U.S. Fish and Wildlife Service

Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout

Data Synthesis and Analyses

Final Report

April 6, 2016

Study funded by:

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On the cover: *Threatened bull trout use critical habitat in the mainstem Columbia and Snake rivers to forage, migrate and overwinter. The cover photograph depicts the Twin Sisters rock formation on the shores of the mainstem Columbia River at Wallula Gap near the mouth of the Walla Walla River. Photograph by Ryan Koch (FWS).*

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Executive Summary

Bull trout (*Salvelinus confluentus)* are listed as threatened under the Endangered Species Act (ESA) throughout their range. This synthesis was developed to answer the following three questions regarding their use of the mainstem Columbia and Snake rivers:

1) Do bull trout from subbasin tributary populations migrate to mainstem areas of the Columbia or Snake rivers, and if so, when?

2) If migratory bull trout enter the mainstem Columbia or Snake rivers, what is the temporal and spatial extent of their migrations?

3) Do Federal Columbia River Power System (FCRPS) dams and reservoirs and their associated operation affect bull trout in the mainstem Columbia and Snake rivers?

Connectivity between tributary subbasins and within the mainstem Columbia and Snake rivers is essential to maintain genetic exchange amongst core area populations, to provide resiliency against environmental and anthropogenic perturbations, and to provide a high likelihood for viability and recovery of these bull trout populations. We define connectivity as the maintenance of suitable stream conditions that allow bull trout to move freely upstream and downstream with habitat linkages (i.e., corridors) that connect to other habitat areas. Providing opportunities to disperse by eliminating impediments to migration and improving migratory corridor habitat conditions is critical for maintaining genetic diversity and the persistence of bull trout local populations and metapopulations, particularly considering the anticipated future conditions associated with climate change.

In summary, bull trout clearly enter the mainstem of the Columbia and Snake rivers, they exhibit movements in these mainstem areas, and they interact with the mainstem dams and reservoirs. Taken together, these movements and interactions occur at all times of the year, and across a broad spatial scale. Existing work should be continued, and new studies are needed to better describe bull trout movements between the various subbasins and the FCRPS in the Columbia and Snake rivers.

This report reviews, analyzes, and synthesizes empirical data and anecdotal information on bull trout use of the mainstem Columbia and lower Snake rivers (hereafter referred to as the “mainstem”). This information and these findings may be useful for informing, in part, ESA Section 7 consultations that involve bull trout as well as recovery planning under Section 4 of the ESA for this threatened species. Within the mainstem, we describe the potential impacts of hydroprojects, their configuration and operations, and associated impoundments on bull trout that use the mainstem. For this assessment, we first discuss what is currently known about bull trout movements, migrations, and mainstem use by tributary subbasin. Bull trout interactions with nine mainstem dams and associated impoundments that are operated under the FCRPS are also described. To synthesize mainstem use as completely as possible and to help inform inferences about potential interactions between bull trout and the mainstem dams and impoundments, and the effects of the dams and impoundments on bull trout life history and connectivity, data and analyses for bull trout interactions with non-FCRPS mainstem projects (e.g., mid-Columbia River) were also considered in this report. In addition to summarizing existing data, we identify critical information gaps that potentially limit the ability to manage and recover bull trout. We also provide recommendations for future research, monitoring, and evaluation that could be useful for tracking the status of connectivity, as well as implementation of actions for restoring connectivity where needed within the assessment area.

Bull trout across their native range exhibit a continuum of life histories involving movements, migrations, spawning, rearing and foraging on time scales ranging from daily to annually or longer, and over different spatial scales. Migratory fish can be exposed to a spectrum of anthropogenic impacts in the mainstem corridors within the Columbia or lower Snake rivers. Some of these conditions may impede migration and connectivity. Although we have attempted to synthesize most of the existing information on migratory bull trout, there are large gaps in our knowledge resulting from the absence of data for many of the populations, and in many of the subbasins. Following is a summary of information available for bull trout populations from 18 subbasins, their movement patterns, and use of the mainstem by migratory individuals.

Do bull trout from subbasin tributary populations migrate to mainstem areas of the Columbia or Snake rivers, and if so, when?

- Local populations of bull trout occur within at least 16 of the 18 subbasins we reviewed (henceforth, subbasin populations). Within each of the 16 subbasin populations, at least one local population (often multiple local populations) has a migratory component.

- Empirical evidence exists suggesting bull trout from nine (56%) of the 16 subbasin populations use the mainstem. Bull trout from eight (50%) of the 16 subbasin populations have been directly observed in the mainstem.

- The number of bull trout migrating to the mainstem has been quantitatively estimated in only the Walla Walla, Tucannon, and Imnaha subbasins.

- In general, subadult bull trout migrate from their respective subbasins to the mainstem primarily during the fall/winter (October – February), and to some extent during the spring/early summer (April – June).

- Adult bull trout migrate from their respective subbasins to the mainstem primarily in the fall, following the spawning period. Migration to the mainstem generally occurs from October through December, but continues through February from subbasins where data are readily available. Movement from some subbasins to the mainstem has been documented during other months, but observations of these movements were less common.

If migratory bull trout enter the mainstem Columbia or Snake rivers, what is the temporal and spatial extent of their migrations?

- Both adult and subadult bull trout were observed within the mainstem Columbia and lower Snake rivers during all months of the year.

- Observations of movements within the mainstem were most common during spring/summer (March-September) for both adult and subadult bull trout, although less frequent observations of movements occurred from October-December.

- With a few exceptions, the movements and disposition of most migratory bull trout that enter the mainstem are unknown. The most robust mainstem movement data sets available are for Imnaha River bull trout in the lower Snake River and Wenatchee, Entiat and Methow River bull trout in the mid-Columbia River.

- Studies of acoustic-tagged individuals in the mainstem Columbia River indicated bull trout utilized deep, slow water habitat. Because of the limited information, it is unclear whether bull trout use other habitat types (e.g., near-shore, shallow water habitat).

- Limited acoustic telemetry data involving bull trout from the Walla Walla River Subbasin suggest bull trout that overwinter within the mainstem may not establish a fixed winter range, but instead continuously move throughout the corridor.

- Available information for bull trout from the Imnaha River Subbasin suggests they move very little in the mainstem of the lower Snake River during the winter (December-February) and demonstrate high fidelity to their mainstem overwintering sites from year to year.

- Radio-tagged adult bull trout from mid-Columbia subbasins exhibited a wide range of behaviors while overwintering in the mainstem. Most fish moved downstream from their respective subbasins once they entered the Columbia River, but some moved upstream. Some demonstrated high fidelity to overwintering locations from year to year while others had no discernible pattern. Subadults from mid-Columbia River subbasins can spend multiple years utilizing foraging, migration and overwintering habitat in the mainstem before ascending tributaries to spawn as adults.

- The upstream and downstream range of mainstem movements for bull trout from many of the subbasins is largely unknown. Individuals have been observed migrating through the mainstem corridor as far as 240 river kilometers (rkm) downstream and 130 rkm upstream from the mouth of their natal subbasin.

- Use (in linear distance) of the mainstem by bull trout has been documented in 63% of the lower Columbia River reach, 93% of the mid-Columbia River reach, and 100% of the lower Snake River reach.

- Upstream movements within the mainstem corridor were most commonly observed during the spring and summer from March – September, although less frequent observations also occurred from October – December. Downstream movements within the mainstem occurred during all seasons and months.

- Adult bull trout overwintered in the mainstem from October – February following spawning, with little movement after reaching overwintering locations. From March – July, adult movements in the mainstem were typically upstream, back towards subbasin spawning areas.

- Observations of subadult bull trout movements within the mainstem were most common during the spring/early summer (March – July). Observations were less common during the fall/winter time period (October – February). This could have been a function of reduced monitoring, unavailability of passage routes at the mainstem dams, or fewer movements while overwintering.

- Bull trout were observed moving from the mainstem into tributary subbasins primarily during the spring and early summer months. Of the bull trout that returned from the mainstem, most entered their natal streams, but some individuals occasionally ascended non-natal tributaries, potentially connecting (genetically) with other local populations.

- Bull trout have also been observed moving from the mainstem into non-natal subbasins during the fall. Some individuals overwintered in these subbasins, but whether they remained there into the next spring/summer is unknown.

- Generally, the movement of bull trout between subbasins appears to decrease as the distance between subbasins increases. However, bull trout have been documented moving up to 240 rkm in the mainstem Columbia River migratory corridor before entering non-natal subbasins.

- Observations of bull trout moving from one subbasin to another were less frequent when a greater number of mainstem dams were present within the migration corridor between the subbasins. However, the number of observations was small and migratory behavior and biological factors may influence connectivity (or not) as the distance between subbasin populations increases.

- Based on PIT tag detection and genetic data, bull trout movement from an upstream subbasin to a downstream subbasin is more commonly observed than from a downstream subbasin to an upstream subbasin.

Do FCRPS dams and reservoirs and their associated operation affect bull trout in the mainstem Columbia and Snake rivers?

- Empirical evidence confirms bull trout interact with all 13 of the mainstem dams with fish passage facilities. Bull trout have passed both downstream and upstream through all of these mainstem dams.

- Chief Joseph and Hells Canyon dams lack fish passage facilities and are barriers to upstream movement of bull trout. However, the presence of migratory bull trout in the relative vicinity of both dams suggests that bull trout interact with theses dams as well. These interactions do not include the opportunity for upstream migration.

- Migratory bull trout from seven (44%) of the 16 subbasin populations have had confirmed interactions with mainstem dams. Bull trout from all but one (86%) of these seven subbasin populations (Hood River) have interacted with more than one mainstem dam, and bull trout from two (29%) of the seven subbasin populations (Entiat River and Tucannon River) had interactions with five hydroprojects.

- Considering that passage facilities at the mainstem dams were designed for anadromous salmonids, it is unknown whether these facilities are entirely suitable for migratory bull trout. They may delay or possibly discourage bull trout from freely moving throughout critical habitat in the mainstem, and they may also impede bull trout dispersal between subbasins.

- There have been changes in FCRPS hydropower project configurations and operations in recent years, including changes to passage routes, spring and summer spill operations, PIT tag detection facilities, and counting dates and procedures. Most of these changes have been implemented to benefit anadromous fish. The benefit of these configurations and operations for bull trout is largely unknown.

- Multiple lines of evidence confirm that bull trout encounter dams throughout the mainstem and at least a portion of those bull trout successfully pass upstream or downstream through the dams; however it is unknown to what extent bull trout attempt to pass the dams and fail, or if fish are injured or impacted while attempting to pass. Bull trout survival associated with the various upstream and downstream passage routes is poorly understood at all FCRPS hydropower projects.

- Downstream migration and passage timing for bull trout includes the time period when the juvenile fish bypass systems are shut down, leaving the turbines and adult fish ladders as the primary downstream passage routes. Turbine passage success and survival for bull trout have not been evaluated.

- Downstream passage delay has been observed in the bypass systems at two FCRPS hydroprojects. Bull trout were delayed on the separators at McNary and Little Goose dams for time periods ranging from 17 hours to 16 days. These delays occurred for 25% of the downstream passage events for PIT-tagged bull trout at FCRPS projects.

- Only 9% of PIT-tagged bull trout passing upstream through FCRPS fish ladders were delayed. Two projects (Little Goose, Lower Granite) have a single fish ladder, and when winter maintenance is conducted in January and February, upstream passage is not possible. Since bull trout are present in the mainstem during this time period, any attempt to migrate upstream will be delayed.

- Upstream passage and delay for adult bull trout have been assessed at multiple hydropower projects in the mid-Columbia River reach of the mainstem. The assessments were based on three separate telemetry studies conducted 10 years apart with a relatively small sample of radio-tagged individuals. The conclusions were that those hydropower projects did not appear to affect the survival of adult bull trout, but the presence of the dams may have slowed migration times. Similar information is lacking for FCRPS dams throughout the mainstem. Relatively short delays at mainstem dams may delay bull trout entry into tributaries and cause bull trout to miss their migration window to successfully reach headwater spawning areas in some subbasins.

- FCRPS dams and their respective impoundments have altered the natural hydrograph and riverine habitats that historically provided seasonal environments for migratory bull trout to forage and overwinter. Relative to historic conditions, the mainstem now consists of slow velocity, seasonally warm-water reservoirs, and it is unclear if and how these conditions may affect bull trout. Although the reservoirs could potentially provide seasonal environments where bull trout can continue to forage and overwinter, physical conditions and species composition have changed, and it is unknown whether or not these changes are beneficial for bull trout growth and survival.

- The Juvenile Fish Transportation Program which was designed to transport juvenile anadromous fish from the Snake River downstream past multiple FCRPS hydroprojects from April – September/October, could be inadvertently transporting bull trout to locations downstream from Bonneville Dam. Bull trout have been observed in condition samples that were destined for barges or trucks at the three lower Snake River transport projects. The observed fish along with any additional bull trout diverted with juvenile anadromous fish for transport during non-sampling periods may be lost to their population of origin.

- The survival of bull trout following upstream passage at the FCRPS mainstem dams has not been evaluated. Observations of PIT-tagged bull trout detected in FCRPS fish ladders indicated 27% were never detected again at any location, and they may not have survived their passage events. Survival of bull trout passing upstream of mid-Columbia PUD hydroprojects was investigated using radio telemetry and conclusions were that no adult bull trout were killed. Post-passage survival was not specifically evaluated.

- The survival of bull trout following downstream passage at the FCRPS mainstem dams has not been investigated. Observations of PIT-tagged bull trout detected in FCRPS juvenile bypass systems indicated 62.5% were never detected again at any location, and may not have survived their passage events. The survival of any bull trout that pass downstream through other available passage routes has not been evaluated, including passage through the turbines during winter. Survival of adult bull trout passing downstream of mid-Columbia PUD hydroprojects was investigated using radio telemetry and no mortalities were documented.

- Whether seasonal mainstem FCRPS reservoir habitat conditions affect bull trout survival has not been specifically assessed.

- Data to directly estimate survival in the mainstem for bull trout is lacking. However, for bull trout in the Walla Walla River Subbasin, evidence exists suggesting the majority of individuals that enter the mainstem (McNary Reservoir) may not survive to return to the subbasin.

- The impact on bull trout by aquatic predators (e.g., northern pikeminnow, walleye and smallmouth bass) that have become more widespread and abundant in the lacustrine habitats that are characteristic of the mainstem impoundments has not been investigated.

- Bull trout that enter the mainstem FCRPS impoundments may be consumed by avian predators, but this has not been specifically evaluated. Similar to concerns about avian predation on salmonid smolts, the predation rate on bull trout may be unusually high because of the high number of avian predators in the reservoir environment. From 2007-2014, 7% of the PIT-tagged bull trout that entered McNary Pool from the Walla Walla River Subbasin were consumed by avian predators.

Conclusions and Research, Monitoring, and Evaluation Needs

Bull trout clearly enter the mainstem Columbia and Snake rivers, they exhibit extensive movements in these mainstem areas throughout the year, and they interact with the dams and reservoirs. Our collective knowledge and understanding regarding use of the mainstem FCRPS corridor by bull trout, and potential impacts associated with the dams and reservoirs of the FCRPS are limited. Conclusions and research, monitoring, and evaluation needs resulting from this synthesis are listed below. We believe the information identified in this report will inform the prioritization of these needs.

Subbasin Populations and Use of the Mainstem by Migratory Bull Trout

Conclusions

Most (56%) of the subbasins with known bull trout populations contain migratory individuals that migrate to the mainstem Columbia or Snake rivers.

Subadult bull trout migrated from their respective subbasins to the mainstem primarily during the fall/winter (October – February), and to a lesser extent during the spring/early summer (April – June). Adult bull trout migrated from their respective subbasins to the mainstem primarily in the fall following the spawning period (October – December), but also continuing into January and February.

The temporal and spatial aspects of migratory bull trout movements from their respective subbasins into the mainstem need a more quantitative, comprehensive description to identify the relevant mainstem reaches for further study.

Research, monitoring, and evaluation needs

- Develop annual abundance estimates of mainstem migrant bull trout for all subbasins with sufficient numbers of migrants.

- Describe the temporal aspects of bull trout migration to and from the mainstem for subbasins where such data are lacking.

- Develop a marking program (e.g., PIT tags) within each of the subbasins with sufficient numbers of migratory bull trout to estimate survival back to the subbasin, and to document connectivity to other subbasin populations of bull trout.

- Collect genetic samples from "unknown" migratory bull trout that enter any particular subbasin to establish population of origin.

- Review and evaluate the PIT detection array infrastructure in lower subbasin areas and determine whether existing sites should be improved, and whether additional sites are needed to track movements of PIT-tagged bull trout.

Temporal and Spatial Aspects of Bull Trout Migrations within the Mainstem

Conclusions

Both adult and subadult bull trout were observed within the mainstem Columbia and lower Snake rivers during all months of the year.

Bull trout movements within the mainstem occured primarily during the spring/summer (March – September), but also during the fall/early winter (October – December).

Adult bull trout overwintered in the mainstem from October – February following spawning, with little movement after reaching overwintering locations. From March – July, adult movements in the mainstem were typically upstream, back towards subbasin spawning areas.

Subadult bull trout movements within the mainstem occurred primarily during the spring/early summer (March – July), but also during the fall/winter (October – February).

Bull trout migrated through the mainstem corridor as far as 240 river kilometers (rkm) downstream and 130 rkm upstream from the mouth of their natal subbasins. Mainstem use has been documented for 63% – 100% (longitudinal distance) of the three mainstem Columbia and Snake river study reaches.

Research, monitoring, and evaluation needs

- Determine movement patterns and the spatial extent of bull trout migrations within the mainstem.

- Describe physical habitat use for migratory bull trout within the mainstem, and develop habitat suitability (preference) criteria based on habitat use observations and habitat availability.

- Modify passage monitoring for bull trout in the FCRPS mainstem fish ladders. During the active monitoring season when fish counters are not present (e.g. 2000 – 0400 hours), record video and quantify the number of bull trout. During the non-active monitoring season when fish counters are not present, record video 24 hours/day and quantify the number of bull trout.

- Determine the routes used for downstream passage at mainstem FCRPS dams by migratory bull trout seasonally, when different routes for passage are available, including downstream passage through fish ladders.

- Develop a PIT tag marking program for all migratory bull trout handled in the mainstem to provide movement information from the array of PIT detection sites at the mainstem dams and within many of the subbasins.

- Determine the population of origin for all migratory bull trout handled within the mainstem at FCRPS dams and in FCRPS reservoirs using genetic information from samples (e.g., fin clips).

Interactions and Potential Effects of Mainstem Dams and Impoundments and their Operations on Bull Trout in the Mainstem

Conclusions

Bull trout interact with all 13 of the mainstem dams with fish passage facilities. Bull trout have passed both downstream and upstream through all of these mainstem dams.

Bull trout upstream passage through FCRPS fish ladders showed little delay. Because two of the FCRPS hydroprojects have only a single fish ladder, upstream passage for bull trout during winter maintenance is not possible.

Over one quarter of the tagged bull trout that passed upstream through FCRPS fish ladders were never observed again, and they may not have survived following their passage events.

Bull trout move downstream throughout the mainstem Columbia and Snake rivers during fall and winter months when spill and bypass options are limited or not available, and fish ladders or turbines are the primary passage routes.

Downstream passage delay can occur on the separators in the juvenile bypass systems at FCRPS hydroprojects. Passage delays were observed for one quarter of the total bull trout downstream passage events through the bypass systems.

Nearly two thirds of the tagged bull trout that passed downstream through FCRPS juvenile bypass systems were never detected again, and they may not have survived their passage events.

Although bull trout have been observed to successfully pass upstream or downstream through the mainstem dams, it is unknown to what extent they attempt to pass the dams and fail, or if they are injured or impacted while attempting to pass.

Bull trout have been observed in the sampling facilities at juvenile bypass systems at lower Snake River transport projects and some unknown number are likely transported via barge or truck to locations downstream from Bonneville Dam as part of the juvenile salmonid transportation program. These individuals may be lost to their population of origin.

