



**An Abstracted Bibliography of  
Bull Trout Studies in the  
Upper Mid-Columbia Recovery Unit  
2000 - 2014**

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Mark C. Nelson and Rebecca Christopherson, editors

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***On the cover:** A gravid female adult migratory bull trout (estimated 650 mm TL) in Early Winters Creek of the Methow Core Area, July 26, 2007. USFWS photograph by Mark C. Nelson.*

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AN ABSTRACTED BIBLIOGRAPHY OF  
BULL TROUT STUDIES IN THE  
UPPER MID-COLUMBIA RECOVERY UNIT  
2000 - 2014

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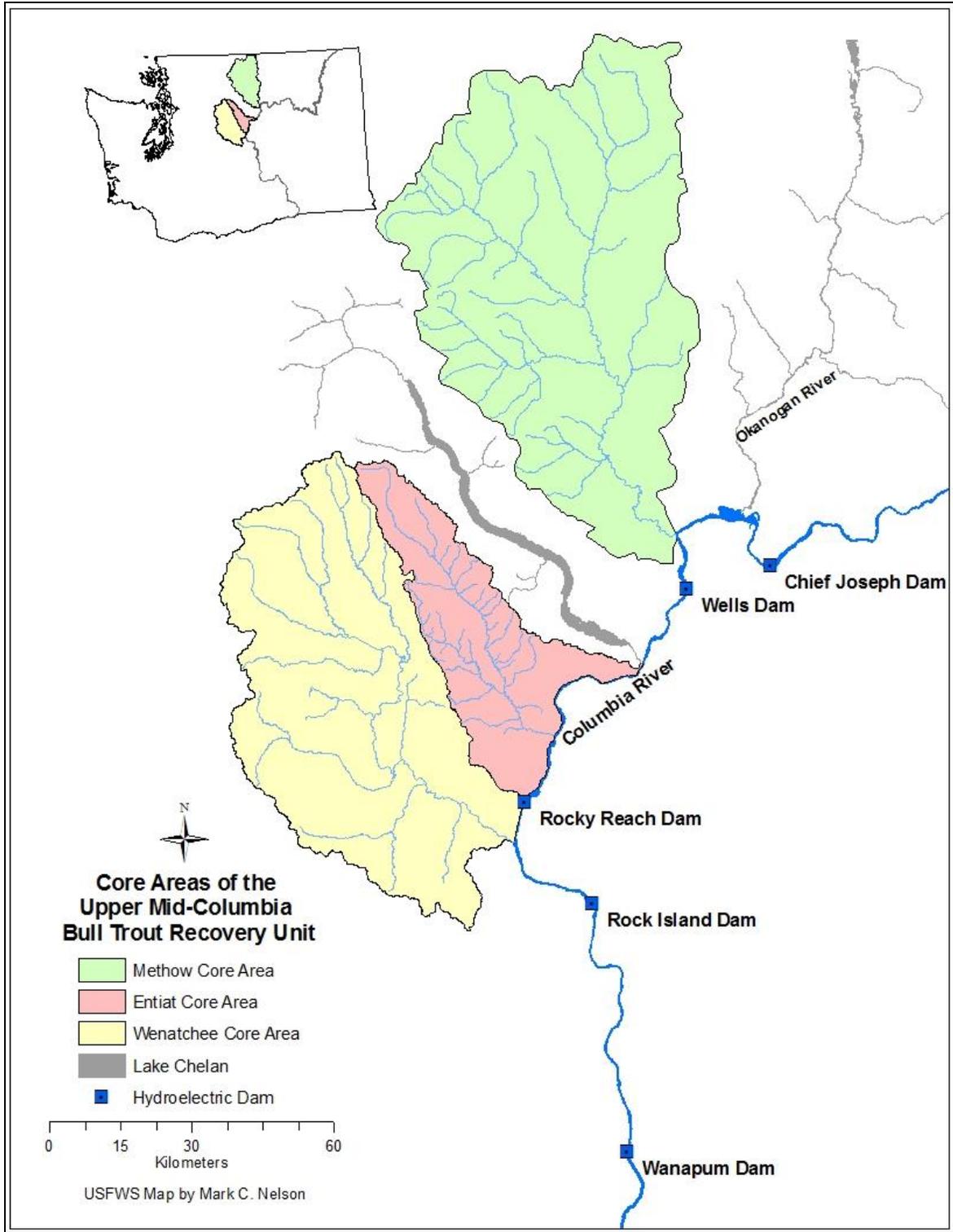
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## Introduction

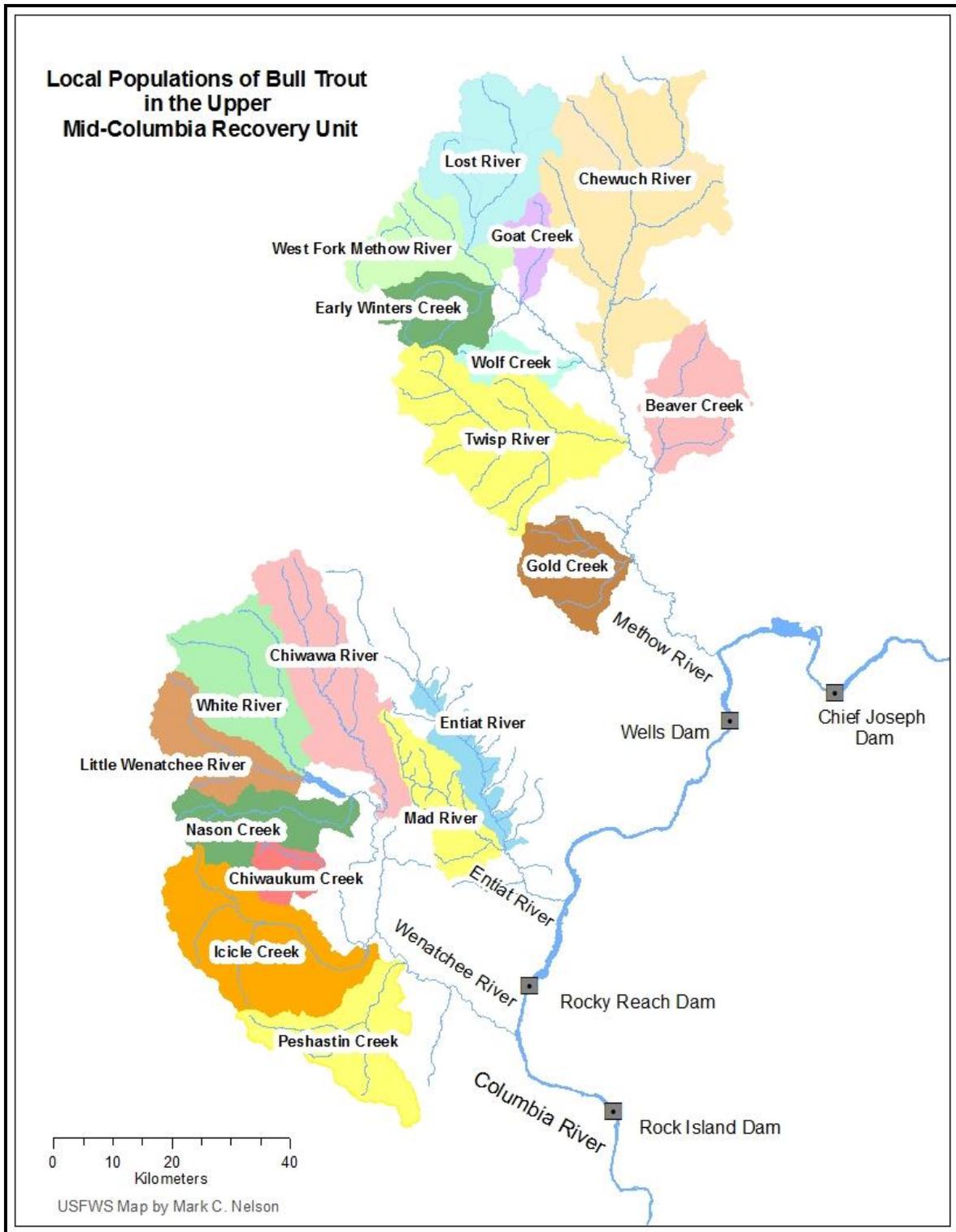
This bibliography is designed as a guide for biologists and managers seeking information on bull trout *Salvelinus confluentus* in the draft upper Mid-Columbia Recovery Unit (Figures 1 and 2). Several study reports on adult bull trout movements, habitat use, and life histories have been released by various agencies since bull trout were listed as threatened in 1999. These grey literature reports may be difficult to locate or retrieve under the different library or archival systems used by each agency. Providing ready access to the available information will help promote understanding of local bull trout life histories and assist collaborative efforts towards recovery of bull trout. To simplify that process, this bibliography reproduces the abstracts, executive summaries, or conclusions from radio-telemetry and associated reports conducted in the upper Mid-Columbia Recovery Unit during 2000 to 2014. The study reports were conducted or funded by the USFWS Mid-Columbia Fishery Resource Office, USFWS Abernathy Fish Technology Center, USFWS Central Washington Field Office, Public Utility District No. 1 of Chelan County, Public Utility District No. 1 of Douglas County, and Public Utility District No. 2 of Grant County.

The report abstracts in this bibliography are organized by the Entiat (Figure 3), Wenatchee (Figure 4), and Methow (Figure 5) core areas and critical habitat in the upper Mid-Columbia River (Figure 6). A section on genetic analyses of local bull trout population structure and identification, pertinent to the entire upper Mid-Columbia Recovery Unit, is included. Each Core Area section contains a map of the local populations to orient the reader. To simplify navigation within the guide, the Table of Contents contains clickable links to each abstract or summary. A Recommended Citations list with hyperlinks to online digital copies of each entire report is included at the end of the document.

It should be noted that several study reports may deal with overlapping information, such as telemetry data for an individual fish being used to report on various aspects of bull trout movements and life histories throughout the year. Consequently, PUD reports may detail information on movements through and between dams in the Columbia River while a USFWS report may have information for the same bull trout on tributary use and movements. A final multi-agency report synthesizing the complexity of bull trout migration patterns documented by telemetry in the Recovery Unit is needed. This abstracted bibliography aims to temporarily fill that need by introducing biologists and managers to the research and information that is currently available.



