population of brook trout, altered flows in the Yakima River, illegal angling in the open or closed sections of the river, and habitat degradation due to development. Easton dam is a potential passage barrier to juvenile trout at certain flows. Although spring chinook salmon are spawning in the upper Yakima River, salmon runs are greatly reduced from historic numbers and this has likely affected bull trout population viability.

Due to the many unknowns about this population, there is also considerable uncertainty regarding severity of threats. Agriculture, entrainment, forest management, and transportation issues are all present in potential spawning, rearing, or FMO areas for the Upper Yakima River population, but until these areas are better defined, it is difficult to assess the severity. The threats of natural dewatering, grazing, limited extent of habitat, and mining are not present.

Table 18. Gold Creek threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority.

THREATS	Rating	ACTIONS	Priority
Introduced Species	SIGNIFICANT	Monitor brook trout introgression	HIGH
Low Abundance	SIGNIFICANT	Redd/snorkel surveys	HIGH
Altered Flows	UNKNOWN SIGNIFICANT	Improve flow conditions	MEDIUM
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Development	UNKNOWN SIGNIFICANT	Land acquisitions	MEDIUM
Passage Barriers	UNKNOWN SIGNIFICANT	Improve juvenile passage at Easton dam	MEDIUM

THREATS	Rating	ACTIONS	Priority
Prey Base	UNKNOWN SIGNIFICANT	Support YKFP program	MEDIUM
Agriculture	UNKNOWN	Habitat restoration in lower Yakima FMO habitat	MEDIUM
Entrainment	UNKNOWN	Monitor diversions	MEDIUM
Forest Management	UNKNOWN	Implement USFS restoration priorities	MEDIUM
Transportation	UNKNOWN	Support I-90 habitat improvement projects	MEDIUM
Recreation	LOW		LOW
Dewatering	NOT PRESENT		LOW
Grazing	NOT PRESENT		LOW
Limited Extent Habitat	NOT PRESENT		LOW
Mining	NOT PRESENT		LOW

Actions

Strategy

The Upper Yakima River population has been identified as a "Monitor" population with a low priority for implementing bull trout actions beyond population monitoring actions to better understand the origin and status of bull trout in this area. If a self-sustaining bull trout population was found to exist in this area, the highest priorities for recovering this population would be to reduce introduced species, improve flow conditions, protect and restore habitat degraded by development, improve passage conditions at Easton dam, and support the YKFP salmon supplementation program. Broad Scale Actions that may benefit bull trout in this reach include: Passage at Major Storage Dams (Keechelus, Kachess and Cle Elum) and Restore Healthy Salmon Populations.

Completed Actions

- A conservation easement was purchased on the Hundley property, adjacent to the Yakima River mainstem in 2008 (see SRFB project 06-2143).
- In Big Creek, an upper Yakima River tributary, the Cascade Land Conservancy acquired a property of 182 total acres in 2008 and 2010.
- Phase 1 of the Interstate-90 Snoqualmie Pass Project, which included highway improvements but also wildlife corridors, culvert improvements and new bridges (see: http://www.wsdot.wa.gov/Projects/I90/SnoqualmiePassEast/).
- Crystal Springs campground (Keechelus-to-Lake Easton reach) closed in 2009.

Recommended Actions

For additional detail on the actions listed below, see Actions Detail (starting on p. 164).

Population Scale

- Upper Yakima River #2: Improve flow conditions.
- Upper Yakima River #3: Floodplain acquisition/easements along the upper Yakima River and tributaries (above the Cle Elum River confluence).
- Upper Yakima River #4: Evaluate and improve juvenile passage at Easton Dam.
- Upper Yakima River #6: Implement the Forest Service Upper Yakima Restoration Project.
- Multiple Populations River #1: Outreach on bull trout conservation issues (landowners, recreationists, anglers, school groups, and others).

Population Monitoring

- Upper Yakima River #1: Continue periodic snorkel surveys to determine whether bull trout are present in the Upper Yakima River, including Easton Lake. PIT tag fish is possible.

Baseline Habitat Monitoring

- Multiple Populations #3: Continue temperature monitoring.

Implementation Monitoring of Completed and Recommended Actions

None

Research, Monitoring, and Evaluation

- Upper Yakima River #5: Improve and monitor effectiveness of screens on diversions.
- Multiple Populations #7: Continue to screen any bull trout genetic samples collected in this reach for evidence of brook trout introgression.
- Multiple Populations #9: Periodic entrainment studies at dams.

Actions Identified in YSRP that would benefit bull trout

(Yakima Basin Fish & Wildlife Recovery Board 2009)

Upper Yakima River #3: Modify flip-flop regime
Upper Yakima River #9: Continue providing access to Yakima River above Easton Dam in all areas
Upper Yakima River #12: Reduce confinement of Upper Yakima River
Upper Yakima River #13: Protect and restore floodplain, riparian, and in-channel habitats in Upper Yakima, Kittitas, and Easton/Cle Elum reaches
Upper Yakima #15: Restore tributary riparian areas

Upper Yakima River #16: Build conservation easements and other habitat protections into development plans
Upper Yakima River #21: Provide adequate late fall/winter flows below storage dams

ACTIONS DETAIL

The following pages provide detailed information on the actions identified in previous sections. This information is maintained in an Access database, allowing for it to be queried, searched, and readily updated.

Broad Scale Action #1: Restore Healthy Salmon Populations

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Subadults/ Adults in FMO Habitat

Threat addressed: Prey Base/ Nutrient Cycle

Severity: Unknown significant **Link to Threats Table:** A10-12,A/U1-3,B7-9,C/W9-11,C5-7,G16-18,IN5,KA7-9,NFT6,R1-3,SFT2,T7-9

Action Description

Continue to support and facilitate the restoration of anadromous salmonid populations in the Yakima Basin.

Justification/Background

Prey availability (juvenile fish) for bull trout has been reduced as a result of the severe depletion of anadromous salmonid populations which historically returned to the Yakima River and its tributaries to spawn.

Key Partners

All agencies involved in fish recovery efforts

Time to Implement: Ongoing **Time to Benefit:** 10-25 years

Cost Estimate: Unknown

Cost Derivation

Broad Scale Action #2: Passage at Tieton Dam

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** IN1,NFT1,SFT1

Action Description

Construct permanent upstream and downstream fish passage facilities at Tieton Dam.

Justification/Background

Studies have shown that bull trout are entrained through the unscreened outlet works of Tieton dam, either causing direct mortality or permanently displacing them. Under either outcome, the population lose productivity.

Key Partners

BOR, DOE, YN

Time to Implement: 9-12 years **Time to Benefit:** >10 years

Cost Estimate: $80-130 million

Cost Derivation

1/3 of $234-410 million estimated cost in YRBWEP Integrated Package for passage at Tieton, Kachess and Keechelus dams.

Broad Scale Action #3: Passage at Keechelus Dam

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** G6

Action Description

Construct permanent upstream and downstream fish passage facilities at Keechelus Dam.

Justification/Background

An entrainment study was conducted at Keechelus Dam in 2010. Although no bull trout were captured, bull trout have been found during spawning and snorkel surveys downstream of the dam and it is believed these fish originated from Keechelus Lake. They cannot return since upstream passage is not available at the dam. The Gold Creek population is small and cannot afford to lose potential spawners.

Key Partners

BOR, DOE, YN

Time to Implement: 9-12 years **Time to Benefit:** >10 years

Cost Estimate: $80-130 million

Cost Derivation

1/3 of $234-410 million estimated cost in YRBWEP Integrated Package for passage at Tieton, Kachess and Keechelus dams.

Broad Scale Action #4: Passage at Kachess Dam

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** B2, KA2

Action Description

Construct permanent upstream and downstream fish passage facilities at Kachess Dam.

Justification/Background

The Box Canyon and Kachess River populations are both small and habitat limited. Long term sustainability will most likely depend on genetic interaction with other populations in the Yakima Basin.

Key Partners

BOR, DOE, YN

Time to Implement: 9-12 years **Time to Benefit:** >10 years

Cost Estimate: $80-130 million

Cost Derivation

1/3 of $234-410 million estimated cost in YRBWEP Integrated Package for passage at Tieton, Kachess and Keechelus dams.

Broad Scale Action #5: Passage at Bumping Dam

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** B2

Action Description

Construct permanent upstream and downstream fish passage facilities at Bumping Dam.

Justification/Background

Bumping Dam is impassable and the Deep Creek population is disconnected. Long term sustainability will depend on genetic interaction with other populations in the Yakima Basin.

Key Partners

BOR, DOE, YN

Time to Implement: 7-10 years **Time to Benefit:** >10 years

Cost Estimate: $21-37 million

Cost Derivation

YRBWEP Integrated Plan initial cost estimates.

Broad Scale Action #6: Passage at Cle Elum Dam

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** B2

Action Description

Construct permanent upstream and downstream fish passage facilities at Cle Elum Dam.

Justification/Background

Cle Elum Dam is impassable and any remnant population would be disconnected. Bull trout which have been previously displaced downstream by entrainment through the outlet works of the dam are unable to return.

Key Partners

BOR, DOE, YN

Time to Implement: 3-5 years **Time to Benefit:** 5-10 years

Cost Estimate: $70-123 million

Cost Derivation

YRBWEP Integrated Plan initial cost estimates.

Multiple Pops Action #1: Outreach (Bull Trout Task Force)

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations, Subadults/ Adults in FMO Habitat

Threat addressed: Angling; Passage, Low Abundance

Severity: Varied; Unkown significant **Link to Threats Table:**

Action Description

This action is a suggested way to accomplish the goals of several other reccommended actions: 1) Outreach on bull Trout conservation issues via public education and field contacts by an established, prominent posting of fishing regulations and presentations; 2) Remove and document recreation dams and 3) Population monitoring. As this program continues, other actions or elements of other actions may be folded into it's scope.

Justification/Background

Bull trout occupy a wide range of habitat, primarily foraging and overwintering in mainstem rivers and reservoirs, with spawning and rearing in headwater tributaries. These habitats are also where recreation is focused, and the intent of the Bull Trout Task Force (BTTF) is to provide an on-the-ground crew to mitigate impacts to bull trout from the public (poaching, misidentification resulting in incidental take, recreation dams, habitat degradation) and assist with monitoring efforts (spawning and snorkel surveys, temperature monitoring)

Key Partners

YBFWRB, MCFEG, WDFW, USFS

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $600,000

Cost Derivation

$60,000 per year for 10 years.

Multiple Pops Action #2: Redd surveys

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Significant **Link to Threats Table:**

Action Description

Annual surveys in all spawning index areas, using experienced and trained personnel. All redds are dcoumented with a GPS waypoint.

Justification/Background

In all populations, even those where low abundance does not currently seem to be a severe threat, monitoring yearly fluctuations in redd numbers, and documenting spatial distribution is critical to managing and protecting bull trout.

Key Partners

WDFW, USFWS, USFS, YBFWRB, BOR, YN

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $253,000

Cost Derivation

$25,300 per year for 10 year period ($17,300 cost to WDFW, plus 20 days in-kind from other agencies @ $200/day = $8000).

Multiple Pops Action #3: Temperature Monitoring

Action Type: Monitoring

Life stage(s) affected: Spawning/egg incubation, Pre/post spawning migrations, Subadults/ Adults in FMO Habitat

Threat addressed: Climate Change; suite of water quality threats

Severity: Significant

Link to Threats Table:

Action Description

Continue to monitor water temperatures in all bull trout streams.

Justification/Background

The majority of climate scientists agree that global climate change is occuring and that air temperatures are increasing at an alarming trend. In the Pacific Northwest, models predict that winters will be wetter and warmer with reduced snowpack. This is likely to have serious consequences for bull trout. Baseline temperature data will be needed to assess potential impacts and address the species requirements to survive.

Key Partners

USFS, YBFWRB

Time to Implement: 1-3 years

Time to Benefit: Immediate

Cost Estimate: $5000

Cost Derivation

50 HOBOs @ $100 each = $5000. Deployed annually in all bull trout streams by the Bull Trout Task Force.

Multiple Pops Action #4: Evaluate Supplementation

Action Type: Research/ Recovery/ **Life stage(s) affected:** Adult

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Varied **Link to Threats Table:** A3,B1,C1,G5,KA1,T1

Action Description

A supplementation or transplantation project may be required to enhance some bull trout populations. Conduct a feasibility study to determine if supplementation is a viable course of action (see Yakima Basin Reintroduction/Supplementation Plan, Appendix D). Pilot populations are proposed, but any population where low abundance is identified as a threat could be considered if initial efforts were successful.

Justification/Background

The effective population size of several bull trout populations in the Yakima basin is chronically low based on annual redd counts, and in some areas bull trout appear to becoming functionally extirpated.

Key Partners

WDFW

Time to Implement: 1-5 years **Time to Benefit:** >10 years

Cost Estimate: $2 million

Cost Derivation

Based on the YBFWRB Integrated Plan cost estimate for this action: $100,000 per year for 20 years.

Multiple Pops Action #5: Carcass analog placement

Action Type: Recovery **Life stage(s) affected:** Juvenile rearing

Threat addressed: Prey Base

Severity: Unknown significant **Link to Threats Table:** A12,A/U3,B9,C/W11,C7,D3,G18,IN5,KA9,NFT6,R3,SFT2,T9

Action Description

For the long term, continue to support and facilitate the restoration of anadromous salmonid populations in the Yakima Basin. In the short term, disburse salmon carcasses or carcass analogs to increase nutrient availability and invertebrate productivity, beginning in a pilot area. Monitoring before and after this action is essential to determine the effect on invertebrate and juvenile fish productivity.

Justification/Background

Numbers of anadromous salmonids which return to spawn have been severely depleted, robbing the streams and rivers of marine-derived nutrients once obtained from their carcasses. These nutrients likely drove invertebrate productivity, the primary food source for juvenile bull trout.

Key Partners

WDFW, BOR, YBFWRB

Time to Implement: 2-5 years **Time to Benefit:** 5+ years

Cost Estimate: $564,000

Cost Derivation

Cost estimate is based on estimate cost of treatment @ $0.50/foot, and assumed treatment of 10 miles/year. Additional cost is $30,000 per year for monitoring (30 days/year @ $200/day).

Multiple Pops Action #6: Floodplain protection and restoration in Naches mainstem

Action Type: Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Development

Severity: Low **Link to Threats Table:**

Action Description

Floodplain restoration/easements/acquisitions in the Naches River.

Justification/Background

This action emphasizes protection element, as current habitat quality is good and not thought to be limiting.

Key Partners

WDFW, USFS, USFWS, WSDOT, County,

Time to Implement: Ongoing **Time to Benefit:** 5-10 years

Cost Estimate: $12.4 million

Cost Derivation

Cost estimate derived from Yakima Steelhead Recovery Plan Naches Actions (5, 6, ,7 and 31) that describe protection and restoration of the Naches River floodplain habitat.

Multiple Pops Action #7: Monitor brook trout introgression

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Non-native

Severity: Significant **Link to Threats Table:** A/U10,B20-21,C/W1-3,D2,D9,G27-28,IN4,IN9,KA 13-14, NFT4, NFT10,SFT13-14

Action Description

Monitor all bull trout genetic samples that are collected for signs of introgression with brook trout, targeting populations with known issues. If deemed possible in the future, design an action to reduce or eliminate brook trout populations in bull trout areas.

Justification/Background

In many population areas, brook trout and other non-native species are present. In some populations, hybrids between bull and brook trout have been identified. In others, no introgression has been identified but there is still competition for space and resources.

Key Partners

WDFW genetics lab, USFWS

Time to Implement: Ongoing **Time to Benefit:** 5-10 years

Cost Estimate: $30,000

Cost Derivation

Currently all samples are screened for brook trout alleles; $ for future genetic analysis (100 samples/year @ $30 per) = $3000 annually for 10 years.

Multiple Pops Action #8: Manage operations to reduce entrainment at Tieton Dam

Action Type: Recovery

Life stage(s) affected: Spawning/egg incubation, Subadults/ Adults in FMO Habitat

Threat addressed: Entrainment

Severity: Unknown significant

Link to Threats Table: IN6, IN7, IN8

Action Description

Manage dam releases to reduce entrainment (with guidance from past entrainment studies). Screening of outlet works could be considered but would be difficult to undertake and may harm bull trout populations due to the level of drawdown necessary to do so. Provide upstream passage at Tieton Dam to enable displaced bull trout to return to the lake.

Justification/Background

Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occuring through Tieton Dam. Entrained fish either die or are unable to migrate back to the lake past the impassable dam.

Key Partners

BOR, USFWS, WDFW, YN, JB

Time to Implement: Ongoing

Time to Benefit: Immediate

Cost Estimate: Part of SOAC negotiations

Cost Derivation

Multiple Pops Action #9: Periodic entrainment studies at dams

Action Type: Monitoring

Life stage(s) affected: Spawning/egg incubation, Subadults/ Adults in FMO Habitat

Threat addressed: Entrainment

Severity: Unknown significant

Link to Threats Table: B12, B13, B14

Action Description

At periodic intervals over the next decade, conduct entrainment studies at each of the reservoirs to monitor on-going levels of bull trout entrainment.

Justification/Background

The outlet works of all dams are unscreened and entrainment of bull trout is likely occuring to some extent. The fate of entrained fish is either death or permanent displacement since upstream passage is not available at the dam.

Key Partners

BOR, USFWS

Time to Implement: 5-10 years

Time to Benefit: 5-10 years

Cost Estimate: $600,000

Cost Derivation

BOR estimated cost of an etrainment study is $120,000, and assuming 5 studies over a 10 year period.

Ahtanum Action #1: Riparian restoration of spawning and rearing reaches.

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management Practices

Severity: Significant **Link to Threats Table:** A1, A2

Action Description

Initiate active restoration of the floodplain and riparian corridors in the forested spawning and rearing reaches in all three forks (South, Middle and North) of Ahtanum Creek.

Justification/Background

Habitat has been degraded by forest management practices, recreation sites and road sedimentation. Restoration will require active development of projects.

Key Partners

DNR, NYCD, YN, private landowners

Time to Implement: 2-10 years **Time to Benefit:** 5-10 years

Cost Estimate: $400,000

Cost Derivation

Based on $100,000 for an initial assessment and creation of a list of potential projects, then treatment of ~1 mile of streambank per year, for 10 years, at a cost of $30,000 per mile. Actions include LWD, revegetating banks and site protection.

Ahtanum Action #2: Address forest health

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management Practices

Severity: Significant **Link to Threats Table:** A1, A2

Action Description

Coordinate with DNR to insure adequate steps are being taken to address forest health in the Ahtanum Creek watershed (e.g. overstocked stands, disease and insect outbreaks) . Further recommended actions would depend on the results of those discussions.

Justification/Background

The condition of forest stands directly affects watershed processes threaten bull trout habitat. Clear cuts have occurred high in the watershed contributing to sedimentation and riparian degradation. Overstocked stands which could produce a catostrophic wildfire are also a concern, as is the potential for disease and/or insect infestation.

Key Partners

DNR, WDFW, YN, private land owners

Time to Implement: Ongoing **Time to Benefit:** 5-10 years

Cost Estimate: $1.2-2.25 million

Cost Derivation

Based on treatment of 2000-5000 acres/year at $350/acre for a 10 year period. Acre costs were esimated based on average costs from other dry forest restoration initiatives, where some treatments generate saleable products and others do not. Additional planning cost of $500,000 were added.

Ahtanum Action #3: Relocate Shellneck Creek Rd & other roads adjacent to streams

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management Practices

Severity: Significant **Link to Threats Table:** A1, A2

Action Description

Relocate road adjacent to Shellneck Creek on North Fork to reduce sediment, riparian loss and soil compaction. Identify other roads which for which relocation or closure would be desirable.

Justification/Background

Road densities are high in the Ahtanum Creek watershed, and this negatively correlated to bull trout persistence.

Key Partners

DNR, WDFW, YN

Time to Implement: 1-3 years **Time to Benefit:** 3-5 years

Cost Estimate: $1.5 million

Cost Derivation

DNR bid estimate for Shellneck Road was ~$150, 000. Cost estimate is based on implementing a similar project annually for 10 years.

Ahtanum Action #4: Sediment monitoring

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management; Recreational Impacts

Severity: Significant **Link to Threats Table:** A1, A2, A17, A18

Action Description

Collect sediment samples at established locations within the Ahtanum drainage and analyze to determine percent fine sediment.

Justification/Background

Initiate a long term sediment monitoring in the Ahtanum drainage, focusing on the upper reaches of the North, South and Middle Forks where forest management issues, roads and recreation impacts overlap with bull trout spawning and rearing areas.

Key Partners

DNR, YN, MCFEG

Time to Implement: 1-3 years **Time to Benefit:** 5-10 years

Cost Estimate: $47,000

Cost Derivation

Cost estimate is based on costs reported by the Forest Service ($1700/year) to collect samples, and the Yakama Nation ($3000/year)to analyze samples and generate annual reports, over a 10 year period.

Ahtanum Action #5: Evaluate movement patterns between forks.

Action Type: Monitoring **Life stage(s) affected:** Adults

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Significant **Link to Threats Table:** A3

Action Description

Collect enough samples from each stream to determine if North, South and Middle Forks of Ahtanum Creek are genetically distinct from each other. Snorkel surveys to determine the downstream distribution of juveniles.

Justification/Background

This is an isolated population of bull trout in a headwater system. If each of the forks contains a genetically distinct population, then each is at a higher risk of extripation from a stochastic or human-caused event, however, having mulitiple sub-populations within the system and no barriers to movement creates an opportunity for natural re-colonization if necessary.

Key Partners

WDFW, USFWS, YN

Time to Implement: 1-3 years **Time to Benefit:** 3-5 years

Cost Estimate: $16,500

Cost Derivation

90 genetic samples * $50/per sample = $4500. Sampling and snorkel surveys = $12,000 (10 miles of survey @ 0.5 miles per night * 3 person days @ $200/day).

Ahtanum Action #6: Increase instream flow in lower Ahtanum Creek

Action Type: Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Altered Flow Regimes

Severity: Moderate **Link to Threats Table:** A4

Action Description

Look for opportunities for diversion reduction- consolidation agreements and/or water right purchases or leases and/or on-farm water conservation projects to reduce water use and augment instream flows. Additional flow will increase habitat complexity.

Justification/Background

Minimum flows have been established in lower reaches but irrigation withdrawal still results in significant flow depletion during the summer and early fall resulting in a net loss of habitat complexity.

Key Partners

WDFW, USFWS, YBFWRB, YN

Time to Implement: Ongoing **Time to Benefit:** 3-10 years

Cost Estimate: $2.4 million

Cost Derivation

Cost in Ahtanum system is estimated as ~$120, 000 per cfs as permanent in-stream purchase. Assume that additional 20 cfs would be ideal over next 10 year period.

Ahtanum Action #7: Monitor habitat & develop projects in mainstem Ahtanum

Action Type: Monitoring **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Development (residential and urbanization), Agriculture, Forest Management, Grazing

Severity: Unknown significant **Link to Threats Table:** A14, A21, A23, A26

Action Description

Monitoring needed to determine where significant habitat degradation is occuring. Where habitat degradation is observed, work with landowners individually to develop in-stream and floodplain restoration projects.

Justification/Background

There is considerable residential and urban development in FMO habitat which is resulting in habitat degradation. Agricultural activities and residential development occur below the forks but their specific effects with respect to habitat degradation are unknown, but have the potential to increase sediment, impact riparian cover, and compact soil.

Key Partners

WDFW, USFWS, YBFWRB

Time to Implement: 3-10 years **Time to Benefit:** 10-25 years

Cost Estimate: $6.5-10.6 million

Cost Derivation

Ahtanum Creek Watershed Restoration Program economic modeling listed this cost estimate for the "Habitat" subcomponent of the analysis (DOE 2005). Habitat monitoring to initiate a revised project list = ~$60,000 for a seasonal crew that would cover areas throughout the basin, including Ahtanum.

Ahtanum Action #8: Screen all diversions

Action Type: Recovery

Life stage(s) affected: Spawning/egg incubation, Subadults/ Adults in FMO Habitat

Threat addressed: Entrainment

Severity: Unknown significant

Link to Threats Table: A15, A16

Action Description

Screen two remaining unscreened gravity diversions (Herke diversion and one across the river nearby on Yakama Reservation. Screen remaining non-compliant pump diversions (~14). Ensure screened diversions are functioning adequately.

Justification/Background

There are two remaining unscreened diversions in resident adult and subadult habitat through which potential spawning could be lost.

Key Partners

YTAPH,WDFW, USFWS, YBFWRB, YN

Time to Implement: 1-2 years

Time to Benefit: 2-10 years

Cost Estimate: $295,000

Cost Derivation

Cost estimate for the Herke diversion is $130,000, and assume that the adjacent diversion on the Yakama Reservation would have a similar cost. To screen the non-compliant pump diversions, $2500 per pump.

Ahtanum Action #9: Close and restore Tree Phones campground

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Recreational Impacts

Severity: Unknown significant **Link to Threats Table:** A17, A18, A19

Action Description

Close or relocate Tree Phones Campground.

Justification/Background

Tree Phones Campground is located in a bull trout spawning and rearing habitat and cause sedimentation, loss of riparian cover, soil compaction, and removal of LWD, compromising habitat complexity.

Key Partners

DNR

Time to Implement: 3-5 years **Time to Benefit:** 5-10 years

Cost Estimate: $90,000

Cost Derivation

Cost estimate is based on restoration cost for 1/2 mile of stream that has been impacted by campground, as well as cost to re-open a new campground in a more suitable location. $50,000 in planning cost is also included.

Ahtanum Action #10: Close Snow Cabin & restore adjacent riparian area.

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Recreational Impacts

Severity: Unknown significant **Link to Threats Table:** A17, A18, A19

Action Description

Permanently close DNR's Snow Cabin campground and restore the site.

Justification/Background

Snow Cabin Campground is located in bull trout spawning and rearing habitat and the area is degraded (sedimentation, loss of riparian cover, soil compaction). Habitat complexity is compromised. The campground was closed in 2010, but is set to open again in 2012.

Key Partners

DNR

Time to Implement: 1-2 years **Time to Benefit:** 3-5 years

Cost Estimate: $90,000

Cost Derivation

Cost estimate is based on restoration cost for 1/2 mile of stream that has been impacted by campground, as well as cost to re-open a new campground in a more suitable location. $50,000 in planning cost was also included.

Ahtanum Action #11: Monitor cattle fencing

Action Type: Monitoring/Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Grazing
Severity: Unknown **Link to Threats Table:** A26

Action Description
Monitor cattle exclusion fencing that was built to protect spawning and rearing areas for effectiveness, repairing sites as necessary. Consider long term purchase of grazing lease if possible.

Justification/Background
Cattle exclusion fencing was installed to protect bull trout spawning and rearing areas, and it is critical to monitor effectiveness of this method of protection.

Key Partners
DNR,WDFW, USFWS

Time to Implement: 0-3 years **Time to Benefit:** Immediate

Cost Estimate: Included in cost estimate for Bull Trout Task Force (see Multiple Pop Action #1).

Cost Derivation

American Action #1: Protect and restore streambanks

Action Type: Recovery **Life stage(s) affected:** Juvenile Rearing

Threat addressed: Recreational Impacts
Severity: Unknown significant **Link to Threats Table:** A/U10

Action Description
Stream bank restoration at Lodgepole, Hells Crossing, and Pleasant Valley campgrounds, including improved definition and consolidation of river access trails, relocation of some dispersed campsites and restoration of dispersed sites closed previously. Continued riparian protection via spur road closures and excluding vehicles via boulder placement.

Justification/Background
Three USFS campgrounds and several dispersed sites are located on the banks of the river adjacent to bull trout spawning and rearing habitat. Habitat degradation is associated with these recreation areas.

Key Partners
USFS

Time to Implement: 1-5 years **Time to Benefit:** 3-10 years

Cost Estimate: $50,000

Cost Derivation
Cost estimate is based on previous restoration work along the American River.

Box Canyon Action #1: Monitor/Fix passage problems at mouth

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations

Threat addressed: Passage Barriers

Severity: Significant **Link to Threats Table:** B2, B3

Action Description

Work with the BOR to develop a solid plan to address the problem when it occurs with an official and solidly funded program (possibly an expanded role for the Bull Trout Task Force). To address the occasional problems associated with recreational dams, use the Task Force to educate public about, monitor for, and disassemble recreational dams when they occur.

Justification/Background

Passage for pre-spawn adults has frequently been observed at the mouth of the creek (e.g. 2001, 2003, 2005) as a result of reservoir draw down and low flows across the permeable reservoir bed. This problem is expected to persist and this small population cannot afford the loss of production that could occur as a result. A permanent solution is difficult as the mouth of the creek is inundated during most months of the year. Recreational dams have also been observed in vicinity of Kachess Campground.

Key Partners

BOR, WDFW, USFWS, YBFWRB

Time to Implement: 1-3 years **Time to Benefit:** Immediate

Cost Estimate: $100-200,000

Cost Derivation

Monitoring of passage conditions and for recreation dams is included in the cost estimate for the Bull Trout Task Force (Multiple Pop #1). Cost estimates are based on expected response needed 2-4 times in the next 10 years, @ $50,000 per.

Box Canyon Action #2: Passage over Peek-a-Boo Falls

Action Type: Research/ Recovery **Life stage(s) affected:** Juvenile Rearing, Resident Adults If present); Spawning/egg incubation

Threat addressed: Limited Extent of Habitat

Severity: Unknown significant **Link to Threats Table:** B15, B22

Action Description

Conduct a study to determine if available rearing habitat area is potentially limiting juvenile growth and survival or if available spawning habitat area is potentially limiting spawning success. If so, providing passage past Peekaboo falls and the barrier directly upstream should be considered. Phase 1 of the feasibility study should be establishing snorkel index areas to determine seasonal juvenile density patterns.

Justification/Background

Juvenile rearing is limited to about 1.5 miles of stream below a natural barrier. Snorkel surveys reveal high densities of juveniles and density dependent mortality is possible. Spawning habitat availability does not appear to be limiting population at its current size (professional opinion) but could if the population were to grow.

Key Partners

USFS, BOR, USFWS

Time to Implement: 3-5 years **Time to Benefit:** Immediate

Cost Estimate: $800,000

Cost Derivation

Snorkeling for juvenile densities could be accomplished by the Bull Trout Task Force and volunteer biologists, beginning in 2012, with no additional costs associated. A complete feasibility study would cost ~$50,000 to collect and analyze habitat and population data. Passage at the two barrier falls would cost $100-200,000 for engineering and $500-700,000 to implement.

Box Canyon Action #4: Carcass analog assessment/pilot project

Action Type: Research/ Recovery **Life stage(s) affected:** Spawning/egg incubation, Subadults/ Adults in FMO Habitat, juvenile rearing

Threat addressed: Prey Base

Severity: Unknown **Link to Threats Table:** B7, B8, B9

Action Description

Evaluate the need for increased nutrients in Box Canyon Creek and also determine juvenile densities of bull trout. If conditions warrant, begin an experimental program of nutrient enhancement via carcass analogs.

Justification/Background

Anadromous fish have been excluded from the Kachess Lake system for nearly 100 years, and this system does not support a large population of kokanee. This system would be a suitable pilot project due to good stream access, reported high juvenile densities, the long period without marine dervied nutrients, and as a baseline stream to monitor prior to the potential reintroduction of sockeye salmon in the future.

Key Partners

USFS, USFWS, MCFEG, YBFWRB, YKFP

Time to Implement: 1-5 years **Time to Benefit:** 5+ years

Cost Estimate: $280,000

Cost Derivation

Cost estimates are based on $15,000/year for 2 years to assess need, and $50,000/year for 5 years to implement carcass analog distribution ($20,000 for carcass analogs and $30,000 for monitoring).

Cle Elum Action #1: Lake trout assessment/removal

Action Type: Research **Life stage(s) affected:** Subadults/ Adults in FMO Habitat (includes resident adults if present)

Threat addressed: Introduced Species

Severity: Significant **Link to Threats Table:** C/W1

Action Description

Conduct lake trout population assessment in Cle Elum Lake to determine population demographics and seasonal concentrations (e.g. primary spawning grounds). Using the information obtained in the lake trout population assessment, initiate a lake trout eradication program in Cle Elum Lake.

Justification/Background

Significant numbers of lake trout, a species known to depress bull trout populations, are present in Cle Elum Lake.

Key Partners

WDFW, BOR, USFWS, YN

Time to Implement: 3-5 years **Time to Benefit:** 5-10 years

Cost Estimate: $1 million

Cost Derivation

Cost estimate is based on $200,000 per year over a 5 year period. This would include assessment of current population conditions, evaluation of eradication options and implementation of a comprehensive program.

Cle Elum Action #2: Snorkel surveys

Action Type: Monitoring **Life stage(s) affected:** Adult

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Significant **Link to Threats Table:** C/W4

Action Description

Additional monitoring is needed to understand population demographics. Night snorkel surveys are the most efficient and complete method for determining bull trout presence/absence, but hook and line or gill netting surveys may also be considered in the future.

Justification/Background

The data needs for this population (or populations) are huge, Despite a great deal of effort we still know little about bull trout in the upper Cle Elum River watershed.

Key Partners

USFWS, BOR, USFS, YBFWRB

Time to Implement: 1-5 years **Time to Benefit:** Immediate

Cost Estimate: $12,000

Cost Derivation

Large-scale effort to cover Cle Elum, Waptus and select tribs would need to cover ~10 miles of stream via night snorkel surveys. 0.5 miles require 3 person-hours, so 60 person hours * $200/person-hour/day.

Cle Elum Action #3: Riparian restoration (campsite and roads)

Action Type: Recovery **Life stage(s) affected:** Juvenile Rearing

Threat addressed: Recreational Impacts; Forest Management

Severity: Unknown significant **Link to Threats Table:** C/W12

Action Description

Restore degraded dispersed camp sites along FS Road 4330 from Salmon la Sac campground to Deception Pass trailhead. Also address forest roads that are contributing to riparian degradation.

Justification/Background

Habitat degradation is occuring as a result of recreational activities in the upper Cle Elum River watershed. Dispersed camp sites along the Cle Elum River cause sedimentation, loss of riparian cover, soil compaction, and the removal of LWD resulting in loss of habitat complexity.

Key Partners

USFS

Time to Implement: 1-5 years **Time to Benefit:** 5-25 years

Cost Estimate: $600,000

Cost Derivation

Cost estimate is based on planning and implementation costs for the first phases of the upper Cle Elum valley restoration project (~$350,000).

Crow Creek Action #1: Expanded redd surveys

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation

Threat addressed: Low Abundance

Severity: Significant **Link to Threats Table:** C1

Action Description

On a periodic basis, cover reaches on Crow Creek above and below the current index area, to confirm that no spawning occurs in these reaches.

Justification/Background

The spawning index area on Crow Creek is based on historic surveys on the entire creek, and where spawning has occurred, but redd locations may shift over time with changes in habitat conditions and/or natural passage barriers.

Key Partners

WDFW, USFS, YBFWRB, other

Time to Implement: 1-3 years **Time to Benefit:** Immediate

Cost Estimate: $0

Cost Derivation

Cost is included as part of redd survey expenses (Multiple Pop #2)

Crow Action #2: Little Naches Action Plan

Action Type: Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Recreational Impacts. Forest Management

Severity: Unknown significant **Link to Threats Table:** C8, C9

Action Description

Implement the proposed Little Naches Aquatic Action Plan (USFS 2011). This includes relocation of the lower 1900 road away from the floodplain, restoration of recreation areas, land acquisitions, road culvert improvements (22 culverts identified), obliteration or closure of 140+ miles of roads, and thinning projects to restore encroached meadows and improve forest health.

Justification/Background

There is heavy recreational use in the Little Naches River watershed that has caused habitat degradation. High road densities are source of sediment, loss of riparian cover and soil compaction resulting in loss of habitat complexity. There are also significant recreational activities throughout the Naches River corridor but these activites are not believed to be causing habitat degradation that is significant at the reach scale. High forest road densitities in the Little Naches watershed have a high potential to contribute sediment to the stream.

Key Partners

USFS, YN

Time to Implement: 5-20 years **Time to Benefit:** 5-50 years

Cost Estimate: $28 million

Cost Derivation

Cost estimate is presented in the Little Naches Action Plan.

Crow Action #3: Relocate Crow Creek campground

Action Type: Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Recreational Impacts.

Severity: Unknown significant **Link to Threats Table:** C8

Action Description

Though restoration of recreation areas is encompassed in the Little Naches Action Plan, the action of relocating Crow Creek campground is not specifically addressed, and will have direct benefit to the Crow Creek bull trout population.