Bull trout that enter the mainstem FCRPS impoundments may be consumed by avian predators. Avian predation (e.g., cormorants, pelicans, terns, gulls) affects survival of bull trout from multiple populations, and although there has been documentation of numerous incidents of avian predation on bull trout, the impact has not been quantified.

Research, monitoring, and evaluation needs

- Determine whether the physical and hydraulic conditions within the FCRPS mainstem dam fish ladders, approaches to the ladders and conveyance channels, and within conveyance channels leading to fish ladder entrances are suitable for bull trout.

- Determine passage efficiency and movement patterns within FCRPS mainstem dam fish ladders and conduct an evaluation of passage delay for migratory bull trout.

- Evaluate options for providing upstream passage for bull trout during the winter at Little Goose and Lower Granite dams.

- Evaluate survival following FCRPS fish ladder passage for migratory bull trout.

- Evaluate downstream passage success, delay, and survival for the various routes available to migratory bull trout at mainstem FCRPS dams.

- Considering the presence and downstream movement of bull trout in the mainstem during the winter when the juvenile bypasses are closed, and the frequent bottom orientation associated with bull trout behavior, studies should be designed to evaluate turbine passage survival at the mainstem FCRPS dams including any associated injuries.

- Review and evaluate the PIT detection array infrastructure at mainstem dams and determine whether existing sites should be improved, and whether additional sites are needed to track movements of PIT-tagged bull trout.

- Evaluate protocols for handling fish on the separators at each dam to avoid passage delay at these locations, and revise protocols to include reporting of bull trout observations.

- Include reporting of bull trout observations during condition sampling for transport of juvenile fish, and evaluate options for avoiding transport of bull trout.

- Describe water temperature conditions horizontally as well as vertically in the FCRPS mainstem reservoirs, including at locations used by migratory bull trout. Describe seasonal fish ladder water temperatures at FCRPS hydroprojects.

- Conduct an evaluation of predation by piscivorous avian predators (e.g., pelicans, cormorants, terns) from mainstem nesting colonies on migratory bull trout. These studies should specifically address the spatial and temporal nature of predation both in the mainstem and within the subbasins.

- Determine overall survival of migratory bull trout in the FCRPS, including dam passage and reservoir survival components.

Introduction

Bull trout (*Salvelinus confluentus*) populations comprising the Columbia River Distinct Population Segment (DPS) were listed as threatened under the Endangered Species Act in June 1998 (63 FR 31647) in response to a general decline in abundance across their native range. The U.S. Fish and Wildlife Service (FWS) Biological Opinion on Effects to Listed Species from Operations of the Federal Columbia River Power System (FCRPS) (USFWS 2000) and the Recovery Plan (USFWS 2015) acknowledge the importance of connected mainstem habitats for successful overwintering survival and dispersal among core areas. Both documents specifically discuss the need for monitoring and research on bull trout use of foraging, migration and overwintering habitat (FMO) in the Columbia and Snake rivers. The mainstem Columbia and lower Snake rivers and a portion of their tributary subbasins were designated as critical habitat for bull trout in 2010 (USFWS 2010), and the designation included both FMO and spawning/rearing habitat. Both habitat types contain features essential for the conservation of bull trout and may require special management and protection. Specifically, FMO habitat provides food and other nutritional or physiological requirements, connectivity among existing bull trout populations, and overwinter cover and/or shelter. The FWS' recovery plan intends to remove threats and ensure an adequate number of sufficiently large, genetically sound and diverse populations exist to withstand stochastic and catastrophic events. Connectivity both within mainstem habitats and between mainstem and subbasin habitats is required to make progress towards the recovery of bull trout. For this assessment, we define connectivity as the maintenance of suitable stream conditions that allow bull trout to move freely upstream and downstream with habitat linkages that connect to other habitat areas (Schaller et al. 2014). We assessed connectivity from two perspectives: (1) connectivity within the migratory corridor (i.e., allowing for unrestricted migration and the full expression of life history strategies and (2) connectivity (i.e., dispersal) among core area populations (Schaller et al 2014). All mainstem Columbia and Snake river dams, including those that comprise the FCRPS, have the potential to affect bull trout connectivity within migratory corridors and between core areas (metapopulations). Dams lacking sufficient, suitable upstream and downstream passage for bull trout may impede migration and contribute to the isolation of historically connected populations and a reduction in opportunities for recolonization in areas where bull trout populations have been extirpated. In addition, dams and their impoundments have altered the natural hydrograph and riverine habitats used historically by migratory bull trout, resulting in slow velocity and at times, warm-water reservoirs compared to natural river conditions (Keefer et al. 2004; Petrosky and Schaller 2010). These altered habitats may affect migration timing, and they are more suitable for avian and aquatic predators and competitors (Williams et al. 2005; Ferguson et al. 2005) than they were historically.

When the FWS' Biological Opinion was published in 2000, information on bull trout use of the lower Columbia and Snake rivers (hereafter referred to as "the mainstem") and the potential effects of the FCRPS on bull trout were very limited. Few studies had been conducted specifically to address the magnitude and timing of use of the mainstem by bull trout, and no studies had been conducted to assess the potential impacts of the FCRPS on bull trout. Since the Biological Opinion was published, new information has been collected on bull trout in the mainstem. In recent years, the FWS' Columbia River Fisheries Program Office (CRFPO), Mid-

Columbia River Fishery Resource Office (MCRFRO) and Idaho Fishery Resource Office (IFRO), along with other agencies and entities, have been conducting research, monitoring and evaluation studies to directly and indirectly assess migratory bull trout use of the mainstem (BioAnalysts 2004,2009; Faler 2008; Nelson and Nelle 2008; Bretz 2011; Anglin et al. 2010; Barrows et al. 2012a, 2012b, 2014a; Nelson and Johnsen 2012; Nelson 2014; Idaho Power Company [IPC], personal communication). Observations at mainstem hydroprojects, PIT array detections, and genetic assignment studies have also contributed to the pool of new information available to managers. Additional incidental and anecdotal information on migratory bull trout resulting from studies targeting anadromous species also exists throughout the DPS. Despite recent efforts and new information, the spatial extent of migration for many bull trout populations in the DPS and the extent to which migratory bull trout use the mainstem remain largely unknown.

The catalyst for this report was the impending re-initiation of consultation on effects of the FCRPS on bull trout. The report itself is intended to be a compendium on bull trout in the Columbia River Basin; what is known, data gaps, and potential issues relevant to the recovery of the species. At the time the Final Bull Trout Recovery Plan was finalized, the necessary information was lacking to characterize whether threats in the mainstem Columbia and Snake rivers would be primary threats to the persistence of bull trout at the core area level (USFWS 2015). The information and synthesis in this report will help inform the characterization of those threats in the future. One of the primary purposes of this synthesis is to identify research needs to help reduce the data gap in what is known about bull trout and use of the mainstem Columbia and Snake rivers so efforts can be focused on the relevant factors to make progress towards recovery. Herein, we synthesize existing data on migratory bull trout for core areas and local populations in the Columbia and Snake rivers downstream from Chief Joseph and Hells Canyon dams, respectively. Core areas and local populations were first defined in the Draft Recovery Plans developed between 2002 and 2004. Since then, a wide array of research has occurred, and a larger body of information on bull trout life history, ecology, and distribution has accumulated. In addition, a status review was conducted in 2008 (USFWS 2008b) that included additional information on the distribution and status of bull trout. Much of this new information is reflected in the Recovery Plan (USFWS 2015). However, core area and local population definitions continue to be refined as new information is generated from ongoing research. In this document we use the best available information to identify the core areas and local populations in each of the subbasins. This information includes the Recovery Plans, relatively new research, and on-the-ground information from local biologists. River locations are used throughout this synthesis to describe the spatial orientation of various natural features, man-made features, monitoring locations, and attributes of bull trout migration patterns. Data and analyses for bull trout interactions with non-FCRPS projects (i.e., mid-Columbia River) are included to provide a more complete synthesis of mainstem use and to help make inferences about potential interactions between bull trout and the FCRPS projects, and the effects of the FCRPS on bull trout life history and connectivity. In addition to summarizing the existing data, we identify information gaps and research needs that potentially limit our ability to effectively manage bull trout, to guide and design future research, and to implement actions to make progress towards recovery. We believe the information identified in this report will inform the prioritization of these needs.

This synthesis of information has been broadly organized around the following three fundamental questions:

1) Do bull trout from subbasin tributary populations migrate to mainstem areas of the Columbia or Snake rivers, and if so, when?

2) If migratory bull trout enter the mainstem Columbia or Snake rivers, what is the temporal and spatial extent of their migrations?

3) Do FCRPS dams and reservoirs and their associated operation affect bull trout in the mainstem Columbia and Snake rivers?

Study Area

Chief Joseph and Hells Canyon dams mark the upstream bounds of fish passage on the mainstem Columbia and Snake rivers, respectively. There are bull trout populations upstream of Hells Canyon Dam on the Snake River and bull trout are occasionally observed upstream of Grand Coulee Dam in Lake Roosevelt (USFWS 2015). Fish passage downstream from the abovementioned dams to the Pacific Ocean is possible. For this review, we included information on migratory bull trout from 18 subbasins upstream from Bonneville Dam (Figure 0.1). We did not include information on migratory bull trout from tributaries such as the Lewis River that support migratory bull trout, but enter the Columbia River downstream from Bonneville Dam. We also describe the configuration, operations, and documented interactions between 14 mainstem Columbia and Snake River dams (including their respective impoundments) and migratory bull trout (Figure 0.2). River kilometers (rkm) are the unit of measure used, and the format that describes a specific location consists of a series of digits and decimals as follows: "xxx.xxx.xxx". The first series of three digits represents the distance from the mouth of the Columbia River to a location in the Columbia River. For example, Bonneville Dam is located at rkm 234, Priest Rapids Dam is located at rkm 639, and the mouth of the Snake River is located at rkm 522. The second series of three digits represents a location in any tributary that flows into the Columbia River. For example, Little Goose Dam is located at rkm 522.113 (mouth of the Snake River at Columbia rkm 522, and Little Goose Dam at Snake rkm 113). The third series of digits represents a location in a stream that flows into a tributary of the Columbia River. For example, the mouth of the Wenaha River is located at rkm 522.271.074 (mouth of Snake River at Columba rkm 522, mouth of the Grand Ronde River at Snake rkm 271, and mouth of the Wenaha River at Grande Ronde rkm 74.

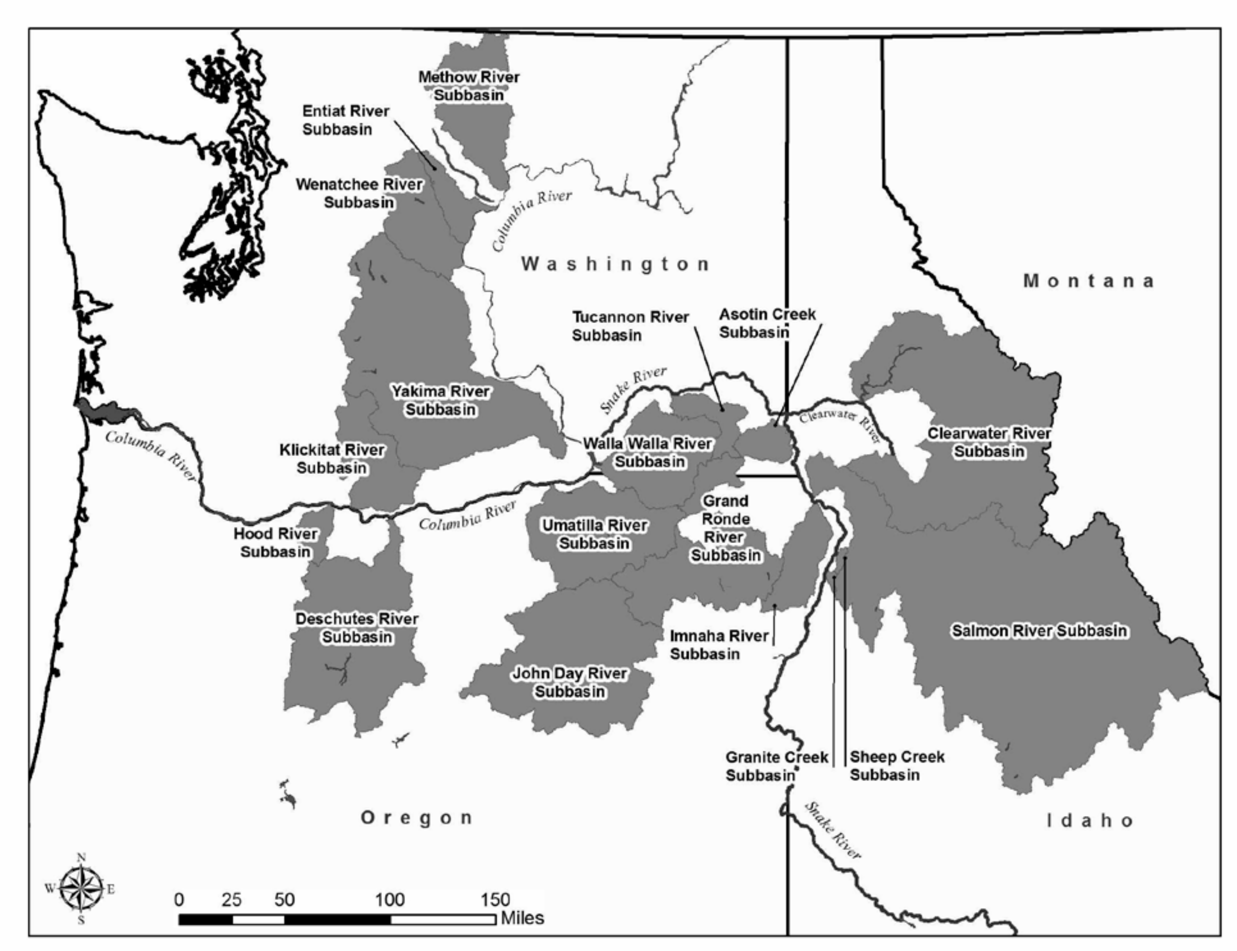

Figure 0.1. Eighteen subbasins that were reviewed to identify which of the Columbia and Snake river tributaries contain migratory populations of bull trout that may use the mainstem.

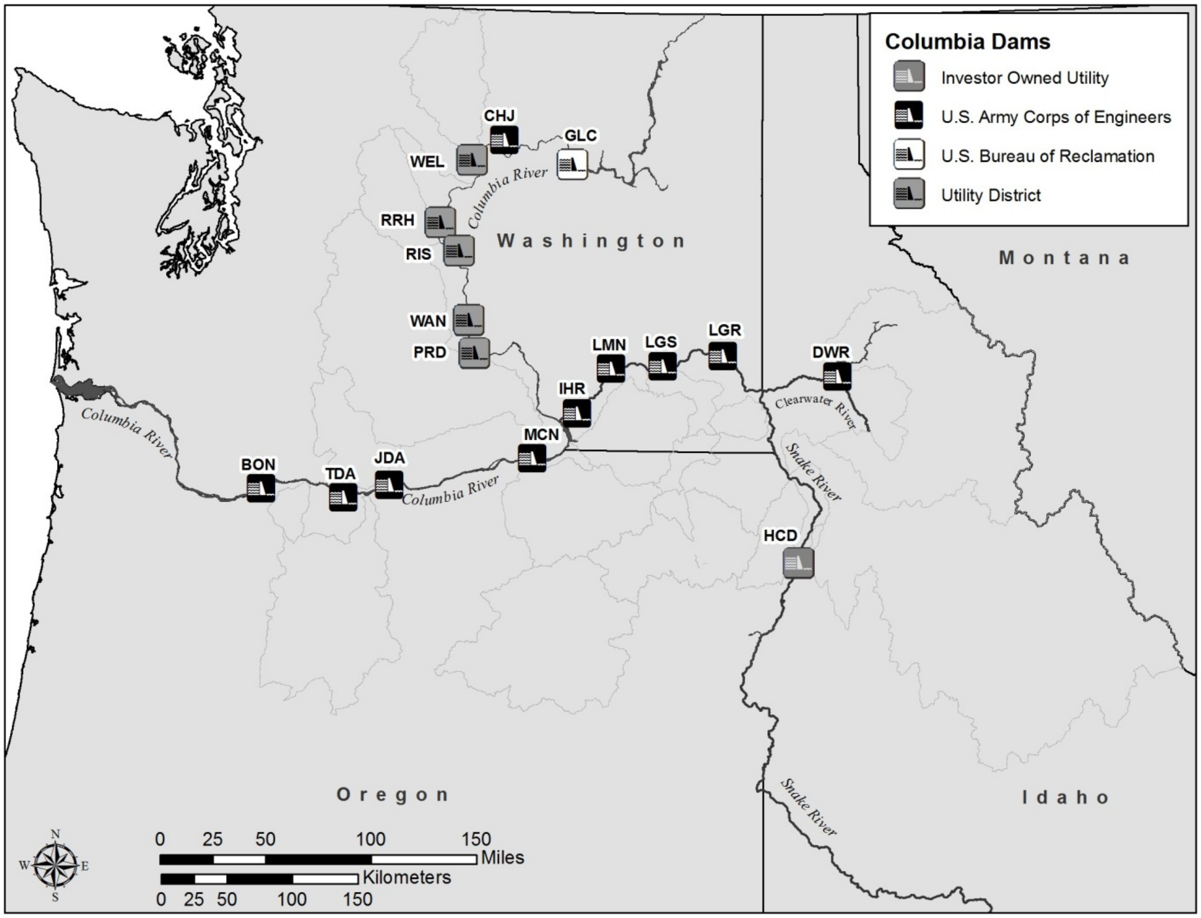

Figure 0.2. Columbia River Basin overview with locations of the mainstem FCRPS dams (U.S. Army Corps of Engineers and Bureau of Reclamation) along with public utility district dams. (BON = Bonneville Dam, TDA = The Dalles Dam, JDA = John Day Dam, MCN = McNary Dam, IHR = Ice Harbor Dam, LMN = Lower Monumental Dam, LGS = Little Goose Dam, LGR = Lower Granite Dam, CHJ = Chief Joseph Dam, GLC = Grand Coulee Dam, PRD = Priest Rapids Dam, WAN = Wanapum Dam, RIS = Rock Island Dam, RRH = Rocky Reach Dam, WEL = Wells Dam, and HCD = Hells Canyon Dam).

We organized the study area into three reaches, the lower Columbia, mid-Columbia and lower Snake rivers. Descriptions of each study area reach are as follows.

Lower Columbia River

We defined the lower Columbia River reach as the 405 river kilometers (rkm) upstream from Bonneville Dam (rkm 234) to the tailrace of Priest Rapids Dam (rkm 639) (Figure 0.2). This entire reach is designated as critical habitat (FMO) (USFWS 2010). Major tributaries within this reach where known bull trout local populations currently exist include the Yakima (rkm 539), Walla Walla (rkm 509), Umatilla (rkm 465), John Day (rkm 351), Deschutes (rkm 330), Klickitat (rkm 290) and Hood rivers (rkm 273). Federal hydroprojects within this reach include McNary Dam (rkm 470), John Day Dam (rkm 347), The Dalles Dam (rkm 308), and Bonneville

Dam (rkm 234). The Hanford Reach is the approximately 82 rkm portion of the Columbia River downstream from Priest Rapids Dam and is the only unimpounded, non-tidal stretch of the Columbia River in the United States.

Mid-Columbia River

The mid-Columbia River reach extends 238 rkm upstream from Priest Rapids Dam (rkm 639) to Chief Joseph Dam (rkm 877); where upstream fish passage in the Columbia River terminates (Figure 0.2). This entire reach is designated as critical habitat (FMO) (USFWS 2010). Major tributaries within this reach where bull trout local populations currently exist include the Methow (rkm 843), Entiat (rkm 779) and Wenatchee rivers (rkm 754). Chief Joseph Dam is the only federal hydroproject within this reach and is operated by the U.S. Army Corps of Engineers (COE). Non-FCRPS hydroprojects within this reach of the Columbia River include Priest Rapids (rkm 639), Wanapum (rkm 669), Rock Island (rkm 730), Rocky Reach (rkm 763), and Wells (rkm 830) dams. Priest Rapids and Wanapum dams are owned and operated by the Grant County Public Utility District. Rock Island and Rocky Reach dams are owned and operated by Chelan County Public Utility District and Wells Dam is owned and operated by Douglas County Public Utility District.