**Figure 1. Map of the draft upper Mid-Columbia Bull Trout Recovery Unit showing the Entiat, Methow, and Wenatchee Core Areas.**



**Figure 2. Map of all local populations of bull trout in the Wenatchee, Entiat, and Methow core areas of the draft Upper Mid-Columbia Bull Trout Recovery Unit.**

**GENETICS OF THE  
UPPER MID-COLUMBIA RECOVERY UNIT**



**An adult migratory bull trout holding in Box Canyon on the Entiat River.**  
*USFWS photograph by Dan Sulak.*

# ANALYSIS OF GENETIC VARIATION WITHIN AND AMONG UPPER COLUMBIA RIVER BULL TROUT POPULATIONS

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*Summary*<sup>1</sup> - The objective of our study was to conduct a more thorough sampling of local bull trout populations in each of the Upper Columbia River sub-basins and then conduct a fine-scale analysis of genetic variation within the Upper Columbia Basin. We wished to examine levels of genetic diversity within local bull trout populations as well as the level of genetic variation among local populations. Bull trout were collected from 18 of the 19 local populations within the Upper Columbia Basin; no samples were collected from the Little Wenatchee River. Individuals were genotyped at a suite of 16 microsatellite loci. We identified a total of 16 samples with hybrid bull x brook trout ancestry collected from five different tributaries. Individual bull trout were grouped for statistical analysis according to their local population of origin as defined in the draft USFWS bull trout recovery plan. Estimates of genetic variation within the different tributaries varied widely. The mean number of alleles per locus ranged from 5.20 in Lost River to 9.33 in the 2009 Early Winters sample; allelic richness ranged from 4.67 in Nason Creek to 7.92 in the 2009 Early Winters sample; expected heterozygosity was lowest in the 2010 Goat Creek sample ( $H_{exp} = 0.594$ ) and highest in Twisp River ( $H_{exp} = 0.740$ ); and observed heterozygosity was lowest in Beaver Creek ( $H_{obs} = 0.469$ ) and greatest in Mad River ( $H_{obs} = 0.731$ ). A permutation test showed there was no significant difference in the mean estimates of genetic diversity among the three different sub-basins ( $P > 0.05$ ), although the mean levels of variation were greatest in the Methow sub-basin. Three local populations, Peshastin Creek, Lake Creek, and Twisp River showed evidence of a recent genetic bottleneck (one-sided Wilcoxon test  $P < 0.05$ ). The overall level of genetic variation we observed among populations (Global  $F_{ST} = 0.174$ ; 95% C.I. = 0.150 – 0.204) suggests a high degree of genetic structuring among Upper Columbia River tributaries as well. Estimates of  $F_{ST}$  for the different sub-basins were 0.182 for the Wenatchee sub-basin, 0.121 for the Entiat sub-basin, and 0.142 for the Methow sub-basin. Similar to previous studies, we observed significant differences in allele frequencies among local populations, suggesting that the local populations we sampled represent genetically independent spawning populations. AMOVA analysis showed that 4.18% of the genetic variation observed was due to differences among the different sub-basins, 14.59% was due to differences among local populations within the different sub-basins, and the remaining 81.23% was due to differences among individuals within populations. Local populations from the same sub-basin generally grouped together on the NJ tree with a few exceptions: Peshastin Creek in the Wenatchee sub-basin grouped with tributaries from the Entiat sub-basin and the two Early Winters Creek collections grouped intermediate to the Wenatchee and Entiat sub-basins. Leave-one-out tests indicated high accuracy for assigning individuals to their population of origin as

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<sup>1</sup> The report does not contain an abstract or executive summary. This summary was assembled specifically for this guide by the editors and edited by P. DeHaan and J. Neibauer.

nearly all of the tributaries in our baseline data set had self-assignment success rates greater than 90%. The proportion of individuals “correctly” assigned to the tributary they were collected from in leave-one-out analysis ranged from 0.643 for the Beaver Creek collection in the Methow sub-basin to 1.0 for 11 different tributaries. “Incorrectly” assigned individuals were mostly assigned to another tributary within the same sub-basin as the collection location. Genetic assignments of bull trout collected outside of spawning areas suggest that maintaining migratory corridors is important for Upper Columbia River bull trout. Estimates of genetic variation in the local populations in this study were similar to, and in many cases greater than, the estimates observed for other Columbia River tributaries including the Lewis, Hood, Willamette, Deschutes, John Day, Walla Walla and Yakima rivers. These results indicate that the bull trout populations in the Upper Columbia Basin do not likely face an increased threat of extirpation due to low genetic diversity and reduced fitness. This information will be useful for further refining local population boundaries, prioritizing local populations for conservation measures, inferring levels of gene flow among local populations, and inferring patterns of movement within the basin.

FINE-SCALE POPULATION STRUCTURE ANALYSIS AND GENETIC POPULATION  
ASSIGNMENTS OF WENATCHEE RIVER SUB-BASIN BULL TROUT

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*Abstract-* Defining population boundaries are an important aspect of conservation planning for threatened and endangered species. The U.S. Fish and Wildlife Service currently designate seven local populations of bull trout within the Wenatchee River Sub-basin; some of which contain a single spawning tributary and others which are comprised of multiple spawning tributaries. In this study, we were interested to know if different tributaries within two designated local populations, Icicle Creek and Peshastin Creek, contained a single or multiple spawning populations of bull trout. We collected juvenile bull trout from French Creek and Jack Creek within the Icicle Creek watershed and Ingalls Creek and Etienne Creek within the Peshastin Creek watershed. Juvenile bull trout were genotyped at 15 microsatellite loci and we used a number of analysis methods to determine the number of genetically unique spawning populations in each watershed. Based on our data, we could not definitively conclude that Jack Creek and French Creek were independent populations. Data for Peshastin Creek were much more conclusive and suggested that Ingalls Creek and Etienne Creek were genetically independent populations. This information on population structure was then incorporated into a genetic baseline dataset previously developed for upper Columbia River bull trout and we used this information to conduct genetic population assignments for bull trout collected downstream of spawning areas in Icicle Creek and Peshastin Creek. Genetic assignments for fish collected in Icicle Creek suggest that individuals from a number of different local populations utilize habitat in lower Icicle Creek and that putative barriers in Icicle Creek downstream of the Boulder Falls do not preclude upstream movement. All bull trout collected above the Boulder Falls were assigned to Icicle Creek. Genetic assignments for bull trout collected in a rotary screw trap downstream of spawning tributaries in Peshastin Creek suggested that most migratory fish originated in Ingalls Creek and that fish in Etienne Creek primarily had a resident life history. Data from this study will be useful for refining population boundaries, targeting different populations for specific management actions, and evaluating the effects of different putative barriers on bull trout movements and migratory patterns.

## ENTIAT CORE AREA



**An adult migratory bull trout jumping in Box Canyon on the Entiat River.**  
*USFWS photograph by Robes Parrish.*

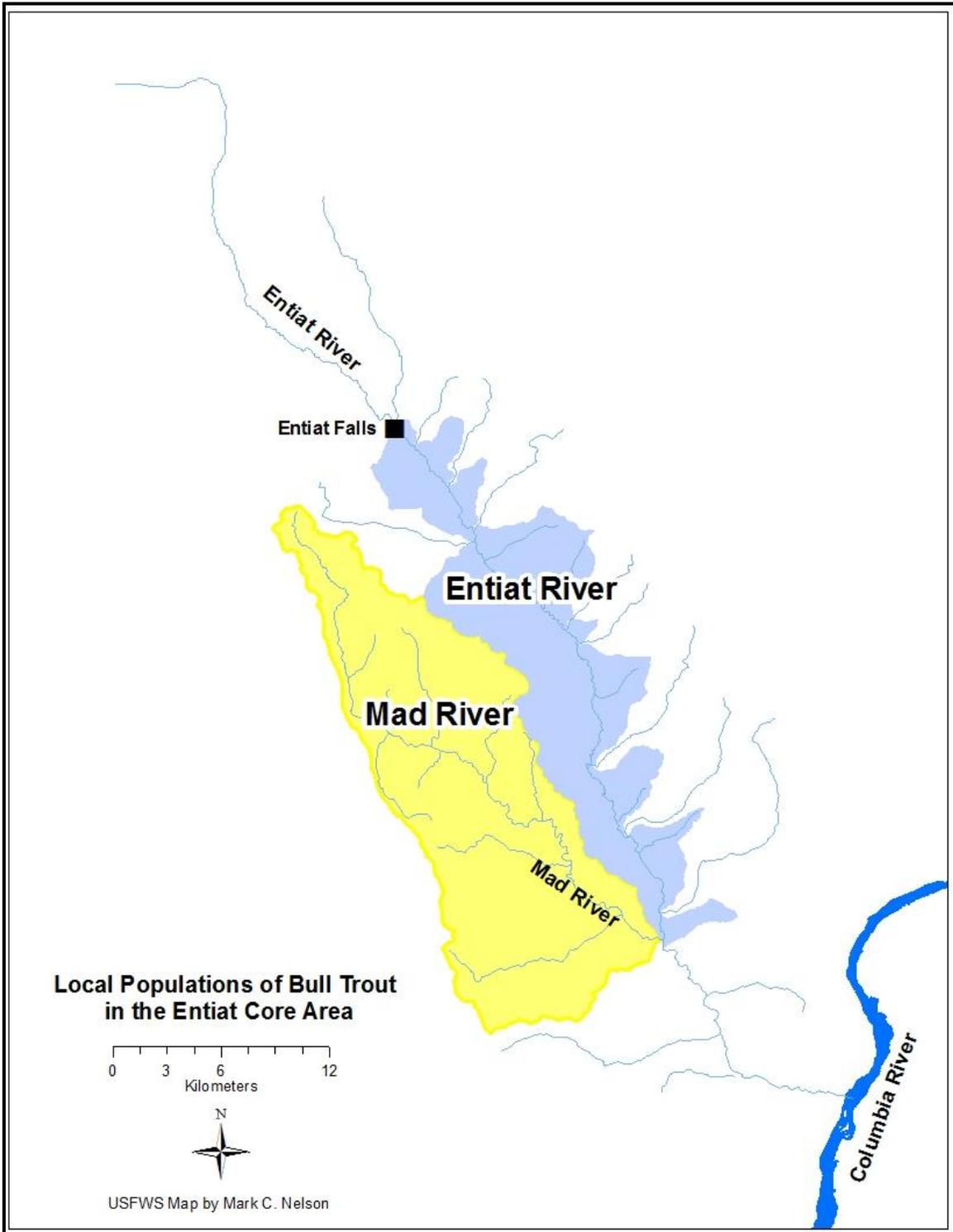


Figure 3. Map of local populations of bull trout in the Entiat Core Area.

## 2005 ENTIAT RIVER BULL TROUT SPAWNING GROUND SURVEYS

Mark C. Nelson and R.D. Nelle

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*Abstract-* In 2005, the Mid-Columbia River Fishery Resource Office (MCRFRO) conducted bull trout spawning ground surveys in the upper Entiat River. Radio-telemetry indicated that adult fluvial bull trout were staging on the spawning grounds downstream of the USFS index reach and that the extended surveys first conducted in 2004 were again warranted. Thirty-four bull trout redds were recorded by MCRFRO in Reaches A and B, and 16 redds were observed by USFS in the index reach, for a total of 50 redds. One spent female spring Chinook salmon and 8 spring Chinook salmon redds were also observed, the first documented spawning in the Entiat River upstream of Box Canyon and Fish Tail Falls (rkm 47.0). These observations indicate that Entiat Falls (rkm 54.5) should be considered the upper limit of anadromy in the Entiat River. Bull trout redds averaged 1.2 m<sup>2</sup> (1.6 m long x 0.7 m wide) and were oblong in shape (2.3 L/W ratio). Spring Chinook salmon redds averaged 7.0 m<sup>2</sup> (3.4 m long x 2.0 m wide) and more oval or circular in shape (1.7 L/W ratio). Five “redds” were intermediate in size and shape and were considered incomplete salmon redds and were not counted. We recommend that dimensions of all redds be recorded during spawning ground surveys in the Upper Columbia Recovery Unit and a reference database be developed to improve species identification of redds in areas where multiple salmonid species concurrently spawn.