Justification/Background

Crow Creek campground is compacting and denuding the banks of lower Crow Creek. Camping in this area also makes migrating, foraging or rearing bull trout more vulnerable to harassment, poaching, and passage barriers via recreation dams.

Key Partners

USFS

Time to Implement: 5-10 years **Time to Benefit:** 5+ years

Cost Estimate: $90,000

Cost Derivation

Cost estimate is based on restoration of 1/2 mile of compacted streambank and cost associated with relocation of the campground, including planning costs.

Crow Action #4: Land Acquisitions

Action Type: Recovery **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Recreational Impacts. Forest Management

Severity: Unknown significant **Link to Threats Table:** C8, C11

Action Description

Acquire private land holdings in the Little Naches drainage to prevent development in this area.

Justification/Background

There are a number of sections of land in the upper Little Naches drainage that are available for purchase and funding is being pursued to acquire these lands and return them to public ownership.

Key Partners

USFS, TNC, WDFW, RMEF, others

Time to Implement: 2-5 years **Time to Benefit:**

Cost Estimate: $19.5 million

Cost Derivation

Cost estimate was included in the Little Naches Action Plan.

Crow Action #5: Continue sediment monitoring

Action Type: Monitoring **Life stage(s) affected:** Subadults/ Adults in FMO Habitat

Threat addressed: Recreational Impacts. Forest Management

Severity: Unknown significant **Link to Threats Table:** C8, C9

Action Description

Collect sediment samples at established locations within the Little Naches drainage and analyze to determine percent fine sediment.

Justification/Background

Sediment monitoring in the Little Naches drainage has been ongoing since 1992. Continuation of this program is important for monitoring conditions in the FMO habitat.

Key Partners

USFS, YN

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $47,000

Cost Derivation

Cost estimate is based on $1700/year Forest Service budget to collect samples, and $3000 Yakama Nation budget to analyze samples and generate annual reports, over a 10 year period.

Gold Action #1: Hydrologic assessment/stream restoration

Action Type: Monitoring/Recovery **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations, Juvenile Rearing

Threat addressed: Dewatering

Severity: Significant **Link to Threats Table:** G1,G2,G3,G4,G10,G11,G12,G19,G25, G26

Action Description

Conduct a comprehensive hydro-geomorphic evaluation in lower Gold Creek to determine the causal mechanisms (and possible solutions) for annual dewatering. The study could potentially lead to stream restoration actions to provide continuous flow depending on evaluation's conclusions.

Justification/Background

Dewatering (which may be the result of past land use actions) occurs annually in the late summer and early fall in a one-to-two mile reach. Primary spawning habitat is above the dry reach and can be inaccessible for weeks or more at a time. Dewatering also strands and causes mortality of adult and juvenile fish, reduces invertebrate biomass, and decreases habitat complexity (the loss of pool holding habitat is of particular concern).

Key Partners

USFS, USFWS, BOR, YBFWRB, KCT

Time to Implement: 1-3 years **Time to Benefit:** 5+ years

Cost Estimate: $115, 000

Cost Derivation

Cost estimate is based on 2012 Salmon Recovery Funding Board proposal assessment and initial design phase. Estimate for stream restoration would be dependant on suggested solutions.

Gold Action #2: Implement Lower Gold Floodplain Restoration Plan

Action Type: Recovery

Life stage(s) affected: Spawning/egg incubation, Pre/post spawning migrations, Juvenile Rearing

Threat addressed: Dewatering

Severity: Significant

Link to Threats Table: G1,G2,G3,G4,G10,G11,G12,G19,G25, G26

Action Description

Gold Creek Floodplain Restoration (USFS) which would include the removal of legacy dikes and road fill from the gravel pit operation, relocation of ADA accessible trail away from Gold Creek, relocation of the footbridge out of floodplain, restoration of hydraulic connectivity through the parking area, installation of an engineered logjam in Gold Creek and replacement of the current Forest Service road bridge.

Justification/Background

The US Forest Service, in the process of completing a large-scale scoping NEPA document, included this project as a placeholder for restoration actions suggested by the results the a hydrological study (Gold #1).

Key Partners

USFS, USFWS, BOR, YBFWRB, KCT

Time to Implement: 3-5 years

Time to Benefit: 5+ years

Cost Estimate: $1 million

Cost Derivation

Cost estimate is based on Forest Service initial estimate for project implementation.

Gold Action #3: Monitor bank stabilization projects

Action Type: Recovery/ Monitoring **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations, Juvenile Rearing

Threat addressed: Development (residential and urbanization)

Severity: Unknown significant **Link to Threats Table:** G20, G21, G22, G23

Action Description

Stringently evaluate all projects associated with residential bank stabilization. Insure all actions are properly permitted and legally conducted. Utilize the Bull Trout Task Force to monitor land use actions on creek via annual photo documentation.

Justification/Background

Bank stabilization and channel redirection has occurred, and is likely to continue to occur, in the middle reach of Gold Creek where. These activities are very intrusive, cause habitat degradation and likely stress migrating and spawning bull trout.

Key Partners

WDFW, BTTF

Time to Implement: 1-5 years **Time to Benefit:** 2-10 years

Cost Estimate: $0

Cost Derivation

Cost is included in estimate for Bull Trout Task Force (Multiple Pops 1).

Gold Action #4: Land acquistion

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations, Juvenile Rearing

Threat addressed: Development (residential and urbanization)

Severity: Unknown significant **Link to Threats Table:** G20, G21, G22, G24

Action Description

Floodplain acquisition/easements in lower creek corridor.

Justification/Background

Adverse impacts on bull trout habitat is possible as a result of residential/recreational development on private land holdings.

Key Partners

WSDOT, USFS, KCT, other?

Time to Implement: 5-10 years **Time to Benefit:** 5+ years

Cost Estimate: $1-3 million

Cost Derivation

Cost estimate is based on initial discussions with land owners in the lower creek corridor and associated appraisal values.

Gold Action #5: Monitor/fix passage problems

Action Type: Monitoring/Recovery **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Passage Barriers

Severity: Unknown significant **Link to Threats Table:** G24

Action Description

Passage problems which preclude or hinder passage into the Gold Creek from the lake are the responsibility of the USBR. Work with the agency to develop a solid plan to address these problems when they occur with an official and solidly funded program (possibly an expanded role for the Bull Trout Task Force). Use the Task Force to monitor for developing passage problems and to address the occasional problems associated with recreational dams (e.g. educating the public about, monitoring for presence, and dismantling when found).

Justification/Background

Field observations indicate that there are potential passage problems into the creek from the lake. Recreational dams have also occasionaly been observed in the lower reaches of the creek.

Key Partners

USFS, USFWS, BOR, BTTF

Time to Implement: 1-5 years **Time to Benefit:** Immediate

Cost Estimate: $100-200,00

Cost Derivation

Monitoring of passage conditions and for recreation dams is included in the cost estimate for the Bull Trout Task Force (Multiple Pop #1). Cost estimates are based on expected response needed 2-4 times in the next 10 years, @ $50,000 per.

Indian Action #1: Re-route motorcycle race

Action Type: Recovery **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Recreational Impacts
Severity: Unknown significant **Link to Threats Table:** IN11

Action Description
Eliminate the motorcycle race held in September from the current location.

Justification/Background
Non-angling harassment occurs as a result of the motorcycle race held on lake bed in the fall which crosses Indian Creek.

Key Partners
USFS, WDFW, USFWS

Time to Implement: 1-3 years **Time to Benefit:** Immediately upon im

Cost Estimate: $0

Cost Derivation
No direct costs from action, but Forest Service and WDFW staff time spent in negotiations with event organizers.

Indian Action #2: Test for genetic temporal stability

Action Type: Monitoring **Life stage(s) affected:** Adult

Threat addressed: Low abundance
Severity: **Link to Threats Table:**

Action Description
Collect genetic samples from 30+ juvenile bull trout in Indian Creek and analyze with WDFW standardized microsatellite loci.

Justification/Background
All genetic samples for Indian Creek were collected in 1996. Since this time the population has experienced major shifts in population abundance, and it would be valuable to resample the population to test for temporal stability in allele frequencies. Collecting juvenile samples would also ensure that the fish are sampled in their population of origin, and not foraging individuals from other populations.

Key Partners
UWFWS, YBFWRB

Time to Implement: Completed in 2011 **Time to Benefit:** Immediate

Cost Estimate: $1500

Cost Derivation
Cost estimate is based on analysis of 30 samples @ $50 per sample. Genetic samples were collected in 2011.

NF Tieton Action #1: Clear Lake dam assessment/modification

Action Type: Research/ Monitoring **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Passage Barriers

Severity: Unknown significant **Link to Threats Table:** NFT1, NFT5

Action Description

A passage assessment should be conducted at Clear Lake Dam. If it is concluded that bull trout passage is impeded, effective upstream passage facilities should be constructed.

Justification/Background

Fish passage past Clear Lake Dam is questionable. The Denil fish ladder constructed in the spillway channel is poorly designed and ineffective. Passage via the spillway channel adjacent to this ladder, while apparently possible at some flows, is unrelaible.

Key Partners

USFWS, BOR, WDFW, MCFEG

Time to Implement: 1-3 years **Time to Benefit:** 3-5 years

Cost Estimate: $273, 000

Cost Derivation

Cost estimate is based on budget for a 4 year PIT tag study underway as a joint effort between USFWS, BOR and WDFW. Cost to modify the dam to maximize passage opportunities for bull trout at all life stages in unknown pending results of study.

Rattlesnake Action #1: Improve screening on diversion/monitor effectiveness

Action Type: Monitoring **Life stage(s) affected:** Juvenile rearing

Threat addressed: Entrainment

Severity: Low **Link to Threats Table:**

Action Description

Monitor condition and effectiveness of fish screens on irrigation diversions, and improve screening as necessary.

Justification/Background

This is one of the few populations where there are irrigation diversions within the known spawning and rearing reach. Entrainment of juveniles and sub-adults could negatively impact the population.

Key Partners

WDFW, irrigators, YN

Time to Implement: 1-5 years **Time to Benefit:** Immediate

Cost Estimate: $2000

Cost Derivation

Initial cost estimates based on 10 days @ $200/day to monitor diversions via electrofishing for entrainted fish. Opportunity to partner with Yakama Nation and the Coho Reintroduction Program. Cost to improve screening if necessary is unknown.

SF Tieton Action #1: Close streamside campsites

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Pre/post spawning migrations

Threat addressed: Recreational Impacts

Severity: Unknown significant **Link to Threats Table:** SFT8, SFT9

Action Description

Close access to dispersed campsites and those in developed campgrounds that are immediately adjacent to bull trout holding/ spawning areas. This would not require closing/relocating the entire campground, but focusing on sites adjacent to the stream.

Justification/Background

Some spawning takes place in close proximity to campgrounds. Some non-angling harassment is probable due to the proximity of the SF Tieton to roads and campgrounds. Several campsites are located adjacent to prime holding pools.

Key Partners

USFS, USFWS

Time to Implement: 5-7 years **Time to Benefit:** 5+ years

Cost Estimate: $90,000

Cost Derivation

Cost estimate is based on relocation and restoration costs, including planning.

SF Tieton Action #2: Address problem roads

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management Practices

Severity: Unknown **Link to Threats Table:** SFT11, SFT12

Action Description

Identify roads which may be contributing sediment to the stream, and reduce road densities, prioritizing roads with highest potential to contribute sediment.

Justification/Background

Logging and recreation occurs in the watershed and forest roads are chronic sediment source. In this drainage, there are a number of abandoned roads that would a prime candidate for formal closures and restoration.

Key Partners

USFS, TNC, USFWS

Time to Implement: 1-5 years **Time to Benefit:** 3-10 years

Cost Estimate: $150-250,000

Cost Derivation

1-2 miles of road per year, and $10,000 per mile for road obliteration and reshaping, over a 10 year period. Includes $50,000 in planning costs.

SF Tieton Action #3: Implement Dry Forest Restoration Strategy

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Juvenile Rearing

Threat addressed: Forest Management Practices

Severity: Unknown **Link to Threats Table:** SFT11, SFT12

Action Description

The Collaborative Forest Landscape Restoration prject (CFLR), a joint effort between the Forest Service and the Nature Conservancy (TNC) has identified the SF Tieton as a priority area for dry forest restoration techniques.

Justification/Background

The watershed has experienced an extensive spruce budworm kill and the forest is at risk of a catstrophic wildfire with potentially dire consequences for this bull trout population.

Key Partners

USFS, TNC, USFWS

Time to Implement: 3-5 years **Time to Benefit:** 5+ years

Cost Estimate: $1.2- 2.25 million

Cost Derivation

Based on treatment of 2000-5000 acres/year at $350/acre for a 10 year period. Acre costs were esimated based on average costs from other dry forest restoration initiatives, where some treatments generate saleable products and others do not. Additional planning cost of $500,000 were added.

SF Tieton Action #4: Relocate river to natural mouth

Action Type: Recovery **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Passage Barriers

Severity: Unknown **Link to Threats Table:** SFT15

Action Description

The desirable long- term solution would be to relocate the mouth of the river near its historic location. In the interim, continue to maintain Rimrock pool level through mid-August to allow successful pre-spawn migration into the stream.

Justification/Background

The lower-most segment of the SF Tieton was rerouted and bridged when the road was built. As a result an impassable waterfall forms at the mouth of the stream when Rimrock Reservoir is drawn down rapidly during flip-flop in September. When post-spawn bull trout return to the reservoir they must migrate downstream over this waterfall which is vertical and reaches a height approaching 10-12 meters. The landing area is rocky and not particularly deep. Some mortality is probable but has not been confirmed.

Key Partners

BOR, USFWS, USFS

Time to Implement: 5-10 years **Time to Benefit:** 5+ years

Cost Estimate: $2.5 million

Cost Derivation

Cost estimate is from the Yakima Basin Integrated Plan, which has included this action in the Habitat component.

SF Tieton Action #5: Monitor cattle exclusion

Action Type: Monitoring **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Grazing

Severity: Unknown low **Link to Threats Table:** SFT16, SFT18

Action Description

Continue to monitor compliance of cattle exclusions and timing restrictions during spawning period.

Justification/Background

A number of egotiations and agreements with Forest Service and grazing leasee are in place to protect bull trout. It is important to continue monitoring to ensure compliance.

Key Partners

USFS, WDFW

Time to Implement: 1-3 years **Time to Benefit:** Immediate

Cost Estimate: $0

Cost Derivation

Cost is included in estimate for Bull Trout Task Force (Multiple Pops #1).

Teanaway Action #1: Snorkel surveys/PIT tags

Action Type: Recovery **Life stage(s) affected:** Adult

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Significant **Link to Threats Table:** T2

Action Description

Continue annual snorkel and redd survey efforts to determine if bull trout are still present in the Teanaway. If possible, PIT tag any bull trout captured to help track movement patterns and habitat use.

Justification/Background

Bull trout in the Teanaway system may be functionally extirptated. There is a need to determine if this is the case before recovery funds are expended to benefit a population that may no longer exists and to determine if reintroduction should be pursued.

Key Partners

YBFWRB, USFWS, WDFW, BOR, YN

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $36,000

Cost Derivation

Cost to cover 0.5 miles via night snorkeling = 3 person days* $200, so total cost to cover 3 miles annually is $3600. Cost is over a 10 year period.

Teanaway Action #2: Increase in-stream flow

Action Type: Recovery **Life stage(s) affected:** Pre/post spawning migrations, Subadults/ Adults in FMO Habitat

Threat addressed: Altered Flow Regimes

Severity: Unknown significant **Link to Threats Table:** T2, T3

Action Description

Continue to pursue water conservation projects and water lease/purchase agreements to enhance summer stream flows. Assignment of a dedicated stream patrolman who will ensure proper regulation of water rights during the irrigation season to fully protect all of the acquired instream flow water rights against diversion and off-stream use by junior-priority irrigation water right holders.

Justification/Background

Summer flow reductions in lower reaches occur as a result of irrigation withdrawals. Habitat complexity is limited and excessive water temperatures are a documented problem in the lower reaches.

Key Partners

WDFW, WWT, DOE, WRBWEP, YN, MCFEG

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $4.6 million

Cost Derivation

Cost in Teanaway system is estimated as ~$200,000 per cfs as permanent in-stream purchase. Assume that additional 20 cfs would be ideal over next 10 year period. Cost for patrolperson estimated at $60,000 annually.

Teanaway Action #3: Habitat surveys and develop projects

Action Type: Monitoring **Life stage(s) affected:** Spawning/egg incubation, Subadults/ Adults in FMO Habitat, Juvenile Rearing

Threat addressed: Recreational Impacts, Development, Agriculture

Severity: Unknown significant **Link to Threats Table:** T10,T13, T14, T15, T17, T18

Action Description

Monitoring is needed to determine if significant habitat degradation is occuring. If so, work with landowners individually to address issues.

Justification/Background

Moderate to heavy recreational activity occurs which may be leading to habitat degradation for these life stages. While the impact on habitat quality is unknown this population (or one that might be reintoduced) needs all the help that it can get. There is considerable residential development along the lower reaches of the Teanaway River which is probably contributing to habitat degradation to some extent.

Key Partners

USFS, MCFEG, YN, KCT, YBFWRB

Time to Implement: 5+ years **Time to Benefit:** 10+ years

Cost Estimate: $50-100,000

Cost Derivation

Cost estimates are based on survey crew for 1-2 year period. Costs for projects developed as a result of these surveys is unknown.

Teanaway Action #4: Floodplain acquistions

Action Type: Recovery **Life stage(s) affected:** Pre/post spawning migrations

Threat addressed: Development (residential and urbanization)

Severity: Unknown significant **Link to Threats Table:** T17

Action Description

Pursue floodplain acquisitions and easements wherever available in the Teanaway system.

Justification/Background

There has been an extensive loss of floodplain function in the Teanaway watershed primarily as a result of residential development.

Key Partners

WDFW, KCT, USFS, BOR, CLC, other

Time to Implement: 3-5 years **Time to Benefit:** 5+ years

Cost Estimate: $4.6 million

Cost Derivation

Cost estimate is from a similar action described in the Yakima Steelhead Recovery Plan (Upper Yakima Action #17).

Teanaway Action #5: Reduce road density

Action Type: Recovery

Life stage(s) affected: Spawning/egg incubation, Subadults/ Adults in FMO Habitat, Juvenile Rearing, Pre/post spawning migrations

Threat addressed: Forest Management Practices

Severity: Unknown

Link to Threats Table: T19, T20, T21, T22, T23, T24

Action Description

Reduce forest road density. Replace undersized bridges and culverts. Restore riparian condition. Ensure proper application of Forest Practices Permits and adherence to the FPHCP.

Justification/Background

The impacts and potential impacts from past and current forest management practices are numerous and extend across many bull trout life stages. These include high sediment input, elevated water temperatures, degraded riparian condition, and impaired habitat quality. Road density is very high in the watershed; undersized bridges and culverts impair floodplain function.

Key Partners

WDFW, USFS, private

Time to Implement: 3-10 years

Time to Benefit: 5+ years

Cost Estimate: $400-800,000

Cost Derivation

Cost estimates is based on road treatment of 1-2 miles of road per year over a 10 year period. Costs will vary depending on the treatment needed (relocation, obliteration, culvert replacement etc) but average cost, including planning is esimated at $40,000 per mile.

Teanaway Action #6: Grazing management

Action Type: Recovery

Life stage(s) affected: Spawning/egg incubation, Subadults/ Adults in FMO Habitat, Juvenile Rearing, Pre/post spawning migrations

Threat addressed: Grazing

Severity: Unknown

Link to Threats Table: T25, T26, T27, T28

Action Description

Reduce impacts of grazing in riparian areas and restore degraded areas.

Justification/Background

Numbers of cattle have diminished in recent years and with them the impacts from grazing but habitat degradation and the stressing of bull trout is still a potential threat to the population and should not be considered fully addressed.

Key Partners

WDFW, KCT, USFS, private, KCCD, NOAA

Time to Implement: 5-10 years

Time to Benefit: 5+ years

Cost Estimate: $350,000

Cost Derivation

Cost estimate is based on fencing cost of $5000 per mile for 10 miles and restoration of the same length of stream at $30,000 per mile.

Upper Yakima Action #1: Snorkel surveys/PIT tags

Action Type: Recovery **Life stage(s) affected:** Adult

Threat addressed: Low Abundance

Severity: Significant **Link to Threats Table:** UY4

Action Description

Continue peridoic snorkel and redd survey efforts to determine if bull trout are present in the Upper Yakima River. If possible, PIT tag any bull trout captured to help track movement patterns and habitat use.

Justification/Background

It is unknown whether there is a genetically distinct, viable bull trout population in the upper Yakima River. There is a need to determine if this is the case before recovery funds are expended to benefit a population that may not exist .

Key Partners

YBFWRB, USFWS, WDFW, BOR, YN

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: $40,000

Cost Derivation

Cost estimate is based on 3 person days to cover 0.5 miles via night snorkeling @ $200/person day, thus $7200 annually to cover 6 miles. This would be done 5 times over the next 10 year period, in addition to 5 years of redd surveys @ 4 person days to cover 6 miles.

Upper Yakima Action #2: Improve flow conditions

Action Type: Recovery **Life stage(s) affected:** Juvenile rearing

Threat addressed: Altered Flows

Severity: Unknown significant **Link to Threats Table:** UY5

Action Description

This action is part of a larger, ongoing effort to improve rearing conditions for juvenile salmonids in the upper Yakima River.

Justification/Background

High flows are persistent throughout the summer months in the upper Yakima River due to irrigation delivery and the subsequent dropping of flows in the fall may strand fish and deplete invertebrate communities.

Key Partners

USFWS, BOR, YN

Time to Implement: Ongoing **Time to Benefit:** Immediate

Cost Estimate: Unknown

Cost Derivation

Upper Yakima Action #3: Land acquisition

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation; juvenile rearing

Threat addressed: Development

Severity: Unknown significant **Link to Threats Table:** UY8, UY9, UY10

Action Description

Floodplain acquisition/easements in upper Yakima River corridor.

Justification/Background

Adverse impacts on bull trout habitat is possible as a result of residential/recreational development on private land holdings.

Key Partners

WSDOT, USFS, CLC, YN

Time to Implement: 5-10 years **Time to Benefit:** 5+ years

Cost Estimate: $3-5 million

Cost Derivation

Cost estimate is based on estimate land values.

Upper Yakima Action #4: Evaluate/improve juvenile passage at Easton dam

Action Type: Recovery **Life stage(s) affected:** Juvenile rearing

Threat addressed: Passage barriers

Severity: Unknown significant **Link to Threats Table:** UY12

Action Description

Evaluate and improve juvenile passage at Easton dam so passage is possible under all conditions.

Justification/Background

There is debate as to the ability of juvenile fish to migrate upstream past Easton dam under certain flow conditions. If this is true, it would be limiting to any juvenile bull trout that are using this reach for rearing.

Key Partners

USFWS, BOR, YN

Time to Implement: 1-5 years **Time to Benefit:** 5+ years

Cost Estimate: $500,000

Cost Derivation

Upper Yakima Action #5: Improve/Monitor effectiveness of screens on diversions

Action Type: Monitoring **Life stage(s) affected:** Adults/subadults in FMO

Threat addressed: Entrainment

Severity: Unknown **Link to Threats Table:** UY25, UY26

Action Description

Monitor irrigation diversion sites to ensure properly functioning screens and also canals for evidence of entrainment. If necessary, improve irrigation systems to minimize entrainment effects.

Justification/Background

There are numerous irrigation diversions on the Yakima River in the reach that adults and subadults are potentially using as FMO habitat.

Key Partners

USFWS, KCCD, JB, YN

Time to Implement: 1-5 years **Time to Benefit:** 5+ years

Cost Estimate: $600,000

Cost Derivation

Cost estimate is based on annual salary cost of $60,000/year for a 10 year period to hire a dedicated person to monitor fish entrainment and analyze results.

Upper Yakima Action #6: Implement USFS Upper Yakima Restoration Project

Action Type: Recovery **Life stage(s) affected:** Spawning/egg incubation, Subadults/ Adults in FMO Habitat, Juvenile Rearing, Pre/post spawning migrations

Threat addressed: Forest Management

Severity: Unknown **Link to Threats Table:** UY27, UY28, UY29, UY30, UY31, UY32

Action Description

Implement the Forest Service Upper Yakima Restoration Project which includes campground closures and restoration, road closures and decommissioning, floodplain and in-stream restoration.

Justification/Background

The Upper Yakima watershed was selected as the Forest Service focus watershed and a large number of restoration projects have been proposed that would benefit bull trout and other aquatic species.

Key Partners

USFS, TNC, WSDOT

Time to Implement: 5-10 years **Time to Benefit:** 5+ years

Cost Estimate: $7 million

Cost Derivation

Cost estimate is based on Forest Service intial estimates.

Waptus Action #1: Snorkel/hook and line surveys

Action Type: Monitoring **Life stage(s) affected:** Adult

Threat addressed: Low Abundance (increased risk of extirpation)

Severity: Significant **Link to Threats Table:** C/W4

Action Description

Additional monitoring is needed to understand population demographics. At this point addressing the threats through the other actions described herein is critical prior to proposing any supplemenation

Justification/Background

The data needs for this population (or populations) are huge, Despite a great deal of effort we still know little about bull trout in the upper Cle Elum River watershed, including the Waptus system.

Key Partners

USFWS, BOR, USFS, YBFWRB

Time to Implement: 1-5 years **Time to Benefit:** Immediate

Cost Estimate: $7,200

Cost Derivation

Cost estimate is based on 3 person days to cover 0.5 miles via night snorkeling @ $200/person day, thus $7200 annually to cover 6 miles.

ACRONYMS, ABBREVIATIONS AND GLOSSARY

Acronyms and Abbreviations

BLM	Bureau of Land Management (federal)
BTAP	Bull Trout Action Plan (also see YBTAP)
CBFWA	Columbia River Fish and Wildlife Authority
CRITFC	Columbia River Inter-Tribal Fish Commission
CWU	Central Washington University
DNA	Deoxyribonucleic acid
DPS	Distinct Population Segment
EIT	Ecological Interactions Team (YKFP)
ESA	Endangered Species Act
FMO or FM&O	Foraging, Migrating, and Overwintering
FR	Federal Register
FS	U.S. Forest Service road
GIS	Geographic Information System
MBTSG	Montana Bull Trout Scientific Group
NA	Not applicable
N_e	Effective population size
N.F./NF	North Fork
NOAA	National Oceanic and Atmospheric Administration
NYCD	North Yakima Conservation District
PIT tag	Passive Integrated Transponder tag
Rd	Road
RM	River mile
SaSi	Salmonid Stock Inventory (WDFW)
S.F./SF	South Fork
S&R	Spawning and rearing
SRFB	Salmon Recovery Funding Board (Washington)

STRS	Supplementation, Transplantation and/or Reintroduction Strategies
UBC	University of British Columbia
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources (also known as DNR)
WDOT	Washington Department of Transportation
WDOE	Washington Department of Ecology
YRBWEP	Yakima River Basin Water Enhancement Project
YBFWRB	Yakima Basin Fish & Wildlife Recovery Board
YBTAP	Yakima Bull Troup Action Plan (also see BTAP)
YKFP	Yakima/Klickitat Fisheries Project
YN	Yakama Nation (also known as, Confederated Tribes and Bands of the Yakama Nation)
YSRP	Yakima Steelhead Recovery Plan

Glossary

adfluvial: A life history strategy of fish in which spawning by adults and rearing of juveniles occurs in streams, but subadults and adults live in lakes or reservoirs.

abundance: The number of adult fish in a defined population group (local population, metapopulations, recovery unit, etc.).

anadromous: Life history strategy of fish in which a species is born and rears in freshwater, migrates to and matures in salt water, and returns to freshwater to spawn.

anadromy: The expression of the anadromous migratory life cycle.

bull trout: *Salvelinus confluentus*

connectivity: Ability for a species to move unimpeded between adjoining, accessible habitats of different types and sufficient quantity and quality to support various life stages of a species; especially critical to the bull trout's migratory forms.

Core Area: The USFWS uses this term to define the basic unit on which to gauge recovery. A core area represents the closest approximation of a biologically functioning unit (metapopulations) for bull trout.

Denil/denil: A fishway using a series of closely spaced baffles on the walls and bottom of a man-made channel.

distinct population segment (DPS): Term applied to a fish stock if (1) it is substantially reproductively isolated from other stocks, and (2) it is an important component in the evolutionary legacy of the species. Yakima bull trout are part of the Columbia River DPS as defined jointly by USFWS and NMFS (67 FR 4722).

diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.

ecosystem: A complex of biological, chemical, and physical components that form and function as a natural environmental unit.

effective population size (Ne): The number of individuals in a population who contribute offspring to the next generation. This is differentiated from total population size in that it refers to genetic variation, and is usually less than the total number of individuals.

endangered: Species that are at risk of extinction throughout a significant portion of their range.

entrainment: The incidental trapping of fish and other aquatic organisms, occurring for example, in waters being diverted for irrigation or similar purposes.

e**xtinct:** There are no individuals of this former population or species anywhere.

extinction risk: The likelihood that a species or population will become extinct within a defined period of time.

extirpated: Elimination of a species from a particular local area.

fluvial: A life history of fish in which spawning by adults and rearing of juveniles occurs in tributaries, but the subadults and adults occupy habitats in larger streams and mainstem rivers.

fry: Young salmonids that have emerged from the substrate and absorbed their yolk sac; up to the time young salmonids are about 2 inches long.

geometric mean: A type of statistical mean or average, which indicates the central tendency or typical value of a set of numbers.

habitat: Specific place or area occupied by an organism, population, or community that provides the basic life requirements of food, water and cover.

heterozygosity: An estimate of the amount of genetic variation in a population.

hybridization: A crossing of individuals of different genetic composition, typically different species, that results in hybrid offspring.

interspecific competition: Competition for resources between two or more different species.

introduction: Fish planted into a habitat where it has not been historically.

introgression: The spread of genes from one species into the gene pool of another by hybridization (or by interbreeding between hybrid and parental species or between hybridized individuals).

legacy effects: Impacts from past activities (usually a land use) that continue to affect a stream or watershed in the present day.

local population: A group of bull trout that spawn within a particular stream or portion of a stream system. Multiple local populations may exist within a core area. A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

loci: From the Latin for 'places.' The physical places or positions occupied by genes or segments of base pairs on a molecule of DNA (chromosome).

mainstem: Term applied to the principal channel of a major stream or river that is fed by numerous tributaries in a watershed.

metapopulation: A group of semi-isolated population or subpopulations of bull trout that are interconnected and that likely share genetic material.

microsatellite: A genetic marker within the non-coding portion of the DNA that consists of a series of a repeating 2-5 nucleotide segment (ex. CAGCAG). This type of genetic marker has become widely used due to the high levels of variability, simple inheritance patterns (one gene from each parent) and a non-lethal sampling requirement.

migratory life history form (bull trout): Bull trout that travel from spawning and rearing habitat to lakes, reservoirs, or larger rivers.

phenotype: Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.

productivity: The average number of surviving offspring per parent. Used as an indicator of a population's ability to sustain itself or its ability to rebound from low numbers.

radio telemetry: Transmission of data from tags attached to an animal and transmit radio signals. The signals are read at either fixed receiving stations or by mobile tracking devices. Radio tags for fish are usually inserted into the stomach or surgically into the body cavity.

recovery unit (bull trout): A USFWS term for one of the nested units delineated for recovery efforts. Biologically, recovery units are considered groupings of bull trout for which gene flow was historically or is currently possible. The Yakima Core Area, is one of many core areas within the Middle Columbia recovery unit, and there are multiple recovery units within the Distinct Population Segment (DPS).

redd: A cavity or "nest" dug by female bull trout and other salmonids in streambed gravels where females deposit and bury eggs fertilized by one or more males. Redds can be distinguished in the streambed gravel by a cleared depression and an associated mound of gravel directly downstream.

resident: Life history strategy in which the entire life cycle occurs in a water body, such as that of resident Ahtanum Creek bull trout, which occur in small headwater streams.

salmonid: Fish of the family Salmonidae, including bull trout (and other trout species) salmon, chars, grayling, and whitefish. In general usage, the term most often refers to salmon, trout, and chars (subfamily Salmoninae).

stochastic: Describes a natural event or process that is random or unpredictable. Examples include environmental conditions such as rainfall, runoff, and storms, or life-cycle events, such as survival or fecundity rates.

species: Animals that are behaviorally, genetically, or reproductively isolated from similar groups of animals.

subpopulation: Groups of local populations between which migration is presumed to occur.

supplementation: The release and management of artificially propagated fish in streams with the intent to increase or establish naturally spawning fish populations while minimizing associated genetic and ecological risks.

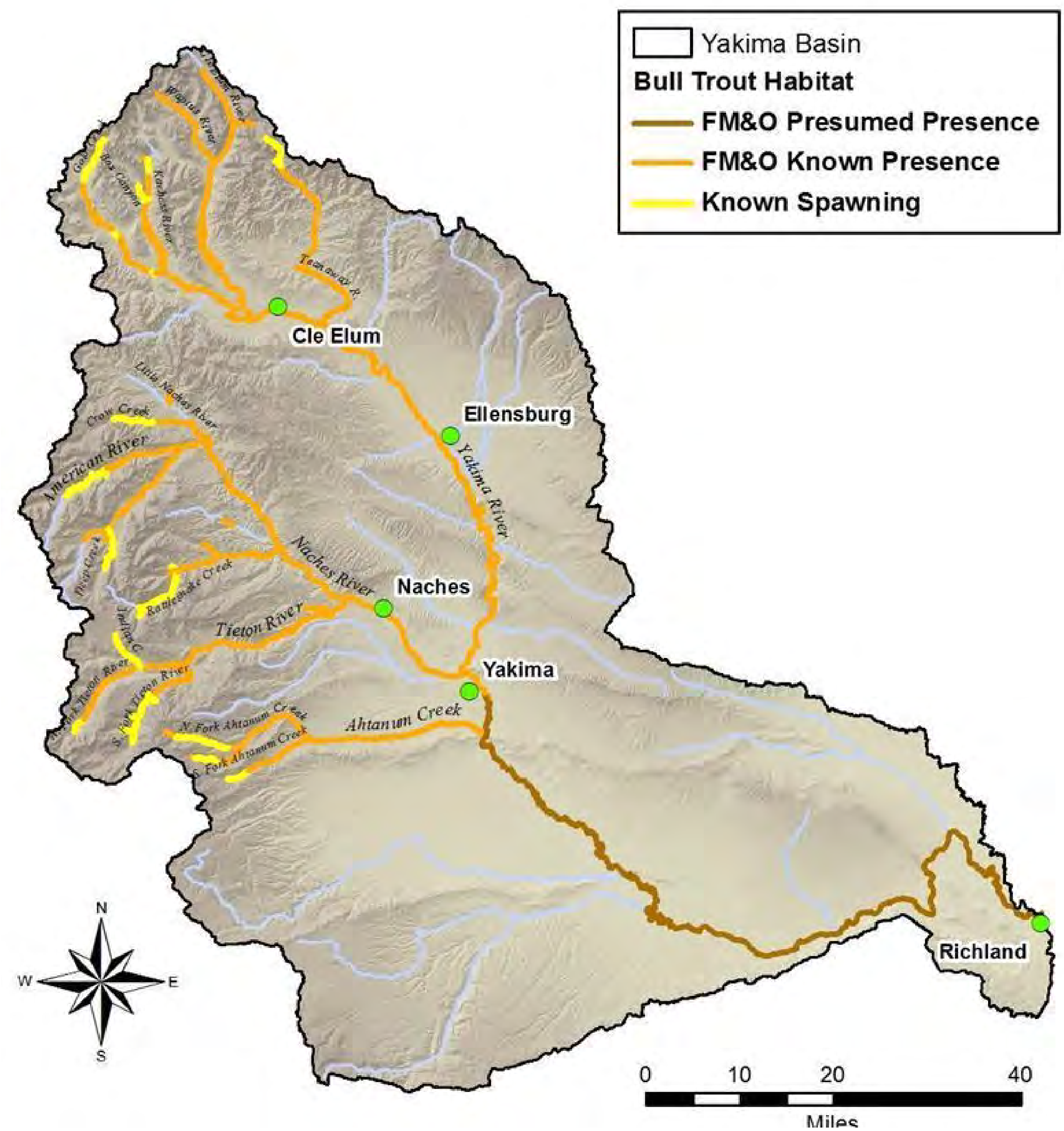
sympatric: Occurring in the same geographic area but without interbreeding as with closely related but distinct species.

threatened: Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range—as defined in the Endangered Species Act.

watershed: Term applied to catchment area of a sloping landscape that collects precipitation and drains the resulting surface and groundwater.