Lower Snake River

We defined the lower Snake River reach as the 398 rkm downstream from Hells Canyon Dam (rkm 522.398) to the Snake River confluence with the Columbia River (rkm 522) (Figure 0.2). This entire reach is designated as critical habitat (FMO) (USFWS 2010). Major tributaries to the Snake River below Hells Canyon Dam that are known to support bull trout local populations include the Imnaha (rkm 522.308), Salmon (rkm 522.303), Grande Ronde (rkm 522.271), Clearwater (rkm 522.224) and Tucannon (rkm 522.100) rivers, and Asotin Creek (rkm 522.234), Sheep Creek (rkm 522.368), and Granite Creek (rkm 522.385). Federal hydroprojects within this reach are Lower Granite, Little Goose, Lower Monumental and Ice Harbor dams. Hells Canyon Dam is owned and operated by IPC and marks the upstream terminus of fish passage in the Snake River.

Chapter 1 : Subbasin Reviews

Eighteen subbasins within the study area were reviewed to identify those supporting migratory bull trout that may use FMO critical habitat within the mainstem river reaches. Portions of these 18 subbasins have also been designated as a combination of spawning/rearing and FMO critical habitat (USFWS 2010). We discuss what is currently known about bull trout populations within each subbasin with a focus on the migratory component and movements within the subbasin. Where there was evidence of mainstem use, we discuss migration timing to and from the mainstem, as well as estimates of abundance for mainstem migrants when they were available. Movement patterns and habitat use in the mainstem were also described when the data existed for a subbasin population. Finally, migratory bull trout interactions with mainstem hydroprojects were described in terms of observations, timing, and upstream and downstream routes of passage that were used. Reviews were completed for subbasins with bull trout populations in the lower Columbia River (Hood, Klickitat, Deschutes, John Day, Umatilla, Walla Walla, Yakima), the mid-Columbia River (Wenatchee, Entiat, Methow), and the lower Snake River (Tucannon, Clearwater, Asotin, Grande Ronde, Salmon, Imnaha, Sheep, Granite). Each subbasin review begins with a summary of the bull trout population(s), use of the mainstem by the migratory component, and a description of interactions with mainstem hydroprojects, followed by the detailed information that was reviewed. As discussed previously, our reference to core areas and local populations is a reflection of the best available information at the time this synthesis was developed.

Lower Columbia River

Hood River Subbasin

Hood River Subbasin summary

<u>Bull trout populations in the subbasin</u>

- The Hood River Subbasin supports two local populations within one core area. It is not clear whether each of the two local populations is separate, and genetically distinct, or if there is interaction between them.

- The Clear Branch local population is functionally isolated above a dam, but escapement downstream occurs during high flows and may contribute individuals to the Hood River local population.

- The Hood River local population occurs primarily in the Middle Fork Hood River and its tributaries. It is unknown whether this is a fully independent population, or if it is supported by emigrants from the Clear Branch population.

Migratory bull trout in the subbasin

- The Clear Branch local population consists of both resident and migratory components. There is regular movement between spawning/early rearing areas and Laurance Lake for rearing and overwintering. These individuals have been referred to as adfluvial. Emigrants that spill over the Clear Branch Dam have been documented in the lower subbasin and at Powerdale Dam (removed in 2010), returning from the lower Hood River or the Columbia River as adults.

- Adult bull trout captured and tagged at Powerdale Dam were strongly associated with the Middle Fork Hood River. Without a genetic analysis, it is unclear whether these migratory, unmarked individuals were produced from the Hood River local population in the Middle Fork and tributaries, or the Clear Branch local population.

- Upstream migration of fluvial/adfluvial adult bull trout occurs from late April through early October, with the median date of migration occurring from late May to early July at the Powerdale trap, and early September from Laurance Lake into Clear Branch. Downstream migration of post-spawning adults to Laurance Lake occurs in September and October, with a median date of 11 October.

- Downstream migration of juvenile and subadult bull trout occurs from March through July, although no downstream migrant sampling has been conducted during the fall when outmigrations have been observed in other basins.

Bull trout movement/habitat use in the mainstem

- Fluvial Hood River adult bull trout return to the Columbia River each year to overwinter, although the timing of these movements has not been thoroughly described.

- Bull trout have been observed in the lower Sandy River, downstream from Bonneville Dam in the mainstem, at Cascade Locks, in Bonneville Pool near Drano Lake, in Drano Lake, and near the mouth of the Klickitat River.

- Cumulative observations of bull trout in Bonneville Pool have established their presence throughout the entire reservoir. Although not all of these observations can be attributed to the Hood River bull trout populations, they are the most likely source.

Bull trout interactions with mainstem hydroprojects

- Bull trout have been observed or detected in the fish ladders at Bonneville Dam multiple times, including soon after the dam was completed (1941). The most recent observation was detection of a Hood River PIT-tagged adult in the Bradford Island fish ladder in 2012.

- Multiple bull trout observations have occurred downstream, at, and upstream of Bonneville Dam, suggesting these fish are moving both downstream and upstream past the dam to access rearing and overwintering areas.

- It is unknown whether downstream passage of bull trout at Bonneville Dam occurs via the turbines, the corner collector, the spillway, or the bypass system. The only downstream route where observation of unmarked fish is possible is the juvenile bypass system.

- The only observation of a bull trout in the juvenile bypass system at Bonneville Dam occurred in March of 2005.

- One bull trout was also observed in a fish ladder at The Dalles Dam moving upstream out of Bonneville Pool. This fish was not marked, but it may have been a Hood River bull trout.

Hood River Subbasin bull trout

<u>Subbasin description</u>

The Hood River Subbasin is located in north central Oregon and has a drainage area of 1,248 km^2 (Figure 1.1). There are three major tributaries, the East, Middle, and West Forks, which originate from the northeast flanks of Mount Hood and generally flow north and converge to form the mainstem Hood River 19.5 rkm from its confluence with the Columbia River. The basin is situated in steep terrain in a transition zone between the moist maritime climate typical of the western Cascade Mountains and the drier continental climate east of this mountain range. Basin elevations range from over 3,353 m to about 23 m at the confluence with the Columbia River (rkm 272). In summer, melting glaciers influence stream discharge, sediment load, and water temperatures. Much of the winter precipitation falls as snow, and rain-on-snow events are common, causing periodic flooding (Coccoli 1999). In November 2006, a debris flow caused by a glacial outburst emanating from the Eliot glacier deposited an enormous amount of sediment and debris downriver and scoured two new falls in the Middle Fork near rkm 28 (Figure 1.1) that may be current barriers to fish passage at certain streamflows. Punchbowl Falls, upstream from the mouth of the West Fork near rkm 19.5, was a potential natural barrier to fish migration during low flows until a fish ladder was installed during the 1950's (R. French, Oregon Department of Fish and Wildlife [ODFW], personal communication).

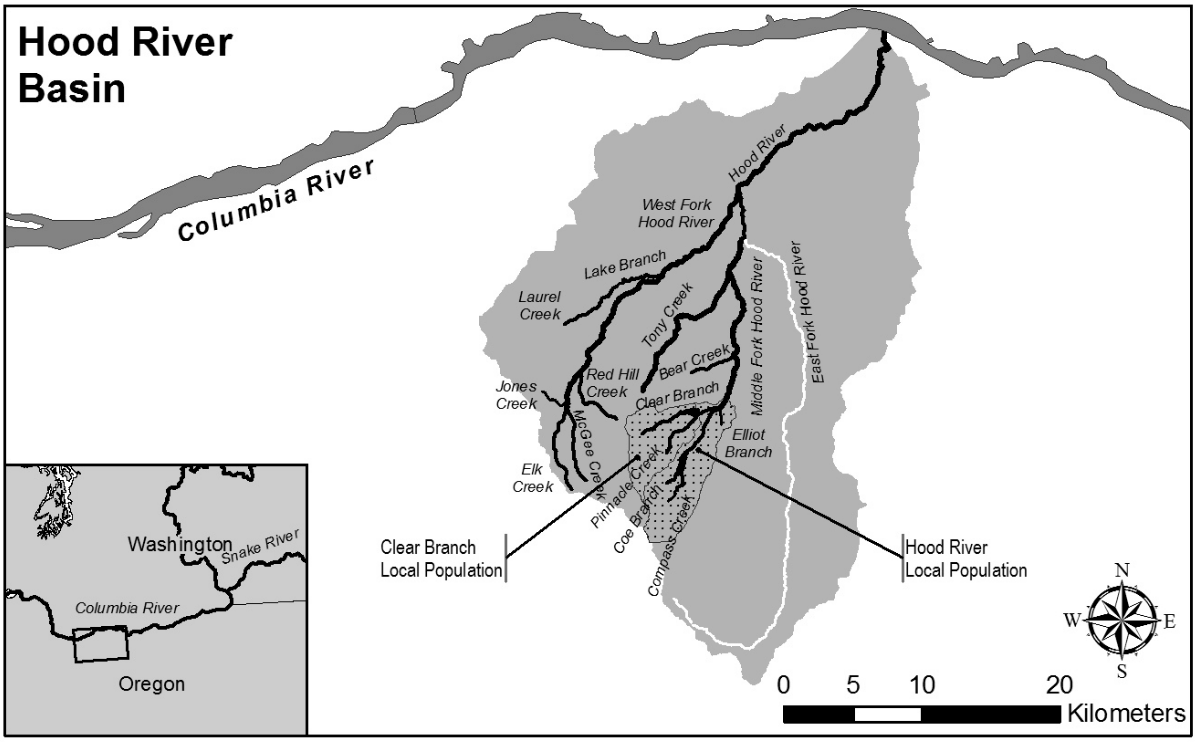

Figure 1.1. Hood River Subbasin including major forks, tributaries, and suspected bull trout distribution.

There are several dams in the subbasin that divert water for agricultural and municipal use, power production, or both. Powerdale Dam in the mainstem Hood River near the mouth (rkm 272.007) was completed in 1923 and removed in 2010. This dam diverted water to a downstream powerhouse until the penstock was damaged in the 2006 debris flow. From 1992 until the dam was removed in 2010, all adult salmon, steelhead, and bull trout migrating upstream were caught in a fish ladder trap at the dam. Clear Branch Dam (rkm 39) was constructed in 1968 for irrigation, and is located on a tributary of the Middle Fork Hood River. The dam stores water from two streams, Pinnacle Creek and Clear Branch, in a 48.5 ha reservoir called Laurance Lake. The 41 m tall dam provides no voluntary upstream fish passage and limited downstream passage during intermittent spill at a surface spillway (Starcevich and Jacobs 2010).

<u>Bull trout populations in the subbasin</u>

Historically, bull trout distribution in the Hood River Subbasin included primarily the mainstem, Middle Fork and tributaries, and a short reach of the West Fork. Bull trout also likely used the Columbia River for juvenile rearing and adult foraging (Buchanan et al. 1997). Although Hood River bull trout share a gentic past with Puget Sound and Olympic Peninsula regions, it is unclear to what extent the the Lower Columbia River core areas supported an anadromous life history in the past or could in the future (Ardren et al. 2011; USFWS 2015). Bull trout in the subbasin likely functioned as a single population prior to the construction of the Clear Branch Dam which fragmented the population and spawning habitat (ODFW 2005). Subsequently, resident and migratory life history forms were identified above and below the Clear Branch Dam, and the total number of mature fish was believed to be less than 300 individuals basin-wide (Buchanan et al. 1997). At the time bull trout were listed as "Threatened" under the ESA, the FWS identified two local populations of bull trout in the Hood River Core Area, both within the Middle Fork Hood River drainage. The Clear Branch local population is located upstream from Clear Branch Dam, and includes bull trout in Laurance Lake and Pinnacle Creek. Most of the current spawning activity in this local population occurs in Clear Branch upstream of Laurance Lake. The Hood River local population includes Clear Branch downstream from the dam, Bear, Coe, Compass, Tony, and Eliot creeks, the Middle and West Forks, and potentially Evans Creek and the East Fork (USFWS 2002). Water transfers between the Middle Fork and Evans Creek, along with fish passage issues may suggest that Evans Creek is not a functional production area for the Hood River local population (R. French, ODFW, personal communication).

The Clear Branch local population was functionally isolated from the rest of the subbasin when the Clear Branch Dam was built in 1968, although there is limited downstream fish passage during periods of spill, and no voluntary upstream passage. The majority of spawning occurs in Clear Branch, but some production also occurs in Pinnacle Creek. Rearing is thought to occur both in the two creeks, as well as in Laurance Lake.

The Hood River local population is currently distributed in the mainstem Hood River, Middle Fork Hood River, and a few Middle Fork tributaries. Although two observations of adult bull trout have occurred in the East Fork (Robert Reagan, ODFW, personal communication) and in Lake Creek in the West Fork, evidence from screw trap sampling since 1995 suggests bull trout reproduction is limited to the Middle Fork subbasin (Olsen 2008). Multiple year classes of rearing bull trout were observed in Compass Creek in the early 2000's, likely indicating spawning. However, a subsequent channel shift that occurred sometime in the late 2000's changed the characteristics of the stream from spring fed to glacial. No rearing bull trout have been identified from Compass Creek recently, although no surveys have been conducted for several years. Bull trout spawners observed in Coe Branch potentially could have been destined for Compass Creek (R. French, ODFW, personal communication). The only other known source of bull trout for the Hood River local population is from the upper Clear Branch local population. Juvenile bull trout PIT-tagged in 2007 from upper Clear Branch and in 2008 from lower Clear Branch were captured as adults (400 mm and 370 mm, respectively) at Powerdale Dam in 2009, and could indicate the Hood River local population may not be an independent population. In addition, detections in the lower Middle Fork of two bull trout PIT-tagged in the lower Clear Branch screw trap showed a range of downstream dispersal behavior that was consistent with the hypothesis that Clear Branch Dam spillover bull trout may be recruited into the Hood River local population. The screw trap catch in lower Clear Branch in 2008 and 2009 suggests substantial numbers of bull trout are passing over the dam during periods of spill. Therefore, the total annual number of potential spillover bull trout was likely much larger than the raw catch (Starcevich and Jacobs 2010).

<u>Migratory bull trout in the subbasin</u>

Bull trout have been captured in small numbers at the upstream ladder and trap at Powerdale Dam, indicating that a migratory or fluvial population of bull trout has existed in the Hood River Subbasin for many years (Pribyl et al. 1995). Fluvial Hood River bull trout are known to migrate between tributaries used for spawning and early rearing, and larger streams such as the Hood River mainstem and the Columbia River for late juvenile or adult rearing (Coccoli 2004).

Bull trout in the Hood River local population utilize portions of the Middle Fork Hood River and its tributaries, mainstem Hood River, and Columbia River throughout their life history. Foraging and overwinter rearing occur primarily in Middle Fork Hood and mainstem Hood rivers and periodically, the Columbia River (USFWS 2002).

Bull trout in the Clear Branch local population are largely restricted to Clear Branch, Pinnacle Creek, and Laurance Lake, all upstream from Clear Branch Dam. Spawning and early rearing occurs in the two creeks, and subadult and adult rearing and overwintering occur in Laurance Lake. This population has been referred to as adfluvial.

Hood River local population – Adult bull trout captured at Powerdale Dam were strongly associated with the Middle Fork Hood River Subbasin and in some cases Clear Branch. Most adult bull trout were captured migrating upstream in May and June and were substantially larger (mean, 483 mm fork length [FL], range; 355-615 mm) than adults in upper Clear Branch. In 2006, three of four adults PIT-tagged at Powerdale Dam homed to the Middle Fork and one was recaptured in a weir trap in Clear Branch near the base of the dam. Upper Middle Fork migration patterns were disrupted by two new impassable falls scoured into the lower Middle Fork channel during a glacial outburst in November 2006. In 2007 and 2008, three adult bull trout radio-tagged at Powerdale Dam entered the Middle Fork by early July and spent several weeks within 200 m of the first new falls. Unable to ascend the falls, these fish then exhibited a range of movement patterns, which included one fish moving downstream below Powerdale Dam and returning again to the same new falls and another moving into upper West Fork basin during the spawning period. In 2009, four PIT-tagged adults were detected near the base of the first new falls on the Middle Fork by mid-July. One of these bull trout, which was also radio-tagged, climbed the first falls by late August, spent six weeks within 200 m of the second falls, and returned downstream on 11 October (Starcevich and Jacobs 2010).

Clear Branch local population – The bull trout population in upper Clear Branch has taken on an adfluvial life history since the construction of Clear Branch Dam. The reservoir created by the dam, Laurance Lake, is used for rearing by both subadult and adult bull trout. Juvenile bull trout migrate downstream to the Lake during the spring freshet, usually at age-2, and subsequently rear for one to three years before returning upstream as adults (Starcevich and Jacobs 2010). Adult bull trout migrate upstream from May through October out of Laurance Lake to spawn in Clear Branch, with an overall median migration date of 2 September. They return to the lake in September and October, with an overall median date of 11 October (Starcevich and Jacobs 2010). Adult bull trout in the upper Clear Branch population are relatively small (mean, 274 mm FL; range, 177-545 mm) when compared to fluvial adult bull trout captured at Powerdale Dam on the lower Hood River (mean, 483 mm FL; range, 355-615 mm) (Starcevich and Jacobs 2010).

Water is typically spilled over Clear Branch Dam during the spring freshet in most years. Screw trap sampling downstream from Clear Branch Dam captured 18 bull trout in 2008, and six bull trout in 2009 suggesting substantial numbers of bull trout are passing over Clear Branch Dam during spring spill (Starcevich and Jacobs 2010). Many of these bull trout were PIT-tagged to track their movements. Three bull trout PIT-tagged in 2008 were subsequently detected migrating downstream in lower Clear Branch and the Middle Fork. Two other bull trout PIT-tagged in 2007 and 2008, were captured as upstream-migrant adults at Powerdale Dam in 2009 (Starcevich and Jacobs 2010).

Hood River Subbasin bull trout in the mainstem Columbia River

<u>Migration to and from the mainstem Columbia River</u>

Bull trout migrate seasonally from the Hood River to the mainstem Columbia River, using the Columbia during a portion of their life history (Buchanan et al. 1997, USFWS 2002, Coccoli 2004). Bull trout that were tagged at Powerdale Dam (rkm 7) have been recovered both in the Columbia River downstream from the mouth of the Hood River, and in Drano Lake, across the Columbia River at the mouth of the Little White Salmon River (Pribyl et al. 1996; USFWS 2002). Marked adult bull trout have been caught at Powerdale Dam migrating upstream in the Hood River in consecutive years (up to four years in a row), suggesting these fluvial adults generally return each year to winter foraging areas in either the Hood River below the dam or Columbia River. However, a radio-tagged bull trout was observed overwintering in the Hood River subbasin upstream of Powerdale Dam, showing that not all fluvial adults use the lower river or the Columbia River every year during this part of their life cycle (Starcevich and Jacobs 2010). Powerdale Dam was approximately 5.4 rkm upstream in the Hood River from the Columbia River backwater. For this discussion, we have assumed that bull trout observed or detected at Powerdale Dam represent entry to, or return from the Columbia River.

ODFW began trapping all upstream migrant bull trout at Powerdale Dam in 1992. Migrating adults were captured annually from mid-May through mid-October, presumably migrating upstream from the Columbia River, and anchor-tagged. Some of these tagged fish were recaptured the following year at the dam. Others were recaptured at various locations in the Columbia River. One bull trout tagged in 1994 was recaptured in 1995 in the Columbia River, and another untagged bull trout was captured in the Columbia River below Bonneville Dam in 1991. These two Columbia River captures suggest that the lower Columbia River is still an important habitat for Hood River bull trout (Buchanan et al. 1997).

Trapping operations at Powerdale Dam have documented bull trout escapement ranging from a low of one adult fish in 2008, to a high of 28 adult fish in 1999. The median date of migration occurred from late May to early July. From 1992 to 2008, there have been 15 adults recaptured. All migrated upstream over the dam in consecutive years, two adults migrated three years in a row, and one migrated upstream in four consecutive years (Olsen 2006, Starcevich and Jacobs 2010, Reagan 2011), suggesting that these large adults generally return each year to winter foraging areas downstream of Powerdale Dam.