SEASONAL MOVEMENTS OF ADULT FLUVIAL BULL TROUT  
IN THE ENTIAT RIVER WA 2003-2006

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*Abstract-* The seasonal movements of adult fluvial bull trout from the Entiat River Core Area of the Upper Columbia Recovery Unit were monitored with radio-telemetry during 2003 – 2006. The objectives were to define migration timing, movement barriers, spawning locations, factors affecting populations, and seasonal movements of adult fluvial bull trout. A total of 92 bull trout were tracked, including 35 tagged in the Entiat River and Mad River by the USFWS Mid-Columbia River Fishery Resource Office and 57 tagged at Columbia River hydroelectric dams by Chelan and Douglas County Public Utility Districts. Analysis of movements confirmed that bull trout from the Mad River and upper Entiat River are separate local populations. Both populations exhibited fidelity to the separate spawning areas, used the lower Entiat River as a migratory corridor, and over-wintered in the Columbia River alongside bull trout from the Wenatchee Core Area and the Methow Core Area. During spring migration in 2004, USFWS tagged bull trout took 0.45 to 4.26 days (mean 2.01 days) to pass upstream of Rocky Reach Dam in the Columbia River. After arriving at the mouth of the Entiat River, tagged bull trout staged for 1 – 22 days before entering the river on the declining hydrograph at 13 – 18 days after peak discharge, as mean daily water temperature increased to > 8 °C. Upstream migration mean speeds ranged from 0.34 – 4.34 km/day, varied by stream reach, and were significantly slower in the Mad River. Bull trout were delayed in Box Canyon for 23 – 38 days until stream discharge declined to < 200 ft<sup>3</sup>/sec, and then migration continued to the upper Entiat River spawning grounds. Due to a debris obstacle, the percentage of bull trout that passed Box Canyon declined from 67% during 2003 – 2005 to 24 % in 2006, and the redd count declined from 50 to 21 redds. Until 2006, Mad River bull trout were prevented from reaching the majority of the optimal spawning and rearing habitat by a log and debris jam at rkm 22.8, and the redd count declined from 52 to 7 redds. Mortality of adult bull trout was significantly higher in the Mad River than in the upper Entiat River. Mean speed during downstream migration ranged from 0.6 – 38.9 km/day, varied by stream reach, and were significantly slower in the Mad River. In 2004, adult bull trout from the Mad River spent significantly more time (mean 168.9 days) in the Entiat Core Area upstream of rkm 5.1 than did upper Entiat River bull trout (mean 130.3 days). Migration distances between spawning reaches and over-wintering sites in the Columbia River ranged from 36.4 – 91.9 km. Mad River bull trout were more likely to use the Rocky Reach Reservoir while upper Entiat River bull trout were more likely to use the Rock Island Reservoir. Several tagged bull trout were documented successfully passing downstream through Rocky Reach and Rock Island dams. Natural factors such as log jams and migration obstacles to optimal spawning areas appeared to play a major role in the distribution and survival of adult bull trout in the Entiat Core Area.

SPAWNING MIGRATIONS OF ADULT FLUVIAL BULL TROUT  
IN THE ENTIAT RIVER 2007 – 2013

Mark C. Nelson

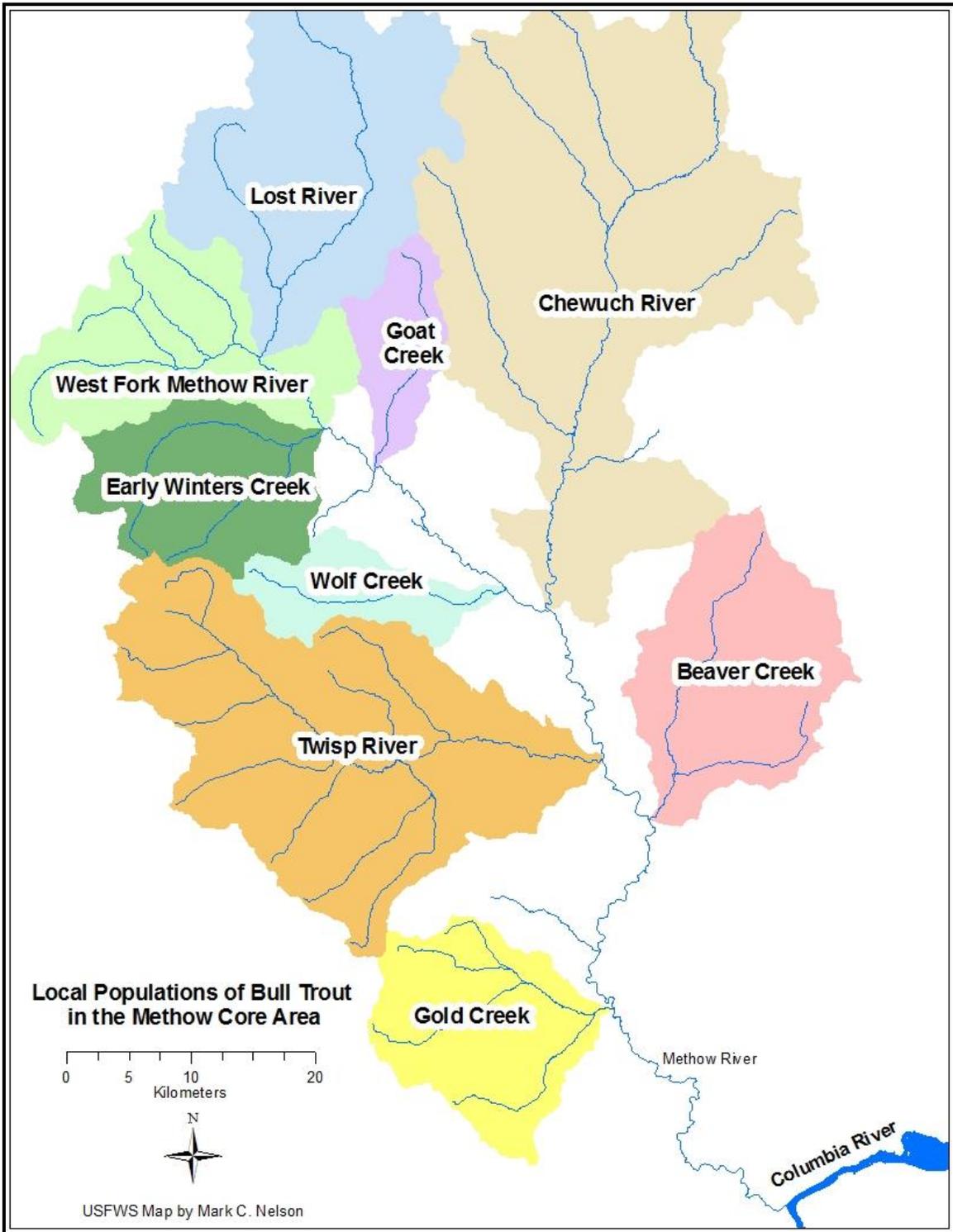
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*Abstract-* Detailed information on the spawning migrations and long-term seasonal movement patterns of adult fluvial bull trout *Salvelinus confluentus* is necessary for management actions including recovery planning, biological consultations, fisheries management, hydroelectric operations, and stream restoration. A radio-telemetry study of adult bull trout in the Entiat River was initiated by the U.S. Fish and Wildlife Service (USFWS) in 2003. The objectives were to define migration timing, movement barriers, spawning locations, factors affecting populations, and monitor seasonal movements. The first part of the study was conducted from 2003 through 2006 and was previously reported. During 2007 to 2012, a total of 29 radio-tagged adult bull trout were monitored in the Entiat River, including 26 bull trout tagged in the Columbia River by Chelan County Public Utility District (PUD) at Rocky Reach and Rock Island dams during 2005 to 2007, one bull trout tagged by Douglas County PUD at Wells Dam during 2006, and one bull trout tagged by USFWS in Icicle Creek during 2009. Overall, the movement patterns were similar to those reported in 2003 to 2006. Adult fluvial bull trout staged in the Columbia River at the mouth of the Entiat River prior to entering the tributary, with those arriving earliest most likely to stage the longest. Tagged bull trout entered the river between May 23 and July 7 on the descending limb of the hydrograph as flows declined to less than 1500 ft<sup>3</sup>/s and mean daily water temperatures ranged from 7.1 to 13.1°C. Eighty-five percent of the tagged bull trout migrated to the upper Entiat River. Similar to conditions in 2006, most tagged bull trout were blocked by a log impediment in Box Canyon and could not reach the optimal spawning area of the upper Entiat River as the number of redds continued to decline during 2007 to 2011. In 2012, the log impediment was washed downstream and the number of redds upstream of Box Canyon increased in 2012 and 2013. Only fifteen percent of the tagged bull trout migrated into the Mad River and the number of redds observed on that spawning ground also continued to decline. In 2010, resident bull trout redds were observed in the Mad River for the first time, but no migratory fish or redds were counted. During 2007 – 2010, post-spawn migrations occurred from September through December, and tagged adult bull trout averaged between 140.8 - 152.8 days in the Entiat River watershed before overwintering in the Columbia River. Maximum weekly maximum temperatures in the upper Entiat River at rkm 41.6 were significantly warmer during the period of 2000 – 2009 compared to the period of 1967 – 1977. Increasing stream temperatures, the presence of brook trout, and obstructions that reduce access to the spawning reaches with the resultant decline in redds are major threats to the survival of the two bull trout populations in the Entiat Core Area.

## METHOW CORE AREA



**Post-spawn adult migratory bull trout in a pool in the Lost River.**  
*USFWS photograph by Mark C. Nelson.*



**Figure 4. Map of local populations of bull trout in the Methow Core Area.**

MOVEMENTS, HABITAT USE, AND MORTALITY OF ADULT FLUVIAL BULL TROUT  
ISOLATED BY SEASONAL SUBSURFACE FLOW IN THE TWISP RIVER, WA

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*Abstract*– The Mid-Columbia River Fishery Resource Office used radio-telemetry to track the movements of eight adult fluvial bull trout tagged by the Chelan, Douglas, and Grant Public Utility Districts at mid-Columbia River hydroelectric projects in 2002. The bull trout migrated from the Columbia River into the Twisp River, where six radio-tagged bull trout, along with the majority of the adult fluvial population, became isolated in the upper Twisp River by a seasonal reach of subsurface flow near Poplar Flats Campground (rkm 35.2 to 38.1). Bull trout spawning, movements, habitat use, and response to isolation were monitored from September 9 to November 26, 2002. Most spawning activity occurred from September 12 to October 4, in the vicinity of North Creek (rkm 42). Post-spawning adults migrated 3 km downstream, encountered the de-watered barrier, and utilized pool habitat in the vicinity of South Creek (rkm 39.3). Bull trout habitat use was significantly different in the spawning and post-spawning areas: spawning habitat units contained significantly higher percentages of riffle and gravel, and more pieces of large woody debris, while post-spawning habitat units had significantly higher percentages of pool and boulder. Four radio tags were recovered during or shortly after spawning, and one tagged bull trout died when stranded and frozen in low water at the upper edge of the dry reach. Another tagged bull trout was stranded in a shallow pool, but was rescued, transported, and released downstream in the lower river. Two tagged bull trout remained isolated in the post-spawning area, but it appears they did not survive over winter. The Twisp River upstream of the dry reach is a critical area of habitats for adult fluvial bull trout migrating from the Columbia River. Potential impacts of isolation are discussed, and management and research options are recommended.