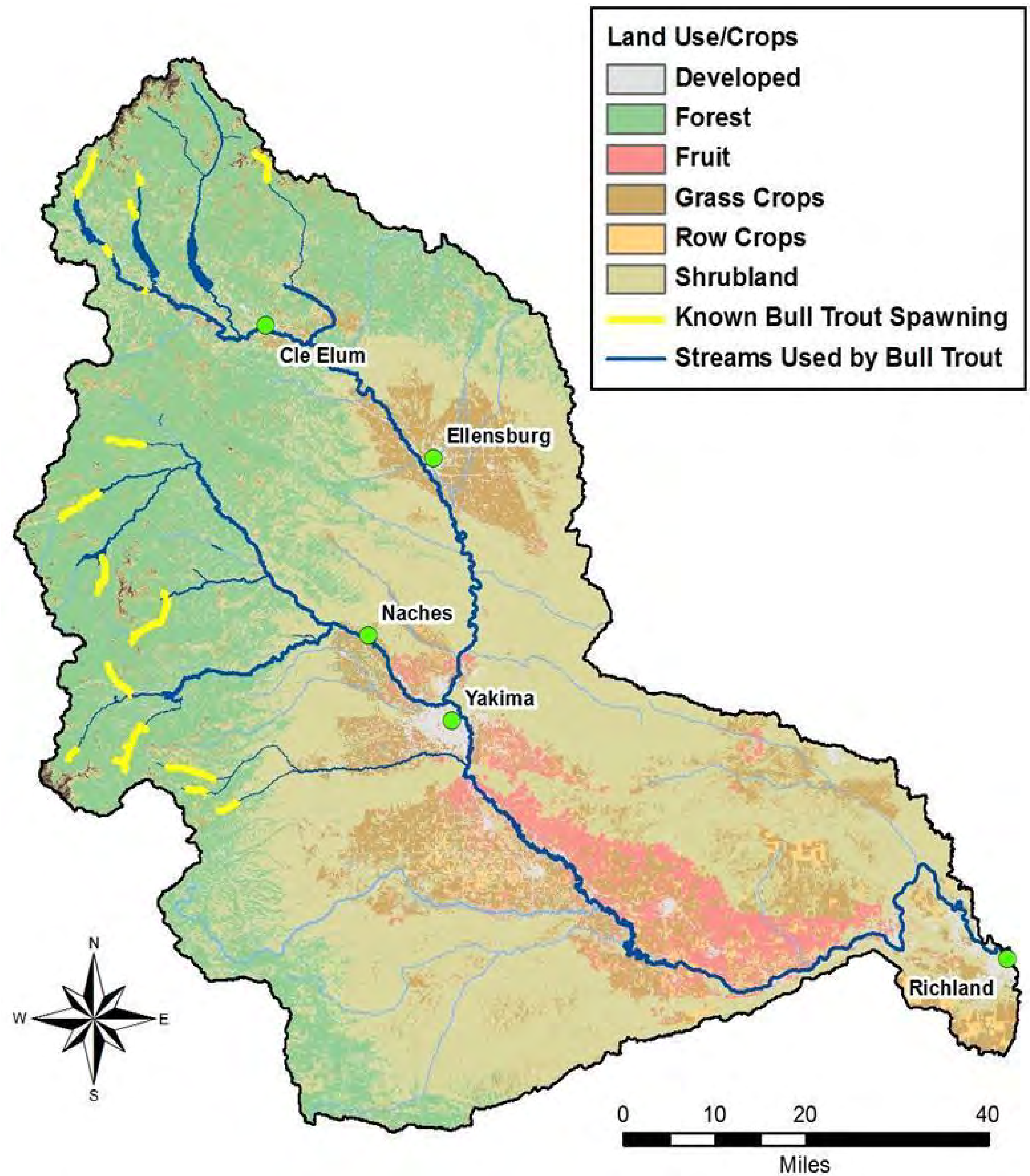
APPENDIX A: ATLAS OF THREATS

The maps that were created for this Action Plan are meant to give a spatial representation of the distribution, severity and extent of identified Threats to local bull trout populations. The maps were completed by a GIS consultant (Jennifer Hackett of Manastash Mapping), working under the direction of the BTAP Working Group. Data, layers, geodatabases, etc. were acquired by Manastash Mapping with express consent of the original source. Data chosen for each map was based on what the BTAP Working Group believed to be the best representation of each Threat. Notes on rationale and data sources for each map are listed below.



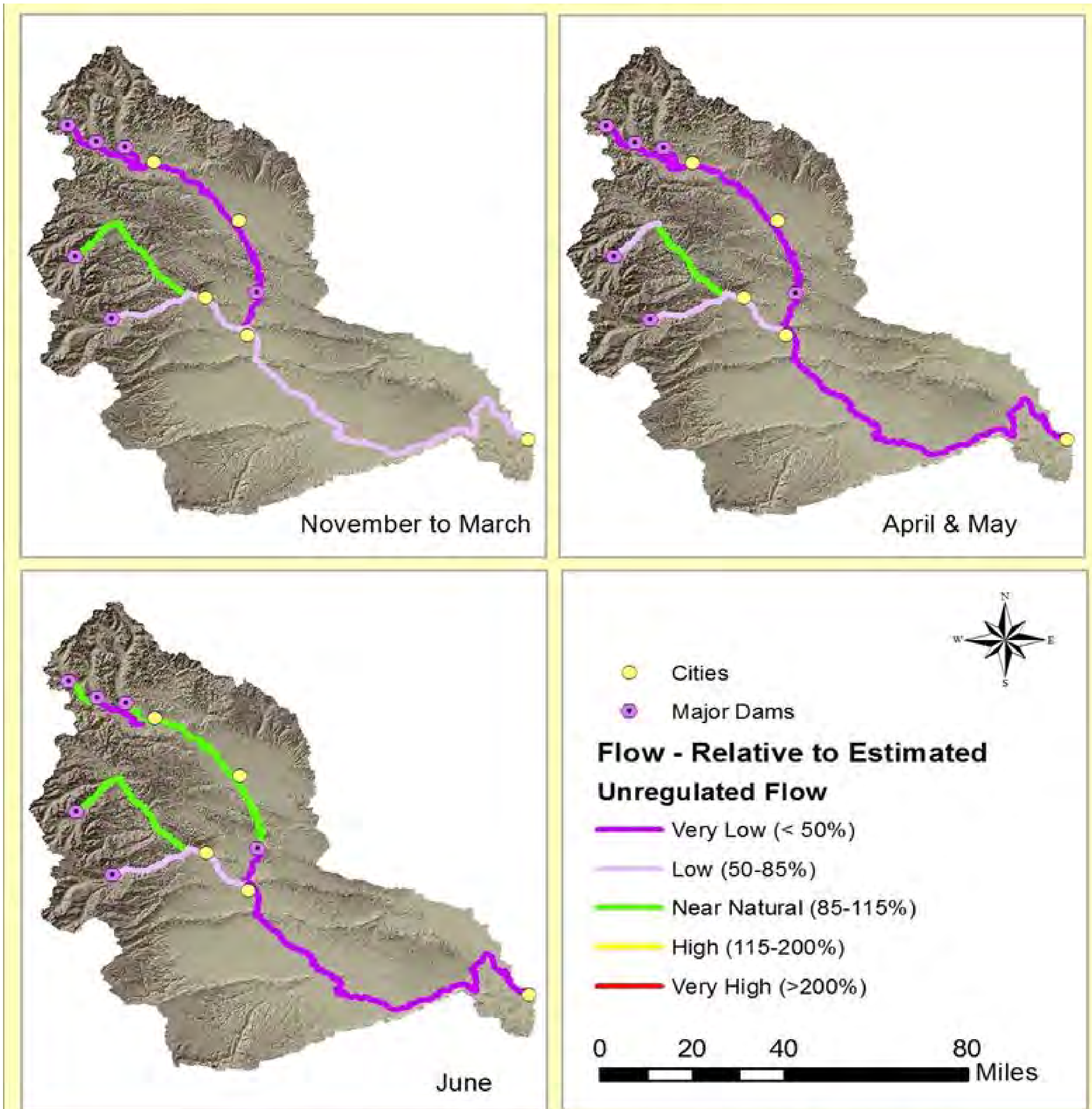
Overview Map:

This map provided the base layer for the creation of all the other maps. The stream layer for this, and all maps, was the Hydrosort hydrology layer, produced by www.streamnet.org. This layer most accurately reflects water courses across land ownerships throughout the Yakima Basin and has the added advantage of having names for most water courses. For roads, the Washington State Department of Transportation (DOT) highway layer was used, as well as Forest Service and Bureau of Land Management road layers. Bull trout distribution was acquired from the WDFW distribution map.



Agriculture:

This map demonstrates the extent to which agricultural areas overlap with known bull trout areas. All of the spawning and rearing areas are within the upper, forested reaches of streams, but in the lower FM&O areas, there are irrigated crop lands with fruit, grass and row crops. The data for this map comes from the USDA crop data layer, and was simplified to focus on key crop types.

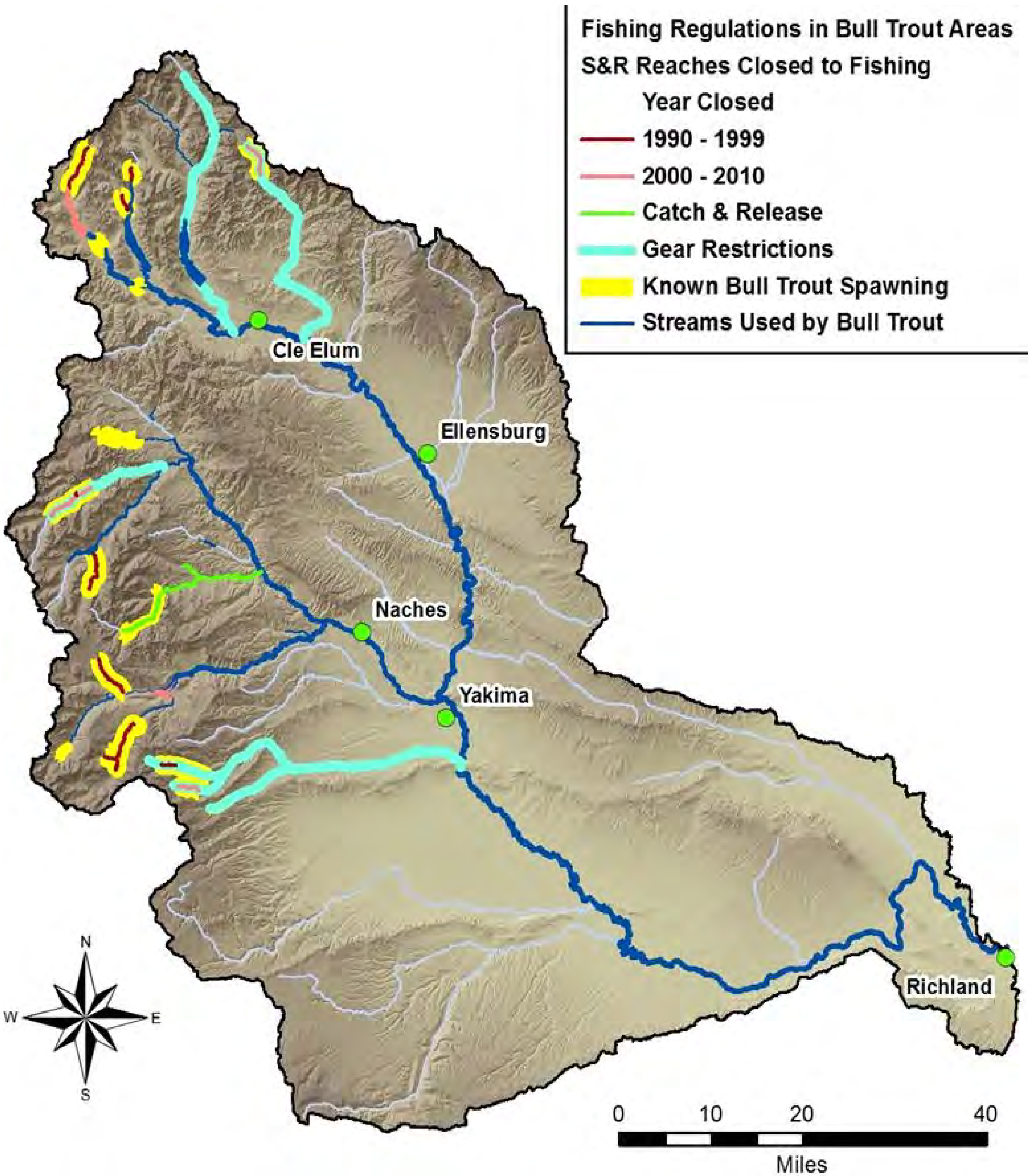


Flow on the Yakima River Expressed as a Percentage of Average Estimated Unregulated Flow

Relative flow was calculated using data from key gauages. Values were adjusted to compensate for known variations on the stretches:
- Yakima River from Roza Dam to Naches,
- Yakima River below the Marion Drain,
- Naches River above the confluence with the Tieton.

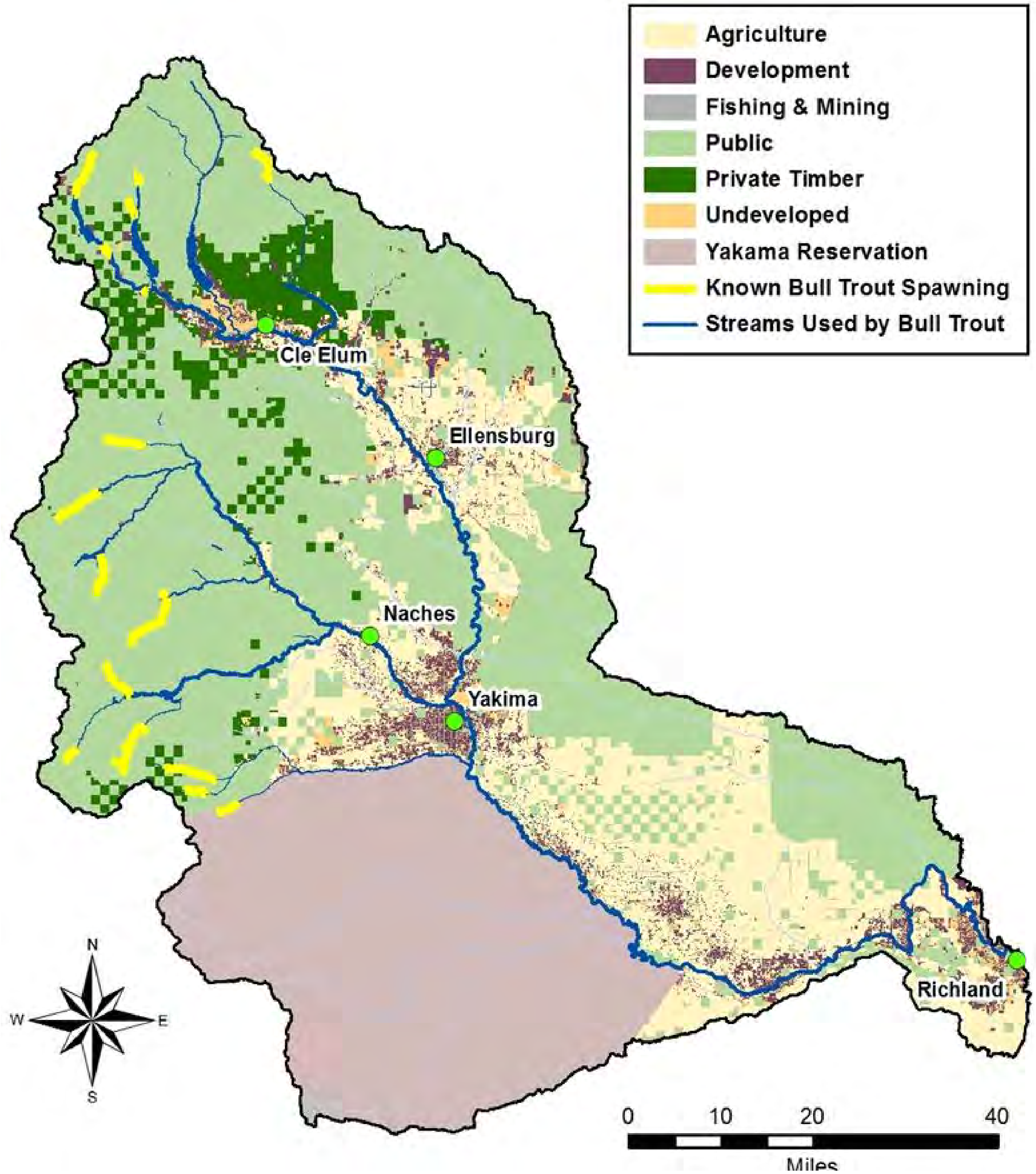
Altered Flows:

This map is meant to show the extent to which flows in bull trout use areas are manipulated by flow regulations. This includes all changes from "normative" flows, both flows that are lower than the seasonal norm and those that are higher. In the months when irrigation water is not being delivered (November-March), bull trout are primarily occupying either headwater rearing areas or downstream FM&O areas. Flows are Low to Very Low, in comparison to estimated unregulated flow, as water is held in upstream reservoirs for irrigation use in the spring.



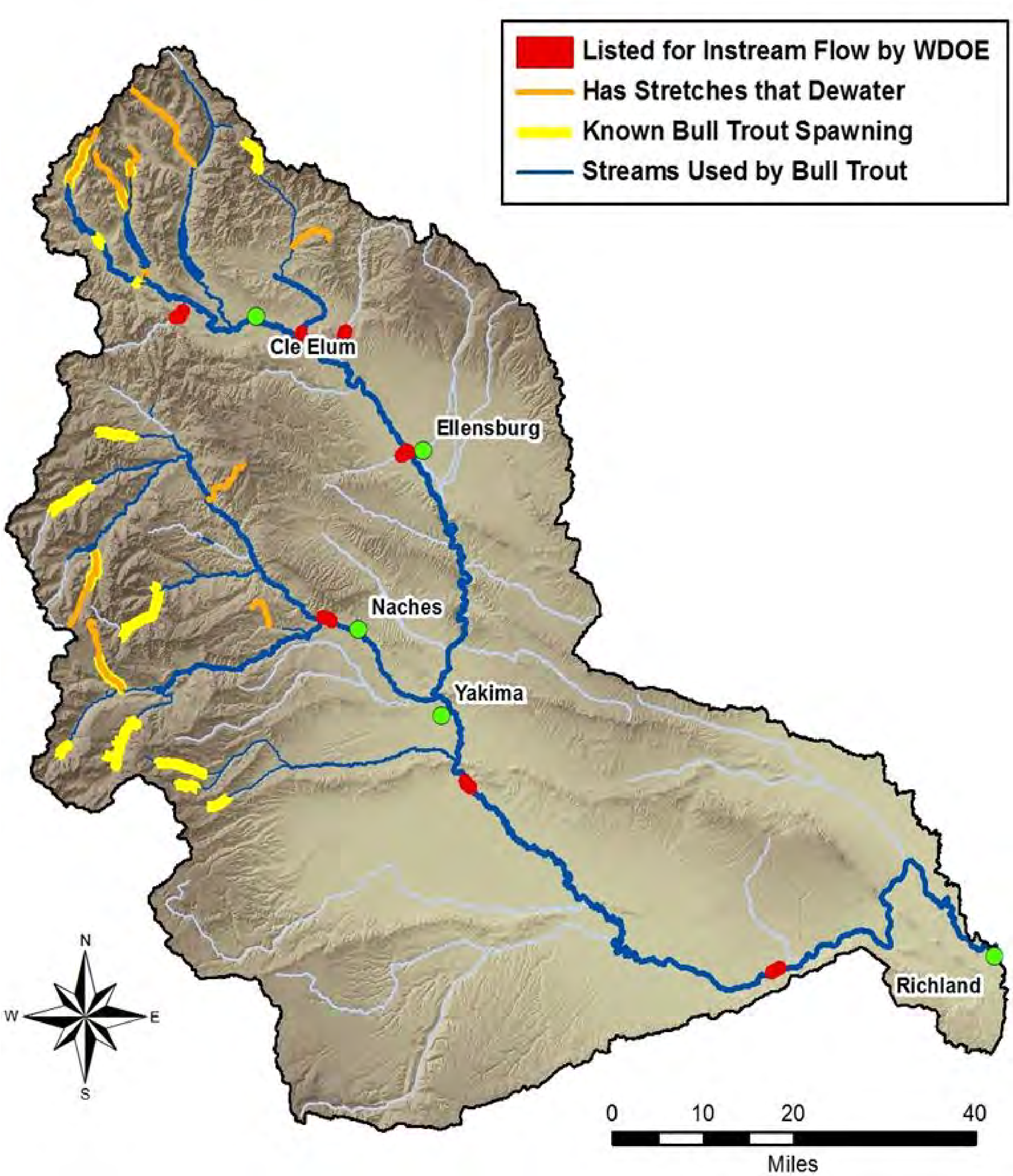
Angling:

This map shows the spatial extent of protective fishing regulations in streams with bull trout presence (closures, gear restrictions and/or catch and release). The data was interpreted from the WDFW 2011 Fishing Regulations Guide.



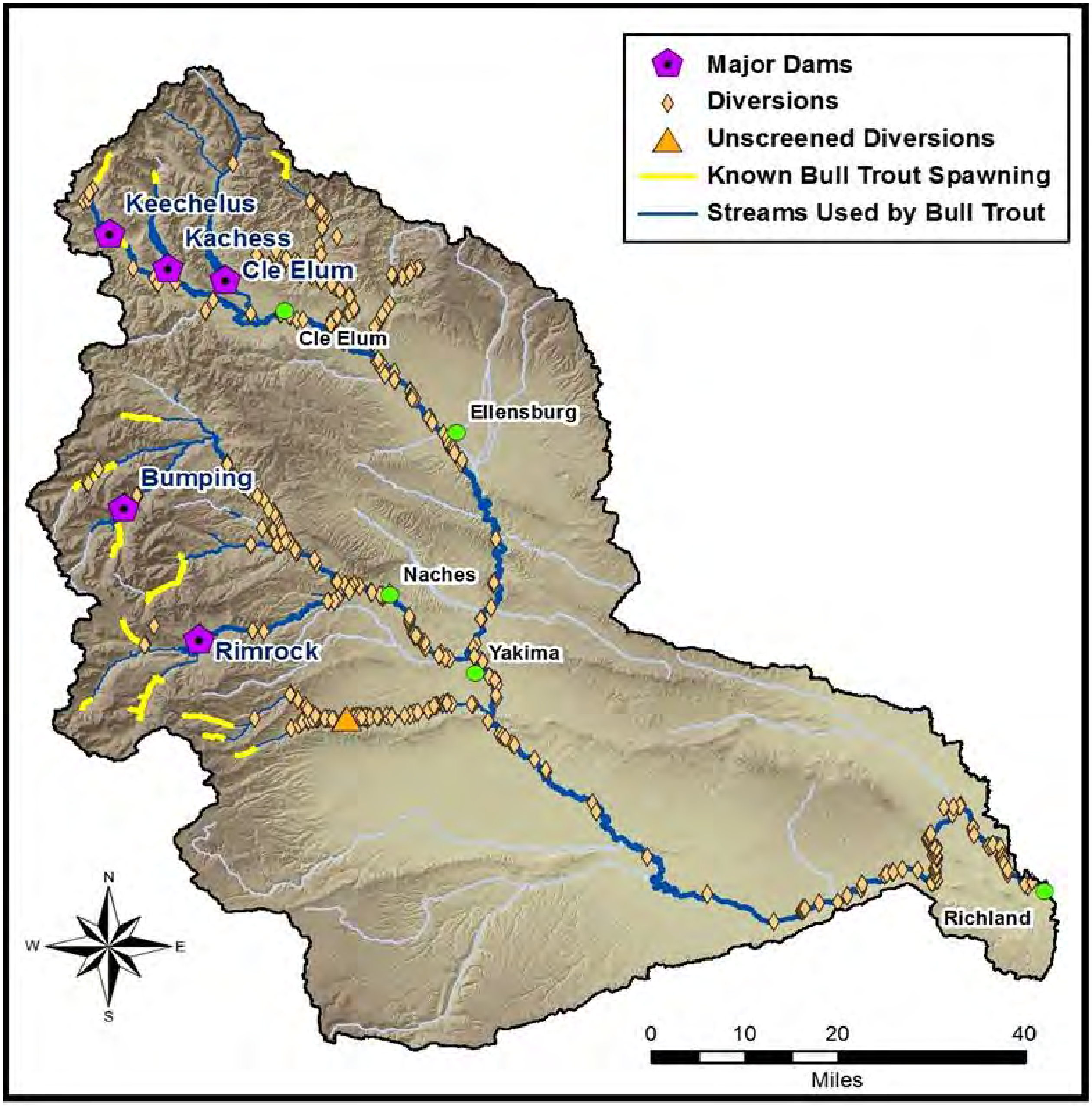
Development:

This map shows land use in the Yakima Basin, and how this overlaps with bull trout distribution. It is interesting to note that the most abundant populations exist where there is solid public ownership, and where the landscape is more highly fragmented by private timber lands and encroaching agriculture and development there are more at-risk populations. The data on public lands came from either the county assessor data (Kittitas and Yakima counties) or the DNR Major Public Lands Data (Benton and Klickitat counties). Private land outside of the reservation was symbolized using the WDOE land use layer and categorized as Agriculture, Development (residential and industrial), Timber, Fishing and Mining, or Public.



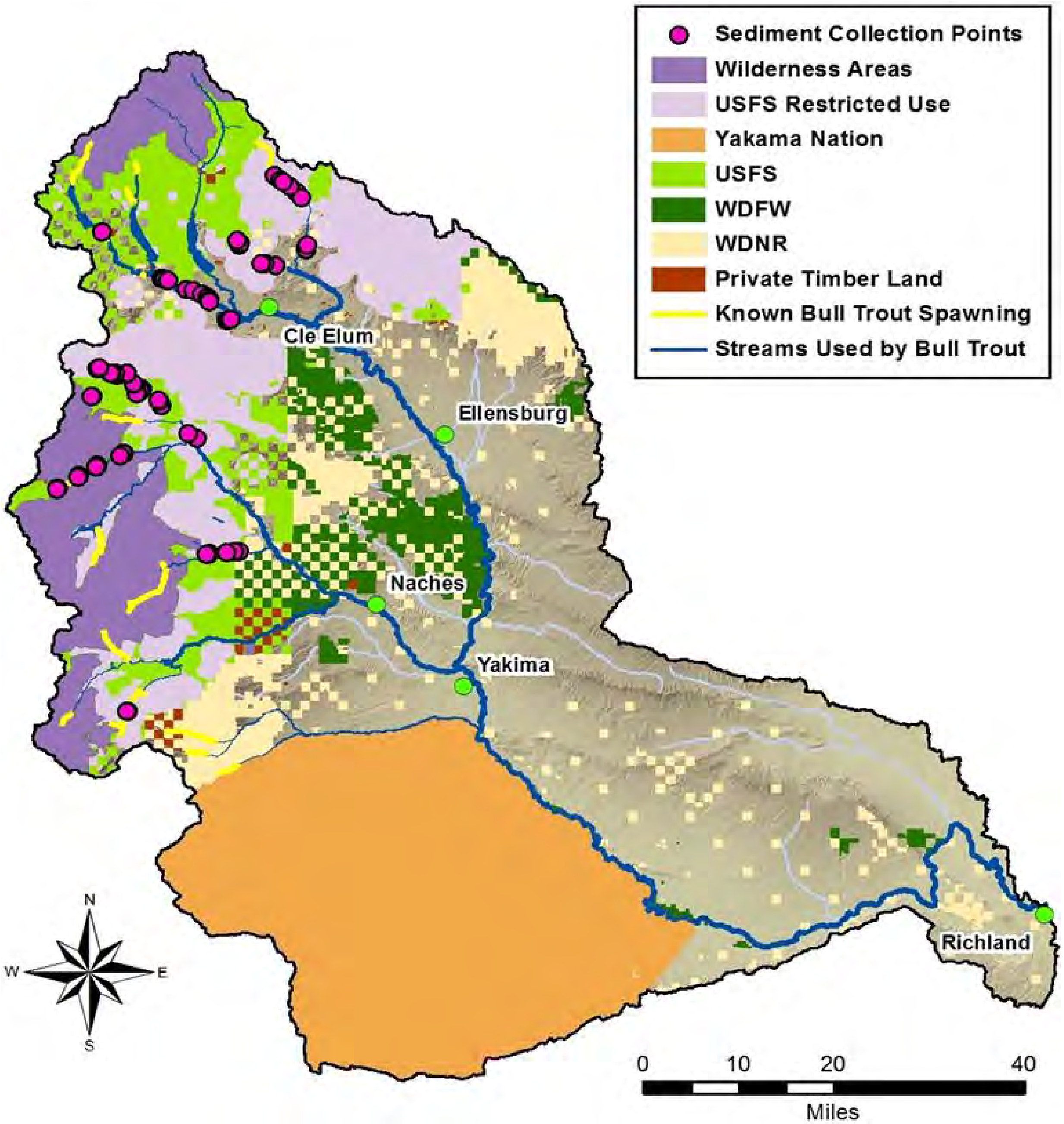
Dewatering:

This map displays areas where natural dewatering occurs in bull trout spawning and rearing areas. The criteria used to determine "natural" dewatering was that it was not associated with irrigation withdrawals (this was listed as Altered Flows). However, there are several streams (Gold Creek and Kachess River) where it is believed that the dewatering patterns are caused by the legacy effects of logging and/or mining. The data for this map was compiled by the BTAP Working Group based on observations in the field.



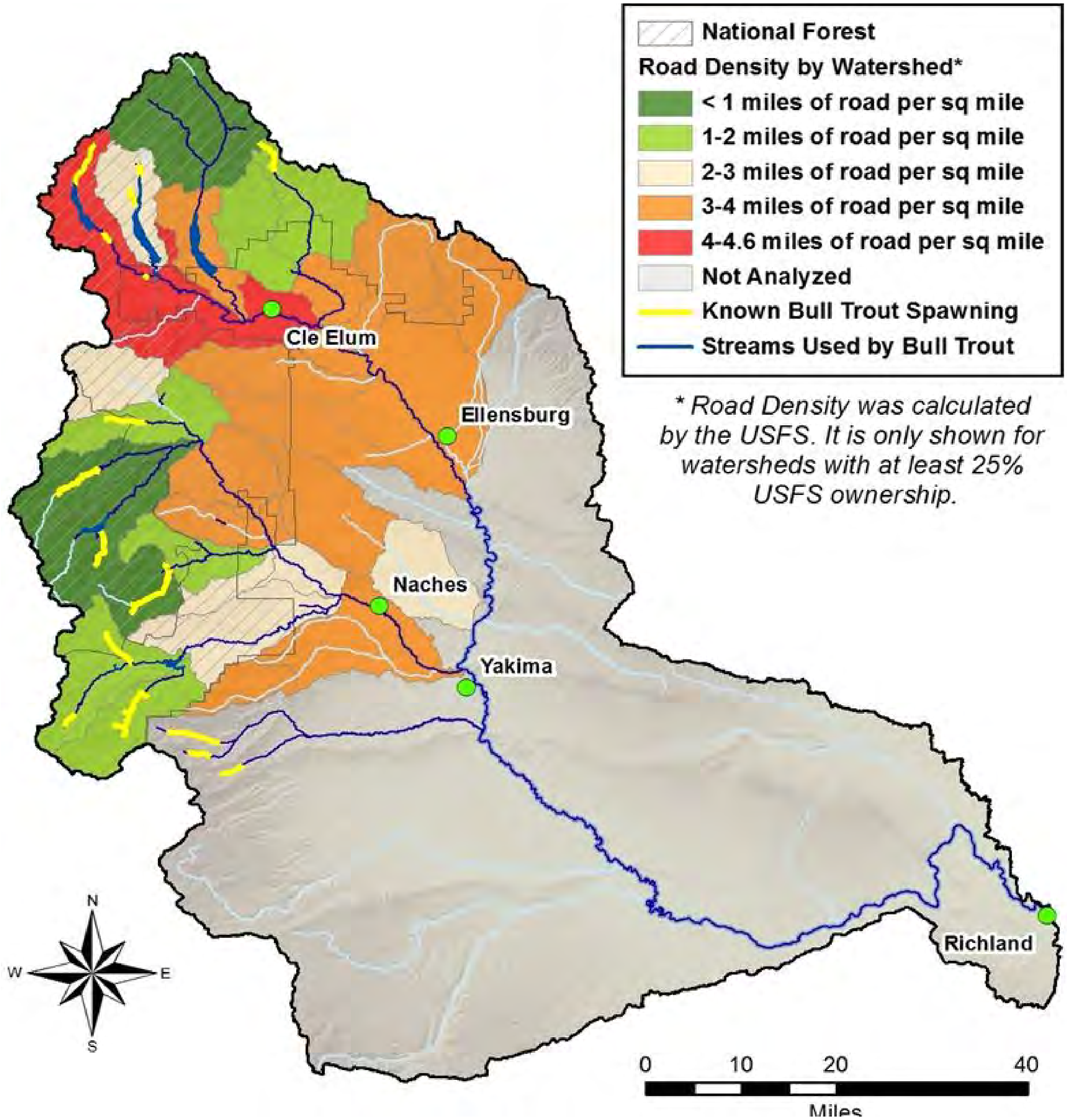
Entrainment:

This map shows where bull trout could become entrained if adequate screening is not maintained, and highlights the large irrigation dams where bull trout are entrained from the reservoir populations. Most diversions are screened, due to 80 years of screening programs, but some unscreened diversions remain, and existing screens need to be maintained and operated in a manner that adequately protects fish. Only diversions present in areas with bull trout are displayed. The data for this map came from the USBR diversion layer and the WDOE diversion layer.



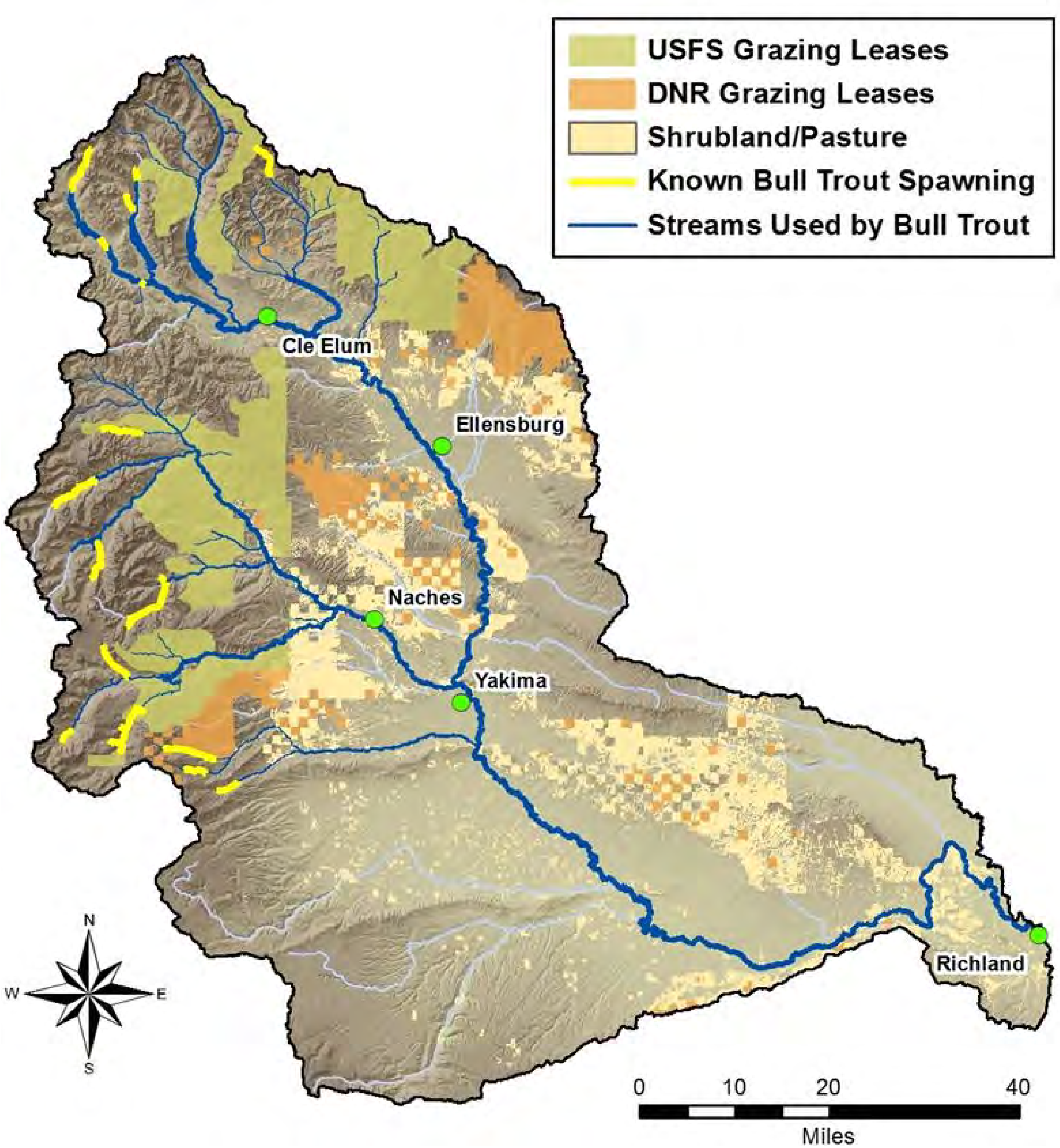
Forest Management I:

This Threat is represented on two separate maps, one showing management designations for various land ownerships, and one showing road density by watershed. The first map addresses potential issues of timber harvest and silvicultural treatments in different forestry zoning. Private timberlands and WDNR is the least restrictive, operating under state timberlands rules. On Forest Service land, there are general use lands, as well as Late Seral Reserve lands, which have more restrictions on harvest, and Wilderness designated areas, where no timber is harvested. Fire management and disease treatment also varies across the landscape. The forest zoning data are based on Forest Service data layers.