From 2007 through 2009, a total of 11 adult fluvial bull trout ranging in size from 370 to 530 mm FL were captured in the trap at Powerdale Dam, returning from the Columbia River. These fish were captured between 13 May and July 1, and they included three recaptures (Starcevich and Jacobs 2010):

- One bull trout that was originally tagged as a 223 mm subadult in 2006 in the Middle Fork returned from the Columbia and was captured at Powerdale Dam in 2007. It had grown to a length of 390 mm.

- One bull trout that was originally tagged as a 200 mm subadult in 2008 in lower Clear Branch returned from the Columbia and was captured at Powerdale Dam in 2009. It had grown to a length of 370 mm.

- One bull trout that was originally tagged as a 123 mm juvenile in 2007 in upper Clear Branch returned from the Columbia and was captured at Powerdale Dam in 2009. It had grown to a length of 400 mm.

Following removal of Powerdale Dam in 2010, adult weir traps were installed by ODFW at several locations. The furthest downstream adult trap was installed in the lower East Fork. Two adult bull trout (530 mm, 590 mm) were captured in June 2011 at this location (Simpson and Reagan 2012). Four adult bull trout (485-610 mm) were captured at this location in 2012 (Simpson and Reagan 2013). Since these weir traps were not likely complete barriers, these observations may represent only a subsample of the population (R. French, ODFW, personal communication). Capture of these large, fluvial adults during early summer possibly indicates they were upstream migrants returning from the Columbia River.

ODFW also PIT-tagged adult bull trout during the course of their Hood River anadromous fish studies. Three adults PIT-tagged in the Middle Fork in 2010, 2011, and 2012 were detected on an instream PIT detection array at the mouth of Hood River returning from the Columbia River. One of these fish was also detected in the Bradford Island Fish Ladder at Bonneville Dam prior to returning to the Hood River. Two additional bull trout PIT-tagged in 2011 and 2012 in the East Fork were subsequently recaptured a year later in May and June at weirs in the mainstem Hood River. These fish were large (550 and 595 mm FL) fluvial adults that may have been returning from the Columbia River.

Hood River studies conducted by ODFW also included sampling for downstream migrants. Sampling was directed at outmigrant anadromous fish, and was conducted from March through July using a mainstem screw trap near the mouth from 1994 – 2010. Six downstream migrant bull trout were captured during this time period. Considering the location of the trap, these migrants were likely headed for the Columbia River. Fall (October, November) is a time period of increased activity for dispersing fluvial subadult bull trout in other subbasins, and the absence of sampling during the fall in the Hood River Subbasin could have missed this period of activity.

<u>Estimates of abundance of mainstem migrants</u>

There have been no studies to estimate the total abundance of fluvial bull trout emigrating from the Hood River Subbasin to the Columbia River. Nearly complete documentation of returning fluvial adults has occurred via the trapping effort by ODFW at Powerdale Dam from 1992 through 2010 (Table 1.1). Powerdale Dam was removed in 2010, and trapping at the dam was terminated on June 30, 2010 (Reagan 2011). Thus, the escapement for 2010 in Table 1.1 may not be complete. There is no longer any capability to monitor total immigration to, or emigration from the subbasin.

Table 1.1. Run year specific counts of wild bull trout escaping to an adult migrant trap operated at Powerdale Dam. Counts are summarized by bi-weekly time period and counts are boldfaced for the bi-weekly period in which the median date of migration occurred during the run year (Source: Reagan 2011, Table 17).

		April		May		June		July		August		September		October	
Run Year	Total Escapement	01-15	16-30	01-15	16-31	01-15	16-30	01-15	16-31	01-15	16-31	01-15	16-30	01-15	16-31
1992	6	0	0	2	**3**	1	0	0	0	0	0	0	0	0	0
1993	2	0	0	0	**1**	1	0	0	0	0	0	0	0	0	0
1994	11	0	0	1	2	**3**	3	0	2	0	0	0	0	0	0
1995	11	0	0	0	0	3	1	**2**	2	1	1	0	0	1	0
1996	18	0	0	2	0	**12**	2	1	0	0	0	0	0	1	0
1997	6	0	0	0	2	0	**2**	2	0	0	0	0	0	0	0
1998	18	0	0	0	1	6	**3**	6	1	1	0	0	0	0	0
1999	28	0	0	0	2	5	**8**	10	1	1	1	0	0	0	0
2000	27	0	0	0	10	**11**	3	2	0	0	0	1	0	0	0
2001	12	0	0	1	**8**	2	1	0	0	0	0	0	0	0	0
2002	5	0	1	1	**2**	0	0	0	1	0	0	0	0	0	0
2003	4	0	0	0	**2**	1	1	0	0	0	0	0	0	0	0
2004	10	0	1	1	**4**	2	1	0	1	0	0	0	0	0	0
2005	7	0	0	3	**2**	2	0	0	0	0	0	0	0	0	0
2006	4	0	0	0	1	**1**	2	0	0	0	0	0	0	0	0
2007	6	0	0	1	**2**	1	1	1	0	0	0	0	0	0	0
2008	1	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
2009	6	0	0	0	0	1	**3**	1	1	0	0	0	0	0	0
2010	7	0	0	0	0	**4**	3	--	--	--	--	--	--	--	--

Bull trout movement/habitat use within the mainstem Columbia River

Records of bull trout in Bonneville Pool, at Bonneville Dam, and immediately downstream of the dam indicate that bull trout from the Hood River Subbasin are foraging and/or overwintering in the Columbia River. Some of these bull trout were marked in the Hood River Subbasin, and others were unmarked. The most likely source population for unmarked bull trout observed in this reach of the Columbia River would be the fluvial population from the Hood River Subbasin. There are no other known sources of fluvial bull trout downstream from The Dalles Dam. Although we know Hood River bull trout migrate to the Columbia River and back, we need a better understanding of the spatial and temporal extent of their use and distribution in the Columbia River mainstem (USFWS 2002). For example, Hood River bull trout may be the most likely source for three observations of bull trout in the Sandy River, downstream from Bonneville Dam. The two possible sources for these observations might include: (1) the Sandy River watershed; or (2) Hood River bull trout that were foraging and/or overwintering in the Columbia River, and subsequently entered the Sandy River (USFWS 2002). According to ODFW (ODFW 2005), a self-sustaining population of bull trout does not exist in the Sandy River Subbasin.

Use of the Columbia River by fluvial Hood River bull trout has been both observed and inferred by a number of researchers. Bull trout were first collected near Fort Dallas (now called The Dalles) in 1854 (Cavender 1978). Individual adults marked externally while ascending the Powerdale Dam fish ladder have been captured occasionally at various locations in the Columbia River (Pribyl et al. 1996). These adults were likely using the Columbia River for both overwintering and adult rearing. Buchanan et al. (1997) and ODFW (2005) have both concluded that the Columbia River provides important rearing habitat for migratory bull trout from the Hood River system. Starcevich and Jacobs (2010) conducted bull trout studies in the Hood River Basin from 2006 through 2009, and they also concluded that fluvial migrants from the Hood River Subbasin forage and winter in the Columbia River.

Possible Hood River origin bull trout have been observed at locations in the lower Columbia River ranging from the Sandy River (mouth at Columbia River rkm 193.9) to the Klickitat River (mouth at Columbia River rkm 290.003). Multiple observations have occurred at or near Drano Lake at the mouth of the Little White Salmon River (mouth at Columbia River rkm 260.7). One bull trout tagged at the Powerdale Dam on 20 July 1994 was recaptured nine months later on 24 April 1995 in the Columbia River approximately 11 rkm downstream from the mouth of Hood River near Drano Lake (Buchanan et al. 1997). Two other bull trout tagged at the Powerdale Dam trap were recovered in 1994 and 2000 at or near Drano Lake (Pribyl et al. 1996, ODFW 2001). The individual recovered in 2000 was tagged the previous year by ODFW, and captured in Drano Lake by an angler in April 2000. Bull trout are caught on a regular, but infrequent, basis in Drano Lake and at the mouth of the Klickitat River by Tribal and ODFW pikeminnow gillnetters. Many others have been landed in recreational fisheries in and adjacent to these same areas (Gray 2006). Recreational pikeminnow anglers recorded six incidental landings of bull trout in 1998, four of which came from Bonneville Reservoir. Additional reports of landings from recreational fisheries have been documented in the Klickitat River mainstem since 1990 and the most recent were reported in 2003. Some of these fish are of Hood River origin, as some of the fish were tagged at Powerdale Dam (Gray 2006). A project to evaluate sampling methods for bull trout in Bonneville Reservoir was conducted in 2006/2007 (Gray 2007). Sampling methods were focused within Drano Lake and gears tested included Merwin traps, benthic hoop traps, beach seines, and small mesh gill nets. A single bull trout was captured in a small mesh gill net in May 2006. It was 304 mm FL and unmarked. Since it was unmarked, the origin was unknown, but the closest and most likely source population was the Hood River. This bull trout was marked with a floy tag and a PIT tag (Gray 2007). We queried PTAGIS to examine the detection history of this fish and determine if it was subsequently detected on the instream PIT detection array at the mouth of the Hood River, but there were no associated records.

ODFW conducts northern pikeminnow research annually as a precursor to the annual sport reward fishery program. They employ electrofishing boats for this work, and during their sampling in 2005, they captured one bull trout from the mainstem Columbia River within Bonneville Reservoir (Gray 2006). This fish was equipped with a PIT tag, external floy tags, and a radio tag. A tissue sample was also collected for genetic analysis. This fish was subsequently detected two months later near the mouth of the Wind River (Gray 2006). When this fish was initially genotyped by the Washington Department of Fish and Wildlife (WDFW) Genetics Lab (Small and Bowman 2007), the analysis indicated it was not a bull trout, and the hypothesis based on the results of the analysis was that it was a Dolly Varden. However, the potential origin was unclear. The closest river with a documented Dolly Varden population was the Quinault River. A subsequent genetic analysis included samples from two private aquaculture facilities that were raising Arctic char, one of which was in the Hood River Basin (Small et al. 2007). This analysis concluded that the fish originally identified as a bull trout was, in fact, an Arctic char that had likely escaped from the aquaculture facility.

Bull trout interactions with mainstem Columbia River hydroprojects

Bull trout that are likely of Hood River origin have been observed or captured in Bonneville Pool and at, or downstream from Bonneville Dam on numerous occasions (Table 1.2). These fish were often referred to as "Dolly Varden", particularly during the early years. Historical data from Bonneville Dam documents bull trout/Dolly Varden passing through the ladders beginning in 1941, soon after the Dam was constructed, up through the mid 1990's (Gray 2007). The most recent observation of a bull trout at Bonneville Dam was the result of a PIT tag detection from a Hood River bull trout in the Bradford Island fish ladder on 31 May 2012. This individual was captured in a screw trap and tagged on 3 July 2011 in the Middle Fork Hood River at a length of 180 mm FL. At this size, this fish was likely a fluvial subadult in search of rearing and foraging areas. Sometime between 3 July 2011 and 31 May 2012, this bull trout left the Hood River, moved downstream past Bonneville Dam, then returned back upstream via the fish ladder on 31 May 2012. This fish was subsequently detected on a PIT tag detection array near the mouth of Hood River on 13 July 2012 moving back upstream, into the subbasin.

There have been a variety of other observations that suggest Hood River bull trout are using the Columbia River and interacting with Bonneville Dam (Table 1.2). Since the Hood River Subbasin is the only confirmed tributary in Bonneville Pool with a migratory population of bull trout (Olsen 2003), many of these observations are likely to be from Hood River bull trout. An untagged bull trout was captured in the Columbia River immediately below Bonneville Dam near Ives Island in 1991. This Columbia River capture and the large size of this fish and the fluvial bull trout captured at Powerdale Dam suggest the lower Columbia River is still an important habitat for Hood River bull trout (Buchanan et al. 1997). Gray (2006) offered some additional details on observations of bull trout at and around Bonneville Dam. These fish are also listed in Table 1.2. The first observation came from the smolt monitoring bypass facility at Bonneville Dam that is operated by Pacific States Marine Fisheries Commission (PSMFC) personnel. On 21 March 2005, the facility captured a 380 mm FL adult bull trout that was measured, photographed, and released back into the smolt flume that exits the facility downstream of Bonneville Dam. The second incidental capture came from another PSMFC sampling crew performing juvenile Chinook monitoring at the mouth of Hamilton Creek, approximately two kilometers below Bonneville Dam. On 23 May 2005, they recovered a single adult bull trout, 330 mm in fork length, during their seine operations for juvenile Chinook abundance. The fish was handled, measured, and released back into the river at the point of capture. This was likely a Hood River bull trout that had passed downstream through (turbines, bypass), or over (spring spill, corner collector) Bonneville Dam. The third anecdotal record of handle occurred in August 2005 when a recreational fisher called to report the catch and release of an adult bull trout from the lower end of Hamilton Island while steelhead fishing. This location is within 0.4 rkm of the previous capture by PSMFC but occurred three months later. This bull trout could have been the same fish captured on 23 May 2005, or it could have been a different individual that also passed Bonneville Dam. The final report was that of a visual sighting of a bull trout near the town of Cascade Locks, Oregon. A WDFW employee, while fishing near Cascade Locks, saw a long slender looking salmonid-like fish swimming in the shallows. The fish was approximately 17-18" long (445 mm) and had distinct light colored spotting along its dorsal side. Some may be skeptical of this sighting. However, it was recorded by an individual that has intimate knowledge of bull trout morphology and is therefore considered credible (Gray 2006). Although it is unknown whether this bull trout had previously passed Bonneville, or would eventually pass Bonneville, it is reported here because of the close proximity to the dam.

We only identified one observation of a bull trout at The Dalles Dam, at the upstream end of Bonneville Pool. An eleven inch (279 mm) bull trout was captured at The Dalles Dam east fish ladder in December of 1997 (Bob Cordie, COE, personal communication, 2003; from Gray 2007). The origin of this fish is unknown, but the two most likely sources are the Hood and Deschutes subbasins.

Table 1.2. Historical bull trout presence within the mainstem Columbia River in Bonneville Pool, at Bonneville Dam, and downstream from Bonneville Dam (Source: Gray 2007).

Observation Date	Observation Location	Observation Source	Sampling Method	Observation Details
3 May 2006	Drano Lake	WDFW bull trout project	Small mesh gill net	Adfluvial, 303 mm
21 March 2005	Bonneville Dam	Dean Ballinger, PSMFC	Smolt bypass facility	Adult, 390 mm
14 April 2005	Columbia River East of Drano Lake 0.4-0.8 rkm	ODFW Northern Pikeminnow Crew, Tom Freisen and Jim Koloszar	Electrofishing	Bull trout (eventually determined to be Arctic char)
23 May 2005	Mouth of Hamilton Cr below Bonneville Dam	Below Bonneville Chinook Evaluations, Ricky Heitz, PSMFC	Seine	Adult bull trout, 330 mm
20 June 2005	Near Cascade Locks	Northern Pikeminnow fisher	Observation	Slender salmonid appears to be bull trout
August 2005	Mainstem Columbia River, below Bonneville Dam, lower end of Hamilton Island	Recreational fisher, Don Howard	Angling	Bull trout, approx. 381 mm
May 2000	Mouth of the Klickitat River	Pikeminnow sport-reward fishermen	Angling	Bull trout/Dolly Varden
May 2000	Mouth of Klickitat River	Pikeminnow Sport Fishery	Angling	Bull trout, no size
April 2000	Drano Lake	Recreational fisher	Angling	Floy tagged bull trout from Hood River, harvested
1998	Mouth of Klickitat River	Tribal fishermen	Tribal Gillnetting	2 bull trout, size undocumented
10 May 1998	Below Bonneville Dam	Northern Pikeminnow fisher	Angling	Bull trout, harvested
24 May 1998	Bonneville Reservoir	Northern Pikeminnow fisher	Angling	Bull trout, harvested
15 June 1998	Bonneville Reservoir	Northern Pikeminnow fisher	Angling	Bull trout catch-and-release
16 June 1998	Bonneville Reservoir	Northern Pikeminnow fisher	Angling	Bull trout catch-and-release
08 May 1994	Bonneville Dam, Washington ladder	??	Observation	Dolly Varden (remarks said possible dolly varden)
11 September 1986	Bonneville Dam, Bradford Island fish ladder	??	Observation	Dolly Varden
28 August 1982	Bonneville Dam ladder passage	Marv Yoshinaka, FWS	Observation	??
8 March 1947	Bonneville Dam, Bradford Island	??	Trapped	Dolly Varden, positively ID'd
3 March 1941	Bonneville Dam, Washington Ladder	??	Observation	Downstream passage of "Dolly Varden"

Recommendations

Historically, bull trout in the Hood River Core Area likely functioned as a single local population prior to the construction of Clear Branch Dam. Currently, there are two possible local populations, the Clear Branch local population and the Hood River local population. There has been speculation that the Hood River local population is not a functional, individual local population, but one that is maintained by spillover fish from the Clear Branch population. There have been no spawning/early rearing areas identified other than the Clear Branch and Pinnacle Creek production areas.

Migratory bull trout in the Hood River Subbasin rear and overwinter in subbasin tributaries and the mainstem Hood River, as well as the Columbia River. Emigration to, and immigration from the Columbia River has been documented for at least 20 years. Observations have included the lower Sandy River, the Hamilton Island complex downstream from Bonneville Dam, Drano Lake at the mouth of the Little White Salmon River, and a number of locations within Bonneville Pool. The Columbia River is an important part of the life cycle for some Hood River bull trout as a source of rearing, foraging, and overwintering habitat, although the proportion of the subbasin population that uses the mainstem is currently unknown.

There have been a number of bull trout observations and PIT tag detections in the fish ladders at Bonneville Dam over the years. There has also been an observation of a bull trout in the smolt bypass facility at Bonneville. These observations along with other data verify that Hood River bull trout are moving both downstream and upstream past Bonneville Dam.

Tagging studies should be implemented for bull trout from the Hood River Subbasin to learn more about the migratory distribution, movement, habitat use, and interaction with Bonneville Dam. The occurrence of these Hood River bull trout in the Columbia River has been established, and more detailed information should be acquired to determine whether there are impacts from dam passage or reservoir operations. Radio-telemetry and/or acoustic tags could provide the detailed information to describe bull trout movements and timing in the mainstem, and PIT tags would be functional for the life of the fish and allow detection at Bonneville Dam, at the mouth of the Hood River, and at other locations in and around Bonneville Dam and Pool. Genetic samples should always be collected when handling any bull trout in this effort to determine or verify origin of the fish. In addition, genetic samples may help to determine whether there are two distinct local populations (i.e., Hood River, Clear Branch) in the Hood River Subbasin, or one.

The original draft Recovery Plan for Hood River bull trout (USFWS 2002) concluded that "It is essential to establish, with greater certainty, the current extent of bull trout distribution and seasonal use areas." This type of information for migratory bull trout will be required to determine whether Bonneville Dam, or any other dam in the FCRPS impacts migration, connectivity, or habitat use, for bull trout from the Hood River Subbasin. Unimpeded passage at mainstem dams may also facilitate the opportunity for the expression (or reexpression) of the anadromous life history in lower Columbia River populations (USFWS 2015).

Klickitat River Subbasin

Klickitat River Subbasin summary

Bull trout populations in the subbasin

- The Klickitat River Subbasin supports one bull trout local population within a single core area.

Migratory bull trout in the subbasin

- The evidence suggests the West Fork Klickitat River population is primarily a resident bull trout population.
- There is the occasional observation of migratory-sized bull trout in the mainstem Klickitat River.
- A few migratory-sized bull trout have been captured near the mouth of the Klickitat River.

Bull trout movement/habitat use in the mainstem

- There is no available information on Klickitat River bull trout movement/habitat use within the mainstem Columbia River.

Bull trout interactions with mainstem hydroprojects

- There is no available information on Klickitat River bull trout interactions with mainstem Columbia River hydroprojects.