UPPER COLUMBIA RECOVERY UNIT BULL TROUT TELEMETRY PROJECT:  
2005 PROGRESS REPORT FOR THE METHOW RIVER CORE AREA

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*Abstract-* During 2005, the Mid-Columbia River Fishery Resource Office radio-tracked adult fluvial bull trout in the Methow River system. The bull trout were tagged at mid-Columbia River hydroelectric dams by the Douglas and Chelan County Public Utility Districts. Six bull trout were located during mobile telemetry surveys, and one radio tag was recovered. Tagged bull trout migrated to several tributaries, including Twisp River, Wolf Creek, West Fork Methow River and Lost River, which all contain known spawning grounds of bull trout. Upstream migration distances were 68.9 to 88 miles (110.0 to 141.6 km) for Wells Dam bull trout and 108.3 miles (174.3 km) for the Rocky Reach bull trout. This study documents the first known migrations of adult fluvial bull trout from the Columbia River to Wolf Creek, West Fork Methow River, and Lost River in the Methow River Core Area.

UPPER COLUMBIA RECOVERY UNIT BULL TROUT TELEMETRY PROJECT:  
2006 PROGRESS REPORT FOR THE METHOW RIVER CORE AREA

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*Abstract-* The USFWS Mid-Columbia River Fishery Resource Office radio-tagged a total of 13 bull trout in the Methow Core Area during the spring and summer of 2006. In April, we tagged 3 bull trout in the lower Lost River and 2 bull trout in the mainstem Methow River, and during July and August we tagged 4 bull trout in Wolf Creek, 3 bull trout in West Fork Methow River, and 1 bull trout in Robinson Creek. We also tracked 17 bull trout tagged by the Douglas and Chelan Counties Public Utility Districts in the Columbia River; of these, 7 were tagged in 2006 and 1 in 2005 at Wells Dam, 6 were tagged in 2006 and 2 in 2005 at Rocky Reach Dam, and 1 was tagged in 2005 at Rock Island Dam. A total of 373 locations of 30 bull trout were recorded during mobile surveys, and 102 migration movements of 26 bull trout were recorded at fixed telemetry stations. Bull trout tagged in the Columbia River migrated into the Methow River from May 23 – July 2, 2006, as stream discharge declined from 12,900 - 2,960 ft<sup>3</sup>/sec, and 9 bull trout entered the Twisp River from June 24 – July 4, 2006, as flows declined from 912 – 537 ft<sup>3</sup>/sec. Columbia River bull trout also migrated to Wolf Creek (1 bull trout), Goat Creek (1 bull trout), Early Winters Creek (1 bull trout), and West Fork Methow River (2 bull trout). In Wolf Creek, none of the tagged bull trout moved past a log debris dam at rkm 6.6. Twenty-two bull trout were radio-tracked to known spawning grounds, and Columbia River bull trout were documented for the first time in Early Winters Creek and Goat Creek. Sixteen radio-tagged bull trout were isolated above the dry reaches that developed in the Twisp River, upper Methow River, and lower Goat Creek, but heavy rains in November re-watered the reaches. Ten radio transmitters were recovered or were motionless. Bull trout tagged in the Methow Core Area exhibited different movement patterns than bull trout tagged in the Columbia River. All 6 of the active Methow River tagged bull trout over-wintered in the Methow Core Area, while 11 of the 12 active Columbia River tagged bull trout returned to the Columbia River.

# MIGRATION PATTERNS OF ADULT FLUVIAL BULL TROUT IN THE METHOW AND COLUMBIA RIVERS DURING 2007

Mark C. Nelson and Andy Johnsen

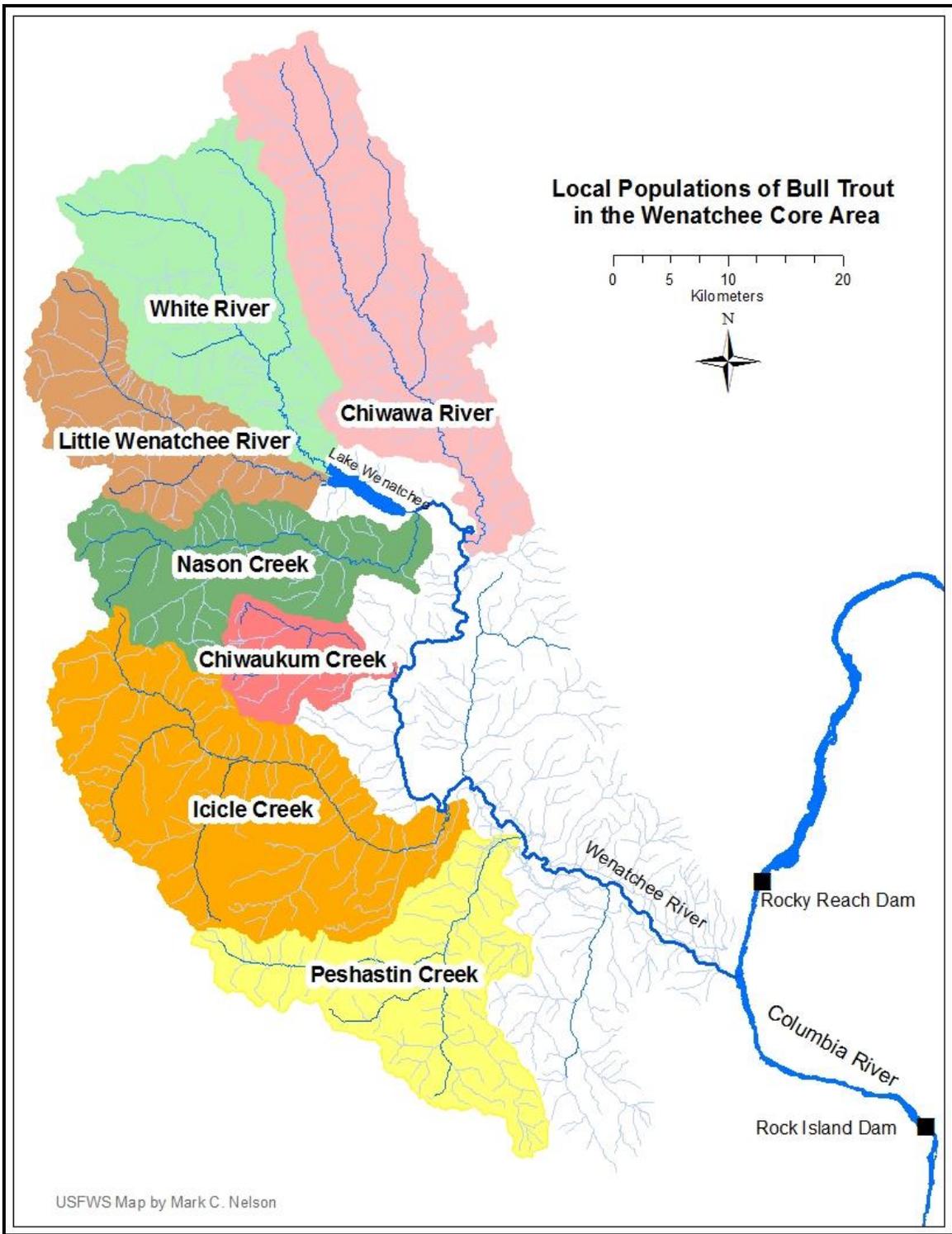
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*Abstract-* In 2007, the USFWS Mid-Columbia River Fishery Resource Office continued a multiyear radio-telemetry study of the movement patterns of adult fluvial bull trout *Salvelinus confluentus* in the Methow Core Area of the Upper Columbia Recovery Unit in Washington. This study is concurrent with the bull trout monitoring programs of the public utility districts (PUDs) of Chelan and Douglas counties. We radio-tracked a total of thirty-six bull trout, including eighteen tagged in 2007, seventeen in 2006, and one in 2005. Of the eighteen bull trout tagged in 2007, five were tagged in the Methow River watershed by USFWS, ten at Wells Dam in the Columbia River by Douglas County PUD, and three at Rocky Reach on the Columbia River by Chelan County PUD. In the Columbia River, migration rate in the reservoirs between dams ranged from 15.8 to 58.7 km/day. The overall migration rate (including the time spent passing each dam) in the Columbia River ranged from 3.9 to 16.1 km/day (mean 8.8 km/day) and in the Methow River ranged from 3.2 to 10.1 km/day (mean 5.6 km/day). Bull trout migrated into the Methow River from May 22 to July 9, after peak discharge when flows declined from 10500 ft<sup>3</sup>/s to 1500 ft<sup>3</sup>/s. The diel movement periods of tagged bull trout in the Columbia River and Methow River varied according to location and season. Pre-spawn movements in the Columbia River occurred mostly during the day, but as migration progressed upstream in the Methow River movements shifted to the night. Most tagged bull trout entered spawning tributaries by early July and were detected on or near spawning areas by mid-July, well in advance of spawning season. The minimum known upstream migration distances to spawning areas ranged from 14.8 to 226.6 km. Fidelity to local populations was observed, as ten bull trout tagged in previous years returned to the same spawning area in 2007. Fluvial bull trout were detected in Foggy Dew Creek and on the spawning grounds in upper Lake Creek for the first time. Three tagged bull trout were tracked to a different core area in 2007. A total of eleven radio-tagged bull trout were isolated upstream of seasonal dry reaches in the Methow River basin during the fall of 2007 (seven in the upper Twisp River and four in the upper Methow River) and four died. During post-spawn migrations, movements were mostly at night in the Methow River, with a shift towards day in the Columbia River. Sixty-two percent of the bull trout tagged in the Columbia River overwintered in the main-stem Methow River compared to only eight percent in 2006. All bull trout tagged in the Methow River overwintered in the Methow River system. Understanding the factors affecting adult bull trout migration patterns, including migration rate, diel movement patterns, homing and navigation, and isolation by dry reaches, is necessary in order to facilitate recovery of bull trout in the Methow Core Area.