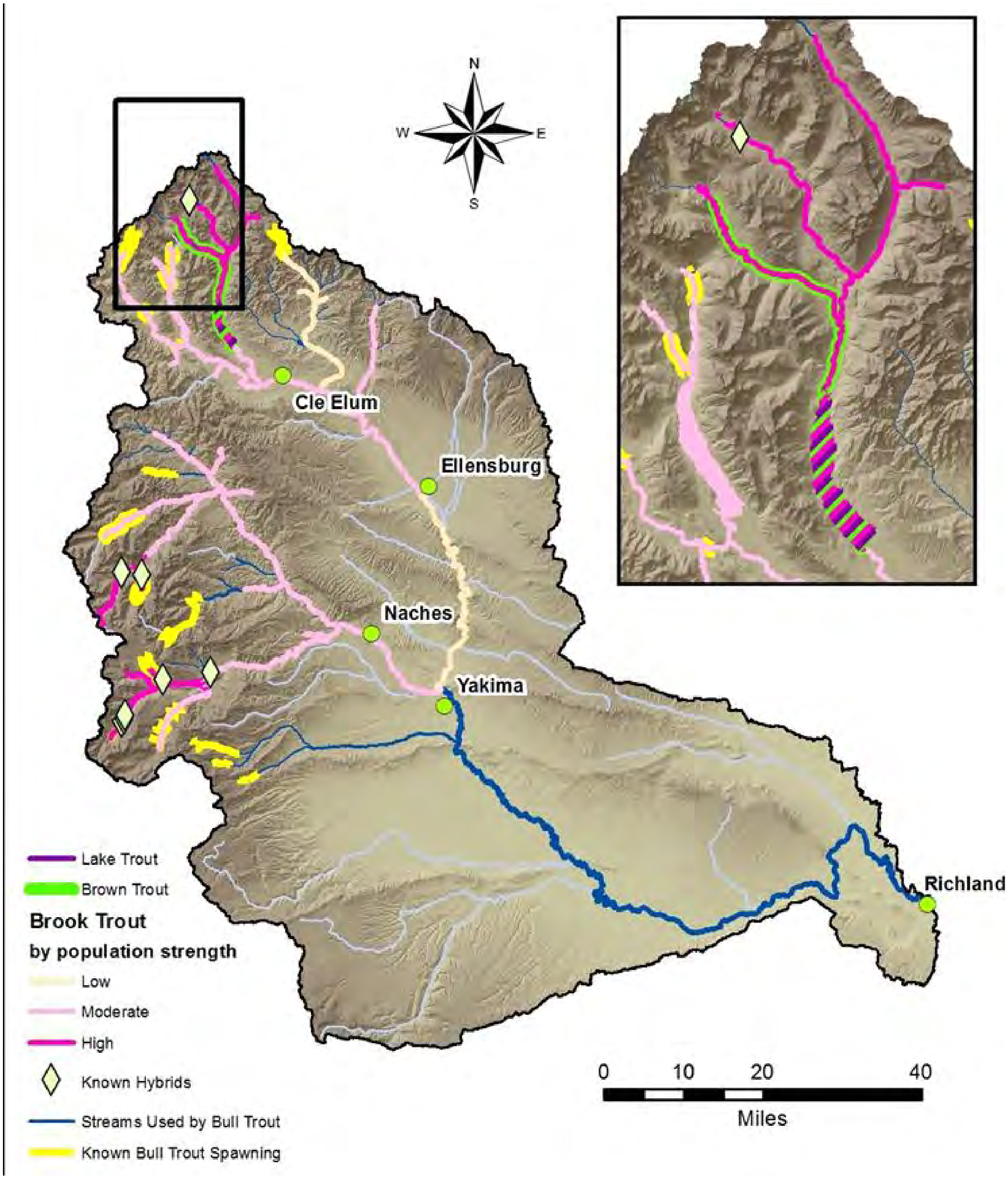
Forest Management II:

The second Forest Management map shows road density by watershed. This is revealing in that, as with Development, the highest road densities are in the upper Yakima basin, where we also have the weakest bull trout populations. In the literature, road densities are strongly correlated with presence or absence of extant bull trout populations (Baxter et al. 1999; Dunham and Rieman 1999). The road densities were calculated by the Forest Service, and are only available for watersheds with >25% Forest Service ownership, therefore excluding the Ahtanum Creek watershed, and also much of the middle and lower Yakima River.



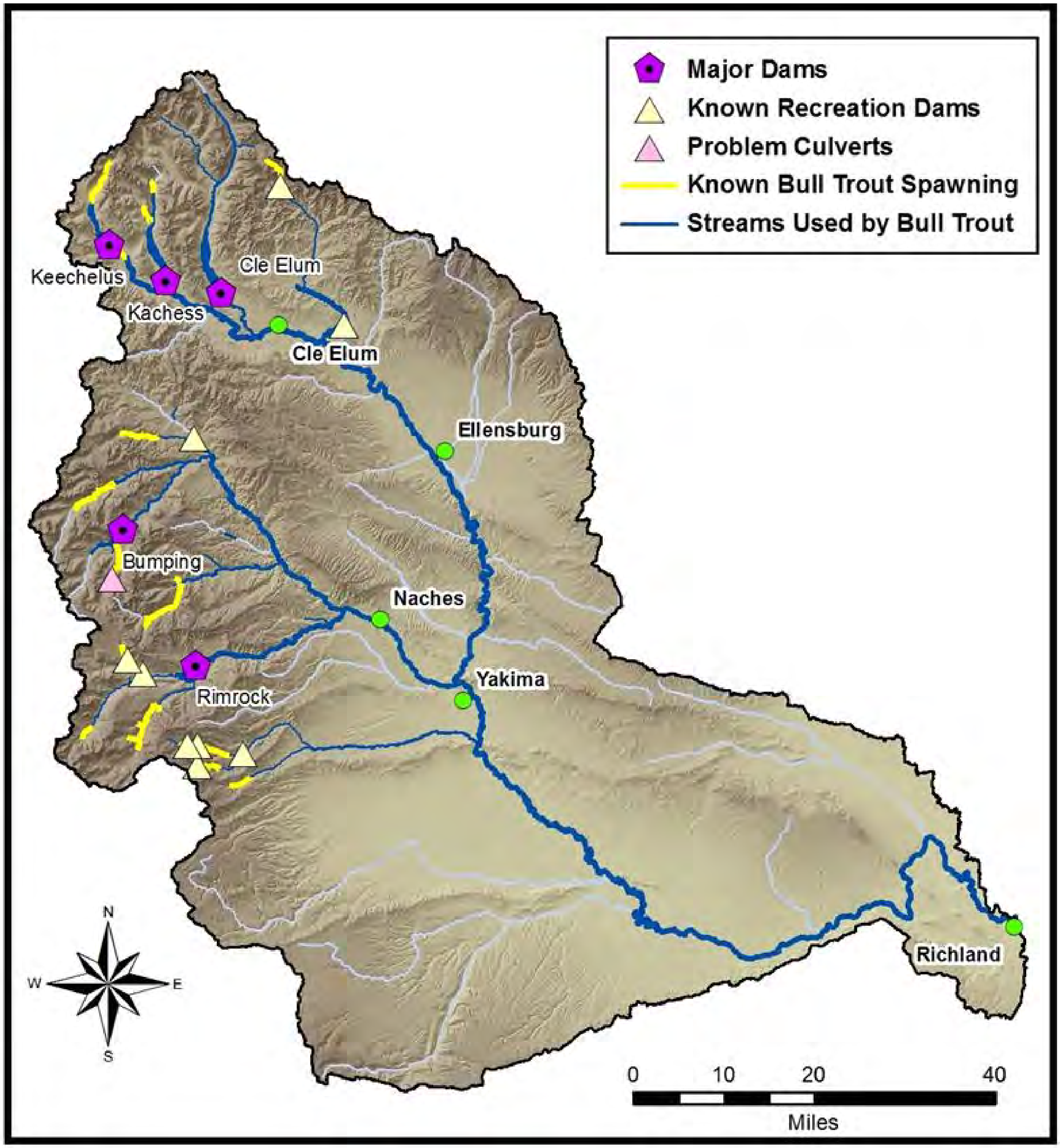
Grazing:

This map shows grazing allotments on Forest Service and DNR lands that are actively grazed annually, and also pasture/shrubland, which may or may not be actively grazed at any given time. The active grazing on forested land where there is bull trout spawning and rearing has the most potential to directly impact bull trout. In the South Fork Tieton River and Ahtanum Creek, where grazing and bull trout spawning areas overlap, there are seasonal restrictions and riparian fencing. In Crow Creek, where there is also a grazing allotment adjacent to a bull trout stream, the local geography protects the streams, as it is much too steep for cows to access. The map was built with data on grazing allotments provided by the Forest Service, WDFW and DNR and private lands grazing derived from the WDOE land use layer



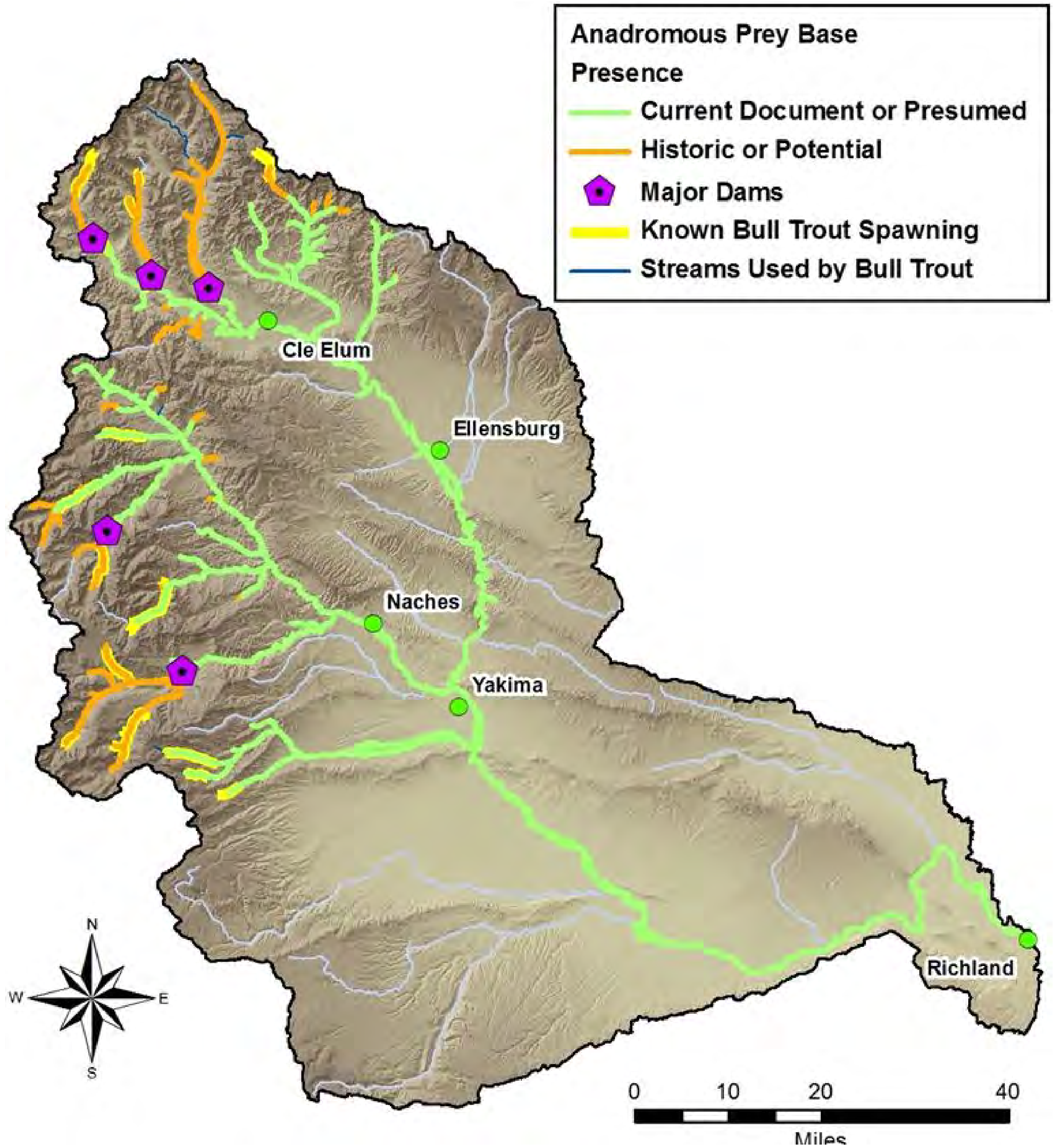
Introduced Species:

This map displays where there is a risk of introgression/competition between bull trout and introduced species. Lake trout and brown trout are limited to the Cle Elum River system. Locations of known bull trout/brook trout hybrids are included on the map based on snorkeling data reports and the genetics results. The data for this map comes primarily from WDFW and Forest Service fish distribution layers. The brook trout population strength information was estimated by the BTAP working group. .



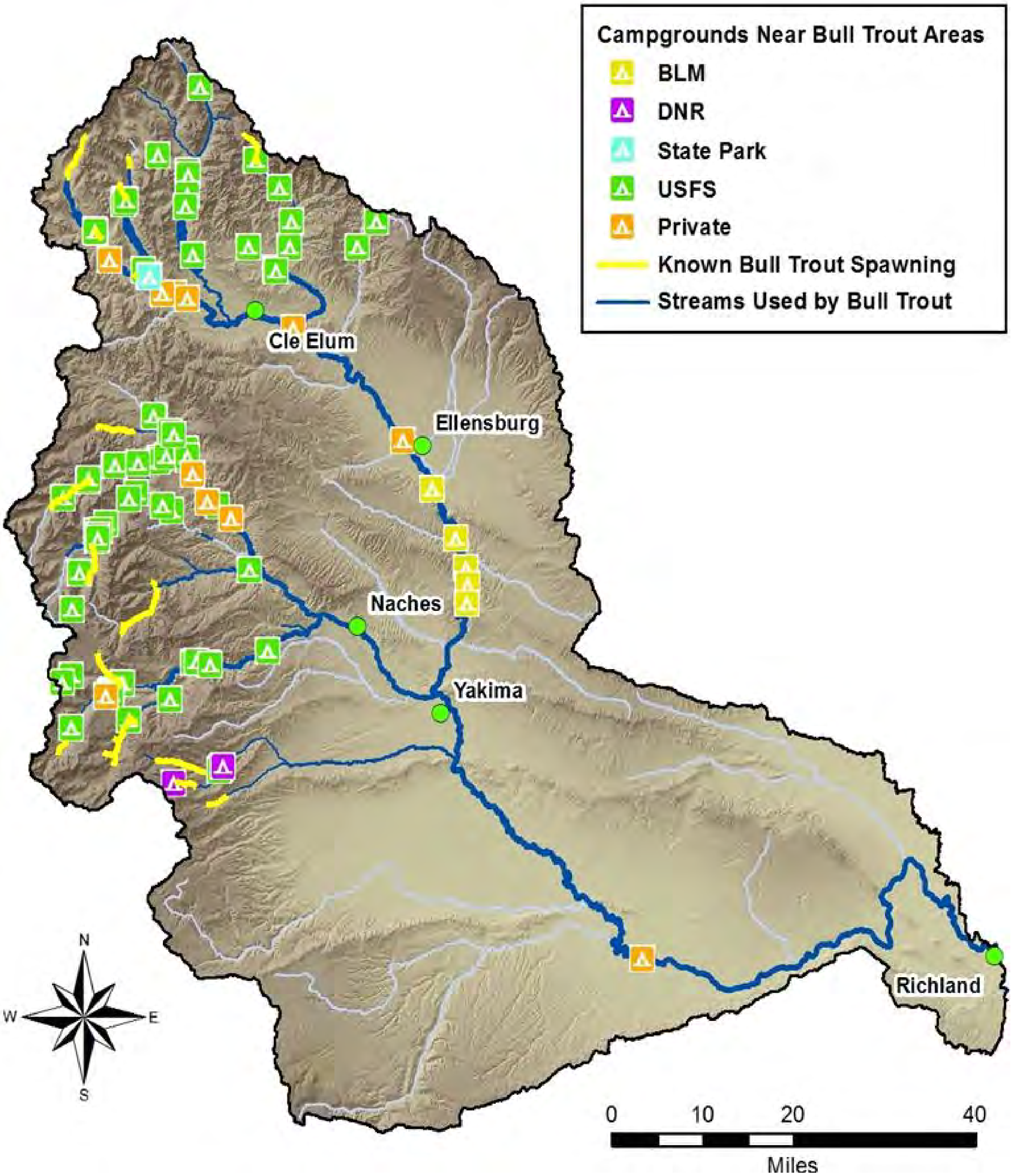
Passage Barriers:

This map shows where passage barriers restrict bull trout movement. The irrigation dams at the five large reservoirs are full barriers during all seasons and have been in place for ~100 years. Recreation dams are seasonal barriers made by recreationists, usually during the late summer low flow period, which may delay or completely block upstream migration of adult bull trout. They have been found at the mapped locations in the past. Culverts are potential barriers that may be present in areas where bull trout are distributed. Many agencies with large land holdings have completed inventories of culverts that do not meet standards and need to be replaced (Forest Service, DNR, YN). However, many of these culverts, though they are out of compliance, are not actually barriers to fish. For this map, we only included one culvert that has been a known barrier to juvenile bull trout. Data source for this map was USBR layer for dam locations, and BTAP working group field notes for recreation dam locations.



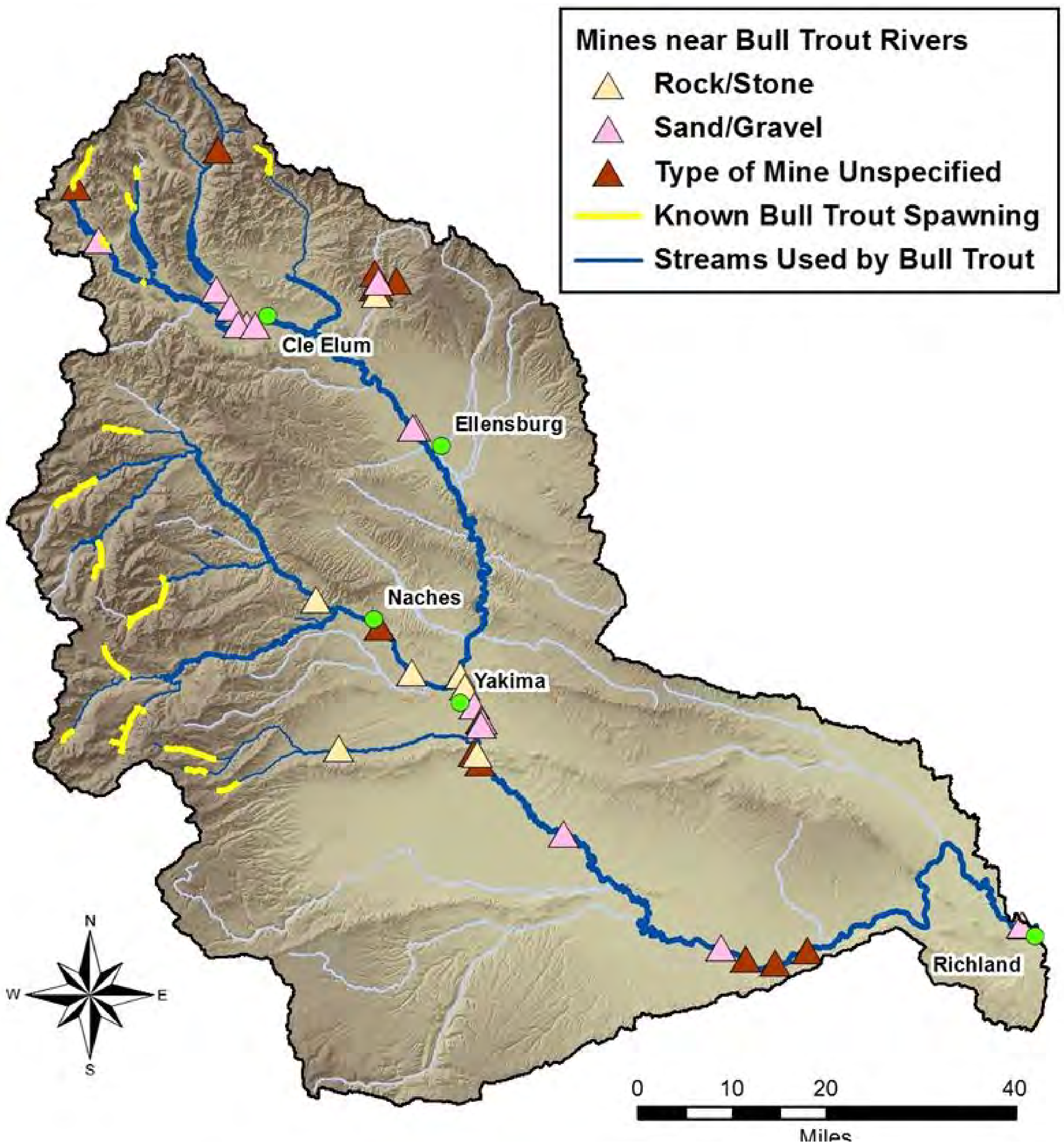
Prey Base:

This map shows the current and historic distribution of anadromous salmon and steelhead in the Yakima Basin, in relation to current distribution of bull trout spawning and rearing. While there are some areas of overlap (though abundance is greatly reduced from historic numbers) there are also a lot of bull trout populations above irrigation dams that preclude anadromy. The data used for this map is from NOAA's intrinsic potential analysis for steelhead, assuming that this was the most widely distributed species, and other salmon species were found within this range.



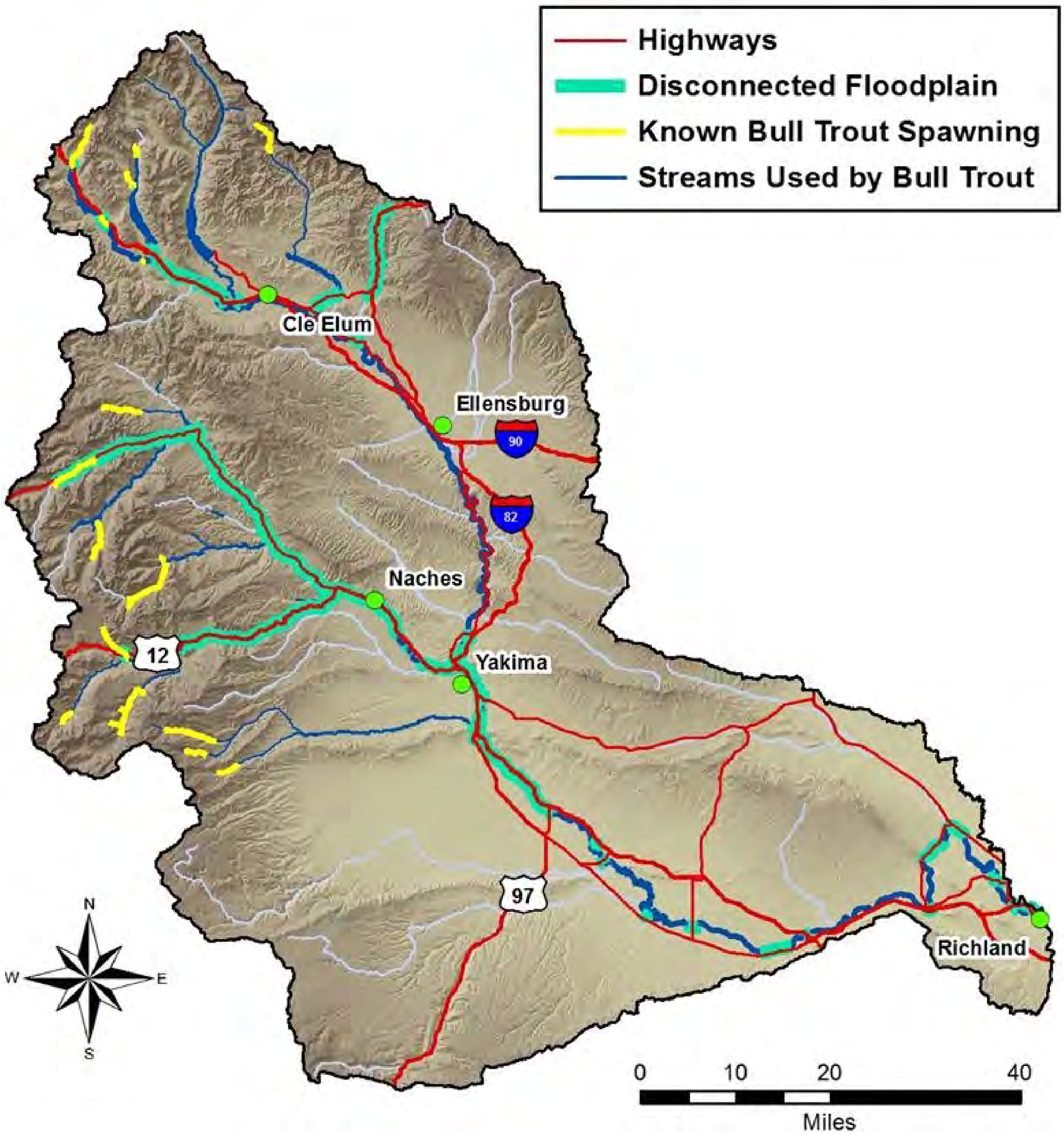
Recreation:

This map displays all campgrounds (BLM, DNR, State Park, Forest Service, and private) that are within 1,000 feet of a stream with bull trout distribution. It shows the heavy overlap between bull trout use and recreational areas and highlights the potential for habitat degradation and illegal fishing (Angling) and indicates the presence of roads (Forest Management). There were no mapping layers with complete data for locations of dispersed campsites, but these create additional recreation pressure on and near bull trout streams. Data source for this map was individual agency layers (Forest Service, BLM, DNR) and also WDOE land use layer for private campgrounds, which was confirmed by consulting a local recreation guide.



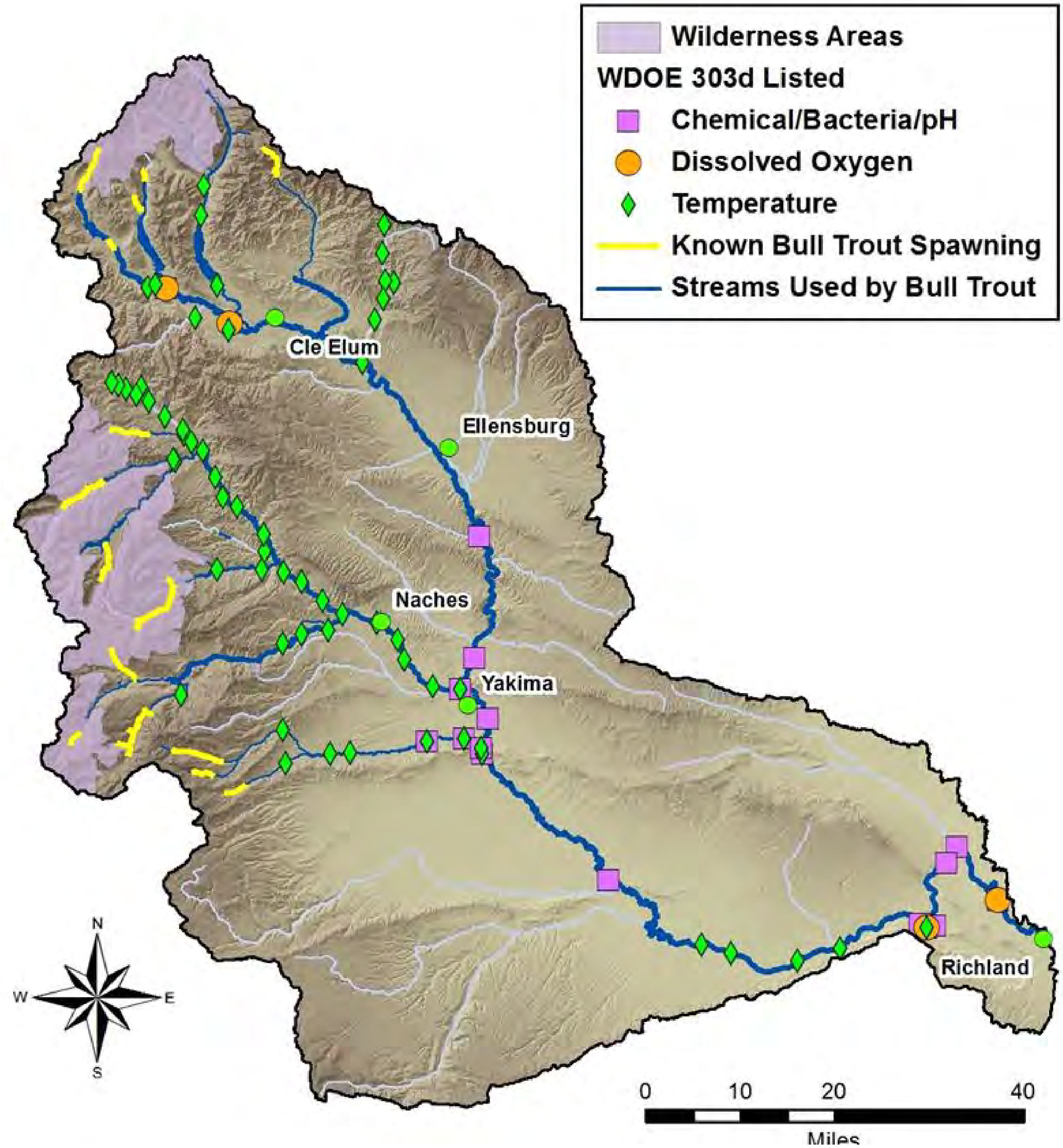
Mining:

In the Threats Analysis, Mining was not found to be a significant threat to any bull trout population in the Yakima Basin. However, we chose to include this as part of the Threats Atlas to demonstrate the presence of mining within FMO habitat. The map includes rock/stone and sand/gravel quarries, as well as other (unspecified) mining operations, all of which were present in the WDOE data layer.



Transportation:

This Threat was defined as paved highways (forest roads are include under the Forest Management Threat), and the map displays roads that are within 500 feet of a stream or river. The intent is to show where there are roads that disconnect the floodplain adjacent to bull trout streams. This was not rated as a significant threat to any bull trout population.



Water Quality:

In the Threats Analysis, Water Quality was not found to be a significant threat for any bull trout population. There are 303D listings for temperature, dissolved oxygen and chemical/bacteria/pH in many locations within the FM&O habitat for bull trout, as displayed on this map. However, the BTAP Working Group did not find these to be limiting to bull trout population

APPENDIX B: REDD COUNT DATA AND METHODS

Table B-1. Summary of bull trout spawning surveys (redd counts) in index areas of the Yakima subbasin, 1984-2011. WDFW Files, Yakima, WA.

(R=Resident, F=Fluvial, F/R=Fluvial/Resident, AD=adfluvial).

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yakima River (F)																												
Keechelus to Easton Reach																	2	1		1			3	1				0
Ahtanum Cr.																												
N.F. Ahtanum Cr.										9	14	6	5	7	5	7	11	20	17	12	8	6	7	8	1	3	0	1
(Shellneck Cr.)																												
M.F. Ahtanum Cr.													1	1		0	10	1	6	8	11	5	6	5	3	9	15	11
S.F. Ahtanum Cr.																	5	14	13	7	5	3	4	5	3	6	2	1
Naches R. (F)																												
Rattlesnake Cr.							2				4	26	38	46	53	44	45	57	69	54	32	15	40	13	37	36	64	42
(L. Wildcat, Shell Cr.)																												
American R.													25	24	31	30	44	36	27	30	40	35	55	31	22	29	47	40
(Union Cr., Kettle Cr.)																												
Crow Cr.																19	26	6	9	9	6	4	8	8	2	5	9	7
Rimrock Lake (AD)																												
S.F. Tieton R.							32			38	167	95	226	177	142	161	144	158	141	178	178	205	189	152	266	259	194	235

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(Bear Cr.)																												
Indian Cr.	29	69	16	35	25	39	69	123	142	140	179	201	193	193	212	205	226	117	100	101	50	91	106	58	130	200	144	147
(+spring tribs)																												
N.F. Tieton (upper)																					1		1	37	28	15	18	11
(+unnamed trib)																												
Bumping Lake (AD)																												
Deep Cr.						17	15	84	78	45	12	101	46	126	98	107	147	51	120	57	97	73	95	130	145	178	199	192
Bumping River											1	0					0				0			0	0	2	9	0
N.F. Teanaway																												
NF Teanaway/ De Roux Cr.													2									2	1	0	0	1	0	0
Kachess Lake (AD)																												
Box Canyon Cr.	5	4	3	0	0	0	5	9	5	4	11	4	8	10	16	17	10	14	15	8	19	8	8	2	8	21	30	31
Kachess R. (upper)															0		15	14	0	16	8	3	0	22	2	2	15	33
Keechelus Lake (AD)																												
Gold Cr.	2	2	21	15	12	3	11	16	14	11	16	13	51	31	36	40	19	15	31	9	20	7	8	6	40	29	23	7
Cle Elum & Waptus Lks (AD)																												
Cle Elum R. (up.) & Waptus R.													0	0	0		0	0	0	0			0	0	0	0		

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Summary	36	75	40	50	37	59	134	232	239	247	404	446	595	615	593	630	704	504	548	490	475	457	531	478	687	795	760	760

Notes:

*Incomplete survey; index area not fully defined or adequately monitored: Yakima R. 2000, 2001, 2003, 2006. M.F. Ahtanum 1996-2001, 2008. S.F. Ahtanum 2000, Rattlesnake 1990-1995, 2007, 2008, 2011. S.F. Tieton 1990-1993,1995, 2010, Indian 1984-1987, Deep 1989-1990, N.F. Teanaway 1996, 2005, 2006, 2008. Kachess 1998, 2005, 2006 Cle Elum 1996, 2000-2002, 2006, 2007, Waptus 1997,1998, N.F. Tieton 2004, 2006, 2010, Bumping 1994, 2000, 2004, 2008. Box 2007, Gold 2007, Crow 2008, 2010, 2011.
(Redds in small tribs (parenthesis) included in total stream count.)