Klickitat River Subbasin bull trout

Subbasin description

The Klickitat River Subbasin is located in south-central Washington, within the Columbia River gorge. The Klickitat River headwaters drain from the eastern side of the Cascade Range to its confluence with the Columbia River at rkm 290, approximately 19 rkm below The Dalles Dam (Figure 1.2). The drainage area is 3,496 km^2.

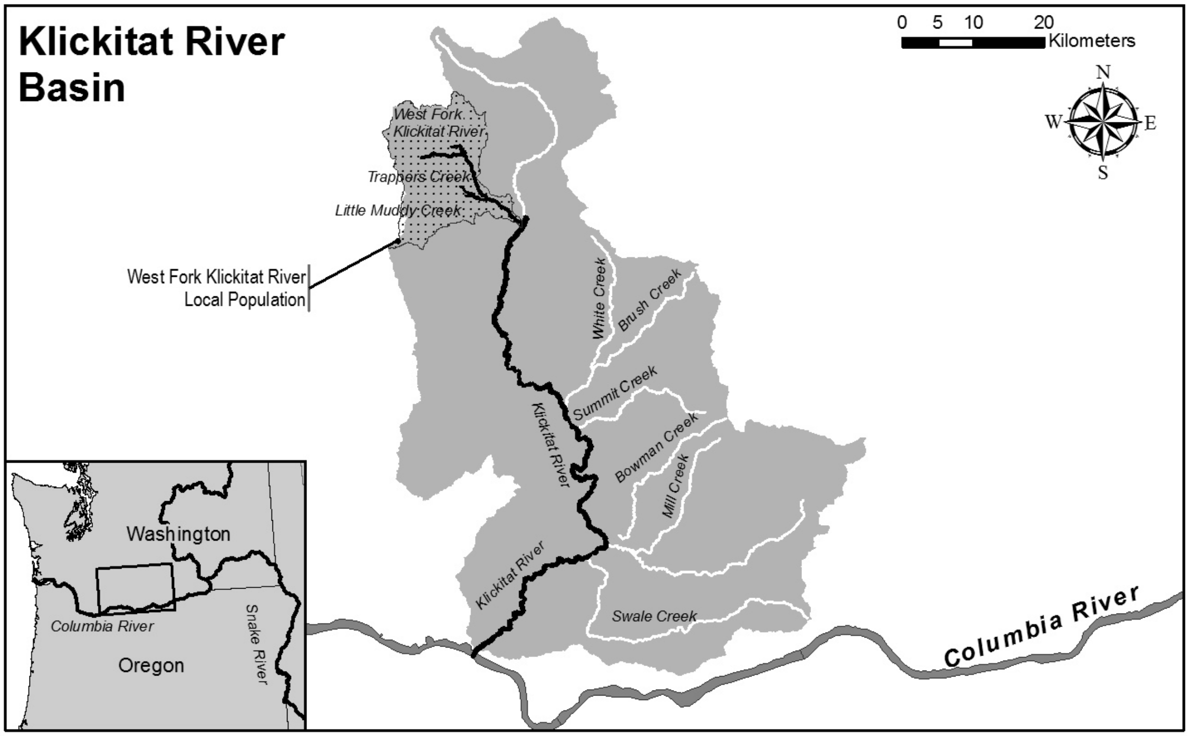

Figure 1.2. Core area and local population in the Klickitat River Subbasin.

<u>Bull trout populations in the subbasin</u>

The Klickitat River Subbasin supports a single bull trout local population within one core area. This local population occurs in the West Fork Klickitat River (West Fork) and it is comprised of bull trout from five tributaries: Trappers Creek, Clearwater Creek, Little Muddy Creek (Byrne et al. 2001), Two Lakes Stream, and an unnamed tributary to Fish Lake Stream (Thiesfeld et al. 2002). There is potential for this population to expand into other tributaries in the upper Klickitat River with fish passage improvements that were made at Castille Falls (rkm 290.103) in 2005 (Sharp et al. 2008). Information on bull trout spawning and life history has been collected in the Klickitat River through several efforts (Byrne et al. 2001; Thiesfeld et al. 2002; USFWS 2002). It is believed this population is comprised of only a resident life history strategy. Genetic analysis of these populations (Small et al. 2007) confirmed some genetic variation among West Fork tributaries, but it was not statistically significant, and the bull trout in those tributaries are therefore considered to be a single, local population. In addition, genetic structure of Trappers Creek and Clearwater Creek in the context of the range of bull trout in the coterminous United States has been described (Ardren et al. 2011).

<u>Migratory bull trout in the subbasin</u>

Information on migratory bull trout in the Klickitat River is limited (Byrne et al. 2001; Thiesfeld et al. 2002; USFWS 2002). All evidence indicates the West Fork population is small and isolated. Many streams in the subbasin, including the mainstem Klickitat River are fragmented by natural falls, creating partial or complete barriers to upstream fish movement (Thiesfeld et al. 2002). There is the occasional observation of bull trout in the mainstem Klickitat River (Table

1.3; Gray 2006), and a few bull trout have been captured near the mouth of the Klickitat River (Thiesfeld et al. 2002; Gray 2005, 2006, 2007). However, some of these fish were of Hood River origin. Salmonid sampling conducted by the Yakama Nation that includes screw traps, adult traps, video monitoring and electrofishing has not detected bull trout outside the West Fork (Joe Zendt, Yakama Nation Fisheries Program [YNFP], personal communication).

Table 1.3. Historical bull trout observations from within the Klickitat River.

Year	# of Observations	Fork Length (mm)	River Kilometer	Type of Observation
1960	1	183-250	> 101	U of Washington
1980's	1	NA	48	Sport Angler
1990	2	356; 360	NA; 23	Sport Angler
1990	4	≤ 254	101	Yakama Nation
1995	23	≤ 178	> 101	Yakama Nation
1998	2	NA	0	CRITFC
2000	1	NA	0	Sport Angler
2000	156	≤ 205	West Fork	WDFW
2001	49	111-174	West Fork	WDFW
2001	2	610	69	WDFW
2001	1	NA	48	Sport Angler
2003	1	330	13	Sport Angler
2004	2	120	103	Yakama Nation
2005	1	~457	2	Sport Angler

Subadult downstream migration — In 1990, four bull trout (up to 254 mm FL) were reported during snorkel surveys in the mainstem Klickitat River upstream of the confluence with the West Fork (Table 1.3; Thiesfeld et al. 2002). This is the only known evidence that suggests bull trout from the West Fork population may migrate downstream, but the origin of these fish is unknown. A barrier in the West Fork near the confluence likely prevents a return upstream migration to spawning areas in the West Fork.

Adult downstream migration — There is no quantitative evidence of migratory adult bull trout downstream migration subsequent to spawning in the West Fork or elsewhere in the subbasin. Adult bull trout have been observed and/or captured in the mainstem Klickitat River, but the origin of these fish is unknown (Table 1.3).

Adult upstream migration — There is no evidence of migratory adult bull trout upstream migration in the subbasin. Adult bull trout have been observed and/or captured in the mainstem Klickitat River, but the origin of these fish is unknown (Table 1.3).

Klickitat subbasin bull trout in the mainstem Columbia River

Little information is available for bull trout movements in Bonneville Pool. WDFW conducted a project from 2004-2006 investigating bull trout use of Bonneville Pool and its Washington tributaries (Gray 2005, 2006, 2007). The project documented bull trout presence in the mainstem Columbia River between Bonneville and The Dalles dams, but could not assign origin to those fish handled. The study further states bull trout may migrate through FCRPS facilities as they do elsewhere in the Columbia and lower Snake rivers. This is confirmed by detection of a bull trout from the Hood River Subbasin at Bonneville Dam in 2012 (www.ptagis.org [queried Dec. 2014]). However, it is still unknown whether bull trout from the Klickitat subbasin migrate to the mainstem Columbia River.

Migration to and from the mainstem Columbia River

PIT detection arrays – The Yakama Nation operates two PIT arrays on the mainstem Klickitat River: one at Lyle Falls (rkm 290.004), and one at Castile Falls (rkm 290.103). There have been no detections of PIT-tagged bull trout at either of these arrays (Joe Zendt, YNFP, personal communication).

Estimates of abundance of mainstem migrants

There have been no studies to estimate abundance of mainstem migrants.

Bull trout movement/habitat use within the mainstem Columbia River

There is no available information on Klickitat River bull trout movement/habitat use within the mainstem Columbia River.

Bull trout interactions with mainstem Columbia River hydroprojects

There have been no detections of Klickitat River origin bull trout at any Columbia River hydroprojects.

Recommendations

We recommend continued monitoring of the West Fork local population to determine if bull trout distribution expands into the upper Klickitat River now that fish passage improvements have been made at Castille Falls above the confluence of the West Fork Klickitat and mainstem Klickitat rivers. Research is also needed to determine if there is a fluvial component of the Klickitat River bull trout population that migrates to the Columbia River, and if so, determine migration patterns and habitat use in the Columbia River between Bonneville and The Dalles dams. Genetic samples should be collected from any bull trout encountered outside of the West Fork to determine whether those fish are of Klickitat origin, or if they originated in a different subbasin. If it is determined that Klickitat River bull trout migrate to, and use the mainstem Columbia River, further research should be conducted to evaluate the effect, if any, of upstream and downstream fish passage at Bonneville and The Dalles dams, and to evaluate passage and rearing conditions in Bonneville Pool.

Deschutes River Subbasin

Deschutes River Subbasin summary

Bull trout populations in the subbasin

- The Deschutes River Subbasin supports six bull trout local populations within two core areas.

- Five of the six local populations reside in the lower Deschutes Core Area and include the Shitike Creek local population, Warm Springs River local population, and three local populations in the Metolius River complex.

- The Odell Lake Core Area supports a single local population and has been isolated from the lower Deschutes by a lava flow for the past 5000 plus years.

Migratory bull trout in the subbasin

- The lower Deschutes populations exhibit resident, fluvial, and adfluvial (reservoir) life histories.

- Fluvial/adfluvial bull trout from the Metolius/Lake Billy Chinook, Shitike Creek, and Warm Springs River local populations all migrate into the lower Deschutes River.

Bull trout movement/habitat use in the mainstem

- Movement into the mainstem Columbia River has rarely been observed although few studies have investigated migratory behavior and mainstem Columbia River use.

- Both adults and subadults have been detected moving into the Columbia River.

Bull trout interactions with mainstem hydroprojects

- It is currently unknown how Deschutes River origin bull trout interact with mainstem Columbia River hydroprojects.

Deschutes River Subbasin bull trout

Subbasin description

The Deschutes River originates on the east slope of the Cascade Mountain range in central Oregon (Figure 1.3). The river begins flowing out of Little Lava Lake and into several reservoirs before reaching the Columbia River at rkm 328. The Deschutes River flows approximately 405 rkm from its origin and discharges into Lake Celilo, the reservoir created by The Dalles Dam (rkm 307). Parts of the Metolius River subbasin and all of Shitike Creek and the Warm Springs

River subbasins lie within the boundaries of the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO).

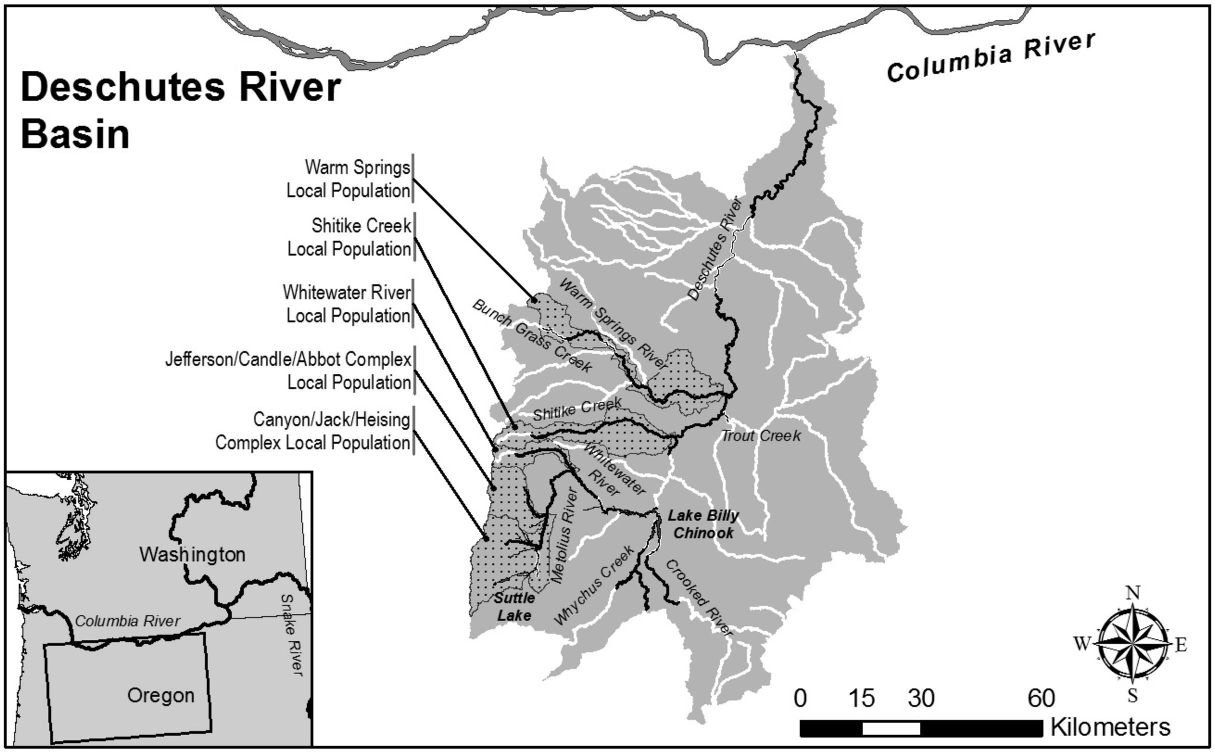

Figure 1.3. Lower Deschutes River and bull trout local populations.

<u>Bull trout populations in the subbasin</u>

Historically, the upper Deschutes subbasin supported numerous populations of bull trout but the species is now thought to be extirpated above Big Falls (rkm 328.212), a natural barrier (Buchanan et al. 1997). Only three tributaries of the Deschutes River continue to support migratory bull trout populations; the Metolius River, Shitike Creek, and the Warm Springs River. Some local populations have gone extinct in the Metolius complex such as the Suttle and Blue lake populations.

The Deschutes River Subbasin contains two core areas with six local populations (USFWS 2002). Five of the six local populations reside in the Lower Deschutes Core Area and include the Shitike Creek local population, Warm Springs River local population, and three local populations in the Metolius River complex. The Metolius River complex populations are comprised of the Whitewater River, Jefferson/Candle/Abbot river complex and the Canyon/Jack/Heising Spring/mainstem Metolius River complex.

The Odell Lake Core Area is comprised of a single local population. The Odell Lake population is the last remaining native, adfluvial bull trout population in Oregon (Ratliff and Howell 1992), and has been isolated from the lower Deschutes River by a lava flow for the last 5000-6000 years. Since it is presumed migration into the lower Deschutes or Columbia rivers is not possible for this population, only the lower Deschutes populations will be discussed further.

Migratory bull trout in the subbasin

Historically, Deschutes River bull trout were distributed throughout the subbasin from the headwaters to the Columbia River (Fies et al. 1996). The development of the subbasin for irrigation and hydropower eliminated habitat, blocked access to spawning areas, and reduced the opportunity for genetic exchange. Additional practices such as introduction of nonnative species and intentional removal of bull trout contributed to population declines subbasin-wide.

Bull trout still exhibit resident, fluvial, and adfluvial life histories in the Lower Deschutes Core Area. All three life histories are present in the Metolius River complex as bull trout are known to reside in the upper Metolius tributaries (resident), migrate into the mainstem Metolius River (fluvial), and migrate into Lake Billy Chinook (adfluvial), the reservoir created by Round Butte Dam (rkm 328.177) (Buchanan et al. 1997). Additionally, bull trout captured at the selective water withdrawal surface intake structure at Round Butte Dam are sorted and fish less than 254 mm (approximately 12% of bull trout observed) are released into the lower Deschutes River below the Reregulating Dam (rkm 328.161) (J. Bartlett, PGE, personal communication). The CTWSRO have been monitoring bull trout in the Warm Springs River and Shitike Creek since 1998. The Warm Springs River and Shitike Creek bull trout local populations exhibit resident and fluvial life histories with some migrants entering the mainstem Deschutes River (CTWSRO 2011).

Observations of bull trout are rare in the lower Deschutes River, but they do occur. A small number of bull trout have been observed ascending the adult ladder at Sherars Falls (rkm 70) even though operation of the fish trap starts in late June/early July, potentially after adult bull trout have initiated upstream spawning movements. Bull trout have also been taken during tribal fisheries at Sherars Falls (Graham et al. 2011). Recent creel reports have included subadult and adult sized bull trout observed during the steelhead fishery below Sherars Falls (J. Seals, ODFW, personal communication). Finally, a subadult bull trout was captured and PIT-tagged in Bakeoven Creek (rkm 328.083), a tributary to the Deschutes River (www.ptagis.org). It is possible that all five lower Deschutes River local populations produce long-range migrants.

Deschutes River Subbasin bull trout in the mainstem Columbia River

Migration to and from the mainstem Columbia River

Observations of bull trout entering the Columbia River from the Deschutes River are rare. Only two studies have recently documented bull trout at the mouth of the Deschutes River. Graham et al. (2011) radio-tagged large adults (669 mm average FL) captured at the head of Lake Simtustus (approximately rkm 328.166) and released them into the Deschutes River at rkm 328.088 in June and July 2007. Of the 23 fish tagged, two were detected at the mouth of the Deschutes and two more were harvested in the mainstem Columbia River by tribal fishers.

A PIT tag array was installed at the mouth of the Deschutes River in spring of 2013 by CTWSRO (CTWSRO 2013). A subadult bull trout was detected at the array on 11 August 2013. This fish was tagged in the Metolius River (rkm 328.177.023) on 1 March 2013 and was 225 mm

FL. It was detected and recaptured at the Round Butte Dam fish transfer facility on 14 April 2013 and had grown 25 mm (M. Hill, PGE, personal communication). It is unknown if this fish was migrating into or out of the Deschutes River as the PIT array did not cover the entire width of the river and direction of movement was not discernable. Neither of the abovementioned studies were intended to directly evaluate bull trout movement into the mainstem Columbia River and the detections and observations were supplementary information.

Estimates of abundance of mainstem migrants

There have been no studies to estimate abundance of mainstem migrants.

Bull trout movement/habitat use within the mainstem Columbia River

Observations of Deschutes River origin bull trout entering the Columbia River are rare; however no studies have been conducted specifically to describe Deschutes River bull trout movements or habitat use within the Columbia River. The 2007 radio-telemetry study that the CTWSRO conducted did recover two radio tags from bull trout taken in mainstem Columbia River tribal fisheries. One bull trout was harvested below John Day Dam (rkm 348) (Graham et al. 2011). The other bull trout was harvested immediately below The Dalles Dam, approximately 22 kilometers downstream from the mouth of Deschutes River.

Bull trout interactions with mainstem Columbia River hydroprojects

There have been no observations of known Deschutes River origin bull trout at any Columbia River hydroprojects. However, one bull trout radio-tagged and released in the Deschutes River (rkm 328.88) was harvested by tribal fishers below The Dalles Dam (Graham et al. 2011). This fish passed downstream through The Dalles Dam, likely through summer spill operations or through the turbines.

Recommendations

Little data exists that describes Deschutes River bull trout use of the Columbia River. No studies have been conducted to document this specific behavior. The PIT tag detection array recently installed at the mouth of the Deschutes River could be an invaluable tool for monitoring bull trout use of the Columbia River. The adult ladders at The Dalles Dam were recently wired for PIT tag detection as well. A coordinated effort should be made to PIT tag and monitor migratory bull trout in the lower Deschutes River so emigration into the Columbia River can be evaluated. Radio- and/or acoustic-tagging studies should also be considered if sufficient numbers of bull trout are encountered in the lower Deschutes. Genetic samples should be collected from any bull trout sampled and tagged in the lower Deschutes River to determine the subbasin local population of origin, or the out of basin population of origin.