## WENATCHEE CORE AREA



**A sub-adult migratory bull trout caught in lower Icicle Creek on September 5, 2013.  
(Genetic stock identification assigned this bull trout to the Entiat River population.)**  
*USFWS photograph by Cal Yonce.*



**Figure 5. Map of local populations of bull trout in the Wenatchee Core Area.**

# FRENCH CREEK BULL TROUT: ANALYSIS OF 2006 – 2007 ISEMP SURVEYS

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*Abstract-* This document contains the Mid-Columbia River Fishery Resource Office analysis of bull trout data collected in French Creek during snorkel surveys conducted by USFS in French Creek for the Integrated Status and Effectiveness Monitoring Program (ISEMP). Sites 232 and RM4 were surveyed during night snorkeling on July 31 and August 1, 2006, and site RM4 was surveyed during day snorkeling on August 16, 2007. During night snorkeling in 2006 at site 232, 20 bull trout were counted and observed density was 0.61 per 100 m<sup>2</sup>, and at site RM4, 64 bull trout were counted and observed density was 2.1 per 100 m<sup>2</sup>. During day snorkeling in 2007 at site RM4, 40 bull trout were counted and observed density was 1.47 per 100m<sup>2</sup>. Using recently published efficiencies to adjust for differences between day and night snorkeling, estimated numbers and total densities at site RM4 were calculated as 193 bull trout (6.2 per 100 m<sup>2</sup>) in 2006 and 320 bull trout (11.8 per 100 m<sup>2</sup>) in 2007. Several size classes of bull trout were present at all sites. Observed and estimated total densities at site RM4 met the criteria of Shepard et al. (1982) for bull trout rearing areas critical to maintaining healthy populations.

ADULT FLUVIAL BULL TROUT PASSAGE OF TUMWATER DAM ON THE  
WENATCHEE RIVER: ANALYSIS OF WDFW LADDER COUNTS (1998-2006)  
WITH APPLICATION TO ICICLE CREEK

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*Abstract-* Because there is little information available on the timing of the movements of adult fluvial bull trout in Icicle Creek, counts of bull trout moving at Tumwater Dam in the Wenatchee River are used to infer bull trout migration in Icicle Creek. This paper contains an in-depth analysis of the Tumwater Dam bull trout counts and Wenatchee River discharge data. Based on data from 1914 – 1997, the mean peak discharge of the Wenatchee River at Plain is 11,547 ft<sup>3</sup>/s and the mean date of peak discharge is May 29. During 1998 – 2006, discharge was below average in 5 years, average in 2 and above average in 2. The date of peak bull trout movement ranged from 28 – 62 days (mean 45 days) after the peak discharge date, and July 7 is the mean date of peak bull trout movement at Tumwater Dam. During the bull trout count period (1998 – 2006) at Tumwater Dam, there was no significant difference in the number of bull trout moving before or after July 7, with an average of 51.8 bull trout moving on or before July 7 and 46.8 after July 7. The yearly percentage of bull trout that moved on or before July 7 ranged from 0 – 76 %, with the highest percentage occurring during years of drought or below average discharge. Ninety percent of all bull trout were counted at Tumwater Dam when daily discharge was less than 5000 ft<sup>3</sup>/s, including 50 % when daily discharge was less than 2500 ft<sup>3</sup>/s. Wenatchee River daily discharge is the most adaptable parameter of the Tumwater model that could be used to infer migration of bull trout into Icicle Creek, predict their arrival at Leavenworth NFH, and assist in adaptive management of operations. Scenarios illustrating the potential use of the model are provided.

SEASONAL MOVEMENTS OF ADULT FLUVIAL BULL TROUT IN ICICLE CREEK  
2008 ANNUAL REPORT

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*Abstract-* Radio telemetry was used to monitor the movements of 3 fluvial bull trout in Icicle Creek in 2008. Two bull trout were radio-tagged in lower Icicle Creek and one was tagged in upper Icicle Creek. On April 7, 2008, bull trout code 20 was captured and radio-tagged in Icicle Creek at rkm 4.3 in the spillway pool of Leavenworth National Fish Hatchery. Code 20 was present in or around the spillway pool from April 7 to December 29 and exhibited several local movements during the period before moving a relatively short distance downstream. Bull trout code 23 was captured and radio-tagged at rkm 4.3 on July 30, 2008. It was present in or near the spillway pool until August 15, when it moved downstream and exited Icicle Creek. On August 19, the motionless signal was detected in the Wenatchee River 3.4 km downstream of the confluence with Icicle Creek, and on August 25, the carcass and tag were recovered. Bull trout code 22 was captured and radio-tagged in upper Icicle Creek at rkm 26 in the Icicle Creek Gorge on July 25, 2008. It was present in the gorge until it jumped the gorge waterfalls sometime between August 12 and 22, when flows (as measured at the USGS gage station at rkm 9.4) declined to 210 – 286 ft<sup>3</sup>/sec. Code 22 passed waterfalls at rkm 29.1 and rkm 34.3 as it moved upstream. It was located in lower French Creek on September 8 and was observed digging a redd while paired with a small resident-sized bull trout on September 22. After spawning, code 22 moved back downstream to the Icicle Gorge, where it held from September 30 to November 3, and then began to slowly move downstream again. On December 1, the motionless signal was detected and the radio tag was recovered in the tail-out of a pool at rkm 19.3. Eight fluvial bull trout redds were counted during spawning ground surveys in French Creek (rkm 0.0 – 7.2). No redds were detected during surveys in upper Icicle Creek (rkm 29.1 – 34.7) or in the lower 3.2 km of Jack Creek (rkm 27.6).

# SEASONAL MOVEMENTS OF ADULT FLUVIAL BULL TROUT AND REDD SURVEYS IN ICICLE CREEK 2009 ANNUAL REPORT

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*Abstract-* Relatively little is known about the life history, movement patterns, population numbers, and genetic diversity of the threatened bull trout *Salvelinus confluentus* in Icicle Creek. In 2007, the Mid-Columbia River Fishery Resource Office of the U.S. Fish and Wildlife Service began a telemetry study of adult fluvial bull trout to determine migration timing and distances, identify migration barriers and obstacles, document passage windows at natural and artificial obstacles, monitor seasonal movements, and locate spawning areas in Icicle Creek. In 2009, an additional seven adult bull trout were captured and radio-tagged in lower Icicle Creek and their movements were monitored. A hybrid bull x brook trout *S. confluentus x fontinalis* was captured and tagged in upper Icicle Creek. Tissue samples for genotypic analysis were taken from all captured bull trout, including 38 untagged juveniles. To date, none of the bull trout tagged in the lower river have attempted to move upstream past Leavenworth National Fish Hatchery or attempted to pass the boulder falls at rkm 9.2. In 2009, bull trout code 20 (tagged in 2008) wintered in the Wenatchee River at the mouth of Icicle Creek and then migrated upstream in the Wenatchee River to its spawning area in Chiwaukum Creek. Temperatures in lower Icicle Creek and the Leavenworth NFH spillway pool were cooler than the Wenatchee River and appeared to offer thermal refuge and foraging opportunities for both adult and juvenile/sub-adult bull trout during summer and early autumn. A total of three resident-sized bull trout redds were counted in French Creek during 2009. As water temperatures cooled in the autumn, radio-tagged bull trout exited Icicle Creek and moved into the Wenatchee River. Some bull trout stopped movements for extended periods and downstream migration rates between fixed telemetry stations ranged from 0.2 to 41.3 km/day in lower Icicle Creek and 0.7 to 47.6 km/day in the Wenatchee River. Downstream movements past fixed stations occurred primarily at night and overall migration distances ranged from 5.4 to 50.1 km. Two tagged bull trout over-wintered in the Wenatchee River and four over-wintered in the Columbia River. Water temperature and stream discharge appeared to be major factors influencing bull trout movement patterns in Icicle Creek and the Wenatchee River. Hybridization with brook trout is likely a significant problem for bull trout in Icicle Creek and surveys to determine population numbers and distribution of brook trout are needed. Genetic analyses may help estimate the emigration and immigration rates of bull trout in Icicle Creek and clarify the importance of this local population to the metapopulation of the Upper Columbia Recovery Unit.

# SEASONAL MOVEMENTS OF ADULT FLUVIAL BULL TROUT AND REDD SURVEYS IN ICICLE CREEK 2010 ANNUAL REPORT

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*Abstract-* Relatively little is known about the life history, movement patterns, population numbers, and genetic diversity of the threatened bull trout *Salvelinus confluentus* in Icicle Creek. In 2007, the Mid-Columbia River Fishery Resource Office of the U.S. Fish and Wildlife Service began a telemetry study of adult fluvial bull trout to determine migration timing and distances, identify migration barriers and obstacles, document passage windows at natural and artificial obstacles, monitor seasonal movements, and locate spawning areas in Icicle Creek. The study was continued in 2010 when six adult bull trout radio-tagged in 2009 and three adult bull trout radio-tagged in 2010 were tracked. None of the three bull trout tagged during late summer in lower Icicle Creek in 2010 attempted to move upstream of Leavenworth NFH. None of the six bull trout tagged in 2009 returned to Icicle Creek in 2010. Instead, four of these bull trout migrated to spawning areas in different local populations, including one in Chiwaukum Creek, one in Nason Creek, one in Etienne Creek, and one in upper Entiat River. One bull trout shed its radio transmitter but its PIT tag was detected passing the fish ladder at Tumwater Dam as it migrated to the upper Wenatchee River. The remaining bull trout spent the summer in Tumwater Canyon downstream of Tumwater Dam. Upstream migration distances ranged from 30.8 to 122 km. During the fall, seven bull trout migrated downstream and four overwintered in the Columbia River while one overwintered in Tumwater Canyon. Downstream migration distances ranged from 17.6 to 118 km. One of the bull trout tagged in 2010 died and the other two apparently shed their radio transmitters. During spawning ground surveys in upper Icicle Creek, two bull trout redds were observed in French Creek. Tissue samples were taken from 17 subadult bull trout in 2010, including 10 captured in upper Icicle Creek and 7 in lower Icicle Creek. To date, tissue samples have been taken from over 90 bull trout in Icicle Creek and eventually a genetic analysis with comparison to the pending genetic baseline will provide additional insights into movements and population structure of bull trout in Icicle Creek. Future studies should focus on subadult bull trout including large scale genetic sampling and PIT tagging in tandem with tracking a small number of radio-tagged fish.

## SNORKEL AND REDD SURVEYS OF BULL TROUT IN FRENCH CREEK 2012

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*Abstract-* Detailed information on distribution, abundance, habitat conditions, and genetic diversity is needed for all bull trout life history forms in order to aid recovery and ultimately remove them from the threatened species list. In Icicle Creek, a resident population with a small migratory component is present in the upper drainage, but until recently, few surveys for bull trout were conducted. Two sites in French Creek (tributary to Icicle Creek at rkm 35) were established and surveyed in 2005 and 2006 during night snorkels under the Integrated Status and Effectiveness Monitoring Program (ISEMP). These sites were revisited and surveyed by USFWS biologists in 2012. A total of 50 bull trout were observed during night snorkeling at site WC-06 (rkm 6.4) in 2012 and the numbers were similar to the surveys in 2005 (44 bull trout) and 2006 (64 bull trout). In 2012, the WM-232 site at rkm 3.7 was significantly changed since it was mapped in 2006 and is now less complex, with fewer logs in the wetted channel, less off-channel habitat, reduced pool habitat, increased riffle habitat and higher overall water velocities. Only 8 bull trout were counted at this site in 2012, compared to 20 in 2006, and the decrease may be the result of the observed habitat changes. Genetic tissue samples were collected from 50 bull trout in 2012 and will be used to increase the robustness of the recently completed genetic baseline of local populations. Two bull trout redds (1 migratory-sized and 1 resident-sized) were observed during the spawning ground survey conducted on September 26, 2012. French Creek has cold water with complex habitats in a pristine wilderness area and is an ideal stream for bull trout that is critical for the maintenance of bull trout in the watershed. Additional snorkel surveys and mark-recapture studies are needed in French Creek to continue monitoring bull trout and to map the extent of their distribution.