*S.F. Tieton redd counts outside of the standard index area not included in above totals: 1995=0, 1996=7, 1997=1, 1998-2002 not checked, 2003=14, 2004=2, 2005=6, 2006=22, 2007 & 2008 not checked, 2009=30, 2010=6, 2011=19

*Exploratory redd count surveys conducted in 2009:N.F. Little Naches - 0, Quartz & N.F. Quartz - 0, Nile - 0, upper Crow (above barrier falls) - 0

Methods

Although WDFW takes the lead, personnel from many agencies participate in the spawning surveys. WDFW does not have the resources to survey all of the bull trout populations in the Yakima Basin without the interagency participation that has been an important component of survey effort through the years.

Bull trout spawning ground (redd count) survey procedures were adopted from Shepard and Graham (1983) and have been refined as described by Brown (1992) and Bonar et al (1997). Surveys are conducted in established "index areas" for each population, which allows for year-to-year comparisons and assessing long-term trends. The goal is to conduct three passes, the first at the beginning of active spawning, the second at the peak of spawning, with the final pass conducted after spawning is completed and after most adults have left the area. The first two surveys offer trend information, which is useful in case the final survey is cancelled or rendered ineffective due to inclement weather and/or high turbulent stream flow. Also, the first two surveys are important for tracking the spawning progression, especially in those areas with a protracted spawning period (i.e., some redds at the start of the season may look old and even indistinguishable by the third survey). Spawn timing varies among populations in the basin. Generally, surveys start in early to mid-September and final pass surveys are conducted in the Naches/Ahtanum drainage by late September to early October and in the upper Yakima River by late October to early November (Table 1).

Table B-2. Timing of spawning period for bull trout populations in the Yakima Basin.

Spawning Period	**Aug**	**Sept**	**Oct**	**Nov**
Ahtanum Creek				
Rattlesnake Creek				
Crow Creek				
American River				
Indian Creek				
SF Tieton River				
NF Tieton River				
Deep Creek				
Cle Elum/Waptus	**Unknown**			
Box Canyon Creek				
Kachess River				
Gold Creek				
Teanaway River	**Unknown**			

Spawning surveys consist of enumerating "definite", "probable" and "possible" redds, along with numbers of adult bull trout observed. The following redd identification criteria are used for every redd survey:

Definite: No doubt about it. The area is definitely cleaned and a pit (excavated pocket) and tailspill are recognizable. Adult bull trout may still be attending the site. Not in an area normally scoured by stream hydraulics.

Probable: An area cleaned that may possibly be due to stream hydraulics, but a pit and tail spill are recognizable, <u>or</u> an area that does not appear clean, but has a definite pit and tail spill (an "old" redd).

Possible: A cleaned area of about the right size and appearance from a distance, but which does not have a definite pit or tailspill. This could be caused by stream hydraulics, by the tentative digging of spawners (false or test dig), or by wading anglers, etc.

For final reports and trend analysis, only definite and probable redds are included. Occasionally, large (up to 5 m x 10 m) multiple redds are encountered in the field where surveyors may find it difficult to determine the exact number of individual redds at the site. In such instances, each identifiable pit or pocket is counted as a separate redd. In such areas, definite and probable redds will also have overlapping tailspills.

During every survey, each new redd is marked (flagged) with the date, redd type, number of fish observed and the surveyor(s) initials. Bright fluorescent colored (e.g., orange) flagging tape is usually used for this purpose. A foot-long strip of flagging is tied to a nearby overhanging bush, tree limb, etc. All information is recorded in the surveyor's field notebook and transferred to the biologist or manager responsible for summarizing the redd count data. This is done in a consistent survey format that includes the surveyors name, stream name, section, date, water temperature, start and end time, number of new and old (definite, probable and possible) redds, number of adult, subadult and juvenile bull trout observed and any other pertinent information the surveyor may observe during the survey (e.g. carcasses, genetic sample, water clarity, conditions, etc.).

In addition to conducting redd counts for known populations in the Yakima subbasin, "exploratory" surveys are conducted each year to determine if bull trout are spawning outside of established index areas or in potential spawning tributaries where bull trout surveys have not been conducted in the past. These surveys are usually conducted in areas where a bull trout may have been recently reported by other field biologists or where it was questionable about whether bull trout were able to migrate past a barrier to spawn.

Starting in 2009 the location (GPS derived latitude/longitude) was marked for every redd in the basin. This spatial data are currently being assimilated by WDFW District Habitat Biologist, William Meyer, and Yakima Basin Recovery Coordinator, Yuki Reiss. Bull trout spawning survey index area lengths have been determined from GPS data and Terrain Navigator topographic map software. A few adjustments were made for annual channel changes and split channels.

At the end of every spawning season, the current year's data are summarized and added to the annual summary table that includes redd count data for all previous years in the Yakima subbasin. The annual summary table is then distributed to various federal, state, tribal and local resource management authorities. Hard copies of all surveys for each year are stored at the WDFW Regional Office in Yakima.

APPENDIX C: GENETIC SAMPLE DATA AND METHODS

Across the range of bull trout, genetic analyses have been used to answer a variety of questions from regional colonization patterns (Leary et al. 1993; Costello et al. 2003; Spruell 2003)to local population dynamics (Spruell et al. 1999; Whiteley et al. 2006; Dehaan and Godfrey 2009). There are four laboratories that have been primarily involved in bull trout genetics research: University of British Columbia (UBC) in Vancouver, Wild Trout and Salmon Genetics Lab (WTSGL) at the University of Montana in Missoula, USFWS Abernathy Fish Technology Center (AFTC) in Longview, WA, and WDFW Molecular Genetics Laboratory in Olympia, WA.

Early studies used allozyme or isozyme markers, which require lethal sampling to obtain liver, eye or muscle tissue for the analysis. The ESA listing of bull trout in 1998 and low numbers of fish in many populations made this type of genetic study impractical. Most labs transitioned to using microsatellites markers. Microsatellites are genetic markers within the non-coding portion of the DNA that consist of a series of a repeating 2-5 nucleotide segment (ex. CAGCAG). This type of genetic marker has become widely used due to the high levels of variability, simple Mendelian inheritance (one gene from each parent) and a non-lethal sampling requirement.

In the early 2000s, labs doing bull trout analysis primarily used microsatellite loci that had been developed for use in other fish species, but were present in bull trout as well. This often worked to answer specific questions, but overall there was less variability, and without consistency between labs, it was impossible to compare results. In 2005, geneticists from the multiple labs working with bull trout met and began work on a suite of standardized loci developed specifically for bull trout (Dehaan and Ardren 2005). These loci are currently used by WDFW Genetics Lab, USFWS Abernathy Fisheries Technology Center, University of British Columbia Genetics Department and the University of Montana’s Wild Trout and Salmon Genetics Lab in all analyses of bull trout samples (M. Small, WDFW, pers comm 2011).

In the Yakima Basin there is a well-established genetics baseline for most local bull trout populations. This began in 2001-2002 with Yuki Reiss’s thesis project for Central Washington University (Reiss 2003). Reiss collected and analyzed samples from 12 local bull trout populations. The two primary sources of tissue samples for this study were: 1) adults captured and sampled as part of a tagging study in the reservoirs (James 2002a), and 2) night snorkel surveys to capture juveniles in known spawning and rearing reaches. These samples were run at the Wild Trout and Salmon Genetics Lab in Montana, using six loci not developed for bull trout, but commonly used for bull trout genetic analysis.

The results of this analysis showed a high level of differentiation among all populations, with some evidence of limited gene flow among the connected fluvial populations. However, above the reservoirs, even those with multiple local populations that use the same FMO habitat there was no evidence of gene flow between populations. In addition, one population from above Rimrock Lake (South Fork Tieton River) showed some level of gene flow with the Naches River fluvial populations below the dam. Two of the local populations which are currently considered “resident” life history type (Teanaway and Ahtanum rivers) appeared quite distinct, despite current connectivity to the fluvial system.

Subsequent genetic analyses (Hawkins and Von Bargen 2006; Hawkins and Von Bargen 2007; Small et al. 2009; Small and Martinez 2011) using the standardized genetic markers re-analyzed these samples, and included additional genetic samples. Similar patterns emerged and information was provided about newly sampled populations or areas (e.g., North Fork Tieton and Upper Bumping rivers).

Many new genetics samples were collected during the 2003-2006 WDFW 4 year radio telemetry study of the bull trout in the Yakima Basin, focusing on the Naches River fluvial system (Mizell and Anderson 2010). This was the impetus to re-analyze the genetic baseline of local populations using the newly developed standardized microsatellite loci. Genetic analysis was used as a tool to help verify movement patterns detected while tracking tagged fish. The samples were run in three phases, each with a subsequent report (Hawkins and Von Bargen 2006; Hawkins and Von Bargen 2007; Small et al. 2009). The results of the analysis using a larger suite of more variable loci showed similar patterns to Reiss (2003).

Aside from these two large-scale studies (Reiss thesis work and the radio telemetry study), genetic samples have been collected based on specific questions. This has mostly involved additions to the baseline (e.g., North Fork Tieton population in 2004/2010, Upper Bumping juvenile samples in 2010, etc.). However, biologists working in the field across the basin are encouraged to collect tissue samples from captured or dead bull trout whenever possible. Individuals that are captured outside of the normal S&R or FMO reaches (e.g., at Roza Dam) give us new information about movement patterns within the basin, or potentially about the presence of a new population.

A complete inventory of all bull trout genetic samples from the Yakima Basin, including information from collection in the field to results of genetic analysis is available via the following link:
http://www.ybfwrb.org/Assets/Documents/Plans/BTAP/Bull_Trout_Genetics_Samples.xlsx

This database (in Microsoft Excel format) will be updated as more samples are added to the genetics baseline in the future.

APPENDIX D: SUPPLEMENTATION OVERVIEW

Supplementation, Transplantation and Reintroduction Strategies in the Yakima Basin to Restore Bull Trout Populations

Prepared by: Washington Department of Fish and Wildlife, 2012

Executive Summary

This brief summary document should be viewed as a primer to a more in depth feasibility study for using supplementation, transplantation and/or reintroduction strategies (STRS) for the purpose of restoring bull trout populations in the Yakima Basin. Some of the previous efforts and approaches to restoring bull trout populations in other geographic areas were reviewed and summarized. Various restoration guidelines for reestablishing locally extinct populations and augmentation strategies for extant bull trout populations were also reviewed for the primary purpose of creating a template for a feasibility study in the Yakima Basin. This document should be viewed in the context of a much larger "action plan" for the basin. The Yakima Basin Bull Trout Action Plan (YBTAP) should be referred to for additional details about each population, including status, threats analysis, completed and future actions, monitoring history and future monitoring priorities (*see Draft Yakima Basin Bull Trout Action Plan, 2012*).

Genetic analysis has identified 12 distinct bull trout populations in the Yakima Basin (Small et. al., 2009). There are also several unknown or functionally extirpated populations and there are some areas identified as critical bull trout habitat (USFWS, 2010) that may be candidates for potential bull trout reintroduction. The focus of this report is to concentrate efforts at restoring bull trout via supplementation or transplantation into areas where they are functionally extinct and /or in very low abundance. A primary caveat for this to occur is that the area contains sufficient and suitable habitat to support all life stages. Other factors include restrictive angling regulations to protect the population, prey availability and a potential donor. Although major obstacles in the basin remain, such as irrigation storage dams that fragment bull trout populations, there have been considerable advances and improvements in protecting bull trout and their habitats to the extent that there is justification for implementing supplementation or transplantation strategies for recovering bull trout in the Yakima core area.

Potential strategies include the establishment of a supplementation facility at Gold Creek near Snoqualmie Pass. Gold Creek bull trout would be a donor source (5 yr. avg.; 21 redds). The facility would include an adult trap, holding pond and rearing vessels for eggs/fry and juvenile rearing. Juveniles would be planted back into Gold Creek and also reintroduced into other upper Yakima tributaries, such as the N.F. Teanaway River and Taneum, Big and Cold creeks. Supplementation could also be used to bolster juvenile production in the Ahtanum drainage, but would necessitate the need for collecting fertilized eggs, fry or juveniles from that population for short-term rearing in a hatchery environment before translocation back into Ahtanum Creek (e.g., captive rearing strategy). In the Naches basin, the S.F. Tieton River, Deep Creek and Indian Creek bull trout populations could be used as potential donor sources for juveniles to be transplanted into Crow Creek, or introduced into Cowiche and Nile Creeks. The

S.F. Tieton River is consistently the healthiest population in the basin (5 yr. avg.; 212 redds), followed by Deep Creek (5 yr. avg.; 149 redds) and Indian Creek (5 yr. avg.; 127 redds). Juvenile bull trout from these healthier populations could also be a potential donor source for reintroduction into the N.F. Teanaway and other upper Yakima River tributaries, especially if Gold Creek is deemed as unsuitable due to its smaller population size.

Introduction

Status of current populations, habitat conditions, threats.

Currently, genetic analysis has identified 12 distinct bull trout populations in the Yakima Basin (Small et. al., 2009). Although there are several additional areas in the basin where bull trout are known to occur, they have not been analyzed due to lack of genetic samples. Most adult bull trout in the Yakima subbasin migrate from large upper basin reservoirs to smaller tributary streams to spawn (adfluvial life history) or they migrate from the mainstem Naches River to smaller spawning tributaries (fluvial). Two populations do not migrate long distances, but instead spend most of their time (all life stages) in the same stream (resident life history). Currently, there are seven adfluvial populations: Gold Creek, Box Canyon Creek, Kachess River, Deep Creek, Indian Creek, N.F. Tieton River and the S.F. Tieton River; three fluvial populations: American River, Crow Creek, and Rattlesnake Creek; and two resident populations: Ahtanum Creek and N.F. Teanaway River. Although a few redds have been observed in the upper Bumping River (above Bumping Lake), the fish are genetically the same as those found in Deep Creek (Small et. al., 2009). A few bull trout redds have also been observed in the mainstem Yakima River below Keechelus Dam (Keechelus Lake), but there is insufficient data to confirm whether they belong to a distinct bull trout population. Likewise, only a few bull trout have been reported from the Cle Elum/Waptus Lake drainage in recent history and no bull trout redds have been confirmed there. It is quite possible that the bull trout observed below Keechelus Dam were entrained out of the reservoir and originated from the Gold Creek population. Bull trout from the upper Cle Elum/Waptus Lake drainage (adfluvial population) and the Teanaway River drainage (resident/fluvial population) may be functionally extinct. Additionally, there are several areas in the basin identified as critical bull trout habitat (USFWS, 2010) that may be candidates for potential bull trout reintroduction, although few to no fish have been found in these areas. They include Cowiche Creek (S. Fork), Nile Creek, and the Little Naches River tributaries (Naches drainage), Taneum Creek (upper Yakima drainage) and Cold Creek (Keechelus Lake).

Annual redd counts have been conducted for the past 10-26 years for most populations in the Yakima Basin (*see Redd Count Summary and Population Data section of BTAP document*). Generally, redd counts are greater and populations healthier in the Naches arm of the drainage than in the upper Yakima arm or in the Ahtanum drainage. Although isolated populations of adfluvial bull trout exist in the upper Naches reservoirs (i.e., Rimrock & Bumping), generally they have a greater amount of accessible and connected spawning, rearing and FMO habitat that consistently maintains populations at a higher level than in other areas of the drainage. There is also an abundant forage base in the form of kokanee salmon that helps to sustain the health of these isolated adfluvial populations. The Naches fluvial populations (except for Crow

Creek) are also relatively stable compared to populations in the upper Yakima. This is partly due to interconnected, high quality spawning, rearing and FMO habitat that also receives some marine derived nutrients from anadromous salmon & steelhead populations, thus increasing the system's productivity (although productivity continues to be low in upper portions of the basin where bull trout rear).

In contrast, redd counts and bull trout population strength in the upper Yakima is much weaker than the Naches system (*see Population Data section in BTAP document*). Although there is some level of anadromous productivity that furnishes marine derived nutrients to fluvial areas of the upper Yakima, past problems associated with migration barriers (i.e., irrigation diversions dams, low stream flows, etc.) in tributary streams (e.g., Teanaway River, Taneum Creek) and passage barriers at upper Yakima reservoirs (i.e., Keechelus, Kachess, Cle Elum) and in the main stem Yakima River (i.e., Roza Dam) have isolated and fragmented bull trout populations to the extent that some are functionally extinct (i.e., N.F. Teanaway River). The added presence of naturally reproducing, non-native lake trout, brown trout and eastern brook trout in the Cle Elum/Waptus drainage appear to have decimated bull trout in that drainage. Despite these problems there is still prime spawning, rearing and FMO habitat in the Keechelus and Kachess drainages (i.e., Gold Creek, Box Canyon Creek, upper Kachess River) and the potential for introduction and recovery of bull trout in tributary streams of the main stem Yakima River (e.g., Taneum Creek tributaries, Big Creek, and Teanaway River). A habitat overview for each population is presented in the "*Bull Trout Action Plan*".

Improvements have been made in some tributaries, such as the removal of a passage barrier on lower Taneum Creek, increasing instream flows in the Teanaway River by consolidating irrigation diversions and implementing other water saving measures. Angling restrictions for bull trout and stream closures in spawning habitat have also been a major factor in helping to protect and restore Yakima Basin bull trout populations. A project to provide anadromous fish passage at Cle Elum dam has been recently initiated and there are plans to reduce or remove lake trout populations (funds pending). However, there remain major issues of blocked upstream fish passage at all the reservoir dams and issues of low productivity (particularly in Keechelus & Kachess Reservoirs). There are additional problems associated with access into tributary spawning streams connected to the reservoirs, particularly during low water years. Bull trout in the Yakima Basin appear to be losing genetic diversity in comparison to bull trout throughout their range in the United States. Average allelic richness in Yakima bull trout was lower than average allelic richness in Columbia and Snake River bull trout (Small et. al., 2009). As population sizes decline genetic diversity is lost. This lower diversity could be the result of environmental conditions in the Yakima Basin. A summary of these and other threats by life stage and habitat use type (e.g., spawning & egg incubation, juvenile rearing, FMO—foraging, migration, overwintering habitat) for each population is presented in the "*Bull Trout Action Plan*" which includes a detailed threats analysis by life stage for each Yakima basin bull trout population. (NOTE: A list of useful definitions is provided near the end of this document).

<u>Assessing the need for a Supplementation, Transplantation and/or Reintroduction Strategy.</u>

Bull trout abundance is so low in some areas of the Yakima Basin that despite past improvements in habitat conditions and fish protections, some populations continue to decline (e.g., Ahtanum Creek, Crow Creek, N.F. Teanaway River,). It is likely that the last real hope for the continued existence and recovery of these critically low or functionally extirpated populations is some type of population enhancement to kick start them back to some higher level of abundance. Provided the major habitat issues and threats associated with the demise/decline of these populations can be addressed and alleviated (or mitigated), then it is possible to move forward with a plan of recovery by using some form of supplementation, transplantation, or reintroduction strategy (STRS). It is the purpose of this document to provide information for consideration in formulating a local strategy to restore and recover selected bull trout populations in the basin.

In the 2002 USFWS Draft Bull Trout Recovery Plan, the Middle Columbia Recovery Unit Team (MCRUT) determined that to reach a recovered condition within 25 years in the Yakima Core Area, the use of artificial propagation may be required (USFWS, 2002; Chapter 21). Further, this artificial propagation could involve the transfer of bull trout into unoccupied habitat within the historic range as has occurred in Oregon (ODFW 1997) or it could involve the use of state or federal hatcheries to assist in recovery efforts (Montana Bull Trout Scientific Group, 1996). The team (MCRUT) recommended that studies be initiated to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery. Section 3(3) of the Endangered Species Act lists artificial propagation and transplantation as methods that may be used for the conservation of listed species.

As per joint policy of the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), any artificial propagation program of listed species initiated in the Middle Columbia Recovery Unit must follow certain policy guidelines (65 FR 56916). The policy states that every effort should be made to recover the species in the wild before implementing a propagation program. However, the policy does allow for experimental pilot projects for propagating bull trout for recovery purposes. Unfortunately, delay and hesitation in making policy decisions concerning the use of supplementation methods may allow the population size to get too small before acting, hence reduced population viability occurs and the population fails to persist. Maintaining an adequate population size is necessary for natural population viability and persistence mechanisms to function, although this population size is not well defined in the literature. The minimum genetically effective population size for short and long-term persistence remains speculative. General guidelines suggest that effective population sizes of 50 adult spawners are needed to minimize inbreeding and 500 for maintenance of adaptive genetic variation for long-term sustainability (Allendorf and Ryman, 2002). Rieman and Allendorf (2001) conclude that cautious, long-term management goals for bull trout populations should include an average of at least 1,000 adults spawning each year. Where local populations are too small, managers should seek to conserve an aggregate of "interconnected populations" that is at least large enough in total to meet this minimum.

The use of a supplementation, transplantation or reintroduction strategy that bolsters a population's size or reintroduces fish to formerly occupied (or presumed occupied) habitat could be a very powerful tool for recovering bull trout in the Yakima Basin. Strategies, populations and habitats should be considered carefully with an approach that gives high priority to the preservation of wild populations along with their locally adapted gene pools and characteristic phenotypes and behaviors. Such an approach is in marked contrast to the typical traditional hatchery programs in which success is a function of the number of fish produced to create a harvestable surplus of fish (Anders, 1998). However, a conservation aquaculture strategy that includes supplementation, transplantation, or reintroduction (STR) should be viewed as just one component of a multi-faceted restoration and recovery plan. Conservation aquaculture is designed to be implemented simultaneously with habitat improvement and ecosystem restoration activities (Anders, 1998). Regardless of the approach used to recover populations, an STR strategy for the Yakima Basin will need peer review and ultimately must be approved by the USFWS. That review should include potential effects of the STR activity on other species as well as the donor population. Any aquaculture activity in the basin must also meet applicable state and federal fish-handling and disease policies.

As previously mentioned, genetic studies show that bull trout in the Yakima Basin appear to be losing genetic diversity in comparison to other bull trout populations throughout their range. This low diversity is likely due to the isolated and fragmented nature of the current populations. A conservation aquaculture (supplementation), transplantation and reintroduction program designed to preserve genetic fitness and diversity of bull trout populations in the basin, while also making habitat and passage improvements, seems like a worthwhile strategy to pursue. The overall recovery strategy for bull trout in the Middle Columbia Recovery Unit should continue to emphasize identifying and correcting threats affecting the fish and their habitats, but it should also include the preservation of genetic traits and enhancement of existing (and future) populations through a restoration stocking program. This will ensure the populations are demographically robust to take full advantage of habitat enhancement and threat reduction.

Recent history of bull trout recovery strategies.

The following Oregon & California efforts were summarized from Clackamas River Bull Trout Reintroduction Plans (2010) as well as personal communications with ODFW staff.

There have been several efforts to propagate or translocate bull trout. In 1989, over 60 resident adult bull trout from the Sprague River in the Upper Klamath Basin were captured and spawned in the Klamath Hatchery for a reintroduction effort in the McCloud River, California. Pre-spawning mortality, egg and juvenile mortality resulted in only 270 juvenile bull trout available for stocking into the wild during the spring of 1990. After five years of monitoring in the McCloud River, the reintroduction was determined a failure and terminated (Buchanan et al. 1997). Contributing factors were the low number of bull trout that were stocked and the resurgence of brook trout overlapping in distribution with the introduced bull trout even though a previous rotenone treatment program was attempted to eradicate brook trout.

In Northeast Oregon, bull trout were thought to be extirpated from the watershed above Wallowa Lake by the 1950s (Buchanan et al. 1997). A reintroduction program using translocated bull trout and/or Dolly Varden from Alaska began in 1968 and ran through 1978 before being terminated. The program was determined to be unsuccessful after no bull trout or Dolly Varden were detected in creel surveys at Wallowa Lake from 1980 to 1996 (Buchanan et al. 1997). (Editorial note: spawning surveys may have been more conclusive). In 1997, 600 bull trout (2 to 15 inches) were taken from Big Sheep Creek (tributary of the Imnaha River) during canal salvage, and translocated to Wallowa Lake. No funds were available to monitor this effort and the status of the translocated fish is generally unknown (Brad Smith, Oregon Department of Fish and Wildlife, August 2006). Though no official creel surveys have been conducted in recent years, sporadic catches of bull trout are reported, and individual bull trout have been occasionally observed in the Wallowa River above Wallowa Lake. Limiting factors in this reintroduction may include limited spawning habitat, redd superimposition by kokanee, and the presence of lake trout, a known predator and competitor with bull trout.

In the Middle Fork Willamette River, a transplantation program has been implemented since 1997. Bull trout were thought to be extirpated or in extremely low abundance at the time the program was initiated. Since 1998, over 10,000 fry have been captured (via screw trap) from Anderson Creek in the McKenzie River (also a Willamette River tributary) and transported directly to multiple release sites in the Middle Fork Willamette River above Hills Creek Reservoir. Over time, annual monitoring has provided evidence of survival, and in 2005 spawning was documented for the first time from 11 adults. Successful recruitment was subsequently documented during the summer of 2006. Since 2007, ODFW has continued bull trout fry collections from Anderson Creek with subsequent transfer of fish to Leaburg Fish Hatchery under a captive rearing program. This program is designed to rear bull trout fry for a period of time before reintroduction into various upper Willamette tributaries to improve survival rates for out-planted fish while also minimizing impact on the donor population (Nick Zymonas, ODFW, per. com. May, 2011).

Bull trout were recently reintroduced (2011) into the Clackamas River, Oregon from the Metolius River after a nearly 50-year absence. Initial efforts included the reintroduction of more than 100 bull trout. Some of the fish are already spawning in their new home waters. The Clackamas River Basin Bull Trout Recovery Team includes individuals from the U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, U.S. Geological Survey, and Mt. Hood National Forest. In June 2011, the Clackamas team began transferring bull trout from a healthy population in the Metolius River to the Clackamas River within Mt. Hood National Forest. Additional fish transfers will be made annually for at least seven and possibly up to 15 years.

The goal is to reestablish a self-sustaining population of 300-500 spawning adult bull trout within 20 years. Bull trout have been extirpated from four subbasins in the Willamette River Basin, including the Clackamas River since 1963. If the reintroduction effort continues successfully, it could be a model for other bull trout reintroductions to reestablish and reconnect isolated populations.

<u>Montana, Idaho & Canada efforts summarized from MT Bull Trout Scientific Group, "The Role of Stocking in Bull Trout Recovery (1996)".</u>

Bull trout are probably the most geographically widespread char native to North America that has not been extensively cultured in hatcheries. As a result, little information exists on bull trout propagation, especially with regard to stocking individuals in the wild. The most extensive information comes from propagation efforts beginning in 1993 by the Creston National Fish Hatchery in Montana. In addition to successfully propagating bull trout, experiments were undertaken to evaluate the effects of water temperature, diet, structure, cover, and rearing density on growth and behavior and to evaluate time of imprinting by juvenile bull trout via thyroid hormone analysis (Fredenberg et al. 1995, Fredenberg, 1998). Due to various concerns, no progeny from these experiments have been stocked into the wild.

Other experiments in bull trout cultivation have occurred by Montana Fish, Wildlife and Parks in the 1940s and 1950s within the Clark Fork and Kootenai River drainages. One effort in 1949 and 1950 involved the collection of 876,000 eggs from bull trout in the Clark Fork River drainage. Subsequently, during 1950 to 1952, about 10,000 of these fish were planted into Lake Pend Oreille and about 65,000 into Flathead Lake (Pratt and Huston 1993).

More recently, several experiments in bull trout cultivation occurred in Idaho and Canada. From 1989 to1991, Idaho Fish and Game conducted a small experimental hatchery program at Cabinet Gorge Hatchery to investigate techniques for egg taking, egg incubation and hatchery rearing (Pratt and Huston 1993). Canada's Kootenay Trout Hatchery in British Columbia conducted experimental work with bull trout in the early 1980s and that work continued at Hill Creek Hatchery in the headwaters of the Columbia River drainage as part of a mitigation program for loss of bull trout spawning habitat due to dam construction. Wild bull trout adults are captured annually, spawned, and then returned to the wild. Resulting juveniles are planted in tributaries as four-inch fingerlings in the fall. Post stocking evaluation of the program has been inadequate to assess its outcome; however, the program is continuing (MBTSG 1996).

Washington efforts summarized from personal communications with USFWS staff at Abernathy Hatchery (May, 2011).

Efforts on bull trout culture at Abernathy Hatchery was tried, but has been restricted by a lack of proper water temperatures. Adults were held in 10-foot circular tanks supplied with well water at 12 to 13.5 C. Creek water was not utilized due to disease concerns. Spawning occurs in October, egg viability is very poor. The best result was 10% hatch from a female that was held for two months in chilled well water at 10 C. Using a chiller/recycle system eggs were incubated at 6 C. Swim up fry was gradually transitioned to 12 C for rearing. Fry accepted salmonid starter feed and grew well. Unlike salmon and steelhead juveniles, bull trout do not use the water column so rearing density should be based on bottom surface area of the tank. Due to aggressive behavior/cannibalism, all life stages should be reared with fish of the same size. Adding structure (e.g., sections of PVC pipes) to tanks and shade cloth helps to provide cover and reduce stress (John Holmes, USFWS, Abernathy Hatchery, per. comm. May, 2011).

Use of supplementation stocking, reintroduction & transplanting in recovery of ESA listed species.

Supplementation relies on artificial production where there is an attempt to replicate natural conditions as much as possible to avoid the problems associated with conventional hatchery production (Sterne, 1995). The process involves taking brood stock from a native population and carefully mating those individuals to provide a representative genetic sample of the population. Spawned fish are released back into the wild or held in a hatchery environment (captive broodstock). Biologists and culturists attempt to simulate natural feeding conditions and teach predator avoidance. Juveniles are acclimated into receiving waters and release densities are kept low to prevent competition with native populations. The ultimate goal of supplementation is to produce fish that retain the genetic makeup of the native stream population so they will return to the stream to reproduce naturally (Stern, 1995). Supplementation can be used for restoration, introduction, rearing augmentation and harvest augmentation. All of these seek to increase the overall survival rate of the target stock, but there is some degree of risk to wild fish inherent in each. Some of these risks have been addressed, but there continues to be some controversy regarding supplementation and the risks associated with it. Much depends on how it is used (e.g., harvest augmentation or aquaculture for conservation and recovery purposes) and the timing of its implementation relative to the demographic and genetic status of the population to be conserved (Stern, 1995).

The Montana Bull Trout Scientific Group (MBTSG) evaluated seven strategies for the potential use of artificial propagation in the recovery of bull trout (MBTSG 1996). The group evaluated the use of hatcheries in establishing genetic reserves, restoration stocking, research activities, supplementation programs, introductions to expand distribution, and the establishment of "put, grow, and take" fisheries. They concluded that the potential use of hatcheries in bull trout recovery could include the establishment of genetic reserves for declining populations, restoration stocking, and some research activities including the evaluation of hybridization.

They further concluded that the use of hatcheries for bull trout "put, grow, and take" stocking and introductions outside the historic range were not appropriate. **The MBTSG recommended that a study be initiated to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery and that specific goals and objectives for the use of hatcheries in the recovery and conservation of bull trout should be identified**. **It has been 16 years since the MBTSG recommendations and there have been no studies conducted to address the issue.** Information gleaned from such a study could help guide proposed artificial propagation programs identified in individual recovery units.

A decision to move forward with a restoration plan in the Yakima River basin, regardless of whether it consists of supplementation stocking, reintroductions or transplanting, will require the development of an implementation plan. That plan will need to be proceeded with an on-the-ground feasibility/pilot study to determine what the best restoration strategy might be. Several potential **strategies include the use of artificial propagation, captive rearing and transplanting** (see definition section). The restoration plan may include or utilize elements from more than one strategy. Advantages and disadvantages of these strategies are outlined below (summarized from Clackamas Feasibility and Restoration Plans, 2010).

Artificial Propagation:

Advantages: 1) can stock a large number of individuals thereby increasing the probability of a successful enhancement of existing population or reintroduction; and 2) reduced risk to the donor population due to a reduced number of individuals needing to be removed.

Disadvantages: 1) high cost relative to other strategies; 2) potential loss of genetic variability and ecological diversity; and 3) possible increase in the frequency of deleterious recessive alleles.

Captive Rearing:

Advantages: 1) better survival of wild eggs, fry and juveniles in hatchery environment compared to in the wild may result in greater numbers available for a reintroduction, and may reduce the number of individuals removed from the donor stock; 2) older age and larger size of captive reared individuals may result in better survival rates when stocked into the wild, relative to individuals translocated directly to the receiving habitat from the wild; 3) captive rearing may allow individuals to attain a size prior to release that would allow for implantation of PIT tags, greatly facilitating future monitoring of survival, growth, movement, distribution and other parameters; 4) captive rearing prior to release into the wild may facilitate disease testing.

Disadvantages: 1) moderate cost relative to other reintroduction strategies (i.e., lower cost relative to artificial propagation, but higher cost than direct transplantation); 2) higher potential for disease transmission relative to direct transplantation; 3) potential catastrophic loss of valuable wild individuals from hatchery malfunction (e.g., temperature, dissolved oxygen, disease); and 4) possible increase in the frequency of deleterious recessive alleles.

Transplantation:

Advantages: 1) lowest relative cost when compared to other reintroduction strategies; 2) assuming appropriate numbers of individuals transferred, least potential for loss of genetic variability and ecological diversity

Disadvantages: 1) highest risk to the donor population relative to the other reintroduction strategies due to the number of individuals needed to start a new population. 2) assuming a transplantation of fry and juveniles, naturally high mortality suggests numbers of individuals transplanted may need to be high, plus the added logistics and effort needed to capture the fish. 3) Assuming a transplantation of eggs would have high mortality rates associated with both the physical aspect of transplanting eggs and naturally high mortality rates in the receiving waters.

Regardless of which strategy or combination of strategies is used in planting or transferring ESA listed bull trout, careful consideration should be given in all of the following areas:

1) risk to the donor population; 2) life stage to introduce; 3) stocking rate or number to introduce to fully reflect the genetic composition and survival capabilities of the donor stock; and 4) how long to conduct the transfer (how many years). Regulatory issues will also need to be addressed; such items include following appropriate state, federal, and tribal fish handling and disease policies. Assessment and planning work should be conducted by a team of bull trout experts in the basin with fisheries management, genetics and fish culture experience. Ultimately, the restoration plan will require peer review, as well as concurrence from various stakeholders in the basin and be approved by the USFWS and NMFS.

Potential Yakima Basin Restoration Strategies

Potential restoration strategies may include the establishment of a supplementation facility at Gold Creek near Snoqualmie Pass. Such a facility would include an adult trap, holding pond and rearing vessels for eggs/fry and juvenile rearing. Juveniles would be planted back into Gold Creek and also reintroduced into other upper Yakima tributaries, such as the N.F. Teanaway, Taneum, Big and Cold Creeks. The area near Gold Creek Pond has good year round access from Interstate 90 as well as a reliable cold groundwater supply that feeds the creek & pond. A negative factor for using this population as a potential donor source is its lower abundance of adult spawners (5 yr. avg.; 21 redds).

Supplementation could also be used to bolster juvenile production in the Ahtanum drainage, but would necessitate the need for collecting fertilized eggs, fry or juveniles from that population for rearing in a hatchery environment (e.g., captive rearing) before translocation back into the Ahtanum Creek tributaries.

In the Naches basin, the S.F. Tieton River, Deep Creek and Indian Creek bull trout populations could be used as potential donor sources for juveniles to be transplanted into Crow Creek or introduced into S.F. Cowiche and Nile Creeks. The S.F. Tieton River is consistently the healthiest population in the basin (5 yr. avg.; 212 redds), followed by Deep Creek (5 yr. avg.; 149 redds) and Indian Creek (5 yr. avg.; 127 redds). Juvenile bull trout from these healthier populations could also be a potential donor source for reintroduction into the N.F. Teanaway and other upper Yakima River tributaries, especially if Gold Creek is deemed as unsuitable due to its smaller population size. Indian Creek, which has a very reliable, year round, cold groundwater source that feeds the N. Spring tributary, is another potential supplementation facility site. It has good access from Hwy 12.