Prior to the construction of the Pelton/Round Butte hydroelectric project, bull trout from local populations in the Metolius River complex were likely connected to the lower Deschutes River and the Columbia River. To re-establish functional connectivity, upstream and downstream passage at the project could be managed to resemble what might have occurred before construction of the dams. For example, all downstream migrant bull trout encountered at the selective water withdrawal intake at Round Butte Dam could be passed downstream. In addition, all upstream migrant bull trout encountered in the adult fish trap at the re-regulating dam downstream from Pelton Dam could be transferred upstream.

John Day River Subbasin

John Day River Subbasin summary

Bull trout populations in the subbasin

- The John Day River Subbasin supports 11 bull trout local populations in three core areas.

- Migratory bull trout are present in each of the core areas, in at least five local populations.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout appear for the most part to remain in the upper portion of the John Day River Subbasin during their seasonal migrations.

Bull trout movement/habitat use in the mainstem

- Use of the Columbia River by migratory bull trout from the John Day River Subbasin has not been documented.

Bull trout interactions with mainstem hydroprojects

- Use of the Columbia River by migratory bull trout from the John Day River Subbasin has not been demonstrated.

John Day River Subbasin bull trout

Subbasin description

The John Day River flows for 457 rkm and enters the Columbia River at rkm 351 in north-central Oregon (Figure 1.4), 4 rkm upstream from John Day Dam and 119 rkm downstream from McNary Dam. The John Day River and its tributaries drain the west slope of the Blue Mountains and the north slope of the Strawberry Mountains. The drainage area is approximately 20,979 km^2. The Middle Fork John Day River and the North Fork John Day River are major tributaries to the John Day River that support bull trout. The North Fork John Day River is 180 rkm long and enters the John Day River at rkm 351.296. The Middle Fork is 121 rkm long and enters the North Fork John Day River at rkm 351.296.051.

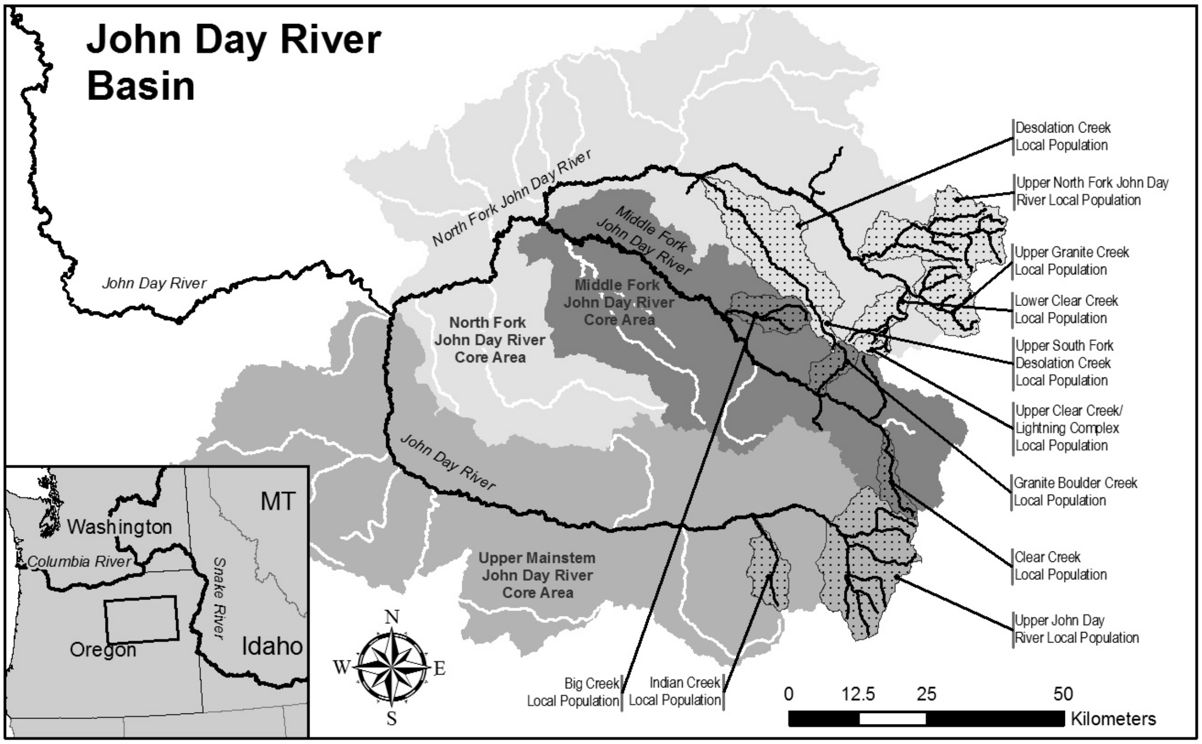

Figure 1.4. Core areas and local populations in the John Day River Subbasin.

Bull trout populations in the subbasin

The John Day River Subbasin contains three core areas, Upper Mainstem John Day River, Middle Fork John Day River, and North Fork John Day River (Figure 1.4) (USFWS 2004). The Bull Trout Draft Recovery Plan identified 11 bull trout local populations in the John Day River Basin, two in the Upper Mainstem John Day River Core Area, two in the Middle Fork John Day River Core Area, and seven in the North Fork John Day River Core Area (USFWS 2002; 2004).

Migratory bull trout in the subbasin

No evidence exists of use of the mainstem Columbia River by bull trout from the John Day River Subbasin. Migratory bull trout are present in each of the three core areas but have been observed only as far downstream as rkm 351.273 on the John Day River (Hemminsen et al. 2001a; USFWS 2002). ODFW used PIT and radio tags to study the migrations of bull trout in the upper mainstem John Day River and its tributaries Call, Dierdorff, Reynolds, and Roberts creeks in 1997-2000 (Hemmingsen et al. 2001a, 2001b, 2001c, 2001d). Up- and downstream migrant weir traps were operated in the tributaries and in the John Day River upstream from Call Creek. A screw trap was operated in the John Day River just below the lowermost tributary (Dierdorff Creek in 1997 and 1998 and Reynolds Creek in 1999). The downstream-most observation of a tagged fish occurred at rkm 351.400 (Hemminsen et al. 2001d; Starcevich et al. 2012). Since that study, bull trout have occasionally been captured incidentally in a screw trap operated in the John Day River at rkm 351.326 (I. Tattam, ODFW, personal communication).

ODFW also radio-tagged two bull trout captured incidentally by a Chinook salmon seining crew in the John Day River at rkm 273 (23 rkm downstream from the mouth of the North Fork John Day River) in April 2000. These fish were 234 mm and 248 mm FL (i.e., subadult-sized) at tagging. One migrated 220 km upstream into the North Fork John Day River and its tributary Granite Creek. The other was observed moving up the North Fork before its transmitter was found at an osprey nest 181 km upstream from the tagging site.

Migratory bull trout abundance is exceedingly low in the Middle Fork John Day River Core Area (USFWS 2002), and, as a consequence, the migrations of bull trout in that core area have not been studied. Twenty-one bull trout have been captured incidentally in a screw trap operated at rkm 351.296.051.024 on the Middle Fork John Day River (i.e., downstream from spawning and early rearing areas) since 2003 (I. Tattam, ODFW, personal communication).

The FWS used radio and PIT tags to study the migrations of adult and subadult bull trout in the North Fork John Day River in 2005-2010 (Sankovich and Anglin 2006, 2007, 2008, 2010, 2011). Both the adults and subadults remained within the North Fork John Day River. No tagged fish were observed using the John Day River.

No bull trout have been detected at a PIT tag detection array operating since 2007 in the lower John Day River at rkm 351.032. However, only a small number of bull trout have been PIT-tagged in the John Day River Subbasin.

John Day River Subbasin bull trout in the mainstem Columbia River

- N/A

Bull trout interactions with mainstem Columbia River hydroprojects

- N/A

Recommendations

Migratory bull trout in the John Day River Subbasin originate in spawning areas in excess of 337 rkm (North Fork John Day River drainage), 360 rkm (Middle Fork John Day River drainage), and 434 rkm (upper John Day River drainage) from the mouth of the John Day River. The populations in which migratory bull trout are relatively abundant spawn in areas in excess of 434 rkm (upper John Day River drainage) and 465 rkm (North Fork John Day River drainage) from the mouth of the John Day River. The greatest migration distance on record for a bull trout (which may not have included the full migration range of that fish) is 307 rkm (Bjornn and Mallet 1964), and shorter migration distances are the norm (e.g., Starcevich et al. 2012 and the references therein). Although migratory bull trout occur in each of the three core areas in the John Day River Subbasin, they are not abundant in any of them (USFWS 2002, 2004; Sankovich and Anglin 2006, 2007, 2008, 2009; J. Neal, ODFW, personal communication). Given this, and the great distances between the spawning areas and mouth of the John Day River, establishing use of the Columbia River by John Day River Subbasin bull trout, if it occurs, might be exceedingly difficult. One approach would be to take advantage of the infrastructure (e.g., screw traps and fixed telemetry and PIT tag detection sites) and sampling efforts (e.g., seining in the John Day River near Spray) that are part of a long-term Chinook salmon and steelhead monitoring program and other studies in the subbasin. Bull trout captured incidentally through those activities could be PIT- or radio-tagged (or both) to monitor their movements and determine whether they pass PIT detection or telemetry sites in the lower John Day River. If those efforts result in documented movement to the lower John Day River or beyond, avenues of further research could be explored.

Umatilla River Subbasin

Umatilla River Subbasin summary

Bull trout populations in the subbasin

- The Umatilla River Subbasin supports one bull trout local population in one core area.
- Migratory bull trout are present in the local population.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout appear for the most part to remain in the upper portion of the Umatilla River Subbasin during their seasonal migrations.

Bull trout movement/habitat use in the mainstem

- Use of the Columbia River by migratory bull trout from the Umatilla River Subbasin has not been demonstrated.

Bull trout interactions with mainstem hydroprojects

- Use of the Columbia River by migratory bull trout from the Umatilla River Subbasin has not been demonstrated.

Umatilla River Subbasin bull trout

Subbasin description

The Umatilla River flows for 144 rkm and enters the Columbia River at rkm 465 in northeast Oregon (Figure 1.5), 118 rkm upstream from John Day Dam and 5 rkm downstream from McNary Dam. The Umatilla River and its tributaries drain the west slope of the Blue Mountains. The drainage area is approximately 6,579 km^2. Major tributaries to the Umatilla River relevant to bull trout include the North Fork and South Fork Umatilla rivers and Meacham Creek. The North and South forks converge to form the Umatilla River and Meacham Creek enters it at rkm 465.127.

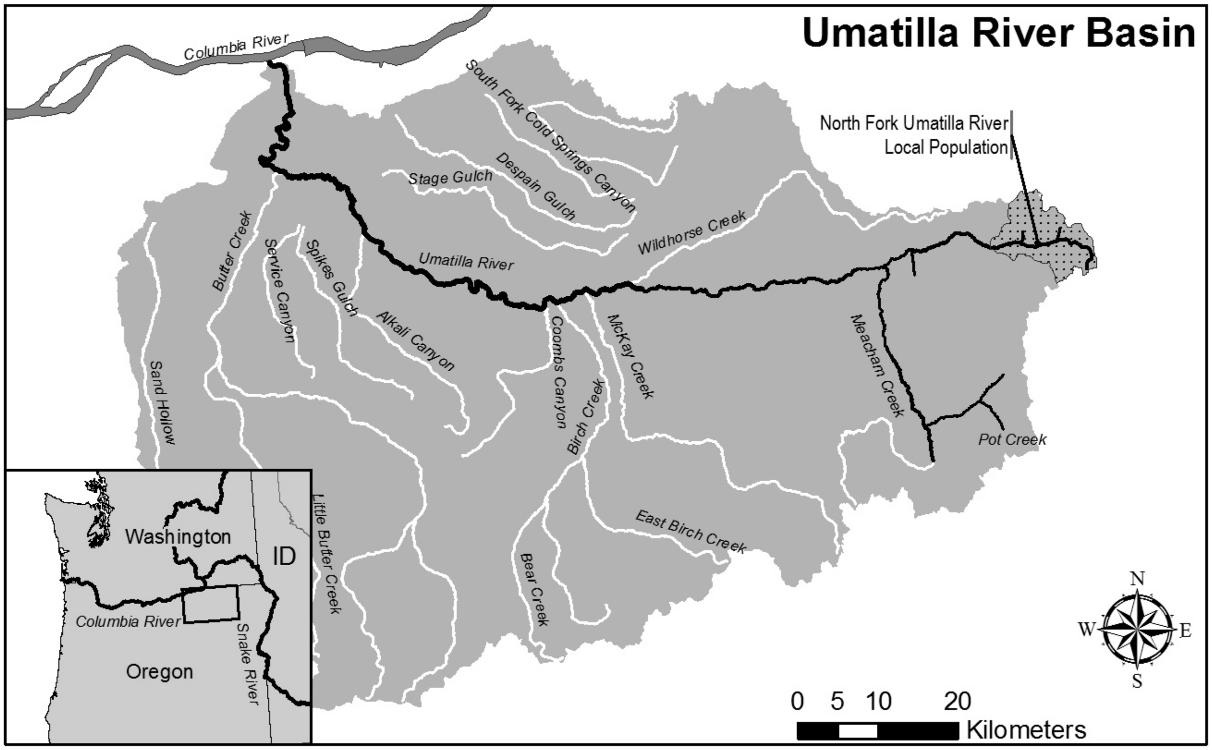

Figure 1.5. Umatilla River Subbasin and bull trout local population.

<u>Bull trout populations in the subbasin</u>

The Umatilla River Subbasin contains one core area, the Umatilla Core Area, which encompasses the entire subbasin (Figure 1.5). The Bull Trout Draft Recovery Plan (USFWS 2002) identified one subpopulation of bull trout in the Umatilla River Subbasin. It was termed the upper Umatilla Complex and included bull trout in the North Fork and South Fork Umatilla rivers. In a subsequent unpublished revised draft of Chapter 10 in the Bull Trout Draft Recovery Plan (USFWS 2004), that subpopulation (termed a local population in the revised draft) was identified along with a local population in North Fork Meacham Creek. Recent work indicates only one bull trout local population in the North Fork Umatilla River currently occurs in the Umatilla Core Area (Sankovich and Anglin 2013).

<u>Migratory bull trout in the subbasin</u>

Migratory bull trout are present in the North Fork Umatilla River local population but appear for the most part to remain in the upper portion of the subbasin (Starcevich et al. 2012; Sankovich and Anglin 2013). Personnel from ODFW studied the migrations of adult bull trout in the Umatilla and North Fork Umatilla rivers in 1998 – 1999 and 2002 – 2003 (ODFW, unpublished report; Sankovich et al. 2003, 2004). The bull trout studied in 1998 – 1999 were outfitted with radio tags, and those studied in 2002 – 2003 were outfitted with radio and PIT tags. All but one of the radio-tagged bull trout overwintered within the upper 39 rkm of the 144 rkm-long Umatilla River, and none utilized the lower Umatilla River or Columbia River. None of the PIT-tagged individuals were detected in the lower Umatilla River or in the mainstem Columbia River. Several observations of bull trout have been made in lower McKay Creek which enters the Umatilla River at approximately rkm 465.085 (C. Contor, Confederated Tribes of the Umatilla Indian Reservation, personal communication).

In fall 2004, two subadult-sized bull trout were radio-tagged by the FWS in the upper Umatilla River (Sankovich and Anglin 2006; Anglin et al. 2008a). They remained in the upper Umatilla River during the lives of their 9-month tags. The FWS also radio-tagged 69 and PIT-tagged 35 subadult bull trout captured in spring and early summer in a screw trap just below the mouth of the North Fork Umatilla River (Sankovich and Anglin 2006, 2007, 2008, 2009). Like the migratory adults in the ODFW studies, the radio-tagged subadults did not undertake extensive migrations. Those that moved downstream after their release remained within the upper 37 rkm of the Umatilla River. None of the PIT-tagged subadults were detected in the lower Umatilla River or Columbia River.

In 2003 – 2009 researchers from Utah State University and the FWS PIT-tagged 543 bull trout in the North Fork Umatilla River (Budy et al. 2004, 2005, 2006, 2007, 2008, 2009; Sankovich and Anglin 2010). None were detected in the lower Umatilla River or Columbia River.

Since 1995, 17 bull trout have been trapped in spring and early summer in the east bank ladder at Three Mile Falls Dam (TMFD), about 6.4 rkm upstream from the mouth of the Umatilla River. They ranged from 250 to 510 mm FL and at that size were likely migratory adults. In 2007-2013, the FWS tagged nine of the bull trout captured at TMFD (Sankovich and Anglin 2008, 2011, 2013; Sankovich et al. 2014). Five were outfitted with radio and PIT tags and four, only with PIT tags. All of the radio-tagged bull trout continued migrating upstream in the Umatilla River, and none returned downstream into the lower Umatilla River or Columbia River. The bull trout outfitted only with PIT tags have not been detected in the Umatilla River or Columbia River Basin (Sankovich and Anglin 2013; Sankovich et al. 2014).

Although bull trout have been observed at TMFD, there is no empirical evidence that any originated in the North Fork Umatilla River. Genetic analyses indicated none of the bull trout tagged at TMFD originated in the Umatilla Basin (Small et al. 2012). Seven bull trout were from the adjacent Walla Walla River Subbasin, and one was from the Tucannon River Subbasin. The genetic sample from an individual captured in 2013 has not yet been analyzed.

Umatilla River Subbasin bull trout in the mainstem Columbia River

- No unequivocal evidence exists of use of the mainstem Columbia River by bull trout from the Umatilla River Subbasin.

Bull trout interactions with mainstem Columbia River hydroprojects

- N/A

Recommendations

The North Fork Umatilla River bull trout local population is exceedingly small (the average redd count over the last ten years is 22 (P. Sankovich, unpublished data), and it appears few if any of the migratory fish from that population use the lower Umatilla or mainstem Columbia rivers. Therefore, expending a great deal of effort to attempt to determine if North Fork Umatilla River bull trout use the Columbia River may not be warranted at this time. Some effort should continue to be directed toward PIT- and radio-tagging, and collecting genetic samples from, bull trout captured at TMFD. The bull trout that ascend the ladder may not have originated in the Umatilla River Subbasin, but it would still be informative to monitor their movements in the Umatilla River, and eventually in the Columbia River if they return there. No bull trout have ever been sampled in the west bank bypass system at TMFD, but any bull trout captured there in the future should also be PIT- and radio-tagged, and genetic samples should also be collected from them.

Walla Walla River Subbasin

Walla Walla River Subbasin summary

Bull trout populations in the subbasin

- The Walla Walla River Subbasin supports six bull trout local populations within two core areas.

- Three local populations are located in the Touchet River Core Area, and three local populations are located in the Walla Walla River Core Area.

- Each of the six local populations has a resident and migratory (fluvial) component.

Migratory bull trout in the subbasin

- Subadult migration from the headwaters peaks during the spring, but occurs during all months into middle subbasin reaches (i.e., middle one-third of the subbasin) as far downstream as rkm 509.060 in the Walla Walla River.

- There is a short cessation of movement in middle and lower subbasin reaches during summer months coinciding with irrigation withdrawals and elevated water temperatures. Migration resumes during fall and winter into lower subbasin reaches and to the mainstem Columbia River through February.

- Following spawning, fluvial adult bull trout migrate from the headwaters into downriver reaches from September through February to utilize more abundant resources and overwintering habitat.

- Adult bull trout in lower subbasin reaches begin migrating upstream in March, peaking in May before decreasing into June. Upstream migration occurs in middle subbasin reaches (i.e., middle one-third of the subbasin) from May through July and in headwater reaches primarily from June through September.

Bull trout movement/habitat use in the mainstem

- Since monitoring in the lower river began in 2005, PIT-tagged bull trout have been detected moving downstream past the Oasis Road PIT array (rkm 509.010), and presumably into the Columbia River from October through February, peaking in November and December during most migration years.

- The quantitative estimate of the number of Walla Walla River Subbasin bull trout that may have used the Columbia River from January 2007 through February 2012 was 496 (95% CI 130 - 898).