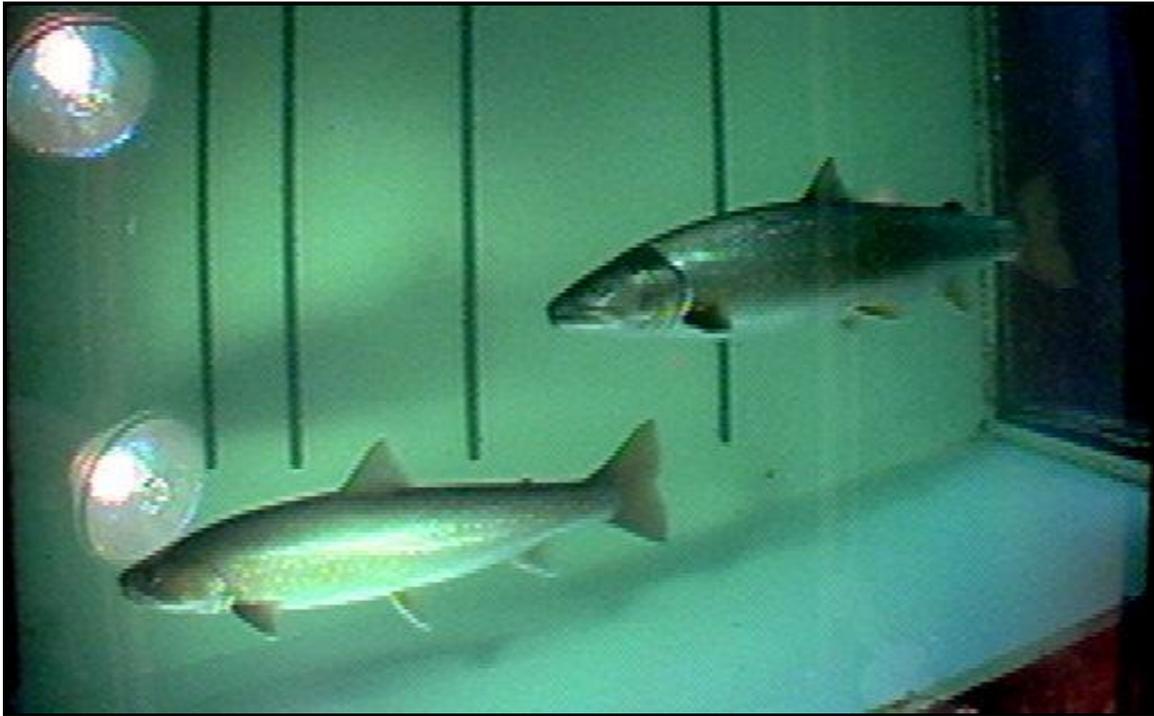
MIGRATION PATTERNS OF ADULT BULL TROUT  
IN THE WENATCHEE RIVER, WASHINGTON 2000-2004

Barbara M. Kelly Ringel, Judy Neibauer, Kathleen Fulmer, and Mark C. Nelson

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*Abstract*— Movements of 62 adult migratory bull trout captured at five locations in the Wenatchee River basin were monitored with radio telemetry during 2000–2004. Objectives were to describe adult bull trout seasonal movements, migration timing, movements past obstacles, and to identify spawning, overwintering, and other areas used. Bull trout from four local populations were tracked to four different overwintering areas, and several distinct migration patterns were documented. Most of the bull trout overwintered in Lake Wenatchee, and four of these spawned in its tributary the White River, but the most common migration pattern (32 bull trout) was downstream from the lake 9.4 km then upstream in the Chiwawa River to spawning areas in its upper main stem and tributaries. Almost half of the Chiwawa bull trout also made forage/refuge movements into another stream (White River, Little Wenatchee River, and Nason Creek). Two bull trout that spawned in the Chiwawa River basin overwintered in the upper Wenatchee River while two others migrated downstream 77.8 km to overwinter in the Columbia River. One bull trout that spawned in Nason Creek also overwintered in the Columbia River, a 130 km migration. Three bull trout spawned in Chiwaukum Creek, overwintered downstream in the middle Wenatchee River, and seasonally used lower Icicle Creek. Thus several complex migration patterns are exhibited by Wenatchee Core Area bull trout, including the unique allustrine-adfluvial migrations between Lake Wenatchee downstream into the Chiwawa River and the lacustrine-adfluvial upstream movement of the White River population. The adfluvial-fluvial migration pattern was expressed primarily in the Chiwaukum and Nason Creek populations, although a few Chiwawa fish adopted this strategy and also moved downstream to larger riverine habitats. The complexity and connectivity of these migrations may increase the likelihood of population persistence. Most of the bull trout (80%) only spawned once, but of those alive the year after first spawning, 50% (7 of 14) spawned again. Bull trout showed fidelity to spawning streams and in other streams they visited were only found downstream of bull trout spawning areas. Spawning migrations began as early as April and lasted into September, but the majority moved in June and July during declining flows at 3 to 5 weeks after peak discharge. Bull trout migrating later in the season often moved when daily water temperatures exceeded 16° C. Several bull trout held downstream of the Chiwawa River weir and did not pass until the weir was down or entered the trap after a few days. Bull trout generally slowly moved upstream in tributaries and entered spawning areas within 2 to 7 weeks. Median dates to move into spawning areas for four streams were between July 23 and August 1. After spawning, most bull trout quickly migrated downstream out of tributaries. In the Wenatchee River bull trout moved slowly through the reach downstream of Tumwater Dam for at least one month before entering overwintering areas. The results of this study provide migration information that will assist in recovery actions including consultation, fisheries management and stream restoration. Potential research and management considerations are discussed.

## UPPER MID-COLUMBIA RIVER



**A pair of adult migratory bull trout counted in the fish ladder at Rocky Reach Dam.**  
*Photograph courtesy of Steven Hemstrom, Chelan County PUD.*

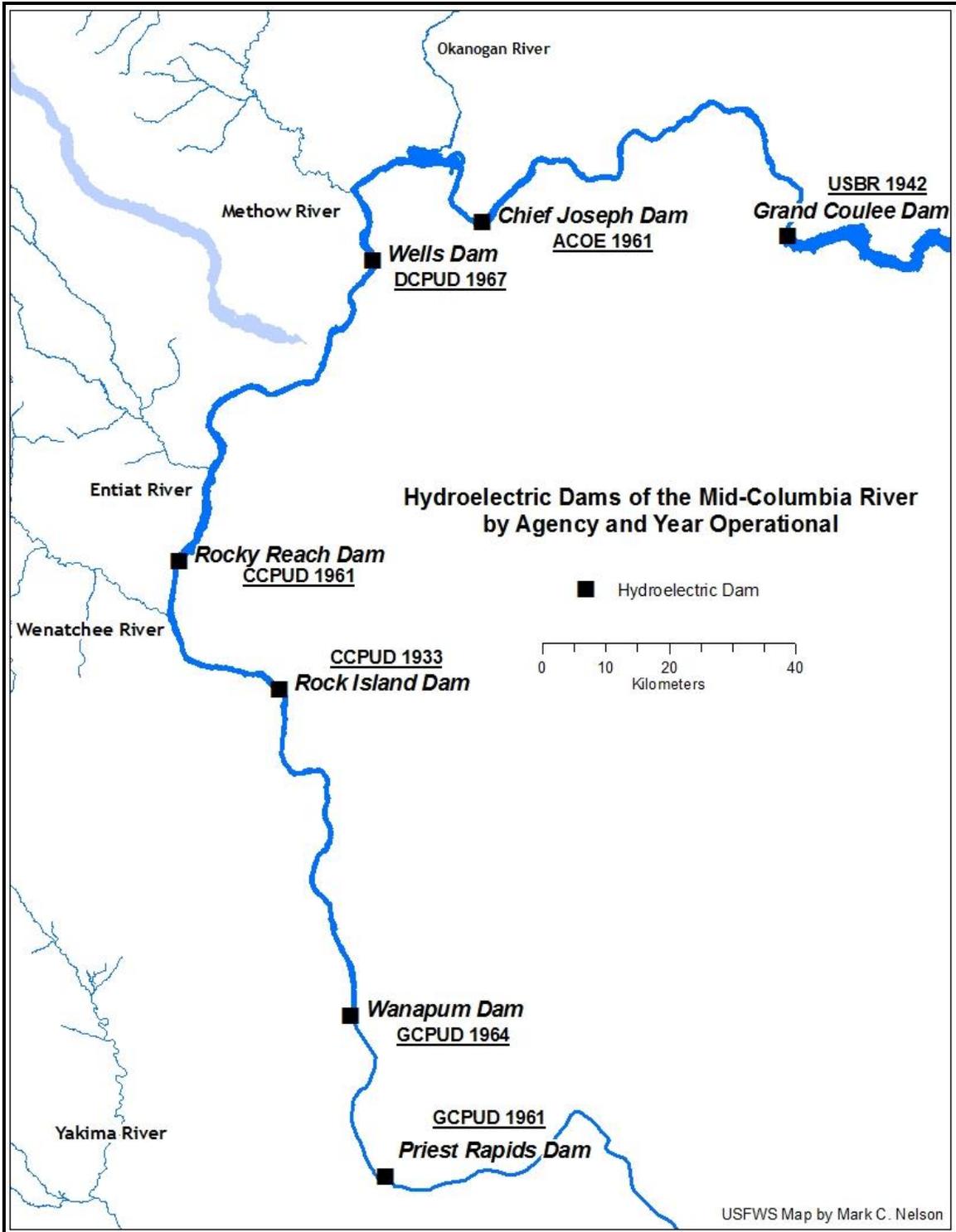


Figure 6. Map of the Mid-Columbia River and Hydroelectric Dams.

MOVEMENT OF BULL TROUT WITHIN THE MID-COLUMBIA RIVER  
AND TRIBUTARIES, 2001-2004

BioAnalysts, Inc.