<u>Yakima populations and proposed restoration stocking options:</u>

<u>12 populations are genetically distinct</u>

- Upper Yakima cluster: Adfluvial -- Gold, Box Canyon, Kachess, Fluvial/Resident -- N.F. Teanaway (likely extirpated)
- Naches cluster: Adfluvial -- Indian, S.F. Tieton, N.F. Tieton, Deep Fluvial -- American, Crow, Rattlesnake
- Ahtanum cluster: Resident – N., M. & S. Forks
- 2 unknown – Upper Yakima and Cle Elum/Waptus
- Other potential areas – Taneum, Big, Cold, Little Naches, Cowiche, Nile

<u>Decision-pathway questions for restoration stocking strategies:</u>

- "Critically" low populations: 1) Are numbers (demographics) of mature adults too low to successfully rebound? (YES); 2) Is the habitat limited? (NO); Recommended Action: **Supplementation** - with artificial production of juveniles or translocation of juveniles from a suitable donor stock
- Functionally extirpated populations: 1) Are neighboring populations too weak to passively re-colonize suitable, but barren habitat? (YES); 2) Have habitat concerns been

addressed? (YES); Recommended Action: **Reintroduction** - with artificial production of juveniles or translocation of juveniles from a suitable donor stock
- No known population: Is there enough designated critical habitat? (YES); Recommended Action: **Introduce** - with artificial production of juveniles or translocation of juveniles from a suitable donor stock.

Potential Options for Stocking

- Transplant juveniles, subadults from suitable donor stock directly into receiving waters (no hatchery rearing).
- Obtain gametes/eggs or juveniles from donor stock and rear in hatchery for a specified period and out-plant juveniles into receiving waters (process used in Willamette basin).
- Captive brood stock of adults (used in Montana).

Status of Yakima populations

- Critically low (average <25 redds/year):
  Ahtanum, Crow, Gold, Kachess, Box Canyon

- Functionally extirpated (average <1 redd/year)
  NF Teanaway, Cle Elum/Waptus

- Maintaining (25 to 250+ redds/year)
  Indian, S.F. Tieton, N.F. Tieton, Deep, Rattlesnake, American
  (Approximately 70% of basin redds are in 3 streams -- Indian, S.F. Tieton & Deep)
  (S.F. Tieton is the healthiest and most stable, followed by Deep & Indian)

Supplementation Facility -- Establish adult trap, egg take, supplementation facility at Gold Creek or Indian Creek (donor sources).

- Small temporary or semi-permanent station, with adult trap, adult holding pond/area, and rearing vessels.
- Out-plant juveniles back into donor populations and/or reintroduce juveniles into other upper Yakima tributaries (e.g., N.F. Teanaway, Taneum, Big, and Cold).

Areas for potential supplementation/translocation:

- Ahtanum – Supplement, transplant. Potential use of Ahtanum adults under a “captive brood stock conservation program” (see definition) or transplant juveniles from a suitable donor stock.
- Crow – Supplement, transplant. Use S.F. Tieton, Indian or Deep Creek as donor stocks. Transplant juveniles directly into the wild and/or rear for a short period (less than 1 yr) in hatchery before out planting.
- N.F. Teanaway – Reintroduce, transplant. Use Gold Creek (most genetically similar?) or Naches basin stocks (i.e., S.F. Tieton, Indian or Deep) as donor(s). Transplant juveniles directly into the wild and/or rear for a short time period (less than 1 yr) in hatchery before out planting.
- Taneum, Big, Cold –Introduce, transplant. Same as strategy as N.F. Teanaway.
- Cowiche, Nile—Introduce, transplant. Same strategy as Crow.

Gold Creek / Pond Supplementation Site

Advantages

- Head of the basin (upper Yakima River).
- Source of entrained fish into Yakima R.
- Federal (USFS) land.
- Easy year round access off I-90 with parking, power.
- Gold Creek Pond has a year round, cold groundwater source that flows through the pond into Gold Creek that could be developed as a supplementation site for collecting (trapping/spawning adults) and or rearing juveniles for out planting into other areas of the basin.
- Good site for public education (kiosk promoting multi-agency bull trout recovery, cooperation, education, etc.).

Disadvantages

- Depressed stock, dewatering in the Gold Creek channel above the pond causes delayed spawning, increased mortality of adults, juveniles.
- If surface water is used, there may be potential concerns about viral diseases as there are other species of fish that occupy the pond and creek (i.e., kokanee, cutthroat trout).

Indian Creek (N. Spring) Supplementation Site

Advantages

- Head of the basin (upper Naches basin).
- A source of entrained fish into the Tieton/Naches R. (S.F. Tieton also major source of entrained fish into Tieton)
- Federal (USFS) land.
- Easy year round access off Hwy 12.
- Indian Creek has a year round, cold groundwater source that flows from the N. Spring right next to a USFS gravel road. Could be developed as a supplementation site for collecting (trapping/spawning adults) and or rearing juveniles for out planting into other areas of the basin.
- Good site for public education (kiosk promoting multi-agency bull trout recovery, cooperation, education, etc.).
- Moderately healthy stock.

Disadvantages

- Stock not as healthy as S.F. Tieton or Deep Creek.
- Road access, but no power close by (nearest power 1.5 miles).

Note: Intercepting and taking gametes from adult bulls before they reach spawning grounds or capturing juvenile bull trout and rearing for a period of time before out planting may reduce mortality rates, increase survivability of the population and provide a genetically feasible gamete source for out planting into other areas (i.e. N.F. Teanaway, etc.).

Methods

Feasibility assessments.

Existing guidelines were consulted and utilized for crafting a framework for assessing the feasibility of using supplementation, transplantation and reintroduction strategies in the Yakima Basin to restore bull trout populations. This report reviewed and utilized information from a variety of sources, but the most useful of these was adapted and modified from Dunham & Gallo, 2008. The AFS guidelines attached to the end of this document should also be consulted as it offers valuable insight into the types of things that should be considered in the restoration of ESA listed species.

The first step in the Dunham & Gallo (2008) feasibility assessment process is to determine the recipient habitats and populations that have the potential to be restored or enhanced via supplementation, reintroduction or transplantation. The second is to determine the potential donor population(s). The following outline provides a useful format for making this assessment. Each step is followed by a series of key questions that will need to be addressed. The bulleted list provides additional information in major category areas that should be considered when making the assessments and formulating a restoration plan that uses supplementation, reintroduction or transplantation strategies. This should be considered carefully. A final plan that includes goals, objectives and strategies, methods, monitoring protocols, evaluation procedures and reporting timelines and recommendations will need to be formulated. An adaptive management process that allows for some degree of flexibility is imperative. Knowledgeable members of the local basin bull trout recovery planning group or team should guide this technical assessment. Ultimately the final plan will need additional peer review by local basin stakeholders, recovery team members and the USFWS.

Draft Assessment Outline for Yakima Basin Bull Trout Restoration/Enhancement Strategies

1. Potential for recipient habitat(s) to support supplementation, reintroduction or transplantation.
   a) Was the recipient habitat historically occupied by a self-sustaining population of bull trout?
   b) Are bull trout currently present in the recipient habitat?
   c) Is the habitat suitable for supporting a self-sustaining population of bull trout (i.e., contains adequate spawning, rearing & FMO habitat)?
   d) Have threats been corrected or sufficiently mitigated to justify supplementation, reintroduction or transplantation?
   e) Is recolonization of the recipient habitat unlikely in the short term?

2. Potential donor population(s) that can be utilized to support supplementation, reintroduction or transplantation.
   a) Is there a donor population that is a sufficient evolutionary match to the recipient?
   b) Can the donor population provide a sufficient number of eggs, fry, juveniles, subadults or adults to the recipient without damage to the donor?

Major areas to consider in the feasibility assessment and restoration planning process:

Primary Areas for Assessment

- Populations – Status, Abundance, Distribution, Life History (Extirpated Populations?)
- Current Habitat Conditions
- Fish Population & Habitat Threats Assessment
- Potential Recovery Methods (e.g., Supplementation, Translocation, Reintroduction)
- Donor Stock Availability & Risk
- Genetic Considerations
- Ecological Interactions
- Monitoring and Evaluation
- Reporting and Recommendations

Population Analysis & Genetic Considerations (Recipient & Donor Populations)

- Adult Abundance (redd counts, etc.)
- Juvenile Distribution / Abundance
- Genetic Analysis (Recipient & Donor Populations, Brood Source?)
- Genetics of Donor Population, Brood Source (How to pick?)
- Minimum Population Size of Donor? (Limit Risk to Donor)
- Stocking Density & Frequency
- Number needed to Stock, Size & Life Stage? (Juvenile, etc.)
- Timeframe to Stock (When, Where, How Long?)

Habitat Analysis

- Survey Data Reports (Past to Present)
- Basin Size (Catchment Area)
- Stream Size / Volume
- Stream Miles for Spawning / Rearing/ FMO Habitat
- Current Temperature Data
- Stream Temperatures (Daily Summer Maximum in FMO, Rearing & Spawning Habitat)
- Natural & Artificial Barriers
- Development, Road Density
- Connectivity with other Streams / Populations / Areas of Suitable Habitat

Ecological Interactions

- Presence / Absence of Exotics / Hybridization Issues? (e.g., Brook Trout)
- Competition / Predation issues with Exotic & Native Species (e.g. Lake Trout)
- Productivity (Forage Base, Presence / Abundance of Salmon Populations)
- Interactions with Listed Steelhead / Salmon Populations

Supplementation, Transplantation & Reintroduction Strategies

- Which strategy will be more effective, economically feasible? -- Risk assessment to the donor and recipient populations. -- Life stage and number of fish or eggs to stock or introduce for effective survival to adult. – Stocking frequency and density?
- Brood & Donor Sources -- In basin or out of basin? Genetic Considerations? Size of donor population?

- Introductions – which to use? Eggs, fry, juveniles, sub adults, adults -- planted into habitat not historically occupied by bull trout.
- Transplanting – which to use? Eggs, fry, juveniles, sub adults, adults -- taken from the wild and transported directly into the receiving habitat.
- Artificial Propagation -- wild donor stock are captured and held in a hatchery environment for development of a captive brood stock. The resulting progeny are released into the wild.
- Captive Rearing -- fertilized eggs, fry or juveniles are taken into a hatchery environment for short-term rearing before translocation into the wild.

Monitoring & Evaluation

- Distribution (spawning area, juvenile distr., FMO)
- Spawning Success
- Recruitment, & Growth
- Genetic monitoring of recipient and donor stocks
- Species Interactions

Past, present and potential future threats.

A threats assessment is included in the Bull Tout Action Plan (BTAP) document. The analysis includes threats for each population by life stage (i.e., spawning and incubation, juvenile rearing, adult/sub adult forging, migration and overwintering habitat). Additional careful review of existing habitat conditions and threats to each population will be needed prior to starting a supplementation, transplantation or reintroduction strategy.

Assessment of donor populations.

As for potential in-basin (Yakima) donor populations, the healthiest populations likely offer the best sources as potential donors. However, there would need to be some evaluation and assessment made as to the threshold (or limit) on the number of eggs, fry or adults that could be extracted from the donor population to be used in the recovery of the recipient population without causing the donor population undue strain. This is an assessment that the local recovery team will need to make based on their comfort level related to the overall health of the donor population and the perceived risk associated to both the donor and recipient populations. An assessment would have to include a genetic component as to what donor source (in basin or out of basin) is appropriate. It would also require a determination of how many eggs, fry or adults would be needed (and how many years) to stock into the recipient population to produce a reasonable response for recovery. Currently, by far the healthiest in-basin donor sources are populations that reside in Rimrock Reservoir (S. F. Tieton, Indian Creek) and in Bumping Reservoir (Deep Creek). Whether their populations are robust enough to support being used as a donor or if they can fit the genetic match needed to be used in the recipient areas intended for recovery remains to be evaluated. That evaluation should be done by the Yakima Basin bull trout recovery team committee with input solicited from the genetics unit in WDFW and additional review/approval by the USFWS.

Screening criteria, interim & long-term objectives.

Refer to the assessment outline section. Additional information needs and screening objectives include: risk to donor population; life stage to use; number of fish to introduce; genetic composition; method of supplementation / introduction and the number of years to continue the introduction.

Research needs.

Additional information needs include downstream juvenile distribution and summer maximum stream temperature data for spawning, rearing areas & FMO habitat.

Recovery Strategies

Yakima basin populations proposed for supplementation, transplantation and reintroduction strategies.

A technical team of local bull trout experts from the Yakima Basin should be assembled to guide the assessment, planning and restoration process. Ideally this will include individuals already associated with recovery planning efforts (e.g., BTAP representatives). Initial efforts might be considered only for those areas where bull trout are extirpated, or nearly so; and for those areas with chronically low population abundance. Supplementation, transplantation and reintroduction strategies should not be used for populations that are reasonably healthy, stable and /or showing long-term signs of increasing population abundance trends (e.g., most of the Naches populations). It should also be focused on areas where past threats have been corrected or mitigated to the extent that there is a strong likelihood of success with the selected restoration strategy and where there is a negligible chance of negatively affecting nearby populations. Current populations in the Yakima Basin that seem to best fit this initial criterion include the N. Fork Teanaway River, Ahtanum Creek, and Crow Creek. The N.F. Teanaway could be a potential candidate for a “reintroduction” as bull trout appear to be functionally extirpated from that drainage. The isolated resident population in Ahtanum Creek and the fluvial population in Crow Creek both have very small effective population sizes. The concern is that natural and artificial recovery options may be rendered ineffective when populations decline below a certain threshold limit which is often difficult to determine. This limit still needs to be defined. Both populations could be candidates for “supplementation” or “transplantation” strategies. If a donor population source could be identified, “transplantation” may be a better fit for both Crow Creek and Ahtanum Creek. Regardless, assessments will need to be conducted for these populations to determine whether such a plan is feasible or not.

Additional locations in the basin that may be considered for potential recovery efforts and assessment work include areas currently identified by the USFWS (2010) as critical bull trout habitat, although there have been few to no bull trout found in these areas. Potential “reintroduction” areas in the Naches River drainage include the South Fork Cowiche Creek, Nile Creek and the upper Little Naches River. Potential “reintroduction” areas in the upper Yakima drainage include upper Taneum Creek and Cold Creek (Keechelus Reservoir tributary).

Areas of the basin that have isolated, depressed populations that may be suitable as potential “mitigation candidates for future supplementation” due to impassable dams include the upper Yakima basin reservoirs (Keechelus, Kachess and Cle Elum). All but Cle Elum have known bull trout spawning populations; the Gold Creek spawning population in Keechelus Reservoir and the Box Canyon Creek and Kachess River spawning populations in Kachess Reservoir. These latter three local populations are all depressed and may be the best potential candidates for an upper basin supplementation recovery strategy for the entire upper section of the Yakima River. The potential to utilize captive brood stock from all three spawning populations for recovery of bull trout in that portion of the drainage should be assessed.

There have been no spawning populations positively identified in the upper Cle Elum River watershed although adult and juvenile bull trout have been found fairly recently in the drainage (WDFW survey file data, 1996) and are thought to have once been abundant in Waptus Lake (anecdotal information). Regardless, in the face of naturally reproducing populations of lake trout, brown trout and eastern brook trout in the Cle Elum system it is hard to conceive or justify pursuing supplementation or reintroduction recovery strategies in that drainage at the present time. Cold Creek, a tributary to Keechelus Reservoir may have the potential for reintroduction of bull trout, but it would require fixing an impassable barrier at the mouth. This was recently accomplished by the Bureau of Reclamation, but due to inadequate design specifications, it was wiped out by a high water in November 2008, just weeks after completion and has not been rebuilt.

Potential Pilot Project(s).

It seems appropriate to begin a supplementation assessment by focusing initial efforts on several different areas of the basin as "experimental pilot projects". By focusing on different areas, each with their own set of past threats and potential for recovery, it may provide a greater chance of success as opposed to the "putting all eggs in one basket" type of approach. Suggested pilot projects include the N. Fork Teanaway River, Crow Creek and the Ahtanum Creek tributaries. All of these areas still have high quality habitat, two are connected to the Yakima River and one to the Naches River and each are located in geographically distinct areas of the Yakima Basin. Bull trout are basically extirpated from the N.F. Teanaway and although still present in Crow Creek and the Ahtanum tributaries, they are at very low, chronically depressed levels. The Teanaway could be a potential bull trout reintroduction project while Crow and the Ahtanum would benefit from transplantation/supplementation. All three could benefit from the use of donor fry from other areas of the Yakima Basin. Other potential pilot projects include supplementation of Gold or Box Canyon Creeks in the upper Yakima drainage. The specific details of any plan would need to be worked through a recovery team and an in depth assessment made as to the best approach, with consideration given to current threats, genetic composition of recipient and donor populations, risk to other populations, etc. (see Methods -- Feasibility Assessments).

Short of going down the path of constructing a full-scale supplementation facility, perhaps the most economically feasible and viable pilot project is to utilize the S.F. Tieton River as a donor source for juveniles. The S.F. Tieton River is consistently the healthiest population in the basin (5 yr. avg.; 212 redds), followed by Deep Creek (5 yr. avg.; 149 redds) and Indian Creek (5 yr. avg.; 127 redds). Any of these populations could potentially supply juvenile bull trout for planting into the Teanaway, Crow Creek or the Ahtanum. Juveniles would be captured during the early part of the year, March-May via rotary screw traps if possible and transported to the receiving waters. It may be beneficial to hold and rear juvenile bull trout for 4-5 months before out planting. This may reduce mortality rates and increase survivability of the population. It also allows the fry to grow to sufficient juvenile size for potential PIT tagging prior to release; an important factor for monitoring later in the study. Of course this would require a cold water hatchery source, with virus free well or spring water. A traditional hatchery may be suitable provided adequate chillers were available.

Populations maintained as status quo.

With the exception of the proposed pilot projects most Yakima River basin bull trout populations would be maintained as status quo except for those areas identified as potential in-basin donor sources.

Monitoring and Evaluation

Regular surveys should be conducted to determine initial survival, recruitment of young, and persistence through environmental disturbances (such as floods, drought, or fire). During the first year, quarterly monitoring may be warranted. If the population becomes established, annual monitoring should be continued for many years to determine long- term survivorship (Williams et al, 1988). (Also refer to Appendix 1-- AFS Guidelines.)

Continued genetic and demographic monitoring and inventory will be needed to evaluate past and present restoration efforts. Post restoration population abundance surveys should be conducted on both recipient and donor populations.

Definitions

Effective Population Size – an important concept in the management of threatened species like

bull trout, *Salvelinus confluentus*. General guidelines suggest that effective population sizes of 50 adult spawners are needed to minimize inbreeding and 500 for maintenance of adaptive genetic variation for long-term sustainability (Allendorf and Ryman, 2002).

Artificial Propagation – wild donor stock (adults) are captured and held in a hatchery environment for development of a captive brood stock. The resulting progeny are released into the wild.

Conservation Aquaculture – the use of aquaculture for conservation and recovery of threatened and endangered fishes (also see Supplementation). (Note -- for all practical purposes & for use in this document, the terms conservation aquaculture and supplementation are often used interchangeably.).

Captive Brood Stock Conservation Program – wild adults are captured and taken into a hatchery environment where they are spawned and their progeny (juveniles) planted back out into the wild.

Captive Rearing – fertilized eggs, fry or juveniles are taken into a hatchery environment for rearing before translocation into the wild.

Genetic Reserve – a stock maintained under wild or hatchery conditions to preserve the genetic diversity of a population (i.e., may be captive brood stock maintained in hatchery or wild, naturally spawning fish).

Introduction – fish planted into a habitat where it has not been historically.

Rearing augmentation – juveniles from artificial propagation or translocated from a donor stock are planted in underutilized habitat to recover a weak population.

Reintroduction – introducing a native species into habitat from which it has disappeared.

Supplementation – (NMFS) the use of artificial propagation to reestablish or increase the abundance of naturally reproducing populations.

– (CRITFC & CBFWA) the stocking of fish into the natural habitat to increase the abundance of naturally reproducing fish populations (under this definition supplementation includes the out planting of wild or naturally reproducing fish).

Transplantation or Translocation -- wild fish (fertilized eggs, fry, juveniles, subadults or adults) are taken from a healthy donor stock and transported directly into the receiving habitat.

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1. Selecting the Introduction Site

A. Restrict introductions to within the native or historic habitat whenever possible.

B. Restrict introductions to a protected site.

C. Restrict introductions to sites where the potential for dispersal has been determined and is acceptable.

D. Restrict introductions to sites that fulfill life history requirements of the species.

E. Restrict introductions to sites that contain sufficient habitat to support a viable population.

F. Prohibit introductions into areas where the endangered or threatened fish could hybridize with other species or subspecies.

G. Prohibit introductions into areas where other rare or endemic taxa could be adversely affected.

2. Conducting the Introduction

A. Choose introduction stock from appropriate source.

B. Examine taxonomic status of introduction stock.

C. Examine introduction stock for presence of undesirable pathogens.

D. Obtain introduction stock of sufficient number and character.

E. Carefully and quickly transport stock.

F. Introduce stock under most favorable conditions.

G. Document the translocation.

3. Post- Introduction Activities

A. Conduct systematic monitoring of introduced populations.

B. Restock if warranted.

C. Determine cause of failures.

D. Document findings and conclusions reached during the post- introduction process.

APPENDIX E: Threats Analysis by Population

Ahtanum Creek (North, Middle, and South Forks)

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A1	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		High road density in spawning habitat. Clearcut upstream. Risk of catastrophic wildfire due to overstocked stands in watershed, Questions about future management (status of DNR staff)
A2	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		High road density in rearing habitat. Clearcut upstream. Risk of catastrophic wildfire due to overstocked stands in watershed, Questions about future management (status of DNR staff)
A3	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on annual redd counts. Adult spawner numbers are low in all three forks and have been for years (<50 redds per year). Population believed to be at significant risk of extirpation
A4	Altered Flow Regimes	Subadults/Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Minimum flows have been established in lower reaches but irrigation withdrawal still results in significant flow depletion during the summer and early fall

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A5	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Recreational dams are the issue here and they have been observed on this stream in the past. They could potentially block spawners from access to the North Fork. Impact would be moderately significant.
A6	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Recreational dams are the issue here and they have been observed on this stream in the past. They could potentially block spawners from access to the North Fork. Impact would be moderately significant.
A7	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the adult and subadult habitats for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take but could be significant given the small size of this population
A8	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the migration corridor for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take but could be significant given the small size of this population
A9	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the FMO habitat for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take but could be significant given the small size of this

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						population
A10	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
A11	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
A12	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		Dearth of anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
A13	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Considerable residential development below spawning and rearing habitat. Impacts associated with this mechanism are unknown but could be moderately significant
A14	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Considerable residential development in FMO (resident adult) habitat. Impacts associated with this mechanism are unknown but could be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A15	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		There are two remaining unscreened diversions in resident adult (and subadult) habitat through which potential spawners could be lost. The effect is unknown but could be moderately significant at the population level given the small size of this population
A16	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		There are two remaining unscreened diversions in FMO habitat through which subadults and adults could be lost. The effect is unknown but could be moderately significant given the small size of this population
A17	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		All mechanisms present in Tree Phones Campground area. Former site of Snow Cabin Campground is also degraded. Impact is unknown but believed to be moderately significant
A18	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		All mechanisms present in Tree Phones Campground area. Former site of Snow Cabin Campground is also degraded. Impact is unknown but believed to be moderately significant
A19	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		All mechanisms present in TreePhones Campground area. Impact is unknown but believed to be moderately significant
A20	Agricultural Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (chemical and high temps)		Agricultural activities occur below the forks but their specific effects on water quality are unknown.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A21	Agricultural Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		Agricultural activities occur below the forks but their specific effects on habitat degradation are unknown.
A22	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Elevated water temperatures possible as a result of large-scale harvest. Impact unknown
A23	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Increased sediment input possible from activities upstream. Impact unknown
A24	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Elevated water temperatures possible as a result of large-scale harvest. Impact unknown
A25	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Elevated water temperatures possible as a result of large-scale harvest. Impact unknown
A26	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Effects were significant in the past. Many have been addressed via exclusion fencing in grazing allotment.
A27	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No reports of non-angling harassment, but possible due to proximity to dispersed campsites and roads. Impact unknown
	Transportation	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Road networks disconnect creek from floodplain.		Ahtanum Road parallels the creek for portions of FMO habitat. Impact unknown but believed to be low.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Agricultural Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		Depends on extent of juvenile rearing habitat. There is limited agriculture above the forks but If rearing habitat extends below the mechanism is possible but not likely significant impacts
	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Regulated flows (too high or low) restrict movement of fish		Low flows in early fall in lower reaches due to irrigation withdrawal but established minimum flows are likely sufficient to allow migrations
	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Most of the grazing concerns have been addressed in spawning habitat. Threat may still be present to some degree but no longer believed to be significant
	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Most of the grazing concerns have been addressed in spawning habitat. Threat may still be present to some degree but no longer believed to be significant
	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		This effect possible but would be unlikely
	Grazing	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Most of the grazing concerns have been addressed in juvenile rearing habitat. Threat may still be present to some degree but no longer believed to be significant
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams are the issue here. Could possibly restrict juvenile habitat access in the short term but not thought to be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams are the issue here. Could possibly restrict habitat access short term for this life stage but not thought to be significant
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No specific data. On the ground observations do not reveal significant recreational impact on habitat quality in FMO habitat
	Agricultural Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		No agricultural activities occur in spawning habitat
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		No reservoirs in watershed. Flows in summer are lower not higher than desired because of irrigation manipulations
	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		No reservoirs in watershed. Flows in juvenile rearing habitat are not subject to manipulation
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Dewatering	Not present for any life stage	NA	NA		No natural dewatering of stream reaches has been observed.
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		Juvenile rearing habitat is upstream of any irrigation diversions
	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Not an adfluvial population. No storage dam
	Introduced Species	Not present for any life stage	NA	NA		No introduced species are present based on snorkel and electrofishing data

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Field observations. There is an excess of available spawning habitat to support this population even if it grew beyond its current small size
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		There is an excess of available rearing habitat to support this population even if it grew beyond its current small size (based on field observations)
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Recreational dams are the issue here but extremely unlikely to cause direct mortality to downstream migrants
	Mining	Not present for any life stage	NA	NA		There are no mining operations or claims within the population area.

American River /Union Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A/U1	Low Abundance	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is chronically low (25-50 redds per year) based on spawning surveys.
A/U2	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
A/U3	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
A/U4	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/survival	Decreased invertebrate biomass		Dearth of anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A/U5	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the American and Naches rivers. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted takes but could be moderately significant.
A/U6	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the American and Naches rivers. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take but could be moderately significant
A/U7	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the American and Naches rivers. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted takes but could be moderately significant.
A/U8	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Union Creek, a major spawning tributary, is very accessible (highway crosses it, cabins nearby). Impact is unknown but possibly moderately significant.
A/U9	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No reports of non-angling harassment, but possible due to proximity of camp sites near river. Impact is unknown but possibly moderately significant
A/U10	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Three USFS campgrounds and several dispersed sites located on river banks. Habitat degradation is documented. Impact is unknown but possibly moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
A/U11	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present but there are no data regarding competition. Significance of threat is unknown
A/U12	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout present but no hybrids have been identified through genetics analyses. Significance of threat is unknown
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout are present in FMO habitat. Impacts associated with this mechanism are unknown but believed to be insignificant due to the extent of habitat area available for this life stage
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton Dams. Impacts associated with this mechanism are unknown but believed to be insignificant
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton dams. Impacts associated with this mechanism are unknown but believed to be insignificant
	Transportation	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 parallels both the American and Naches rivers (FMO habitat). Impacts associated with this mechanism are unknown but believed to be insignificant.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Transportation	Spawning/egg incubation	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 parallels the American River adjacent to spawning and rearing habitat. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Pre/post spawning migrations	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 parallels both the American and Naches rivers (FMO habitat). Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Juvenile rearing	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 parallels the American River adjacent to spawning and rearing habitat. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Most spawning occurs away from any residential development. A few cabins relatively close to Union Creek. Mechanism possible but not thought to be significant
	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Mechanism not an issue except maybe near the cabins on Union Creek. Impact not thought to be significant
	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Residential development is present in FMO habitat but is not thought to cause significant habitat degradation considering the extent of FMO habitat
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						be significant at this time
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low effective population size		Effective population size estimated based on annual redd counts. Adult population size is small to moderate but appears stable. Population's risk of extirpation is probably low due to it's connectivity to other fluvial populations

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Camping areas generally not near spawning areas. No data but impact believed to be insignificant based on field observations.
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in FMO habitat but are not thought to cause significant habitat degradation considering the extent of FMO habitat
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in spawning and rearing or FMO habitat.
	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Unnatural flow alterations of any kind do not occur in juvenile rearing habitat
	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Regulated flows (too high or low) restrict movement of fish		Threat is not present. High flows in lower Naches during flip-flop but pre-spawn bull trout are well upstream by the time they occur
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss		Essentially no residential/urban development occurs in the habitat for this life stage

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				of habitat complexity		
	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Dewatering	Not present for any life stage	NA	NA		No natural dewatering of stream reaches has been observed.
	Entrainment	Not present for any life stage	NA	NA		The potential for entrainment of subadults or adults does not exist on the American River and would be highly unlikely in the FMO habitat for this population
	Grazing	Not present for any life stage	NA	NA		No livestock grazing occurs in the population area.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Field observations. There is an excess of available spawning habitat to support this population
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		There is an excess of available rearing habitat to support this population (based on field observations)
	Passage Barriers	Not present for any life stage	NA	NA		Passage problems of any kind have not been observed.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Mining	Not present for any life stage	NA	NA		No mining operations or claims in this population area

Box Canyon Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
B1	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is chronically low based on spawning surveys (<50 redds per year). Population is isolated behind impassable dam but connected to one other population. Population believed to be at significant risk of extirpation
B2	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Kachess Dam is impassable. Population is disconnected. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham). Also a significant problem with passage at the mouth of the stream.
B3	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Passage blockage frequently observed at mouth of creek (2001, 2003, 2005) as a result of reservoir draw down and low flows across permeable reservoir bed. Recreational dams have also been observed in vicinity of Kachess Campground

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
B4	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing but illegal angling for bull trout has occurred. Unknown impact but could be significant given the small size of this population
B5	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing but illegal angling for bull trout has occurred. Is definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
B6	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
B7	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is theoretically unknown but could be significant
B8	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is theoretically unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
B9	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is theoretically unknown but could be significant
B10	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		The entire stream is fairly accessible to large numbers of people due to its proximity to Kachess Lake Campground and the road. Area below Peekaboo Falls is particular concern. Impact is unknown but is believed to be AT LEAST moderately significant
B11	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Spawning area is fairly accessible to large numbers of people due to its proximity to Kachess Lake Campground and the road. Impact is unknown but possibly moderately significant
B12	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		No diversions Box Canyon Creek. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.
B13	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		FMO habitat is in Lake Kachess. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
B14	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		FMO habitat is in Lake Kachess. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.
B15	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Juvenile rearing is limited to about 1.5 miles of stream below a natural barrier. Much of lower creek was inundated with construction of Kachess Dam in 1912. Snorkel surveys reveal high densities of juveniles. Impact is unknown but could be moderately significant
B16	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat is unknown
B17	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat is unknown
B18	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat is unknown
B19	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat is unknown
B20	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Small numbers of brook trout are present based on snorkel observations. Significance of threat is unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
B21	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Small numbers of brook trout are present based on snorkel observations but no hybridization has been observed. Significance of threat is unknown
B22	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Accessible spawning reach is less than 1.5 miles in length. Much of lower creek was inundated with construction of Kachess Dam in 1912. Spawning habitat availability does not appear to be limiting population at its current size (professional opinion). Unknown if it would if the population were to grow
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		FMO habitat is in Kachess Lake where brook trout are present in small numbers. Threat is unknown but believed to be insignificant
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No known problem based on observations during spawning surveys. Very limited recreational activity that would result in habitat degradation for this life stage
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No known problem based on observations during spawning surveys. Very limited recreational activity that would result in habitat degradation for this life stage
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in population area.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Altered Flow Regimes	Not present for any life stage	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Not present for any life stage	NA	NA		Essentially no residential/urban development occurs in the habitat for any life stage
	Dewatering	Not present for any life stage	NA	NA		No natural dewatering occurs above the mouth of the creek. Could happen during severe drought years but would be rare otherwise
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable
	Grazing	Not present for any life stage	NA	NA		No livestock grazing occurs in the habitat for this population.
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream		No barriers exist to downstream migration. Post-spawn bull trout likely return to lake when stream flows increase following rainfall

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				migration		event
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams observed near the Kachess Lake Campground would not impede access to juvenile spawning and rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Transportation	Not present for any life stage	NA	NA		No paved road networks in population area.
	Mining	Not present for any life stage	NA	NA		No mining operations or claims in population area.