- Almost all migratory bull trout from the Walla Walla River Subbasin that enter the mainstem Columbia River are larger subadults or small adult-sized fish measuring between 200 and 300 mm FL; only a few fish exceed 350 mm FL.

- Bull trout returning to ascend the Walla Walla River were detected from March through June, generally peaking in April and May.

- Relocations in the mainstem Columbia River of acoustic-tagged bull trout from the Walla Walla River Subbasin ranged from 12 rkm downstream to approximately 14 rkm upstream from the mouth of the Walla Walla River.

- Mobile tracking data from acoustic-tagged bull trout indicated that bull trout were actively moving while occupying the mainstem corridor and may suggest that fish moved beyond the study area (Lake Wallula) soon after their initial detection.

- Only 54% of the acoustic-tagged bull trout that entered the Columbia River subsequently returned to the mouth of the Walla Walla River.

- Relocation site data from acoustic-tagged fish indicated that deep, slow water habitat was utilized by bull trout in the mainstem.

- A genetic analysis of bull trout trapped at the Three Mile Falls Dam in the Umatilla River since 2007 indicated a high probability that seven of the eight fish captured originated in the South Fork Walla Walla River.

Bull trout interactions with mainstem hydroprojects

- There have been five PIT-tagged bull trout from the Walla Walla River Subbasin detected in the fish ladders and juvenile bypass systems at Columbia River dams, including Priest Rapids (n=1) and McNary dams (n=4).

- A bull trout PIT-tagged in the Walla Walla River in November 2011 was detected at the PIT array near the mouth of the Walla Walla River in December 2011 and was subsequently recaptured within the Umatilla River Basin in May 2012, having migrated to the Columbia River, passed downstream of McNary Dam and entered the Umatilla River. The detection history of this fish indicates that it may have passed downstream of McNary Dam during the winter when turbines are the likely route. If the fish passed downstream of McNary Dam following 10 April 2012, then possible passage routes included the turbines and spill gates.

Walla Walla River Subbasin bull trout

<u>Subbasin description</u>

The Walla Walla River Subbasin is located in southeast Washington and northeast Oregon. The Walla Walla River headwaters drain from the steep volcanic canyons of the Blue Mountains through foothills and alluvial lowlands before eventually reaching its confluence with the Columbia River at about rkm 509 (Figure 1.6). This portion of the Columbia River is known as Lake Wallula, which is the reservoir formed by McNary Dam (rkm 470).

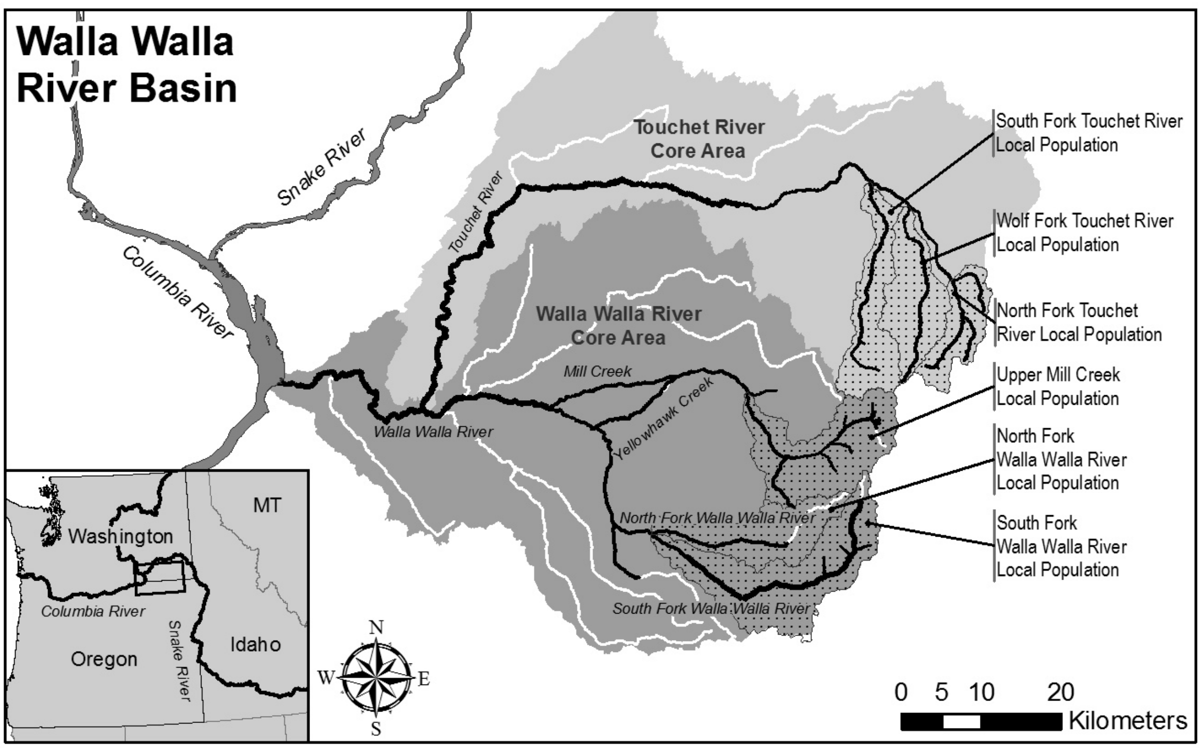

Figure 1.6. Walla Walla River Subbasin and bull trout local populations.

<u>Bull trout populations in the subbasin</u>

The Walla Walla River Subbasin supports six bull trout local populations within two core areas (USFWS 2002). Three local populations are located in the Touchet River watershed (Touchet River Core Area), and three local populations are located in the Walla Walla River watershed

(Walla Walla River Core Area). Each local population in the Walla Walla River Subbasin has a resident and migratory (fluvial) component (USFWS 2002). Bull trout spawning and early life history have been extensively studied in both the Touchet River Core Area (Mendel et al. 1999, 2000, 2001; Mahoney et al. 2012) and in the Walla Walla River Core Area (Al-Chokhachy and Budy 2007, 2008; Al-Chokhachy et al. 2005, 2009; Budy et al. 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011; Bowerman and Budy 2012; Bowerman 2013; Hemmingsen et al. 2001a, 2001b, 2001c, 2001d, 2002). In addition, genetic structure, characterization and population assignment studies have been conducted throughout the subbasin (Small et al. 2012; Kassler and Mendel 2007; Homel et al. 2008).

<u>Migratory bull trout in the subbasin</u>

A considerable amount of effort has gone into developing a long-term bull trout movement dataset for migratory bull trout in the Walla Walla River Subbasin through the use of PIT tag detection technology (Schaller et al. 2014; Anglin et al. 2008a, 2008b; Barrows et al. 2014a, 2014b, Koch 2014; Hemmingsen et al. 2001a, 201b, 2001c, 2001d, 2002; P. Sankovich, unpublished data). Migratory bull trout have also been monitored via video while passing Nursery Bridge Dam in Milton-Freewater, OR and captured at the Touchet River trap in Dayton, WA for over a decade (Mahoney et al. 2012). Radio-telemetry studies have been conducted throughout the Touchet River subbasin (Mendel et al. 2007) throughout the South Fork and mainstem Walla Walla rivers (Mahoney et al. 2006, 2008, 2012; Gallion et al. *in review*, *b*) and in Mill Creek (Hemmingsen et al. 2001a, 201b, 2001c, 2001d, 2002; Starcevich et al. 2012). Multiple snorkeling and electrofishing studies have also contributed to a better understanding of bull trout life history stages and strategies throughout the Basin (Mahoney et al. 2008; Mendel et al. 2007; Gallion et al. *in review, a;* Schaller et al. 2014).

The aforementioned studies collectively verify that Walla Walla River Subbasin bull trout exhibit a continuum of life histories involving migrations, movements, spawning, foraging and rearing on time scales ranging from daily to annually or longer, and over different spatial scales. The following are descriptions of subadult and adult bull trout migration patterns derived from the previously mentioned movement studies.

<u>Subadult downstream migration</u> – In the Walla Walla River Subbasin, migratory subadult bull trout initially begin migrating downstream from headwater spawning and juvenile rearing areas in the spring (March) during high flows and as water temperatures begin to rise. Although peak subadult migration from the headwaters generally occurs in the spring, movement occurs during all months. This incremental downriver movement pattern continues to occur on the declining portions of the hydrograph throughout middle subbasin areas (i.e., middle one-third of the subbasin) through July and into August. Spring migrant subadult bull trout have been detected moving into areas as far downstream as Burlingame Dam (rkm 509.060) in the Walla Walla River. As irrigation diversions draw surface water to summer base flows and water temperatures elevate, there is a short cessation of movement in middle and lower subbasin reaches (i.e., middle and lower one-third of the subbasin) during summer months. Recent migrants into lower river reaches must seek refuge in pools with adequate cover and groundwater influence or retreat back upstream to find more tolerable habitat conditions to oversummer. This upstream movement pattern commonly occurs in reaches downstream from rkm 509.078 in the Walla

Walla River and downstream of the Mill Creek Diversion Dam in Mill Creek, starting when surface flows decrease and water temperatures increase in approximately June and continuing through August (Schaller et al. 2014; Koch 2014). Downstream migration resumes during fall and winter into lower subbasin reaches (i.e., lower one-third of the subbasin) and into the mainstem Columbia River through February.

Adult downstream migration ─ Following spawning, resident adult bull trout remain in the headwater reaches while the migratory component of the population moves from headwater stream reaches into larger streams and downriver reaches (including the mainstem Columbia River) to find more abundant resources and overwintering habitat. To reach overwintering areas, bull trout make rapid, incremental downstream movements through migratory corridors. This generally occurs from September through February in the Walla Walla River Subbasin.

Adult upstream migration ─ After overwintering, adult bull trout in lower subbasin reaches and the Columbia River begin migrating upstream in March, peaking in May before decreasing in late June. Upstream migration occurs in middle subbasin reaches (i.e., middle one-third of the subbasin) from May through July and in upper subbasin reaches (i.e., upper one-third of the subbasin) primarily from June through September. The timing of adult upstream migration through middle and lower reaches in the Walla Walla River Subbasin is critical because irrigation diversions draw surface water down to summer base flows and water temperatures elevate creating barriers to fish passage through portions of the migration corridor (Schaller et al. 2014). Even short delays may prove costly to bull trout attempting to ascend the river during this limited migration window.

Walla Walla River Subbasin bull trout in the mainstem Columbia River

Multiple lines of evidence indicate Walla Walla River Subbasin bull trout use the mainstem Columbia River. Almost all migratory bull trout from the Walla Walla River Subbasin that enter the mainstem Columbia River are larger subadults or small adult-sized fish measuring between 200 and 300 mm FL. Only a few fish exceed 350 mm FL (Anglin et al. 2009a, 2009b, 2010; Barrows et al. 2012a, 2012b).

Migration to and from the mainstem Columbia River

PIT detection array ─ The COE funded the installation and operation of a PIT detection array near the mouth of the Walla Walla River (rkm 509.010) from 2005 through 2009 to monitor bull trout use of the Columbia River, and to estimate the number of Walla Walla subbasin bull trout that were using the Columbia River (Anglin et al. 2009a, 2009b, 2010; Barrows et al. 2012a, 2012b). The COE resumed funding for the continued operation and maintenance of the Oasis Road Bridge PIT array during FY2012 (Barrows et al. 2014a). Since 2014, this PIT detection site has been maintained and operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). It should be noted that detection at the ORB PIT array does not confirm that a bull trout actually entered the mainstem Columbia River, but the close proximity suggests that emigration to the mainstem was likely. PIT-tagged bull trout were detected moving downstream past the PIT array from October through February, peaking in November and December during most migration years. Bull trout returning to ascend the Walla Walla River were detected from March through June, generally peaking in April and May. Figure 1.7 is a summary of individual PIT-tagged bull trout detected at the Oasis Road Bridge PIT array from 31 January 2007 to 17 January 2014. Detections are grouped by migration year (e.g., October 2007 through September 2008).

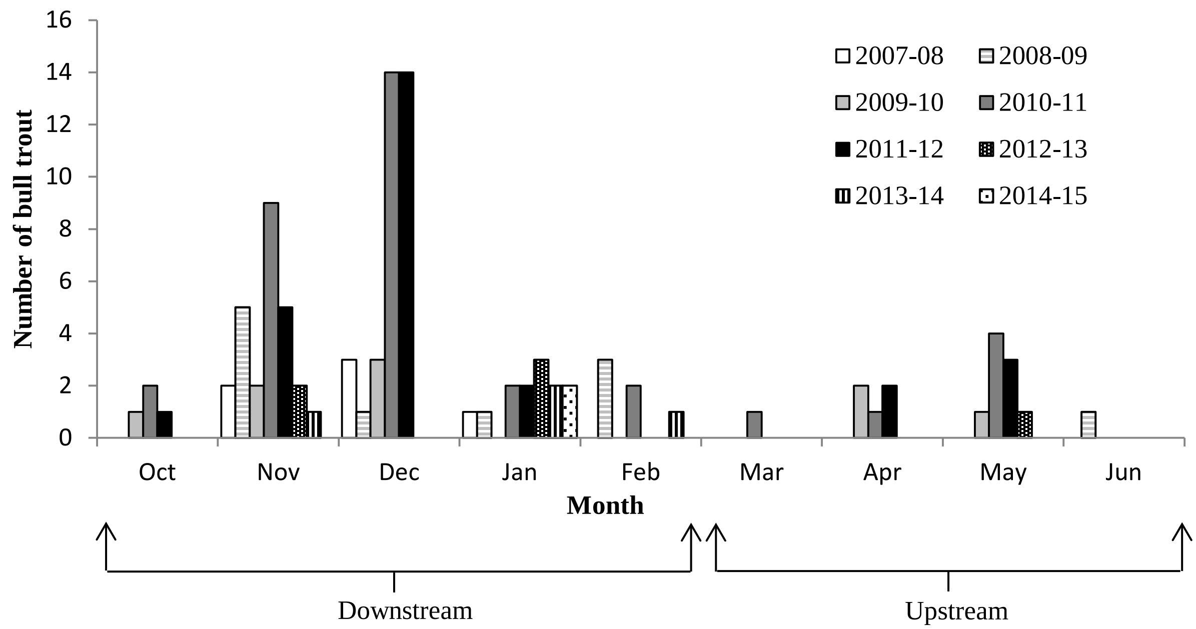

Figure 1.7. Detections of PIT-tagged bull trout at the Oasis Road Bridge PIT detection site from 31 January 2007 to 17 January 2014. Detections are grouped by migration year.

<u>*Mainstem survival*</u> ─ Evidence exists suggesting the majority of Walla Walla River Subbasin bull trout that enter the mainstem may not survive to return to the subbasin. A total of 89 individual bull trout have been detected at the Oasis Road Bridge PIT array, near the mouth of the Walla Walla River (rkm 509.010), from January 2007 to January 2014 (www.ptagis.org [queried Mar. 2014]). Sixteen (18%) were subsequently detected returning to ascend the Walla Walla River, of which only two (13%) reached headwater spawning areas. Only one (1%) of the 89 individual bull trout detected at the ORB PIT array has migrated to the Columbia River multiple times. PIT tags from six (7%) of the individual bull trout detected at the ORB PIT array were subsequently recovered on avian nesting colonies on islands in the mainstem (www.ptagis.org [queried Dec. 2014]; Appendix A). One bull trout was recaptured within the Umatilla River Subbasin. The ultimate fates of 66 (74%) of the 89 PIT-tagged bull trout that were detected at the Oasis Road Bridge PIT array are unknown but did not return to ascend the Walla Walla River.

<u>Estimates of abundance of mainstem migrants</u>

One of the objectives of the aforementioned COE funded study was to estimate the number of Walla Walla River Subbasin bull trout that were using the Columbia River. Table 1.4 summarizes the number of outmigrants for every year the PIT detection array was operational and detected a suitable number of PIT tags to estimate abundance (Barrows et al. 2014a). The quantitative estimate of the number of Walla Walla subbasin bull trout that may have used the Columbia River from January 2007 through February 2012 was 496 (95% CI 130 - 898).

Table 1.4. Migration year PIT detections at ORB, estimates of the annual proportion of the outmigrant population with PIT tags ($\hat{p}$), resulting estimates of the population of outmigrants ($\hat{\tau}$), estimates of the total population of outmigrants adjusted for physical detection efficiency (PDE) (1/PDE*$\hat{\tau}$), and the 95% confidence interval (CI). Table is adapted from Barrows et al. 2014a.

Migration Year	PIT Tags Detected	($\hat{p}$)	($\hat{\tau}$)	Estimated Number of Outmigrants adjusted for PDE (1/PDE*$\hat{\tau}$)	95% CI
2007/08	6	0.125	48.0	49	6-96
2008/09	12	0.174	69.2	120	38-203
2009/10	6	0.286	21.0	23	6-46
2010/11	29	0.167	173.7	263	59-466
2011/12	21	0.526	39.9	41	21-87
Total	**74**		**351.8**	**496**	**130-898**

Bull trout movement/habitat use within the mainstem Columbia River

The spatial and temporal migration patterns of bull trout within the Walla Walla River Subbasin have been relatively well-documented, but the use of the mainstem Columbia River has not received the same degree of study. Despite obvious data gaps, information regarding the movements of Walla Walla River Subbasin bull trout within the mainstem Columbia River is hereafter summarized.

Acoustic-telemetry — The COE funded the first three years (FY2010-FY2012) of a proposed six year study to better understand the movements and disposition of Walla Walla River Subbasin bull trout that enter the Columbia River and how they may be influenced by mainstem hydroprojects and their associated reservoirs (Barrows et al. 2012a, 2012b, 2014a). During FY2011 and FY2012, a total of 27 migratory bull trout were acoustic-tagged in the lower Walla Walla River. Tagged bull trout averaged 281 mm FL and ranged from 215 to 438 mm FL. Thirteen of the 27 acoustic-tagged bull trout were known to have subsequently entered the mainstem Columbia River. Acoustic-tagged bull trout moved into the mainstem from late November through late February. The limited extent of the mobile surveys as a result of river conditions, the large size of the study area, the small bull trout sample size, and equipment capabilities combined to limit the number of individuals and relocations that were obtained. Despite these limitations, nine relocations of five individual acoustic-tagged bull trout were subsequently recorded during bi-weekly mobile tracking surveys (FY2011 and FY2012) or at stationary hydrophone arrays (FY2012 only) in the mainstem Columbia River. Mainstem relocations ranged from 12 rkm downstream to approximately 14 rkm upstream from the mouth of the Walla Walla River. Following their initial relocation in the mainstem Columbia River, acoustic-tagged fish were usually not subsequently detected during mobile tracking surveys or at fixed hydrophone arrays. This indicates bull trout were actively moving while occupying the mainstem corridor and may suggest fish moved beyond the study area soon after the initial detection (Barrows et al. 2014a). Of the 13 acoustic-tagged bull trout that entered the Columbia River, only seven (54%) returned to the mouth of the Walla Walla River. Of those that returned, PIT detections and recapture data indicated only three reached Nursery Bridge Dam (rkm 509.074), the downstream extent of hospitable summer habitat conditions (Schaller et al. 2014), and none reached known spawning grounds in the South Fork Walla Walla River. In addition, the PIT tag from one of the acoustic-tagged bull trout was recovered on Foundation Island during 2011, indicating avian predation in either the mainstem or in the lower Walla Walla River. Complete detection histories were assembled for each acoustic-tagged bull trout for a comprehensive description of the temporal and spatial movement patterns (Barrows et al. 2012b, 2014a).

Detections of Walla Walla River Subbasin bull trout in other subbasins ─ From 2007 through 2012, migratory bull trout have been trapped while moving upstream at Three Mile Falls Dam in the Umatilla River. The FWS funded a genetic analysis of these bull trout (Small et al. 2012). Genetic assignments indicated a high probability that all eight of the bull trout captured originated from outside the Umatilla River Subbasin, most of which (N = 7) originated in the South Fork Walla Walla River, and one was from the Tucannon River Subbasin (Small et al. 2012; Barrows et al. 2014a; Sankovich et al. 2014). Fish from the South Fork Walla Walla River population migrated a distance of over 97 rkm to reach the Columbia River and an additional 42 rkm downstream before entering the Umatilla River (total distance of over 139 rkm). The bull trout from the Tucannon River Subbasin likely migrated over 78 rkm from spawning grounds to the mouth of the Tucannon River, another 98 rkm in the Snake River to the Columbia River confluence and an additional 57 rkm before entering the Umatilla River (total distance of over 233 rkm).