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*Conclusions-* Based on the results from the 2001-2004 study, we offer the following conclusions:

1. Seventy-nine adult bull trout were successfully tagged with radio tags in 2001 and 2002. Of those, it appears that 15 may have died or shed their tags. However, there is no evidence that any of these potential deaths were the result of hydroelectric projects.
2. Based on data collected in 2001-2004, operations of hydroelectric facilities on the mid-Columbia River did not negatively affect the survival of adult bull trout. That is, no adult bull trout were killed during upstream or downstream passage through the mid-Columbia dams.
3. Although hydroelectric operations did not appear to affect the survival of adult bull trout, the presence of dams may have slowed migration times. On average, it took bull trout longer to pass dams than it did for them to move through reservoirs (i.e., from project to project). One reason for the possible delays is that bull trout found increased foraging opportunities in the tailraces. Additional work is needed to verify this possibility.
4. The overall dam passage time is considerably greater for fish tagged and released into the tailrace of a given project than it is for fish that migrated upstream after being released at downstream projects. The release location of future studies assessing passage rates at dams should be made upstream of the project or far enough downstream to allow adequate recovery following tagging.
5. At Rocky Reach Dam, the location where tagged fish are released appears to influence tributary selection. Of the tagged fish released downstream from the project in 2001, 55% (6 of 11) moved downstream and entered the Wenatchee River. In 2002, 33% (4 of 12) of the fish released downstream from Rocky Reach Dam entered the Wenatchee River. In contrast, only 3% of the fish released upstream from dams move downstream into tributaries.
6. There were nine downstream passage events observed at Rocky Reach Dam (5 in 2002 and 4 in 2003) and two at Wells Dam (2002). Of those, six occurred within 24 hours after exiting the ladder system(s), and two within 15 hours after the fish were released into the forebay (one at Rocky Reach and one at Wells Dam). These two events may be related to releasing the fish too close to the dam. For three fish, after exhibiting downstream movement behavior, two migrated into tributaries downstream of the given project, and one resided within the mainstem Columbia River. Future studies that include forebay releases should consider releasing fish further upstream from the projects to eliminate the effects of handling on downstream movement.

7. Bull trout entered tributaries shortly after release. They selected the Wenatchee, Entiat, and Methow systems. No bull trout selected the Okanogan system, although one entered the Okanogan River, it quickly left and moved into the Methow system. Most entered tributaries by the end of June and were found in possible spawning streams well before the initiation of spawning. Most tagged trout left tributary streams by late November.

8. For the three years of data regarding tributary entrance into the Wenatchee, Entiat and Methow rivers, a total of 91 tributary entrance events occurred. During the study period bull trout entered mid-Columbia tributaries from April to September but most (94%) entered tributaries during May, June and July. At the time bull trout entered tributary streams the mean daily temperatures in the mainstem Columbia River varied from 5.4 °C to 19.6 °C. Similarly, tributary mean daily temperatures ranged from 7.5 °C to 17.2 °C. Most bull trout (92.3%) entered tributaries before the Columbia River reached a mean temperature of 15 °C. The successful migration of bull trout into the various spawning streams of the Wenatchee, Entiat and Methow suggests that temperatures at the time of migration in the mid-Columbia River did not appear to limit the migration of radio-tagged bull trout.

9. Over half (53%) of the bull trout detected within the Wells Dam tailrace entered the hatchery outfall. Four of the five bull trout released downstream of the dam entered the outfall multiple times. Because there was little difference in temperature between the outfall and the mainstem Columbia River, it is unlikely that bull trout used the outfall as a temperature refuge. Instead, they may have used the outfall to increase feeding opportunities.

10. Of the 79 bull trout tagged in 2001 and 2002, ten (12.7%) moved downstream of Rock Island Dam after an extended stay in tributaries. At the conclusion of the study period (31 March 2004), one tagged bull trout had passed Wanapum Dam, and is presumed to have also passed Priest Rapids Dam.

## MOVEMENTS OF RADIO-TAGGED BULL TROUT THROUGH ROCKY REACH AND ROCK ISLAND DAMS AND RESERVOIRS: 2005 – 2009

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*Introduction-* On 1 November 1999 bull trout were listed as threatened under the Endangered Species Act (ESA) by the United States Fish and Wildlife Service (USFWS). As such, Chelan PUD initiated research to monitor incidental take associated with the Rock Island and Rocky Reach dams and reservoirs. This study was developed to address that objective, and has been ongoing continuously since 2005. This is the final report for the bull trout research encompassing the period of 16 May 2005 through 19 June 2009.

During the period of study, Chelan PUD began baseline work to initiate the federal relicensing process for Rocky Reach Dam. The relicensing process for the Rocky Reach Hydroelectric Project brought fisheries agencies, tribes, and interested parties together in a Natural Resources Working Group (NRWG) that provided opportunities for comprehensive review of current and future management priorities for fish resources potentially impacted by project operations. The NRWG was established to identify issues, develop study plans, review study reports, and develop long-term management plans for fish and wildlife species. As such, Chelan PUD, in conjunction with the NRWG, developed Comprehensive Bull Trout Management Plans (BTMP) for both Rock Island and Rocky Reach dams.

The goal of the BTMPs is to identify, develop, and implement measures to monitor and address ongoing impacts on bull trout resulting from project operations and facilities in a manner consistent with the U.S. Fish and Wildlife Service (USFWS) Biological Opinions, issued in May 2004 and February 2009; and the USFWS draft bull trout recovery plan for the Upper Columbia River Recovery Unit. The BTMP measures are designed specifically to meet the following objectives: 1) monitor incidental take associated with project dams and reservoirs; 2) identify and address any negative ongoing project-related impacts on adult bull trout passage; 3) investigate potential project-related impacts on upstream and downstream passage of sub-adult bull trout through Rock Island and Rocky Reach dams and reservoirs; and 4) investigate the potential for sub-adult entrapment or stranding in off-channel or backwater areas of Rock Island and Rocky Reach reservoirs as a result of project operations. This study was developed to address the first objective of the BTMPs and has been ongoing since 2005.

*Executive Summary-* During the period 14 April to 15 November 2009, a total of 83 bull trout were observed ascending the Rocky Reach Dam fishway. At Rock Island Dam, a total of 60 bull trout ascended the three separate fishways. Consistent with the original study design, no bull trout were tagged during the 2009 study period. Instead, fish tagged during the 2005-2007 study periods were monitored and provided data on survival and various metrics of passage at Rocky Reach and Rock Island dams. During the first three years of study, a total of 86 bull trout were tagged, with 38, 29, and 19 fish tagged in 2005, 2006, and 2007, respectively. Furthermore, of

those 86 bull trout, 15 were tagged and released at Rock Island Dam and 71 at Rocky Reach Dam. All fish were tagged with radio transmitters having a two-year battery life expectancy.

Of the 86 bull trout tagged during the period of 2005 to 2007, a total of 17 active transmitters were detected at some time in 2009. Of those, we believe that 9 tagged fish were alive and active during the 2009 period. For the other 8 fish, we believe they either perished or shed their transmitters based on an extended stationary detection history. During the 2009 study period, no tagged fish were observed migrating either up or downstream of Rock Island Dam. At Rocky Reach Dam, we observed a total of three passage events, with one downstream and two upstream events occurring. Furthermore, of the 9 active bull trout, seven migrated into the Entiat basin, one into the Methow basin, and another's transmitter failed before tributary entrance could be documented.

For the period of 2005 – 2009, a total of 41 upstream passage events were observed at Rocky Reach Dam. Based on those observations, we estimated that the median time tagged bull trout resided within the tailrace (Tailrace Residence Time) was 0.28 days; the median time spent migrating in and out of the fishway (Fishway Cycling Time) was 2.48 days; and the median time spent migrating up the fishway (Fishway Migration Time) after final entry was 0.25 days. Collectively, the overall median Project Migration Time from tailrace to exit was 3.84 days. At Rock Island Dam during the same period, a total of 5 upstream passage events were observed. For those events, the median tailrace, fishway cycling, and fishway migration times were 0.26 days, 0.84 days, and 0.23 days, respectively. Collectively, the overall Project Migration Time (median) for tailrace to exit was 1.38 days. Review of project migration times at Rocky Reach and Rock Island dams suggest that most of the time spent migrating upstream of the projects occurred at or near the fishway entrance (fishway cycling time). In comparison, relatively little time was spent in the tailrace or within the fishway (fishway migration time) after last detection at the fishway entrance. For the 41 upstream passage events, no mortality was observed during the study period.

In addition to passage rates at Rocky Reach and Rock Island dams, we assessed in-river migration rates between projects and between projects and various tributaries during the 2005 to 2009 period. For tagged bull trout, the median migration time from Rock Island Dam to the fixed-telemetry site on the Wenatchee River was 6.87 days (5.3 km/d). For tagged trout migrating to Rocky Reach Dam from Rock Island Dam, the median migration time was 2.28 days (14.3 km/day). For tagged bull trout migrating from Rocky Reach Dam to either the Entiat River telemetry site or Wells Dam, the migration rates were 6.87 days (1.9 km/d) and 2.88 days (23.5 km/d). Clearly, the migration rate within the Columbia River to the next upstream project is much faster when compared to migrations upstream to the Wenatchee and Entiat river telemetry sites. This may suggest that tagged bull trout entering these tributaries may stage within the Columbia River or within the lower Wenatchee and Entiat rivers prior to migrating upstream and being detected at the tributary telemetry sites.

During the 2005 to 2009 study period there were a total of 56 downstream passage events at Rock Island and Rocky Reach dams combined; with 9 downstream passage events at Rock Island Dam and 47 passage events at Rocky Reach Dam. Of the 9 passage events documented at Rock Island Dam, 2 were through one of the two powerhouses, one through the spillway; and 6

through unknown routes. At Rocky Reach Dam, a total of 35 downstream passage events occurred at the powerhouse, 2 through the spillway, 2 through the Juvenile Bypass System, and 8 through unknown routes. For these 56 passage events observed over the entire study period, no documented mortality associated with downstream passage through either dam was documented.

There was no downstream passage movement of tagged bull trout following ladder exodus in 2005 or during the 2007-2009 period at Rocky Reach Dam. However, in 2006, four bull trout migrated back downstream of Rocky Reach Dam after an initial ascent of the fishway, only to re-ascend a second time. For those four fish, the mean elapsed time between fishway exit and downstream passage at Rocky Reach Dam was 3.56 hours (range of 0.68 to 5.91 hours). A fifth bull trout released upstream of Rocky Reach Dam after being tagged, subsequently migrated downstream of the project, and later re-ascended the fishway. For all five of these bull trout exhibiting this behavior, after re-ascending the Rocky Reach fishway they migrated upstream of the project.

Of the 86 bull trout that were tagged during the period of 2005-2007, thirty (34.9%) either perished or shed their transmitters during the course of the study. Of those recoveries, seven transmitters were recovered in 2005, four in 2006, eleven in 2007, and eight in 2008. No transmitters were recovered in 2009. Of the recoveries, 9 transmitters were recovered with a carcass, 19 without, and two were inconclusive. Furthermore, 20% of the transmitters were located within the mainstem Columbia River and 80% within tributaries of the Columbia River (i.e., Wenatchee, Entiat, and Methow basins).