Cle Elum/Waptus

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
C/W1	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Significant numbers of lake trout are present in Cle Elum Lake and significant numbers of brook trout are present in Waptus Lake (based on hook & line and creel surveys). Lake trout are generally confined to the lake but brook trout are ubiquitous throughout the streams in the watershed. The threat is believed to be significant
C/W2	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are ubiquitous throughout the streams in the watershed based on all manner of surveying. The threat is believed to be significant
C/W3	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present, but no bull trout redds have been positively identified anywhere in the watershed. Limited genetics analysis has identified brook x bull hybrids. Although impact is unknown it is believed to be significant
C/W4	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Given very limited success locating bull trout in this system, this population (or populations) appear to be on

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						the brink of extirpation
C/W5	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Cle Elum Dam is impassable. Population is disconnected. Cle Elum and Waptus Lake are disconnected by a barrier falls.
C/W6	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		No diversions in these watersheds. Entrainment through Cle Elum Dam possible but effects are unknown. Population size is likely very small. Effect of entraining just a few fish could be significant. Lake trout and burbot have both been found below dam
C/W7	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		FMO habitat is in the lakes. Entrainment through Cle Elum Dam possible but effects are unknown. Population size is likely very small. Effect of entraining just a few fish could be significant. Lake trout and burbot have both been found below dam.
C/W8	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		FMO habitat is in the lakes. Entrainment through Cle Elum Dam possible but effects are unknown. Population size is likely very small. Effect of entraining just a few fish could be significant. Lake trout and burbot have both been found below dam

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
C/W9	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is theoretically unknown but could be significant
C/W10	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is theoretically unknown but could be significant
C/W11	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is theoretically unknown but could be significant
C/W12	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Juveniles have been found in the Cle Elum River. Impact from dispersed camp sites (100+) is unknown but believed to be moderately significant
C/W13	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake(s). Possible that bull trout are caught there (incidentally or illegally targeted). Anecdotal accounts of bull trout caught in Waptus Lake in the past but not confirmed in relatively recent hook and line sampling. Unknown impact from this threat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
C/W14	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in these lakes and streams. Is definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Probably does not occur much, if at all, in the streams because of the scarcity of the species. Anecdotal accounts of bull trout caught in Waptus Lake in the past but not confirmed in relatively recent hook and line sampling. Unknown impact
C/W15	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in these streams. Illegal angling for bull trout possible but probably does not occur much, if at all, because of the scarcity of the species. Unknown impact.
C/W16	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Summer and early fall water temperatures in the upper Cle Elum River push or extend beyond the suitable range for bull trout. Whether this is partially the result of past Forest Management Practices or mostly due to the lakes upstream is unknown.
C/W17	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Summer and early fall water temperatures in the upper Cle Elum River push or extend beyond the suitable range for bull trout. Whether this is partially the result of past Forest Management Practices or mostly due to the lakes upstream is unknown.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Transportation	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Road networks disconnect river from floodplain		Highway 903 parallels both Cle Elum Lake and the upper Cle Elum River. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Spawning/egg incubation	Habitat degradation	Road networks disconnect river from floodplain		Highway 903 parallels both Cle Elum Lake and the upper Cle Elum River. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Pre/post spawning migrations	Habitat degradation	Road networks disconnect river from floodplain		Highway 903 parallels both Cle Elum Lake and the upper Cle Elum River. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Juvenile rearing	Habitat degradation	Road networks disconnect river from floodplain		Highway 903 parallels both Cle Elum Lake and the upper Cle Elum River. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Mining	Spawning/egg incubation	Disruption of egg incubation due to mining gravels in stream	Mining disturbs instream gravels.		As no redds have been positively identified in the Cle Elum watershed, effects of this threat are unknown.
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the upper Cle Elum River watershed but not in the upper Waptus watershed (wilderness). Not sure of future harvest plans. Mechanism does not present a current problem but possible in the future

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the upper Cle Elum River watershed but not in the upper Waptus watershed (wilderness). Not sure of future harvest plans. Mechanism does not present a current problem but possible in the future
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in spawning, rearing or FMO habitat.
	Altered Flow Regimes	Not present for any life stage	NA	NA		FMO habitat is in the lake(s) and unnatural flow manipulations do not occur in the rivers.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Not present for any life stage	NA	NA		A few scattered cabins along the upper Cle Elum, none along the Waptus, threat is rare or not present.
	Dewatering	Not present for any life stage	NA	NA		No natural dewatering of stream reaches has been observed.
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lakes. Mechanism is not applicable

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lakes. Mechanism is not applicable
	Grazing	Not present for any life stage	NA	NA		No livestock grazing occurs in the population area.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Have not located any redds in this system. Adult observations have been few and far between. Plenty of available spawning habitat in upper Cle Elum River but may be limited by high water temperatures. Spawning habitat above Waptus Lake may be limited based on limited field observations. Area is remote
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Small numbers of juveniles have been observed in the upper Cle Elum River and one hybrid was observed and captured in the upper Waptus River. Rearing habitat is everywhere in both rivers but high water temperatures may diminish its suitability in the upper Cle Elum River
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Passage problems of any kind have not been observed
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Passage problems of any kind have not been observed
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable		Passage problems of any kind have not been observed

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				habitat		
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational use along the Cle Elum River is heavy and the impact might be moderately significant if we could find a spawning area. But we haven't so the threat is not present at this point. Impacts on the Waptus River are non-existent.
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Recreational use along the Cle Elum River is heavy and the impact might be moderately significant if we could find a spawning area. But we haven't so the threat is not present at this point. Impacts on the Waptus River are non-existent
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Recreational use along the Cle Elum River is heavy and the impact might be moderately significant if we could find a spawning area. But we haven't so the threat is not present at this point. Impacts on the Waptus River are non-existent.
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake(s). Mechanism is not applicable

Crow Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
C1	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on annual redd counts. Adult spawner numbers are chronically low (<50 redds per year). Population is connected to other fluvial populations but believed to be at significant risk of extirpation due to a catastrophic event
C2	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the FMO habitat for this population. Illegal angling for bull trout may also occur. Unknown impact but could be significant given the small size of this population
C3	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the migration corridor for this population. Illegal angling for bull trout may also occur. Unknown impact but would be significant if only a few fish were killed given the small size of this population

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
C4	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the adult and subadult habitats for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take but could be significant given the small size of this population
C5	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
C6	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
C7	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/survival	Decreased invertebrate biomass		Dearth of anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
C8	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Crow creek FMO includes Little Naches. Heavy recreational use in Little Naches and some along Naches River. Impact likely insignificant on the Naches; is unknown in the Little Naches but could be moderately significant
C9	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		High road densities in the Little Naches may be source of sediment. Impact unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout are present in the Naches and Little Naches Rivers. Impacts associated with this mechanism are unknown but believed to be insignificant due to the extent of habitat area available for this life stage
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton dams. Threat present but not believed to significantly affect growth and condition by this mechanism
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton dams. Threat present but not believed to significantly affect growth and condition by this mechanism
	Transportation	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Road networks disconnect creek from floodplain.		Highway 410 parallels the FMO habitat. Impact unknown but believed to be low.
	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No residential/urban development occurs Crow Creek or the Little Naches River. Some occurs on the Naches River but is not believed to be a significant cause of habitat degradation
	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack		Recreational dams occasionally observed. Effect not believed to be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				of gene flow		
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Recreational dams occasionally observed. Effect not believed to be significant
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams occasionally observed could possibly restrict habitat access short term for this life stage but not thought to be significant
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No reports of non-angling harassment, but possible near campground at mouth and in heavily recreated Little Naches River. Not likely significant
	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		There is a grazing allotment along Crow Creek but due to local topography, cows have no direct access to creek.
	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		There is a grazing allotment along Crow Creek but due to local topography, cows have no direct access to creek.
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in this population area
	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of		Unnatural flow alterations of any kind do not occur in juvenile rearing habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				prey		
	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Regulated flows (too high or low) restrict movement of fish		Threat is not present. High flows in lower Naches during flip-flop but pre-spawn bull trout are well upstream by the time they occur
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Juvenile rearing habitat is located in remote with access difficult. Threat does not exist
	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Dewatering	Not present for any life stage	NA	NA		No natural dewatering of stream reaches has been observed.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Entrainment	Not present for any life stage	NA	NA		The potential for entrainment of subadults or adults does not exist on Crow Creek and would be highly unlikely in the FMO habitat for this population
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Spawning habitat is in wilderness where no logging occurs. Mechanism is not applicable
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging does not occur in the Crow Creek subbasin but has occurred in the Little Naches and Naches Rivers subbasins. Elevated water temperatures as result have not been observed. Mechanism probably not present or rare
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging does not occur in the Crow Creek subbasin but has occurred in the Little Naches and Naches Rivers subbasins. Elevated water temperatures as result have not been observed. Mechanism probably not present or rare
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Rearing habitat is mostly in the wilderness where no logging occurs. Mechanism is not applicable
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Rearing habitat is mostly in the wilderness where no logging occurs. Mechanism is not applicable
	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Livestock grazing does not interfere with migration into Crow Creek. That which occurs downstream in the Naches River would not present the threat of harassment to migrating fish

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Some livestock grazing occurs along the Naches River but habitat degradation significant at the reach scale is not believed to occur
	Introduced species	Juvenile rearing	Reduced growth/condition	Competition for food and space		No introduced species are present in the habitat for this life stage based on snorkel and electrofishing data
	Introduced species	Spawning/egg incubation	Decrease in fertility	Hybridization		No introduced species are present in the habitat for this life stage based on snorkel and electrofishing data
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Population is very small. Available spawning habitat could support many more spawners than it currently does (field observations)
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Spawning population is very small. Available rearing habitat could support many more juveniles than it currently does (expert opinion)
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Recreational dams occasionally observed are extremely unlikely to cause direct mortality to downstream migrants
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams occasionally observed are well downstream of spawning and rearing habitat
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat		Spawning is in isolated areas remote from recreational areas. No impacts

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				complexity		
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Spawning is in isolated areas remote from recreational areas. No impacts
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Juvenile rearing occurs mostly in isolated areas remote from recreational areas. No impacts
	Mining	Not present for any life stage	NA	NA		No mining operations or claims in this population area.

Deep Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
D1	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Bumping Dam is impassable. Population is disconnected. Genetic diversity lower than other populations (Reiss, Small) and for long-term sustainability better to have gene flow (Rieman, Dunham).
D2	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in stream and some hybridization with bull trout has been documented. Long-term impact of this threat could be significant
D3	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
D4	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing but illegal angling for bull trout may occur to a limited extent. Is probable that some bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
D5	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Is probable that some bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be moderately significant
D6	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing but illegal angling for bull trout may occur to a limited extent. Unknown impact but could be moderately significant
D7	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		Dewatering occurs frequently in a reach that begins at about RM 1.5. This precludes further upstream movement of spawners. Overall impact on productivity is unknown but could be moderately significant
D8	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO habitat		Dewatering occurs frequently in a reach that begins at about RM 1.5. This precludes further upstream movement of spawners. Overall impact is unknown but could be moderately significant. Probably not a problem for post-spawn fish returning to the lake. They can just wait until the it is passable
D9	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in the stream. No data regarding impact on juvenile growth and condition as a result of competition. Unknown impact but could be moderately significant
D10	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream		FMO habitat is Bumping Lake. Genetic studies confirm that Deep Creek fish are entrained through Bumping Dam. The impact on this population is unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				passage back to lake		
D11	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		FMO habitat is Bumping Lake. Genetic studies confirm that Deep Creek fish are entrained through Bumping Dam. The impact on this population is unknown. No irrigation diversions exist on Deep Creek
D12	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		FMO habitat is Bumping Lake. Genetic studies confirm that Deep Creek fish are entrained through Bumping Dam. The impact on this population is unknown. No irrigation diversions exist on Deep Creek
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		FMO habitat is in Bumping Lake where brook trout are present. Threat is unknown but believed to be insignificant
	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		Possible that some juvenile fish may die as a result of stranding in the dewatered reach but never actually observed. Loss would not be significant at the population level
	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat- Reduced pool quantity and quality		Very few, if any, holding pools are present in the reach that dewaters (which is only a few hundred yard long). No overall effect on quantity and quality of holding habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		Dewatering occurs frequently in a reach that begins at about RM 1.5. No stranded adults have been observed. Mechanism is possible but is not believed to result in a significant impact on the population
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality-Pre-spawn fish stranded in dewatered habitat		Dewatering occurs frequently in a reach that begins at about RM 1.5. No stranded adults have been observed. Mechanism is possible but is not believed to result in a significant impact on the population
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is large and stable (>50 redds per year). Population is isolated behind impassable dam so the possibility exists of long-term genetic effects. Population not believed to be at significant risk of extirpation due to its size
	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is reasonably healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is reasonably healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Recreational activities occur in the watershed but associated impacts are not believed to be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in population area.
	Altered Flow Regimes	Not present for any life stage	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Not present for any life stage	NA	NA		Essentially no residential/urban development occurs in the habitat for this population.
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures- Low flows increase water temperatures to unsuitable levels for successful spawning		Dewatering mentioned above does not appear to affect water temperatures downstream where large numbers of redds are usually found. Since the water that went subsurface returns downstream it may actually have a cooling effect
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds dewatered		Reach that dewaters does not contain suitable spawning habitat. Dewatered redds have not been observed in the stream during years of

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						spawning surveys
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		Dewatering is short term. The reach waters up readily with rainfall that always occurs in the fall. Limited access to juvenile rearing habitat does not persist long enough to significantly affect growth and condition
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality- Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		Dewatering is short term. The dewatered reach is only a few hundred yards long and is not great rearing habitat anyway (the creek is a bit over five miles in length below the barrier waterfall) Net effect on overall rearing habitat quality is negligible
	Dewatering	Juvenile Rearing	Reduced growth and condition	Food shortage- Loss of aquatic invertebrate biomass in dewatered channel		Doubtful that invertebrate biomass is significantly affected by the dewatering at the reach level
	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures- Low flows increase water temperatures to levels which negatively affect juvenile physiology		Dewatering does not appear to affect water temperatures downstream. Since the water that went subsurface returns downstream it may actually have a cooling effect
	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access- Higher water temperatures resulting from low flows result in thermal barriers to migration		Dewatering does not appear to affect water temperatures downstream. Since the water that went subsurface returns downstream it may actually have a cooling effect

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access-Dry reaches limit access to FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality-Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		FMO habitat is in the lake. Mechanism is not applicable
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable
	Grazing	Not present for any life stage	NA	NA		No livestock grazing occurs in the habitat for this population.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Just over five miles of Deep Creek is accessible to spawners. Plenty of available spawning habitat but access can be sporadically restricted to the lower 1.5 miles because of natural dewatering.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Quality rearing habitat is abundant
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Culverts thought to be partial passage barriers on FS Roads 1800 and 1808 are only known passage issues for this life stage. Culverts will be replaced with bridges during summer of 2011
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		No artificial downstream barriers exist
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		The culverts scheduled for removal on FS Roads 1800 and 1808 were likely barriers to juvenile migration but probably did not matter. The entire creek is spawning and rearing habitat.
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Transportation	Not present for any life stage	NA	NA		No paved road networks within population area.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Mining	Not present for any life stage	NA	NA		No mining operations or claims within population area.

Gold Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G1	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		Dewatering (which may be the result of past land use actions) occurs annually in the late summer and early fall in a one-to-two mile reach that begins about a mile upstream of the mouth. Primary spawning habitat above this reach is inaccessible for weeks (or more) at a time. Very low redd counts in many years for this small population indicate that this impact is significant
G2	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality- Pre-spawn fish stranded in dewatered habitat		Dewatered reach is extensive and numerous carcasses of stranded fish have been found over the years. Given the small size of this population the impact is believed to be significant
G3	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO habitat		Dewatering (which may be the result of past land use actions) occurs annually in the late summer and early fall in a one-to-two mile reach that begins about a mile upstream of the mouth. Primary spawning habitat above this reach is inaccessible for weeks (or more) at a time. Very low redd counts in many years for this small population indicate

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						that this impact is significant
G4	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		Dewatered reach is extensive and numerous carcasses of stranded fish have been found over the years. Given the small size of this population the impact is believed to be significant
G5	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is chronically low based on spawning surveys (<50 redds per year). Population is isolated behind impassable dam. Population believed to be at significant risk of extirpation
G6	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Keechelus Dam is impassable. Population is disconnected. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham). Potential passage problems into creek from lake

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G7	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing but illegal angling for bull trout may occur, particularly nearer the mouth. Is definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
G8	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing but illegal angling for bull trout may occur near mouth. Unknown impact but could be significant given the small size of this population
G9	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
G10	Dewatering	Juvenile Rearing	Reduced growth and condition	Food availability- Loss of aquatic invertebrate biomass in dewatered channel		Since the reach essentially dewaters every summer for extended periods and is extensive in length it is reasonable to assume that invertebrate biomass gets hammered. Impact is unknown but could be significant
G11	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		Dewatered reach is extensive and stranded juveniles are often observed. If not already dead most will die from various causes (avian and mammalian predation, starvation etc.). Impact is unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G12	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality-Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		Habitat quality in the dewatered reach is either nonexistent or severely diminished for extended periods in the summer and early fall. Impact is unknown but could be significant because of the amount of potential habitat involved
G13	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		Entrainment studies were conducted at Keechelus Dam in 2010. No bull trout were captured but bull trout have been found during spawning and snorkel surveys downstream of the dam. The impact on this population is unknown but could be significant due to small population size. No irrigation diversions exist on Gold Creek
G14	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		FMO habitat is Keechelus Lake. Entrainment studies were conducted at Keechelus Dam in 2010. No bull trout were captured but bull trout have been found during spawning and snorkel surveys downstream of the dam. The impact on this population is unknown but could be significant due to small population size
G15	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		FMO habitat is Keechelus Lake. Entrainment studies were conducted at Keechelus Dam in 2010. No bull trout were captured but bull trout have been found during spawning and snorkel surveys downstream of the dam. The impact on this population is unknown but could be significant due to small population size

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G16	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is unknown but could be significant
G17	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is unknown but could be significant
G18	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
G19	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat-Reduced pool quantity and quality		Given the extensive length of the dewatered reach, holding habitat is obviously reduced or severely degraded in quality. Unknown impact but probably at least moderately significant
G20	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Bank stabilization and channel redirection has occurred, and is likely to continue to occur, in the middle reach of Gold Creek where redds are occasionally found. These activities are very intrusive and cause habitat degradation. The impacts are unknown but given the small size of this population could be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G21	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Bank stabilization and channel redirection has occurred, and is likely to continue to occur, in the middle reach of Gold Creek. These activities are very intrusive and cause some juvenile rearing habitat degradation. Effect is unknown but may be moderately significant
G22	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Bank stabilization and channel redirection has occurred, and is likely to continue to occur, in the middle reach of Gold Creek. These activities are very intrusive and would likely stress fish. Although the effect is unknown it could be moderately significant
G23	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Bank stabilization and channel redirection has occurred, and is likely to continue to occur, in the middle reach of Gold Creek. These activities are very intrusive and would likely stress fish. Although the effect is unknown it could be moderately significant
G24	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Field observations that there are potential passage problems into the creek from the lake. Effect is unknown but thought to be moderately significant Recreational dams have occasionally been observed during spawning surveys.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
G25	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		The dewatered reach would obviously restrict access to summer rearing habitat for extended periods. Access to rearing habitat above and below the dewatered reach is restored with the normal fall precipitation. Impact is unknown
G26	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access- Higher water temperatures resulting from low flows result in thermal barriers to migration		Dewatering in the upstream reach does not appear to affect water temperatures downstream. The water that went subsurface may actually return cooler. However, elevated water temperatures resulting from dewatering that occurs on the lakebed could dissuade spawners from entering the creek. Impact is unknown
G27	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in the stream. No data regarding impact on juvenile growth and condition. Unknown impact
G28	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in the stream. Hybridization with bull trout has not been documented. Significance of the threat is unknown
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		FMO habitat is in Keechelus Lake where brook trout are present. Threat is unknown but believed to be insignificant
	Transportation	Pre/post spawning migrations	Habitat degradation	Road networks disconnect river from floodplain		Interstate 90 crosses the lower end of Gold Creek, with an expanded bridge in 2012. Impacts associated with this mechanism are unknown but believed to be insignificant.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Transportation	Juvenile rearing	Habitat degradation	Road networks disconnect river from floodplain		Interstate 90 crosses the lower end of Gold Creek, with an expanded bridge in 2012. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds dewatered		Mechanism has not been observed. May occur but the dewatered reach, when it has flowing water, is not normally spawned in. Even if is not completely dewatered streamflows are considerably depleted. Mechanism possible but not likely a significant impact
	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures- Low flows increase water temperatures to levels which negatively affect juvenile physiology		Dewatering does not appear to affect water temperatures downstream. The water that went subsurface may actually return cooler. However, any juveniles stranded for extended periods in pools in the dewatered reach would likely suffer, if not die, from water temperatures that are too warm. Mechanism is present but probably not significant at the population level
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in this population area.
	Altered Flow Regimes	Not present for any life stage.	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. There are few or no lakeshore residences. Mechanism is not applicable
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures- Low flows increase water temperatures to unsuitable levels for successful spawning		Dewatering mentioned above does not appear to affect water temperatures downstream. The water that went subsurface may actually return cooler. Bull trout do not normally spawn below the dewatered reach unless they are denied access to higher quality habitat upstream
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access- Dry reaches limit access to FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality- Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		FMO habitat is in the lake. Mechanism is not applicable
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened		There are no irrigation diversions in juvenile rearing

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				irrigation diversions		habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable
	Grazing	Not present for any life stage	NA	NA		No livestock grazing occurs in the habitat for this population.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Approximately 6.8 miles of Gold Creek is accessible to spawners below a natural barrier. There is ample spawning habitat to support this population but a serious dewatering issue is present that limits access to spawning habitat.
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Rearing habitat is sufficient to support this population but dewatering mentioned above is a concern.
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Recreational dams occasionally observed are extremely unlikely to cause direct mortality to downstream migrants
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams occasionally observed are generally well downstream of spawning and rearing habitat and would not impede juvenile access to juvenile rearing habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Mining	Not present for any life stage	NA	NA		No mining operations or claims in population area.

Indian Creek

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
IN1	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Tieton Dam is impassable. Population is disconnected. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham)
IN2	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing but illegal angling for bull trout occurs, particularly near the mouth. Unknown impact but could be significant. Is also probable that some bull trout are caught in the lake (incidentally or illegally targeted)
IN3	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing but illegal angling for bull trout occurs, particularly near the mouth. Unknown impact but could be significant. Is also probable that some bull trout are caught in the lake (incidentally or illegally targeted)
IN4	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in stream and some hybridization with bull trout has been documented. Long-term impact of this threat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						could be significant
IN5	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
IN6	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
IN7	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
IN8	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
IN9	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in the stream. No data regarding impact on juvenile growth and condition as a result of competition. Unknown impact but could be moderately significant
IN10	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Field observations that there are rarely passage problems out of the lake (happened in 2001) but recreational dams have frequently been observed before and during spawning surveys near campground on lower creek. Impact is unknown but possibly moderately significant
IN11	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Non-angling harassment definitely possible due to proximity of Indian Creek campground to lower creek and motorcycle race on lake bed. Effects are unknown but could be moderately significant
IN12	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Is probable that some bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		Dewatering of intermittent reaches has been observed occasionally during extremely dry years. Unknown impact but not believed to be significant at the population level
	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO		Dewatering of intermittent reaches has been observed occasionally during extremely dry years. Unknown impact but not believed to be significant at the population

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				habitat		level
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout present are present in Rimrock Lake. No data regarding impact on growth and condition. Threat is believed to be insignificant
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality- Pre-spawn fish stranded in dewatered habitat		Dewatering mentioned above has been occasional. No carcasses of stranded adult fish have been observed in years of redd surveys. Possible impact but not likely significant at population level
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds dewatered		Dewatering has been occasional. No dewatered redds have been observed in years of surveys. Possible impact but not likely significant at population level
	Dewatering	Juvenile Rearing	Reduced growth and condition	Food shortage- Loss of aquatic invertebrate biomass in dewatered channel		Dewatering has been occasional. Stream rewaters with fall rains. Possibly some impact on invertebrate biomass but would not likely affect juvenile growth and condition at the population level
	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat- Reduced pool quantity and quality		Dewatering has been occasional. Probably some reduction in quantity and quality of pool habitat when it happens but not likely a significant impact at the reach level

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		Dewatering mentioned above has been occasional. No carcasses of stranded adult fish have been observed in years of redd surveys. Possible impact but not likely significant at population level
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size appears healthy (>50 redds per year) and recovered after an apparent crash (2001-2007) but the cause of that event is still unknown and the population may be vulnerable to a similar event in the future. Population is isolated behind Tieton Dam but connected to two other populations in the Rimrock Lake basin. Population not believed to be at significant risk of

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						extirpation
	Prey base	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Prey base	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Transportation	Pre/post spawning migrations	Habitat degradation	Road networks disconnect river from floodplain		Highway 12 crosses the lower end of Indian Creek. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Juvenile rearing	Habitat degradation	Road networks disconnect river from floodplain		Highway 12 crosses the lower end of Indian Creek. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Agricultural Practices	Not present for any life stage	NA	NA		No agricultural activities occur in this population area.
	Altered Flow Regimes	Not present for any life stage.	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality		Remotely possible that juvenile fish are occasionally caught but the impact would

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				caused by capture		be insignificant
	Development (residential and urbanization)	Not present for any life stage	NA	NA		Essentially no residential/urban development occurs in the habitat for this population.
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures- Low flows increase water temperatures to unsuitable levels for successful spawning		No natural dewatering of stream reaches has been observed that would significantly affect spawning water temperatures.
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		Dewatering has been occasional. Stream rewaters with fall rains. Habitat access limitations would be short-term and would not likely affect juvenile growth and condition at the population level
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality- Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		Dewatering has been occasional. Stream rewaters with fall rains. Decrease in habitat quality would be short-term and would not likely affect juvenile growth and condition at the population level
	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures- Low flows increase water temperatures to levels which negatively affect juvenile physiology		No natural dewatering of stream reaches has been observed that would significantly affect water temperatures

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		Dewatering has been occasional. Possibly some juvenile mortality as a result of stranding but never observed. Not likely a significant impact
	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access-Higher water temperatures resulting from low flows result in thermal barriers to migration		No natural dewatering of stream reaches has been observed that would significantly affect water temperatures downstream
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access-Dry reaches limit access to FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality-Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		FMO habitat is in the lake. Mechanism is not applicable
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable
	Grazing	Not present for any life stage.	NA	NA		No livestock grazing occurs in the habitat for this population.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Nearly five miles of Indian Creek is accessible to spawners below a natural barrier. There is ample spawning habitat to support this population
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Rearing habitat is sufficient to support this population (based on expert opinion)
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Recreational dams observed are extremely unlikely to cause direct mortality to downstream migrants
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams observed are generally well downstream of spawning and rearing habitat and would not impede juvenile access to juvenile rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss		No known problem based on observations during spawning surveys

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				of habitat complexity		
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		No known problem based on observations during spawning surveys
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No known problem based on observations during spawning surveys. Essentially no recreational use in juvenile rearing habitat that would result in habitat degradation
	Mining	Not present for any life stage	NA	NA		No mining operations or claims in this population area.

Kachess River

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
KA1	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is chronically low based on spawning surveys (<50 redds per year). Population is isolated behind impassable dam but connected to one other population. Population believed to be at significant risk of extirpation
KA2	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Kachess Dam is impassable. Population is disconnected. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham)
KA3	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		Population spawns later than any other population in basin because spawners are usually precluded from entering the stream until late October or early November. In some dry years they fail to show up at all when the delay extends later. The impact of this threat is believed to be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
KA4	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO habitat		Population spawns later than any other population in basin because spawners are usually precluded from entering the stream until late October or early November. In some dry years they fail to show up at all when the delay extends later. The impact of this threat is believed to be moderately significant. Not believed to be a problem for fish returning to lake when stream is reconnected
KA5	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing and difficult to access. Is possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
KA6	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Definitely possible that bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact but could be significant given the small size of this population
KA7	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is unknown but could be significant
KA8	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available and introduced kokanee population in lake is weak. Impact is unknown but

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						could be significant
KA9	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
KA10	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		No diversions on Kachess River. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.
KA11	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		FMO habitat is Kachess Lake. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.
KA12	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		FMO habitat is Kachess Lake. Entrainment through Kachess Dam possible but effects are unknown. Could be moderately significant given small population size.
KA13	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Small numbers of brook trout are present based on snorkel observations. Significance of threat is unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
KA14	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Small numbers of brook trout are present based on snorkel observations but no hybridization has been observed. Significance of threat is unknown
KA15	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Slightly less than two miles of spawning habitat is available below a natural barrier. Much of lower creek was inundated with construction of Kachess Dam in 1912. Spawning habitat availability does not appear to be limiting population at its current size (professional opinion).
	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing and difficult to access. Illegal angling for bull trout may occur but has not been documented. Unknown impact but probably not significant due to relative inaccessibility and time of year adult bull trout are present
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		FMO habitat is in Kachess Lake where brook trout are present in small numbers. Threat is unknown but believed to be insignificant
	Dewatering	Juvenile Rearing	Reduced growth and condition	Food shortage- Loss of aquatic invertebrate biomass in dewatered channel		Stream does not dewater above lower-most reach. Some loss of invertebrate biomass probable but not likely a significant impact on juvenile growth and condition at the population level
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Juvenile rearing habitat includes not only the Kachess River but potentially slightly more than half a mile of Mineral Creek. Doubtful that rearing habitat is limited. Spawning population is small based on annual redd counts
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Definite passage problem into stream from the lake but thought to be natural (see dewatering threat). Occasional recreational dams observed but effect not thought to be significant
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of		Recreational activities occur in the watershed but associated impacts are not

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				eggs in gravel		believed to be significant
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the watershed but associated impacts are not believed to be significant
	Agricultural Practices	Not present for any life stage.	NA	NA		No agricultural activities occur in population area.
	Altered Flow Regimes	Not present for any life stage.	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Not present for any life stage.	NA	NA		Essentially no residential/urban development occurs in the habitat for this population.
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures-Low flows increase water temperatures to unsuitable levels for successful spawning		Stream does not dewater above lower-most reach and population spawns late. Mechanism does not occur

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality- Pre-spawn fish stranded in dewatered habitat		Stream does not dewater above lower-most reach. Stranded adults have not been observed there. Mechanism does not occur
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds dewatered		Stream does not dewater above lower-most reach that fish don't spawn in. Mechanism does not occur
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		Stream does not dewater above lower-most reach. Mechanism does not occur
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality- Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		Stream does not dewater above lower-most reach. Mechanism does not occur
	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures- Low flows increase water temperatures to levels which negatively affect juvenile physiology		Stream does not dewater above lower-most reach. Mechanism does not occur
	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		Stream does not dewater above lower-most reach that is not rearing habitat. Mechanism does not occur
	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access- Higher water temperatures resulting from low flows result in thermal barriers to migration		No natural dewatering of stream reaches has been observed that would significantly affect water temperatures downstream

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat- Reduced pool quantity and quality		Stream does not dewater above lower-most reach that is not rearing habitat. Mechanism does not occur
	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		Stream does not dewater above lower-most reach. Stranded adults have not been observed there. Mechanism does not occur
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access- Dry reaches limit access to FMO habitat		FMO habitat is in the lake. Mechanism is not applicable
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality- Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		FMO habitat is in the lake. Mechanism is not applicable
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Grazing	Not present for any life stage.	NA	NA		No livestock grazing occurs in the habitat for this population.
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Recreational dams occasionally observed are extremely unlikely to cause direct mortality to downstream migrants
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams occasionally observed would not impede juvenile access to juvenile rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Transportation	Not present for any life stage	NA	NA		No paved road networks within population area.
	Mining	Not present for any life stage	NA	NA		No mining operations or claims within population area.

North Fork Tieton River

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
NFT1	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Tieton Dam is impassable this population is disconnected from fluvial populations below the dam. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham). Also, Fish passage past Clear Lake Dam is questionable. Denil fish ladder constructed in spillway channel is poorly designed and ineffective.
NFT2	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species occurs in the stream and the two lakes (Clear and Rimrock). Is definitely possible that bull trout are caught in the lakes (incidentally or illegally targeted) and in the stream as well, particularly in the reach directly below Clear Lake Dam. Unknown impact but could be significant given the apparent small size of this population

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
NFT3	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species occurs in the stream, particularly in the reach below Clear Lake Dam where migrating fish congregate. Illegal angling for bull trout has been known to occur in this reach and incidental catching of bull trout is possible both there and above Clear Lake. Unknown impact but could be significant given the apparent small size of this population
NFT4	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in stream and some hybridization with bull trout has been documented. Long-term impact of this threat could be significant
NFT5	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Fish passage past Clear Lake Dam is questionable. The Denil fish ladder constructed in spillway channel is poorly designed and ineffective. Passage via the spillway channel adjacent to this ladder, while apparently possible at some flows, is unreliable. While the effect on the population is unknown it is believed to be significant
NFT6	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Kokanee in lake don't solve this problem. Impact is unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
NFT7	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
NFT8	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
NFT9	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
NFT10	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in the stream. No data regarding impact on juvenile growth and condition as a result of competition. Unknown impact but could be moderately significant
NFT11	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake (presumably Rimrock). Is probable that some bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
NFT12	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data (but data very limited). The adult population size appears small. Population is isolated behind Tieton Dam but connected to two other populations in the Rimrock Lake basin. Risk of extirpation is hard to estimate
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout present are present in Rimrock and Clear Lakes. No data regarding impact on growth and condition. Threat is believed to be insignificant
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Clear Lake Dam is the only barrier to downstream migration. Bull trout are believed to use the spillway channel to return to Rimrock Lake. Effect on population is not believed to be significant. They can hang in Clear Lake until time is right

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is theoretically unknown but may be insignificant because of numbers of kokanee in lake
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No reports of non-angling harassment but mechanism is possible due to proximity of NF Tieton River to roads, the campground at Clear Lake Dam and dispersed camp sites upstream of Clear Lake. Impact not believed to be significant
	Agricultural Practices	Not present for any life stage.	NA	NA		No agricultural activities occur in the population area.
	Altered Flow Regimes	Not present for any life stage.	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Development (residential and urbanization)	Not present for any life stage.	NA	NA		Essentially no residential/urban development occurs in the habitat for this population.
	Dewatering	Not present for any life stage.	NA	NA		No natural dewatering of stream reaches has been observed that would preclude access to habitat.
	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		No natural dewatering of stream reaches that would strand migrating adults has been observed
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Spawning habitat is in wilderness where no logging occurs. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake (presumably Rimrock). Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake (presumably Rimrock). Mechanism is not applicable
	Grazing	Not present for any life stage.	NA	NA		No livestock grazing occurs in the habitat for this population.
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population		Fish spawn high in the subbasin. Based on field observations there are several miles of quality

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				could use		habitat below a natural barrier. Spawning population is relatively small base on redd counts conducted since 2004. No habitat limitations
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Rearing habitat is available in approximately nine miles of the NF above Clear Lake, more than sufficient to support this population
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		There are no artificial passage barriers that would limit access to juvenile spawning and rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Spawning habitat is relatively isolated far upstream of recreational activities
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Spawning habitat is relatively isolated far upstream of recreational activities
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is probably Rimrock Lake. Mechanism is not applicable

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities which would result in habitat degradation would be rare
	Transportation	Not present for any life stage	NA	NA		No paved road networks within population area.
	Mining	Not present for any life stage	NA	NA		No mining operations or claims within population area.

Rattlesnake Creek

	Severity:					
		Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
R1	Low Abundance	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is chronically low (25-50 redds per year) based on spawning surveys.
R2	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but likely significant
R3	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but likely significant
R4	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/survival	Decreased invertebrate biomass		Dearth of carcasses robs stream of marine-derived nutrients that drove invertebrate productivity. Impact is unknown but likely significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
R5	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the adult and subadult habitats for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take
R6	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the migration corridor for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take
R7	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the FMO habitat for this population. Illegal angling for bull trout may also occur (probably does to a limited extent). Unknown impact
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout are present in the Naches River but there are no data regarding competition. Threat believed to be insignificant due to the extent of habitat area available for this life stage
	Transportation	Pre/post spawning migrations	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 crosses the lower end of Rattlesnake Creek. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Transportation	Juvenile rearing	Habitat degradation	Road networks disconnect river from floodplain		Highway 410 crosses the lower end of Rattlesnake Creek. Impacts associated with this mechanism are unknown but believed to be insignificant.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton Dams. Threat present but not believed to significantly affect growth and condition by this mechanism
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Altered flows in FMO habitat are result of reservoir releases from Bumping and Tieton dams. Threat present but not believed to significantly affect growth and condition by this mechanism
	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		A few cabins in the low to mid reaches of the creek. Harassment of migrating fish is possible but not believed to be a significant threat
	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Residential development is present in FMO habitat but is not thought to cause significant habitat degradation considering the extent of FMO habitat
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Logging has occurred in the watershed. Not sure of future harvest plans. Impact from this threat does not appear to be significant at this time
	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low effective population size		Effective population size estimated based on annual redd counts. Adult population size is small to moderate but appears stable. Population's risk of extirpation is probably low due to it's connectivity to other fluvial populations
	Recreational Impacts	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		A couple of unscreened pump diversions remain but effects are not likely to be significant at reach level.
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in FMO habitat but are not thought to cause significant habitat degradation considering the extent of FMO habitat
	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Sheep grazing does occur along this river but is not believed to present a threat of harassment to migrating fish

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Grazing	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Sheep grazing occurs in the habitat for this life stage, but is not believed to be a significant threat.
	Agricultural Practices	Not present for any life stage.	NA	NA		No agricultural activities occur in population area.
	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Unnatural flow alterations of any kind do not occur in juvenile rearing habitat
	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Regulated flows (too high or low) restrict movement of fish		Threat is not present. High flows in lower Naches during flip-flop but pre-spawn bull trout are well upstream by the time they occur
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Essentially no residential/urban development occurs in the habitat for this life stage

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		No natural dewatering of stream reaches has been observed that would preclude access to spawning habitat. Could happen during severe drought years but would be rare otherwise
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures- Low flows increase water temperatures to unsuitable levels for successful spawning		No natural dewatering of stream reaches has been observed that would significantly affect spawning water temperatures. Could happen during severe drought years but would be rare otherwise
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality- Pre-spawn fish stranded in dewatered habitat		No natural dewatering of stream reaches that would strand pre-spawn fish has been observed. Could happen during severe drought years but would be rare otherwise
	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds dewatered		No natural dewatering of stream reaches has been observed that would dewater redds. Could happen during severe drought years but would be rare otherwise
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		No natural dewatering of stream reaches has been observed that would preclude juvenile habitat access. Could happen during severe drought years but would be rare otherwise

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality-Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		No natural dewatering of stream reaches has been observed that would significantly affect juvenile rearing habitat quality. Could happen during severe drought years but would be rare otherwise
	Dewatering	Juvenile Rearing	Reduced growth and condition	Food shortage-Loss of aquatic invertebrate biomass in dewatered channel		No natural dewatering of stream reaches has been observed that would significantly affect invertebrate biomass. Could happen during severe drought years but would be rare otherwise
	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures-Low flows increase water temperatures to levels which negatively affect juvenile physiology		No natural dewatering of stream reaches has been observed that would significantly affect water temperatures in juvenile rearing habitat. Could happen during severe drought years but would be rare otherwise
	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		No natural dewatering of stream reaches that would strand juvenile fish has been observed. Could happen during severe drought years but would be rare otherwise
	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO habitat		No natural dewatering of stream reaches has been observed that would limit movement of adult fish. Could happen during severe drought years but would be rare otherwise
	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access-Higher water temperatures resulting from low flows result in thermal		No natural dewatering of stream reaches has been observed that would significantly affect water temperatures and result in thermal barriers to migration.

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				barriers to migration		Could happen during severe drought years but would be rare otherwise
	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat- Reduced pool quantity and quality		No natural dewatering of stream reaches has been observed that would significantly affect holding habitat quality. Could happen during severe drought years but would be rare otherwise
	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		No natural dewatering of stream reaches that would strand migrating adults has been observed. Could happen during severe drought years but would be rare otherwise
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		No natural dewatering of stream reaches that would strand adult fish has been observed
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access- Dry reaches limit access to FMO habitat		No natural dewatering of stream reaches has been observed that would limit access to FMO habitat
	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality- Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		No natural dewatering of stream reaches has been observed that would significantly affect FMO habitat quality
	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation		The potential for entrainment of adults is low in Rattlesnake Creek and would be highly unlikely in the FMO habitat for this population

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				diversions		
	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		The potential for entrainment into the two remaining unscreened pumps is low for this life stage.
	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Not an adfluvial population. No storage dam
	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Spawning habitat is in wilderness where no logging occurs. Mechanism is not applicable
	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		No livestock grazing occurs in the habitat for this life stage
	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		No livestock grazing occurs in the habitat for this life stage
	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Some livestock grazing occurs along the Naches River but habitat degradation significant at the reach scale is not believed to occur

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		No introduced species are present in the habitat for this life stage based on snorkel and electrofishing data
	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		No introduced species are present in the habitat for this life stage based on snorkel and electrofishing data
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Fish spawn high in the creek in the wilderness. No spawning habitat limitations based on field observations
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Rattlesnake Creek is over 20 miles in length. Rearing habitat is more than sufficient to support this population
	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Passage problems of any kind have not been observed
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Passage problems of any kind have not been observed
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Passage problems of any kind have not been observed

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		There are no artificial passage barriers that would limit access to juvenile spawning and rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		There are no artificial passage barriers that would limit access to FMO habitat
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		There are no recreational activities that would result in habitat degradation where fish spawn. The area can only be accessed by trail and is in the Wilderness Area.
	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Spawning area is remote and far removed from recreationists other than an occasional backpacker or hunter
	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No reports of non-angling harassment. Most of the river is remote and access is difficult
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		There are no recreational activities that would result in degradation of juvenile rearing habitat.
	Mining	Not present for any life stage.	NA	NA		No mining operations or claims in population area.

South Fork Tieton River

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
SFT1	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Tieton Dam is impassable. Population is disconnected. Genetic diversity is not particularly low (Reiss, Small) but for long-term sustainability better to have gene flow (Rieman, Dunham).
SFT2	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		No anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Kokanee in lake don't solve this problem. Impact is unknown but could be significant
SFT3	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Stream is closed to fishing but illegal angling for bull trout occurs. The impact is unknown but could be moderately significant
SFT4	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Stream is closed to fishing but illegal angling for bull trout occurs. The impact is unknown but could be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
SFT5	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
SFT6	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
SFT7	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		Tieton Dam entrainment studies, hydro project salvage, and genetic studies all indicate that entrainment is occurring through Tieton Dam. The impacts on this population are unknown but could be moderately significant. There are no irrigation diversions on the creek
SFT8	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Some spawning takes place in proximity to campgrounds. Mechanism is possible but effects are unknown. Could be moderately significant
SFT9	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		No direct reports of non-angling harassment but is definitely possible due to proximity of SF Tieton to roads and campgrounds. Several campsites located adjacent to prime holding pools. Believed to have moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						impacts
SFT10	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Bull trout are believed to be migrating upstream while cattle still have access to the stream (before August 15). Impact from this mechanism is unknown but probably not significant
SFT11	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Grazing allotment in watershed cut from 398 cow/calf pairs to 248 in 2010. Cattle excluded after August 15 in pastures adjacent to river since 2006 but not always a timely removal. Threat is still present and may be moderately significant if cattle exclusion is not maintained.
SFT12	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		If regulations cited above are not followed, cattle may be present adjacent to the stream when spawning occurs.
SFT13	Grazing	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Cattle have access to the stream from spring to late summer. Significant degradation of juvenile habitat is possible.
SFT14	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		FMO habitat is in the lake. Is probable that some bull trout are caught in the lake (incidentally or illegally targeted). Unknown impact

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
SFT15	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging occurs in the watershed. Roads are possible sediment source but impact unknown. High risk for catastrophic wild fire due to extensive spruce budworm kill
SFT16	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging occurs in the watershed. Roads are sediment source but impact unknown. High risk for catastrophic wild fire due to extensive spruce budworm kill
SFT17	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in the stream. No data regarding impact on juvenile growth and condition. Unknown impact
SFT18	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in stream. Genetic analyses to date do not indicate that hybridization is occurring. Significance of the threat is unknown
SFT19	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		By the time post-spawn bull trout return to the lake a waterfall has formed at the mouth of the South Fork. Fish must spill over it. Effect on population is unknown but some mortality is possible
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout present are present in Rimrock Lake. No data regarding impact on growth and condition. Threat is believed to be insignificant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Population size estimated based on spawning survey data. The adult population size is large and stable (>50 redds per year). Population is isolated behind Dam but connected to two other populations in the Rimrock Lake basin. Substantial risk of catastrophic wildfire in the spawning/rearing watershed. Barring such a catastrophic event the risk of extirpation is low
	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is unknown but may be insignificant because of numbers of kokanee in lake
	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish excluded from streams above impassable dam. Juvenile anadromous salmonid prey not available but introduced kokanee population in lake is healthy. Impact is unknown but may be insignificant because of numbers of kokanee in lake
	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		No known problem based on observations during spawning surveys. Much of spawning habitat is difficult to access. Recreational Impacts on habitat quality probably occur in more accessible areas but impacts thought to be insignificant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational Impacts on habitat quality probably occur in areas near campgrounds but impacts thought to be insignificant
	Agricultural Practices	Not present for any life stage.	NA	NA		No agricultural activities occur in population area.
	Altered Flow Regimes	Not present for any life stage.	NA	NA		FMO habitat is in the lake and unnatural flow manipulations do not occur in the stream.
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
	Development (residential and urbanization)	Not present for any life stage.	NA	NA		Essentially no residential/urban development occurs in the habitat for this population.
	Dewatering	Not present for any life stage.	NA	NA		No natural dewatering of stream reaches has been observed that would preclude access to habitat.
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		There are no irrigation diversions in juvenile rearing habitat
	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Unsuitably high water temperatures have not been observed in the stream in many years of redd surveys. Mechanism does not appear to be present

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		FMO habitat is in the lake. Mechanism is not applicable
	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Unsuitably high water temperatures have not been observed in the stream in many years of redd surveys. Mechanism does not appear to be present
	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		FMO habitat is in the lake. Mechanism is not applicable
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Over 14 miles of the SF Tieton is accessible to spawners below a natural barrier. This population is very healthy but there is ample spawning habitat to support it base on field observations
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Rearing habitat is sufficient to support this population
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		No problems for fish entering the stream from the lake as long as the reservoir pool is 127 KAF or more through mid-August (has not been below this level on this date since flip-flop was implemented in 1981).

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		There are no artificial passage barriers that would limit access to juvenile spawning and rearing habitat
	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Not applicable. FMO habitat is in the lake downstream
	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		FMO habitat is in the lake. Mechanism is not applicable
	Transportation	Not present for any life stage	NA	NA		No paved road networks within population area.
	Mining	Not present for any life stage	NA	NA		No mining operations or claims within population area.

Teanaway River

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T1	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low effective population size		Given very little success locating bull trout, this population appears to be on the brink of extirpation.
T2	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Summer flow reductions in lower reaches occur as a result of irrigation withdrawals. Impact on FMO habitat complexity is unknown but could be significant
T3	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Low summer flows physically restrict movement of fish and result in elevated water temperatures that function as thermal barriers to migration		Mechanism is documented and although recent actions have improved the condition to some extent negative impacts still exists and could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T4	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the adult and subadult habitats for this population. Illegal angling for bull trout may also occur but probably without success given that we rarely see a fish in the Teanaway River. Unknown impact from incidental or targeted take but would be significant if even one fish was taken
T5	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the migration corridor for this population. Illegal angling for bull trout may also occur but probably without success given that we rarely see a fish in the Teanaway River. Unknown impact from incidental or targeted take but would be significant if even one fish was taken
T6	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the FMO habitat for this population. Illegal angling for bull trout may also occur but probably without success given that we rarely see a fish in the Teanaway River. Unknown impact from incidental or targeted take but would be significant if even one fish was taken
T7	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T8	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is unknown but could be significant
T9	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		Dearth of anadromous carcasses robs stream of marine-derived nutrients that likely drove invertebrate productivity. Impact is unknown but could be significant
T10	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Moderate to heavy recreation near spawning habitat based on field observations and reports. Impact is unknown but could be significant
T11	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Moderate to heavy recreation near spawning habitat based on field observations and reports. Impact is unknown but could be significant
T12	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Moderate to heavy recreation occurs in the migration corridor. Impact is unknown but could be significant
T13	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Moderate to heavy recreation near spawning habitat based on field observations and reports. Impact is unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T14	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Moderate to heavy recreation near spawning habitat based on field observations and reports. Impact is unknown but could be significant
T15	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		There is considerable residential development (residential and urbanization) along the lower reaches of the Teanaway River. The impacts related to this mechanism are unknown but could be moderately significant
T16	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		There is considerable residential development (residential and urbanization) along the lower reaches of the Teanaway River. The impacts related to this mechanism are unknown but could be moderately significant
T17	Agricultural Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (chemical and high temps)		Limited agricultural activities are present lower in the river. Unknown impacts from this threat
T18	Agricultural Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		Limited agricultural activities are present lower in the river. Unknown impacts from this threat
T19	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging occurs in the watershed. High road densities are possible sediment source. Unknown impact. Hardly any adult bull trout ever observed

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T20	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging occurs in the watershed. High road densities are possible sediment source. Unknown impact. Hardly any bull trout ever observed
T21	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Logging occurs in the watershed. High road densities are possible sediment source. Unknown impact. Hardly any adult bull trout ever observed
T22	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Elevated water temperatures have been observed in FMO habitat. Could possibly be due in part from past forest management practices. Impact unknown. Hardly any adult bull trout ever observed
T23	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Depends on the extent of rearing habitat (can't find juveniles). If summer rearing habitat extends well downstream from spawning elevated water temperatures could be a problem. Unknown impact
T24	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Elevated water temperatures have been observed along the migration corridor. Could possibly be due in part from past forest management practices. Impact unknown. Hardly any adult bull trout ever observed
T25	Grazing	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Can't find redds and also can't find juveniles. Since we don't know where they are rearing it is difficult to assign a threat level so it is given an unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
T26	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Grazing impacts have diminished in recent years but mechanism still possible on AFR lands. Severity of the threat is unknown
T27	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Numbers of cattle have diminished in recent years but mechanism still possible on AFR lands. Severity of the threat is unknown
T28	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Numbers of cattle have diminished in recent years but mechanism still possible on AFR lands. Severity of the threat is unknown
	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		With the exception of Deroux Creek where there is no grazing no redds have been found elsewhere in this subbasin. Habitat degradation for this life stage resulting from this mechanism is unknown. If bull trout spawn where we think they should the threat would not likely be significant
	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		Brook trout are present in FMO habitat in small numbers. Threat believed to be insignificant due to the extent of habitat area available for this life stage
	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		Brook trout are present in stream in small numbers. No data on impacts to this life but believed to be insignificant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		Brook trout are present in stream. Genetic analyses to date do not indicate that hybridization is occurring. Significance of the threat is unknown but believed to be insignificant
	Mining	Spawning/egg incubation	Disruption of egg incubation due to mining gravels in stream	Mining disturbs instream gravels.		As very few redds have been positively identified in the Teanaway watershed, effects of this threat are unknown.
	Transportation	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Road networks disconnect river from floodplain		Highway parallels the mainstem Teanaway River. Impacts associated with this mechanism are unknown but believed to be insignificant.
	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		The potential for entrainment of subadults and adults into irrigation diversions in the NF Teanaway River is greatly diminished as a result of relatively recent actions but still possible, Impacts from this threat are not believed to be significant
	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		The potential for entrainment of juveniles into irrigation diversions in the NF Teanaway River is greatly diminished as a result of relatively recent actions but still possible, Impacts from this threat are not believed to be significant
	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		The potential for entrainment of subadults and adults into irrigation diversions in the NF Teanaway River is greatly diminished as a result of relatively recent actions but still possible, Impacts from this threat are not believed to be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners unable to reach spawning habitat or lack of gene flow		Passage problems associated with push-up berms in river either have been or will soon be rectified. Recreational dams occasionally observed. Effect not believed to be significant
	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Passage problems associated with push-up berms in river either have been or will soon be rectified. Recreational dams occasionally observed. Effect not believed to be significant
	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		No artificial downstream barriers exist
	Passage Barriers	Subadults/Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Recreational dams occasionally observed could possibly restrict habitat access short term for this life stage but not thought to be significant
	Agricultural Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		No agricultural activities occur in spawning habitat
	Agricultural Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		No agricultural activities occur in juvenile rearing habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		No reservoirs in watershed. Flows in summer are lower not higher than desired because of irrigation manipulations
	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		No reservoirs in watershed. Flows in juvenile rearing habitat are not subject to manipulation
	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Very difficult, if not impossible, to find any juvenile fish so the threat would be rare
	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Essentially no residential/urban development occurs in the habitat for this life stage
	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Essentially no residential/urban development occurs in the habitat for this life stage
	Dewatering	Not present for any life stage.	NA	NA		No natural dewatering of stream reaches has been observed that would preclude

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
						access to habitat.
	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Not an adfluvial population. No storage dam
	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Potential spawning area is extensive and not limited. Only a handful of redds have been found over the years.
	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Extensive stream network with abundant rearing habitat, presently unused as far as we can tell
	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		There are no artificial passage barriers that would limit access to juvenile spawning and rearing habitat

Upper Yakima River

	Severity:	Present, significant impacts	Impacts unknown but could be significant or moderately significant (see justification/ supporting data)	Impacts unknown but not believed to be significant	Mechanism not present or extremely rare	
		Present, moderately significant impacts	Impacts unknown. No judgment as to potential significance	Present, not thought to be significant at reach or population level		

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY1	Introduced Species	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Competition for food and space		There is a strong population of brook trout in the presumed spawning and rearing reach for bull trout in the upper Yakima River
UY2	Introduced Species	Juvenile rearing	Reduced growth/condition	Competition for food and space		There is a strong population of brook trout in the presumed spawning and rearing reach for bull trout in the upper Yakima River
UY3	Introduced Species	Spawning/egg incubation	Decrease in fertility	Hybridization		There is a strong population of brook trout in the presumed spawning and rearing reach for bull trout in the upper Yakima River
UY4	Low Abundance (increased risk of extirpation)	Adult	Inability of population to maintain genetic health and/or recover from catastrophic events	Low population size		Given that we know very little about this population, but bull trout are extremely rare, this is a significant threat. Population is either on the brink of extirpation or this was not historically a local population.
UY5	Altered Flow Regimes	Juvenile Rearing	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of		This condition is a significant issue for this population. Impacts associated with this mechanism are unknown but could be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				prey		
UY6	Angling	Pre/post spawning migrations	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the migration corridor for this population. Illegal angling for bull trout may also occur. Unknown impact but would be significant if only a few fish were killed given the small size of this population
UY7	Angling	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Hooking or stress related mortality caused by capture		Legal angling for other species does occur in the FMO habitat for this population. Illegal angling for bull trout may also occur (probably does to a limited extent). Unknown impact but could be significant given the small size of this population
UY8	Development (residential and urbanization)	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Residential development is present in the spawning area. Impacts associated with this mechanism are unknown but could be moderately significant
UY9	Development (residential and urbanization)	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Residential development is present in the spawning area. Impacts associated with this mechanism are unknown but could be moderately significant
UY10	Development (residential and urbanization)	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Residential development is present in juvenile rearing habitat areas. Impacts associated with this mechanism are unknown but could be moderately significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY11	Passage Barriers	Juvenile rearing	Habitat availability/ access	Restrict access to suitable habitat		Passage for juvenile bull trout at Easton Diversion Dam is questionable. Impacts associated with this mechanism are unknown but could be moderately significant
UY12	Prey Base/ Nutrient Cycle	Spawning/egg incubation	Population productivity decreased	Reduced prey base results in smaller adults and less fecundity (fewer eggs in gravel)		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is theoretically unknown but likely significant
UY13	Prey Base/ Nutrient Cycle	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduced food availability results in poorer overall adult health		Anadromous fish runs severely depleted from historic levels. Juvenile anadromous salmonid prey is scarce or not available. Impact is theoretically unknown but likely significant
UY14	Prey Base/ Nutrient Cycle	Juvenile rearing	Reduced growth/condition/ survival	Decreased invertebrate biomass		Dearth of carcasses robs stream of marine-derived nutrients that drove invertebrate productivity. Impact is theoretically unknown but likely significant
UY15	Agricultural Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (chemical and high temps)		This mechanism would definitely affect bull trout in the lower river but it is not known to what extent this population resides there if at all. Impact is unknown
UY16	Agricultural Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		Agricultural impacts in the mainstem Yakima River are primarily restricted to the lower Yakima River below the city of Yakima. Impacts in the river above Yakima are unknown

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY17	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Reduction in habitat complexity (side channel habitat, pool frequency & depth, and habitat heterogeneity)		Heavily altered flows occur in FMO habitat as a result of reservoir operations (Keechelus, Kachess, Cle Elum). The impacts on habitat complexity for this life stage are unknown
UY18	Altered Flow Regimes	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Low winter flows, high summer flows reduce foraging efficiency and availability of prey		Heavily altered flows occur in FMO habitat as a result of reservoir operations (Keechelus, Kachess, Cle Elum). The impacts on foraging efficiency and availability of prey for this life stage are unknown
UY19	Angling	Spawning/egg incubation	Population productivity decreased	Removal of potential spawners by illegal angling		Legal angling for other species does occur in the adult and subadult habitats for this population. Illegal angling for bull trout may also occur. Unknown impact from incidental or targeted take
UY20	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Mortality caused by entrainment through unscreened outlet works of storage dams or irrigation diversions		No storage dams are present in FMO habitat. Very few unscreened diversions remain in the FMO habitat for this population. Impacts are unknown
UY21	Entrainment	Spawning/egg incubation	Population productivity decreased	Loss of potential spawners through unscreened outlet works of storage dams or unscreened irrigation diversions		No storage dams are present in FMO habitat. Very few unscreened diversions remain in the FMO habitat for this population. Impacts are unknown
UY22	Development (residential and urbanization)	Subadults/ Adults in FMO Habitat (includes resident	Habitat degradation	Sedimentation, loss of riparian cover and soil		Residential development and urban development is present in FMO habitat. The

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
		adults if present)		compaction, removal of LWD resulting in loss of habitat complexity		extent to which habitat is degraded on a reach scale is unknown but not believed to be significant
UY23	Development (residential and urbanization)	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Residential development and urban development is present in FMO habitat. The effects of this mechanism on migrating fish are unknown but not believed to be significant
UY24	Forest Management Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant
UY25	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant
UY26	Forest Management Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant
UY27	Forest Management Practices	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Impaired water quality (high water temperatures)		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant
UY28	Forest Management Practices	Juvenile Rearing	Reduced growth/condition	Impaired water quality (high water temperatures)		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY29	Forest Management Practices	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Impaired water quality (high water temperatures)		Extensive logging occurred in the upper Yakima River in the distant past. The legacy effects of these activities are unknown but not believed to be significant
UY30	Passage Barriers	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat availability/ access	Restrict access to suitable habitat		Fish passage facilities at mainstem diversion dams were designed for anadromous salmonids but likely are effective for adult bull trout as well. Impacts of this mechanism are unknown but not believed to be significant
UY31	Recreational Impacts	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Light recreational activities occur in the spawning habitat for this population. The impact on habitat quality is unknown but not believed to be significant
UY32	Recreational Impacts	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the mainstem Yakima River. The effects on this life stage are unknown but not believed to be significant
UY33	Recreational Impacts	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD resulting in loss of habitat complexity		Recreational activities occur in the mainstem Yakima River. The effects on this life stage are unknown but not believed to be significant
UY34	Passage Barriers	Spawning/egg incubation	Population productivity decreased	At population level reduced because potential spawners		Fish passage facilities at mainstem diversion dams were designed for anadromous salmonids but likely are effective for adult

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				unable to reach spawning habitat or lack of gene flow		bull trout as well. Impacts of this mechanism are unknown but not believed to be significant
UY35	Passage Barriers	Pre/post spawning migrations	Habitat availability/ access	Spawners unable to reach spawning habitat and/or return to FMO habitat		Diversion dams in the mainstem Yakima River, though designed for anadromous salmonids, are believed to be effective in passing bull trout as well. Mechanism is present but the effects are not thought to be significant
UY36	Passage Barriers	Pre/post spawning migrations	Direct mortality	Impingement or blunt trauma during downstream migration		Possible that this mechanism could occur at Easton Diversion Dam but unlikely
UY37	Recreational Impacts	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Light recreational activities occur in the spawning habitat for this population but the impact through this mechanism is not believed to be significant
UY38	Recreational Impacts	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Recreational activities occur in the mainstem Yakima River. The effects on this life stage are not believed to be significant
UY39	Agricultural Practices	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction, removal of LWD, loss of instream complexity		No agricultural activities occur in the spawning habitat for this population
UY40	Agricultural Practices	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction,		No agricultural activities occur in juvenile rearing habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				removal of LWD, loss of instream complexity		
UY41	Altered Flow Regimes	Pre/post spawning migrations	Habitat availability/ access	Low summer flows physically restrict movement of fish and result in elevated water temperatures that function as thermal barriers to migration		Low summer flows is the opposite of what this population experiences
UY42	Angling	Juvenile rearing	Direct mortality	Hooking or stress related mortality caused by capture		Remotely possible that juvenile fish are occasionally caught but the impact would be insignificant
UY43	Dewatering	Spawning/egg incubation	Population Productivity decreased	Habitat access- Dry reaches preclude access to spawning habitat upstream		Dewatering does not occur in the spawning area for this population
UY44	Dewatering	Spawning/egg incubation	Population Productivity decreased	Water temperatures- Low flows increase water temperatures to unsuitable levels for successful spawning		Dewatering does not occur in the spawning area for this population
UY45	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality- Pre-spawn fish stranded in dewatered habitat		Dewatering does not occur in the spawning area for this population
UY46	Dewatering	Spawning/egg incubation	Population Productivity decreased	Direct mortality (eggs)- Redds		Dewatering does not occur in the spawning area for this

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
				dewatered		population
UY47	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat access- Dry reaches limit access to rearing habitat		Dewatering does not occur in the juvenile rearing area for this population
UY48	Dewatering	Juvenile Rearing	Reduced growth and condition	Habitat quality- Suitable rearing habitat dried up or loss of complexity (e.g. pools, side channels)		Dewatering does not occur in the juvenile rearing area for this population
UY49	Dewatering	Juvenile Rearing	Reduced growth and condition	Food shortage- Loss of aquatic invertebrate biomass in dewatered channel		Dewatering does not occur in the juvenile rearing area for this population
UY50	Dewatering	Juvenile Rearing	Reduced growth and condition	Water temperatures- Low flows increase water temperatures to levels which negatively affect juvenile physiology		Dewatering does not occur in the juvenile rearing area for this population
UY51	Dewatering	Juvenile Rearing	Direct mortality	Juvenile fish stranded in dewatered habitat		Dewatering does not occur in the juvenile rearing area for this population
UY52	Dewatering	Pre/post spawning migrations	Habitat access	Spawners unable to physically reach spawning habitat and/or return to FMO habitat		Dewatering does not occur anywhere in the Yakima River

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY53	Dewatering	Pre/post spawning migrations	Habitat access	Habitat access- Higher water temperatures resulting from low flows result in thermal barriers to migration		Dewatering does not occur anywhere in the Yakima River
UY54	Dewatering	Pre/post spawning migrations	Habitat quality	Holding habitat- Reduced pool quantity and quality		Dewatering does not occur anywhere in the Yakima River
UY55	Dewatering	Pre/post spawning migrations	Direct mortality	Pre- and/or post-spawn fish stranded in dewatered migration reaches		Dewatering does not occur anywhere in the Yakima River
UY56	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Direct mortality	Fish stranded in dewatered FMO habitat		Dewatering does not occur anywhere in the Yakima River
UY57	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat access- Dry reaches limit access to FMO habitat		Dewatering does not occur anywhere in the Yakima River
UY58	Dewatering	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Reduced growth/condition	Habitat quality- Suitable FMO habitat dried up or loss of complexity (e.g. pools, side channels)		Dewatering does not occur anywhere in the Yakima River
UY59	Entrainment	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Isolated from natal population	Entrainment through unscreened outlet works of storage dam. No upstream passage back to lake		Not an adfluvial population. No storage dams are present in FMO habitat

#	Threat	Life Stage	Effect	Mechanism	Severity	Justification/Supporting Data (JSD)
UY60	Entrainment	Juvenile rearing	Direct mortality	Loss of juveniles through unscreened irrigation diversions		No unscreened diversions occur in the presumed juvenile rearing area for this population. The mechanism is not present for this life stage
UY61	Grazing	Juvenile Rearing	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Livestock grazing does not occur in the spawning or juvenile rearing areas for this population
UY62	Grazing	Subadults/ Adults in FMO Habitat (includes resident adults if present)	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Livestock grazing is very limited along the mainstem Yakima River. The mechanism is not present
UY63	Grazing	Pre/post spawning migrations	Increase stress/reduced condition/possible direct mortality	Harassment (intentional or inadvertent)		Livestock grazing is very limited along the mainstem Yakima River. The mechanism is not present
UY64	Grazing	Spawning/egg incubation	Population productivity decreased	Stressed fish and/or direct mortality of eggs in gravel		Livestock grazing does not occur in the spawning or juvenile rearing areas for this population
UY65	Grazing	Spawning/egg incubation	Habitat degradation	Sedimentation, loss of riparian cover and soil compaction		Livestock grazing does not occur in the spawning or juvenile rearing areas for this population
UY66	Limited Extent of Habitat	Spawning/egg incubation	Population productivity limited	Less available spawning habitat than population could use		Spawning habitat is abundant in the upper Yakima River
UY67	Limited Extent of Habitat	Juvenile Rearing/resident adults	Reduced growth/condition	Insufficient rearing habitat leading to intraspecific competition for food and space		Juvenile rearing habitat is abundant in the upper Yakima River

APPENDIX F: Fishing Regulation History for Each Population

Ahtanum Creek

Fishing regulations have been implemented to specifically protect bull trout populations in the Ahtanum drainage. Restrictive fishing regulations for bull trout began in 1986 with a one fish catch limit and an 8-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Starting in 1992 fishing for bull trout in the Ahtanum Creek drainage has been prohibited (part of a statewide closure). Sections of the North Fork have been closed to fishing since in 1998 and the Middle Fork since 2010 to protect spawning and rearing bull trout. Also, beginning in 1998 the use of bait and barbed treble hooks has been prohibited in the North and Middle Forks of Ahtanum Creek, thereby reducing the mortality rate of released bull trout.

American River

Fishing regulations have been implemented specifically to protect bull trout populations in the American drainage. Restrictive fishing regulations for bull trout began in 1986 with a one fish catch limit and an 8-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Starting in 1992 fishing for bull trout in the American River and tributaries has been prohibited (part of a statewide closure). Beginning in 1998 there has been a total fishing season closure on a section of Union Creek to protect spawning and early-rearing bull trout. Since 2007 a section of the American River has been closed from July 16-Sept. 15 to protect staging and spawning bull trout. Also, since 1998 the use of bait and barbed treble hooks has been prohibited in the Naches, Little Naches, Bumping and American rivers (including the Rainier Fork) and in Cowiche Creek, thereby reducing the mortality rate of released bull trout.

Kachess Lake, Box Canyon Creek, and Kachess River

Fishing regulations have been implemented specifically to protect bull trout populations in Box Canyon Creek. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and 20-inch minimum size limit for fish caught in Kachess Reservoir and six inches for fish caught in tributary streams. In 1986 the minimum size limit was increased statewide to eight inches in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Since 1987 fishing for bull trout has been prohibited in Kachess Lake. In addition, there has been a total fishing season closure on sections of Box Canyon Creek since 1990. Since 2008 the Box Canyon Creek fishing closure has included that part of the creek flowing through the dry Kachess Reservoir lakebed.

Fishing regulations have been implemented specifically to protect bull trout populations in Kachess Lake and Kachess River. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and a 20-inch minimum size limit for fish caught in the lake and six inches for fish caught in streams. In 1986 the minimum size limit was increased to eight inches in streams and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. Since 1987 fishing for bull trout has been prohibited in

Kachess Lake. There has been a total fishing season closure on sections of the Kachess River and Mineral Creek since 1990 to protect spawning and early-rearing bull trout.

Bumping Lake and Deep Creek

Fishing regulations have been implemented specifically to protect bull trout populations in Bumping Reservoir and Deep Creek. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and 20-inch minimum size limit for fish caught in the lake and six inches for fish caught in tributary streams. In 1986 the minimum size limit was increased to eight inches in streams, and fishing for bull trout in Bumping Reservoir and tributary streams was closed from August 15 to September 30 to protect spawning fish. Since 1992 fishing for bull trout has been prohibited in the Bumping Lake drainage (part of a statewide closure). Also, since 1998 the use of bait and barbed treble hooks has been prohibited in the Bumping River downstream of the reservoir.

Fishing regulations have been implemented specifically to protect bull trout populations in Deep Creek. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and 20-inch minimum size limit for fish caught in the Bumping Lake and six inches for fish caught in tributary streams. In 1986 the minimum size limit was increased to eight inches in streams, and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. Beginning in 1992 fishing for bull trout was prohibited in the Bumping Lake drainage (part of a statewide closure). In addition, there has been a total fishing season closure in a section of Deep Creek since 1995 to protect spawning and rearing bull trout.

Cle Elum/Waptus Rivers

Fishing regulations have been implemented specifically to protect bull trout populations in the Cle Elum/Waptus drainage. Restrictive fishing regulations for bull trout/Dolly Varden began in 1984 with a one-fish catch limit and 20-inch minimum size limit for fish caught in Cle Elum Lake. More restrictive fishing regulations for bull trout began in 1986 with a one fish catch limit and an 8-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 in lakes and streams to protect spawning fish. Starting in 1992 fishing for bull trout in the Cle Elum River and tributaries has been prohibited (part of a statewide closure). Also, since 2002 the use of bait and barbed treble hooks has been prohibited in the upper Cle Elum River.

Crow Creek

Fishing regulations have been implemented specifically to protect bull trout populations in Crow Creek. Restrictive fishing regulations for bull trout began in 1986 with a one fish catch limit and an 8 inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Since 1992 fishing for bull trout in the Crow Creek drainage has been prohibited (part of a statewide closure).

Keechelus Lake and Gold Creek

Fishing regulations have been implemented specifically to protect bull trout populations in Gold Creek. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and a 20-inch minimum size limit for fish caught in the lake and six inches for fish caught in streams. In 1986 the minimum size limit was increased to eight inches in streams and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. Since 1987 fishing for bull trout was prohibited in Keechelus Lake. In addition, there has been a total fishing season closure on Gold Creek since 1990 to protect spawning and rearing bull trout.

Rimrock Lake and Indian Creek fishing regulations have been implemented specifically to protect bull trout populations in Indian Creek. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and a 20-inch minimum size limit for fish caught in the lake and six inches for fish caught in streams. In 1986 the minimum size limit was increased to eight inches in streams and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. In addition, there have been total fishing season closures on Indian Creek since 1990 to protect spawning and rearing bull trout. In 1992 fishing for bull trout was prohibited (part of a statewide closure). Since 2008 the Indian Creek fishing closure has included that part of the creek flowing through the dry Rimrock Reservoir lakebed.

North Fork Tieton River

Fishing regulations have been implemented specifically to protect bull trout populations in the North Fork Tieton River. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and a 20-inch minimum size limit for fish caught in Rimrock Reservoir and six inches for fish caught in streams. In 1986 the minimum size limit was increased to eight inches in streams and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. In 1992 fishing for bull trout was prohibited (part of a statewide closure. Since 2008 the North Fork Tieton River has been closed to fishing after August 15, including the river below Clear Lake that flow in the dry lake bed (Rimrock Reservoir).

South Fork Tieton River

Fishing regulations have been implemented specifically to protect bull trout populations in the South Fork Tieton River. Restrictive fishing regulations for bull trout began in 1984 with a one-fish catch limit and a 20-inch minimum size limit for fish caught in Rimrock Reservoir and six inches for fish caught in streams. In 1986 the minimum size limit was increased to eight inches in streams and fishing for bull trout in lakes and streams was closed from August 15 to September 30 to protect spawning fish. In 1992 fishing for bull trout was prohibited (part of a statewide closure). In addition, there has been a total fishing season closure on South Fork Tieton River since 1995. Since 1998 a section of Bear Creek (a tributary to the South Fork) has been closed to fishing.

Rattlesnake Creek

Fishing regulations have been implemented specifically to protect the bull trout population in Rattlesnake Creek. Restrictive fishing regulations for bull trout began in 1986 with a one-fish catch limit and an eight-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Catch-and-release regulations were implemented in 1990 on Rattlesnake Creek.

North Fork Teanaway River/DeRoux Creek

Fishing regulations have been implemented specifically to protect bull trout populations in the Teanaway drainage. Restrictive fishing regulations for bull trout began in 1986 with a one-fish catch limit and an eight-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. In 1992 fishing for bull trout was prohibited in the Teanaway drainage. Beginning in 1998 the use of bait and barbed treble hooks has been prohibited in the Teanaway River, North Fork Teanaway River and DeRoux Creek to reduce hooking mortality of released fish. Part of the North Fork Teanaway River has been closed to all fishing since 2008. Also starting in 2008, the Teanaway River and that part of the North Fork Teanaway River open to fishing have been restricted to catch-and-release fishing for trout.

Upper Yakima River

Fishing regulations have been implemented specifically to protect bull trout populations in the upper Yakima River. Restrictive fishing regulations for bull trout began in 1986 with a one-fish catch limit and an eight-inch minimum size limit in streams. Additionally, fishing for bull trout was prohibited from August 15 to September 30 to protect spawning fish. Beginning in 1992 fishing for bull trout was prohibited in the Yakima River drainage (part of a statewide closure). Since 1990 the use of bait and barbed treble hooks has been prohibited in the upper Yakima River (from Roza Dam to Keechelus Dam), thereby reducing the mortality rate of released bull trout. In addition, since 1990 the upper Yakima River has been open year round for catch-and-release trout fishing.

APPENDIX G: KEY MEETINGS DURING PLAN DEVELOPMENT

December 14, 2010, 1-4 PM: Meeting of the bull trout informal working group
Convened by the Yakima Basin Fish and Wildlife Recovery Board and the U.S. Fish and Wildlife Service

YBTAP on the agenda: Presented template, discussed purpose of the plan and updates on ongoing bull trout projects

Meeting location: YBFWRB office, 1110 W Lincoln Ave, Yakima, WA

Participants:
Yuki Reiss, Alex Conley (YBFWRB)
Jeff Thomas, Judy delaVergne, Pat Monk, Richard Visser (USFWS)
Eric Anderson, Jim Cummins, William Meyer (WDFW)
Sean Gross (NOAA)
David Child (Yakima Basin Joint Board)
Arden Thomas (BOR)

March 31, 2011, 9 AM-3 PM: Meeting of the bull trout informal working group
Convened by the Yakima Basin Fish and Wildlife Recovery Board and the U.S. Fish and Wildlife Service

YBTAP on the agenda: Review draft of YBTAP including Threats Analysis and prioritization of actions

Meeting location: YBFWRB office, 1110 W Lincoln Ave, Yakima, WA

Participants:
Yuki Reiss (YBFWRB)
Jeff Thomas, Judy delaVergne (USFWS)
Eric Anderson, Jim Cummins (WDFW)
Sean Gross (NOAA)
David Child (Yakima Basin Joint Board)
Arden Thomas (BOR)
Jim Matthews, Tim Resseguie (Yakama Nation)
Gary Torretta, Tina Mayo (U.S. Forest Service)

December 13, 2011, 9 AM-12 PM: Meeting of the bull trout informal working group
Convened by the Yakima Basin Fish and Wildlife Recovery Board and the U.S. Fish and Wildlife Service

YBTAP on the agenda: Review of controversial proposed actions, discussion of passage at dams, and updates on bull trout projects
Meeting location: YBFWRB office, 1110 W Lincoln Ave, Yakima, WA

Participants:
Yuki Reiss, Alex Conley (YBFWRB)

Jeff Thomas, Richard Visser, Pat Monk (USFWS)
Eric Anderson, William Meyer, John Easterbrooks (WDFW)
David Child (Yakima Basin Joint Board)
Arden Thomas (BOR)
Tim Resseguie, Dave Fast (Yakama Nation)
KC Briggs (U.S. Forest Service)

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