MOVEMENTS OF RADIO-TAGGED BULL TROUT  
WITHIN PRIEST RAPIDS AND WANAPUM RESERVOIRS: 2001-2003

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*Introduction-* On 10 June 1998, the U.S. Fish and Wildlife Service (Service) listed bull trout (*Salvelinus confluentus*) within the Columbia River basin as threatened under the Endangered Species Act (ESA) (50 CFR 63(111)). Later (1 November 1999), the Service listed bull trout within the coterminous United States as threatened under the ESA (50 CFR 64(210)). The Service identified habitat degradation, fragmentation, and alterations associated [*with*] dewatering, road construction and maintenance, mining, and grazing; blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species as major factors affecting the distribution and abundance of bull trout. They noted that dams (and natural barriers) have isolated population segments resulting in a loss of genetic exchange among these segments (50 CFR 63(111):31657). The Service believes many populations are now isolated and disjunct.

In response to these listings, Grant, Chelan, and Douglas Public Utility Districts (PUDs) funded research in 2001-2004 to assess effects associated with the operation of mainstem hydroelectric projects on bull trout movements within the mid-Columbia River. The research focused primarily on passage at Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams, and within each respective reservoir. That research investigated: (1) passage at the five hydroelectric facilities, specifically, migration rate from the tailrace of the projects to the ladder entrances, from the ladder entrances to the ladder exits, and from the ladder exits to the next upstream project or the tributary of residence, and fallback rate at each project; (2) tributary selection and residence; and (3) mainstem Columbia River residence (Stevenson et al. 2002; Stevenson et al. In prep<sup>2</sup>).

This report, written at the request of Grant County PUD, provides information from May 2001 through 13 June 2003 and supplements a previous report provided to Grant County PUD (Stevenson et al. 2003). This report provides information on: (1) the detection history of the bull trout tagged at Rock Island, Rocky Reach, and Wells dams in 2001 and 2002 that were detected downstream of Rock Island Dam; and (2) the detection history of all bull trout tagged at Rock Island Dam in 2001 and 2002. Because the data presented in this report for the 2003 study period do not span the entire third year of research (the 2003 study period concludes 31 March

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<sup>2</sup> Editors' note: the recommended citation for "Stevenson et al. In prep." is BioAnalysts 2004- see Literature Citations section.

2004), certain data are yet to be collected, compiled, and analyzed (e.g., flow data, bull trout passage distribution at the collection sites, diel passage, and tagging data). Data missing from this supplemental report will be included in the 2004 bull trout report prepared for the Mid-Columbia PUDs.

The area downstream from Rock Island Dam is the most downstream portion of the larger mid-Columbia River bull trout study area. The effects of hydroelectric facilities on bull trout movement and migration within this portion of the study area are primarily related to operations at Priest Rapids and Wanapum dams. Because this report supplements the Stevenson et al. reports (2002; 2003; In Prep.), we included those reports by reference throughout this document.

The objective of this report is to describe the extent of the movement of radio-tagged bull trout within the area of operational concern to Grant County PUD. The information in this report includes the history of those fish detected downstream from Rock Island Dam during the period of May 2001 through 13 June 2003 and the complete detection history of fish tagged at Rock Island Dam in 2001 and 2002. The radio-transmitters used to tag fish in 2001 had an operational life of 360 days. Some of those transmitters continued to operate well beyond the expected life, and therefore, the detection histories of those fish are included to the point the transmitters expired. Fish tagged in 2002 were tagged with transmitters with a 761 day operational life and should continue to operate until mid to late 2004.

*Conclusions-* Based on results from 2001-2003, we offer the following observations and conclusions:

Of the 79 bull trout radio-tagged during the 2001 and 2002 study periods, only nine (~11%) were detected within Wanapum reservoir. Most of these remained within a 10-km reach immediately downstream from Rock Island Dam.

Only one of the 79 bull trout migrated downstream past Wanapum Dam. This trout ultimately move downstream through Priest Rapids Dam. This observation indicates that few bull trout migrate through projects owned by Grant County PUD.

Based on the detections within Wanapum reservoir, it appears the primary area of habitat use is within a 5-km reach immediately downstream of Rock Island Dam.

Of the 15 fish collected and tagged at Rock Island Dam (these fish came from locations downstream from Rock Island Dam), only four returned to locations downstream from Rock Island Dam. This suggests that at least for the bull trout tagged at Rock Island Dam, these fish were not faithful to specific rearing locations within the Columbia River.

BULL TROUT MONITORING AND MANAGEMENT PLAN  
2005-2008 FINAL REPORT WELLS HYDROELECTRIC PROJECT

LGL Ltd. and Public Utility District No. 1 of Douglas County

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*Executive summary-* The goal of the Wells Hydroelectric Project (Wells Project) Bull Trout Monitoring and Management Plan (Bull Trout Plan) is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout (*Salvelinus confluentus*) associated with the operations of the Wells Project and associated facilities. The Bull Trout Plan was prepared and implemented to meet monitoring requirements stipulated in a U.S. Fish and Wildlife Service (USFWS) Biological Opinion regarding implementation of the Wells Project Anadromous Fish Agreement and Habitat Conservation Plan. The USFWS Biological Opinion monitoring requirements were also incorporated by the Federal Energy Regulatory Commission (FERC) into the existing Wells Project license in 2004. The Bull Trout Plan was developed in collaboration with the USFWS, National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), the Colville Confederated Tribes, and the Yakama Nation, and was approved by the FERC. The Bull Trout Plan has four objectives, addressed by implementing various field study components from 2004 to 2008 at the Wells Project. This document is the final report summarizing the results of all study activities required by the Bull Trout Plan.

The first objective was to identify potential project-related impacts on upstream and downstream passage of adult bull trout (fish  $\geq 400$  mm in length) through Wells Dam and reservoir, and implement appropriate measures to monitor any incidental take of adult bull trout. To meet the first objective, radio telemetry was used to monitor upstream and downstream passage, and offseason video counting was done in the Wells Project fishways during the winter. Between 2005 and 2008, 26 adult bull trout were trapped at Wells Dam and radio-tagged. Concurrent with the implementation of the Bull Trout Plan, the USFWS and Public Utility District No. 1 of Chelan County (Chelan PUD) radio-tagged and released 136 adult bull trout at other mid-Columbia River basin locations including the Methow River, and Rock Island and Rocky Reach dams (50 USFWS tags 2006-2008, 86 Chelan PUD tags 2005-2007).

From 2005 to 2008, 25 downstream passage events and 52 upstream passage events by 40 individual bull trout were recorded at Wells Dam. Of these, 17 downstream and 41 upstream passage events occurred within one year of tagging and release. Of all tags released from 2001 to 2004, there were 2 downstream passage events and 41 upstream passage events. Of these, 2 downstream and 38 upstream passage events occurred within one year of release. The take estimates for the Wells Project were based upon the number of unique upstream and downstream passage events that took place within one year each bull trout being tagged and release. During

the six year study and eight years of monitoring, 19 downstream and 79 upstream passage events took place at Wells Dam by radio-tagged bull trout within one year of release. Taking into account all observed passage events a total of 27 downstream and 93 upstream passage events took place at Wells Dam. Radio-tagged bull trout passed downstream through the turbines or spillways as no downstream passage events were recorded via the fishways. Out of the 19 downstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project. Out of the 79 upstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project.

Upstream passage of adult bull trout through the fish ladders at Wells Dam has historically occurred between early May and late October, with peak passage typically occurring in May and June. During the 2005 and 2008 study, 214 adult bull trout were counted passing upstream through Wells Dam. The proportion of the bull trout population at Wells Dam that was radiotagged was 24% ( $52/214 = 0.24$ ).

Project operations did not appear to influence the movements of adult bull trout. Instead, adult bull trout passage events appeared to be more closely associated with water temperature, photoperiod and time of year with rather predictable patterns of upstream and downstream movement. Because no take (injury or mortality) was observed during the study, there was no need to investigate how Project operations affected take at Wells Dam.

During the 2005-2008 monitoring period, no adult bull trout were counted during the 24-hour off-season fishway counting period (November 16 to April 30).

No upstream or downstream passage problems were identified during this study. Passage times upstream through the fishway appeared reasonable relative to the species migration and spawn timing. Because no passage problems were identified during the study, there was no need to develop recommendations to change or modify the fishway operations at Wells Dam.

The second objective was to assess project-related impacts on upstream and downstream passage of sub-adult bull trout (fish <400 mm in length). During the development of the Bull Trout Plan, stakeholders agreed that because of the inability to collect a sufficient sample size of sub-adult bull trout at Wells Dam, it was not feasible to assess sub-adult passage. However, when encountered at Wells Dam, or in tributary traps, sub-adult bull trout would be PIT tagged. Douglas PUD provided funding, equipment, training, and coordination for the sub-adult bull trout PIT tag program. From 2004 to 2008, 67 sub-adult bull trout were PIT tagged in the Methow River sub-basin during standard tributary smolt trapping operations. Douglas PUD operated PIT tag detection systems year-round within the Wells Dam fishways during the study period (2005 to 2008) and no PIT tagged sub-adult bull trout were detected. Additionally, subadult bull trout were to be PIT tagged opportunistically when encountered at the Wells Project; however, no sub-adult bull trout were encountered at Wells Dam during the study period.

Off-season (November 16 to April 30) video monitoring of the Wells Dam fishways for subadult bull trout was conducted during each of the years of this study including the winter of 2004 and 2005 as required by the Bull Trout Plan. Additional off-season counting took place during the

winters of 2006 and 2007. To date, no sub-adult bull trout have been observed utilizing the fishways at Wells Dam.

The third objective was to investigate the potential for sub-adult entrapment or stranding in offchannel or backwater areas of Wells Reservoir. Field surveys were conducted at potential bull trout stranding sites during a period of low reservoir elevation. High resolution bathymetric information, reservoir elevations, backwater curves, and inflow patterns were used to identify potential stranding sites for the survey. No stranded or entrapped bull trout of any size were found during the field surveys conducted in 2006 and 2008. No surveys were conducted during 2005 or 2007 because river operations were not low enough to warrant a survey.

The fourth objective was to identify the core areas and local populations of bull trout that utilize the Wells Project. Data from radio-tagged bull trout tracked during the 2005 to 2008 study period were analyzed with data from the 2001 to 2004 study. Bull trout that pass Wells Dam (either upstream or downstream) migrated into the Methow, Entiat, and Wenatchee rivers during the spawning period. Observed tributary entrances of bull trout detected at Wells Dam from 2005 to 2008 were 86% Methow River, 10% Entiat River, and 2% Wenatchee River. Genetic samples of all fish tagged at Wells Dam were submitted to the USFWS for analysis. The USFWS is responsible for analyzing the genetic samples and providing those results. To further support this objective (Strategy 4-2: Work cooperatively with other agencies to obtain locations of radio-tagged fish outside the project area), Douglas PUD regularly coordinated bull trout data and monitoring activities with other agencies including the USFWS, and CCPUD). In summary, no mortality or injury was observed for bull trout (adult and sub-adult) passing through or interacting with the operations of the Wells Project during the take monitoring studies conducted between 2001 and 2008. No incidental take of bull trout was observed at the Wells Project, and the Wells Project is presumed to be within the incidental take levels authorized by the USFWS Biological Opinion Incidental Take Statement.

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(with [Hyperlinks to online reports](#))

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