Bull trout interactions with mainstem Columbia River hydroprojects

Mainstem dam detections of bull trout originally PIT-tagged within the middle (i.e., middle one-third) portion of the Walla Walla River Subbasin have been documented (Barrows et al. 2012a, 2012b, 2014a). There have been five PIT-tagged bull trout from the Walla Walla River Subbasin detected in the fish ladders and juvenile bypass systems at Columbia River dams, including Priest Rapids and McNary dams (Table 1.5). On 15 April 2009, a bull trout was detected at the McNary juvenile bypass, 39 rkm downstream from the mouth of the Walla Walla River. On 25 May 2009 and again on 19 June 2009, a bull trout was detected while ascending the adult ladder (Oregon side) at McNary Dam. On 5 July 2009, a PIT-tagged bull trout ascended the Priest Rapids Dam adult ladder (east), approximately 128 rkm upstream from the mouth of the Walla Walla River. A PIT-tagged bull trout was in the McNary Dam adult ladder (Oregon side) from 26 June 2012 through 29 June 2012 before exiting upstream. In addition, a bull trout that was PIT-tagged at the Dayton smolt trap at rkm 509.035.088 in the Touchet River on 7 April 2013 was detected at the McNary Dam juvenile bypass on 1 June 2014 and 2 June 2014. Detection histories of the aforementioned fish indicated that these fish likely entered the mainstem Columbia River during the fall or winter months. Due to their relatively rapid rate of movement through the lower Walla Walla River, the fish detected in the McNary Dam adult ladder most likely moved downstream of McNary Dam during fall or early winter. During that timeframe, the most likely downstream route of passage was through the turbines at McNary Dam which are not equipped with PIT detection capabilities. If the fish passed downstream of McNary Dam following 10 April, then downstream options would have included spring spill. Overall, PIT tag detections at mainstem hydroprojects confirm Walla Walla River Subbasin bull trout utilize at least 167 rkm of the Columbia River migratory corridor from below McNary Dam (rkm 470) to above Priest Rapids Dam (rkm 637).

Table 1.5. Migratory bull trout PIT detections at mainstem Columbia River hydroprojects.

Tagging Site	Detection Location	Tagging Date	Detection Date
Walla Walla River	McNary juvenile bypass	7/30/2008	4/15/2009
Walla Walla River	McNary adult ladder (Oregon)	10/23/2008	5/25/09 & 6/19/09
Walla Walla River	Priest Rapids adult ladder (east)	1/28/2009	7/5/2009
Walla Walla River	McNary adult ladder (Oregon)	10/24/2011	6/26-29/2012
Touchet River	McNary juvenile bypass	4/7/2013	6/1/2014 & 6/2/2014

PIT tag detection in the Umatilla River

A bull trout PIT-tagged in the Walla Walla River was recaptured within the Umatilla River Subbasin, having migrated to the Columbia River, passed downstream of McNary Dam and entered the Umatilla River (Barrows et al. 2014a; Sankovich et al. 2014). This fish was tagged on 17 November 2011 in the Walla Walla River (rkm 74), detected at the PIT detection array near the mouth of the Walla Walla River (rkm 10) on 28 December 2011 and recaptured at Three Mile Falls Dam on 10 May 2012. The detection history of this fish suggests it may have passed downstream of McNary Dam during the winter through the turbines. If the fish passed downstream of McNary Dam following 10 April 2012, downstream passage options would have included the spill gates.

Recommendations

Use of the Columbia River by Walla Walla River Subbasin bull trout has been monitored since 2007, but COE funding for this monitoring effort ended following 2012. Despite efforts to continue this valuable long-term dataset by the FWS and the CTUIR, the number of PIT-tagged individuals in the migratory component of the bull trout population has dwindled and is no longer at levels conducive to monitoring mainstem use. The PIT-tagging effort also provided a quantitative estimate of the total number of bull trout that used the mainstem each year, and a tagged population of migratory individuals to evaluate the impacts of avian predation (e.g., pelicans, cormorants, terns) on Walla Walla River Subbasin bull trout. At current tagging levels, quantitative estimates of mainstem use and avian impacts to bull trout are difficult to characterize. We recommend reinitiating the migratory bull trout sampling, PIT-tagging, and PIT tag monitoring program to continue the abovementioned research and long-term monitoring datasets. In addition, the COE funded only the first three years of the proposed six year acoustic-telemetry study to better understand the movements and disposition of bull trout that enter the Columbia River and how they are influenced by mainstem projects (Barrows et al. 2012, 2014a). We recommend the completion of this study to guide additional research needs and inform future management actions. These recommendations are similar to research, monitoring and evaluation recommendations listed in the Mid-Columbia Recovery Unit Implementation Plan for bull trout (USFWS 2015).

Yakima River Subbasin

Yakima River Subbasin summary

Bull trout populations in the subbasin

- The best available information indicates the Yakima River Subbasin supports 15 bull trout local populations in one core area.
- Migratory bull trout are present in 13 of the local populations; fluvial and adfluvial bull trout are present in four and nine of those populations, respectively.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout disperse seasonally throughout the middle to upper portions of the Yakima River Subbasin.

Bull trout movement/habitat use in the mainstem

- Use of the Columbia or Snake rivers by migratory bull trout from the Yakima River Subbasin has not been demonstrated.

Bull trout interactions with mainstem hydroprojects

- N/A

Yakima River Subbasin bull trout

Subbasin description

The Yakima River flows for 344 rkm and enters the Columbia River at rkm 539 in south-central Washington (Figure 1.8), 69 rkm upstream from McNary Dam and 100 rkm downstream from Priest Rapids Dam. The Yakima River and its tributaries drain the east slope of the Cascade Mountain Range. The drainage area is approximately 15,900 km^2. The Naches River is the largest tributary to the Yakima River, entering it at rkm 539.188. Ahtanum Creek is the downstream-most tributary to the Yakima River supporting a bull trout local population. It enters the Yakima River at rkm 539.173.

Bull trout populations in the subbasin

The Yakima River Subbasin contains a single core area, the Yakima Core Area, which encompasses the entire subbasin (Figure 1.8). The Bull Trout Recovery Plan identified 15 bull trout local populations in the Yakima Core Area (USFWS 2015). They reside in Ahtanum Creek; Rattlesnake and Crow creeks and the American River (Naches River); Indian Creek, the South Fork Tieton River, and the North Fork Tieton River (Rimrock Lake); Deep Creek (including the Bumping River) (Bumping Lake); the Cle Elum and Waptus rivers (Cle Elum Lake); Box Canyon Creek and the Kachess River (Kachess Lake); Gold Creek (Keechelus Lake); and the Teanaway and upper Yakima rivers.

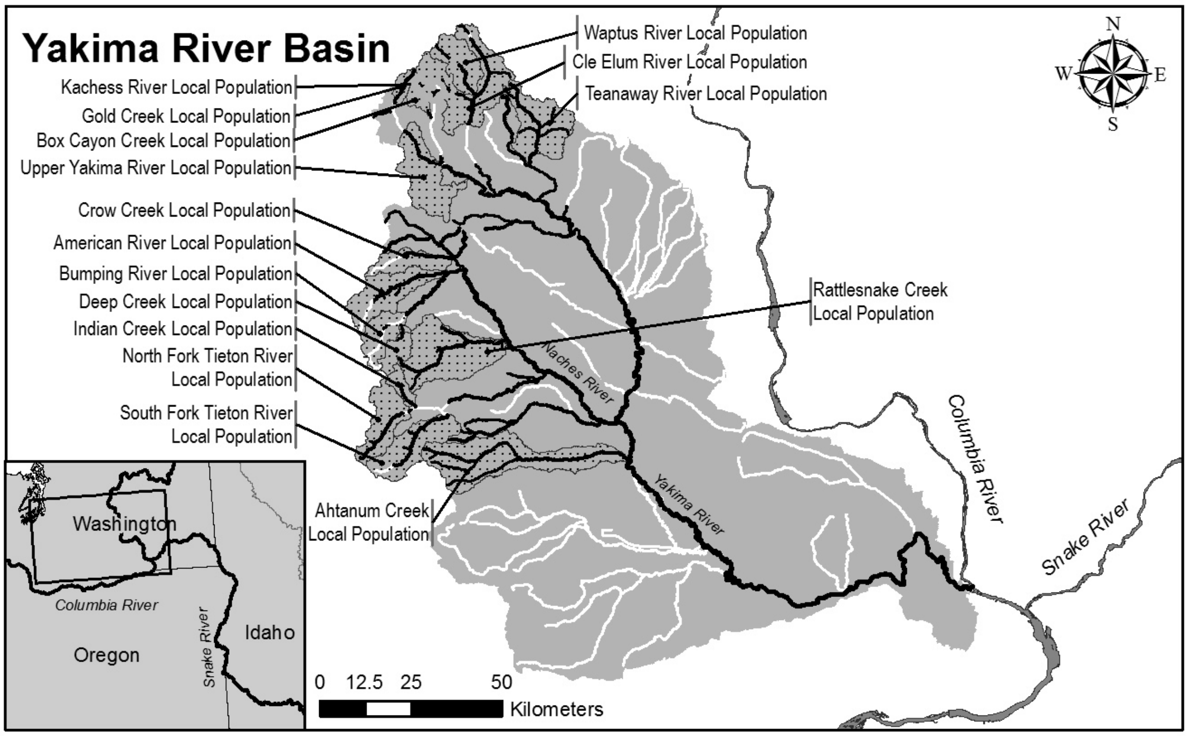

Figure 1.8. Yakima River Subbasin and bull trout local populations.

<u>Migratory bull trout in the subbasin</u>

Migratory bull trout are present in thirteen of the local populations. Fluvial bull trout are present in Rattlesnake Creek, Crow Creek, the American River, and the upper Yakima River. Ahtanum Creek is thought to have supported fluvial bull trout in the past, but currently appears to support only resident bull trout (Reiss et al. 2012). Adfluvial bull trout are present in Rimrock, Bumping, Cle Elum, Kachess, and Keechelus lakes. Mizzel and Anderson (2010) used radio-telemetry to study the migrations of primarily adult bull trout in the Naches River, Ahtanum Creek, and upper Yakima River drainages in 2003-2006. None of fish in that study used the Yakima River downstream from the mouth of the Naches River (rkm 539.188). However, there is some evidence bull trout infrequently use the lower to middle Yakima River. One adult bull trout has been captured in an anadromous salmonid smolt trap that has been operated at the mouth of Ahtanum Creek since 2000 (Reiss et al. 2012), and that fish presumably entered the Yakima River. In addition, a small number of bull trout were observed in the lower Yakima River or its tributaries in the late 1990s and early 2000s (USFWS 2002). Bull trout use of the lower Yakima River is thought to have occurred more frequently prior to the construction of irrigation dams and withdrawals in the subbasin (USFWS 2002).

Yakima River Subbasin bull trout in the mainstem Columbia River

No evidence exists of use of the Columbia or Snake rivers by bull trout from the Yakima River Subbasin. Although bull trout from the Yakima River Subbasin have not been observed in the Columbia or Snake rivers, a bull trout from the Columbia River has been observed in the Yakima River. That bull trout was PIT-tagged and released in the Entiat River in September 2009, detected in the Rock Island adult fishway in early July 2010, and then detected in the Yakima River at the Prosser Diversion Dam (rkm 76) in late June 2011. It was subsequently detected in the adult fishways at Priest Rapids Dam (24 May 2012), Rock Island Dam (1 June 2012), and Rocky Reach Dam (3 June 2012), and at a PIT tag antenna array in the Entiat River (8 July 2012).

<u>Bull trout interactions with mainstem Columbia and Snake River hydroprojects</u>

- N/A

Recommendations

Historically, Yakima subbasin bull trout may have migrated to the Columbia and Snake rivers, but anthropogenic factors have likely negatively affected habitat conditions in the lower Yakima River to the point where bull trout cannot utilize it. The lower-most local populations in the Yakima subbasin are located in excess of 200 rkm from the mouth of the Yakima. Local populations above the upper subbasin storage reservoirs are located in excess of 300 rkm from the mouth of the Yakima. The greatest migration distance on record for a bull trout (which may not have included the full migration range of that fish) is 307 km (Bjornn and Mallet 1964), and shorter migration distances are the norm (e.g., Starcevich et al. 2012 and the references therein). Considering the long distances required to access and use the Columbia River, along with the compromised condition of the lower Yakima as a result of diversion dams, water withdrawals, and the modified hydrograph, establishing use of the Columbia River if it occurs, could be difficult. Efforts to determine mainstem use should focus on the lower subbasin local populations that are not affected by dams and storage reservoirs. For these populations, PIT- and radio-tagging efforts could be implemented or continued to determine migratory patterns. Research on local populations in the upper subbasin that occur upstream of storage reservoirs that do not provide upstream and downstream passage would be a lower priority. Genetic samples should be collected from all bull trout handled, particularly in tributaries and the mainstem Yakima that are downstream of current local populations to confirm origin and potentially add to descriptions of migratory patterns. Streamflow, water temperature, and habitat conditions in the lower mainstem Yakima should be evaluated with respect to whether there are flow or temperature barriers affecting the migration patterns of Yakima River bull trout. Additional monitoring sites for bull trout could be established if data gaps in migratory patterns are observed as studies proceed.

Mid-Columbia River

Wenatchee River Subbasin

Wenatchee River Subbasin summary

Bull trout populations in the subbasin

- The Wenatchee River Subbasin supports seven bull trout local populations in one core area.

- Migratory bull trout are present in all of the local populations in the core area.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout disperse seasonally throughout the Wenatchee River and its major tributaries.

Bull trout movement/habitat use in the mainstem

- Bull trout from the Wenatchee River Subbasin use the Columbia River, primarily as overwintering habitat and a migratory corridor.

Bull trout interactions with mainstem hydroprojects

- Bull trout from the Wenatchee River Subbasin have been observed at Rock Island, Rocky Reach, and Wells dams on the Columbia River; interactions between PIT-tagged bull trout and individual dams have generally been brief (one day) and have not exceeded three days.

Wenatchee River Subbasin bull trout

Subbasin description

The Wenatchee River originates at Lake Wenatchee and flows for 87 rkm before entering the Columbia River at rkm 754 in central Washington (Figure 1.9), 24 rkm upstream from Rock Island Dam and 9 rkm downstream from Rocky Reach Dam. The Wenatchee River and its tributaries drain the east slope of the Cascade Mountain Range. The drainage area is approximately 3,551 km^2. The Chiwawa River and Nason Creek are major tributaries to the Wenatchee River, entering it at rkm 754.077 and 754.086, respectively. Peshastin Creek is the downstream-most tributary to the Wenatchee River supporting a bull trout local population. It enters the Wenatchee River at rkm 754.029.

Bull trout populations in the subbasin

The Wenatchee River Subbasin contains one core area, the Wenatchee Core Area, which encompasses the entire subbasin (Figure 1.9). The Wenatchee Core Area supports seven bull trout local populations. They reside in the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and James creeks), White River (including Canyon and Panther creeks), Little Wenatchee River (below a falls), Nason Creek (including Mill Creek), Chiwaukum Creek, Icicle Creek (including Icicle, French, and Jack Creeks), and Peshastin Creek (including Ingalls Creek).

Migratory bull trout in the subbasin

Migratory bull trout occur in all of the local populations in the Wenatchee River Subbasin. Both adfluvial and fluvial forms are present in the subbasin. In 2000-2004, Kelly Ringel et al. (2014) used radio-telemetry to study the migrations of 62 adult bull trout captured in the Wenatchee River at Dryden and Tumwater dams (rkm 754.028 and 754.050, respectively), and in the Chiwawa River (rkm 1.5 on the Chiwawa River), Icicle Creek (rkm 4.3 on Icicle Creek), and Lake Wenatchee (rkm 754.087 on the Wenatchee River). The bull trout in that study exhibited a wide range of migratory patterns, including allacustrine - adfluvial migrations (as defined by Kelly Ringel et al. [2014]) from Lake Wenatchee downstream in the Wenatchee River and upstream in the Chiwawa River. Individuals seasonally used non-natal as well as natal tributaries and the full length of the Wenatchee River. Overwintering areas were identified in Lake Wenatchee, the Wenatchee River, and the Columbia River, where one of the tagged fish was observed and four others were suspected to have spent the winter. The fish that entered the Columbia River and could be assigned to a local population because they were on spawning grounds during the spawning period were from the Chiwawa River and Nason Creek local populations. Migratory adult-sized bull trout captured and radio-tagged in lower Icicle Creek also have entered the Columbia River (Nelson et al. 2011, 2012; Kelly Ringel et al. 2014). The origin of these fish was unknown, since no known spawning population exists in lower Icicle Creek.

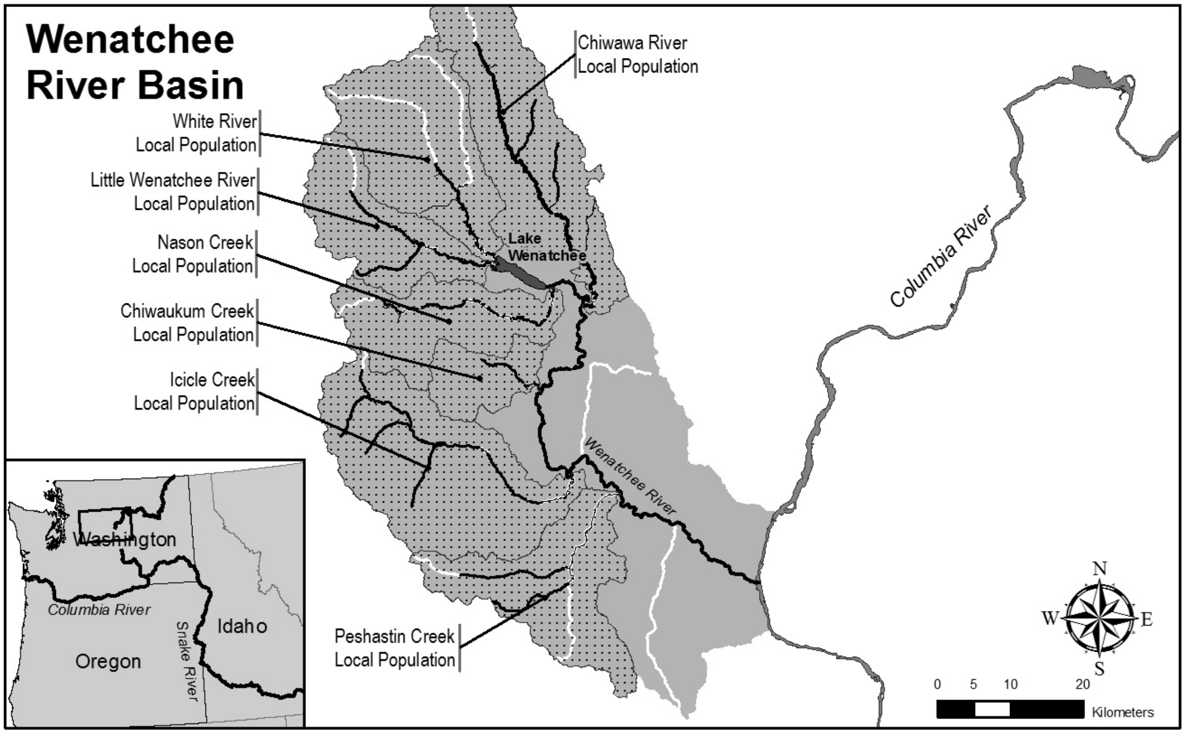

Figure 1.9. Bull Trout local populations in the Wenatchee River Subbasin.

Wenatchee River Subbasin bull trout in the mainstem Columbia River

Migration to and from the mainstem Columbia River

The Washington Department of Fish and Wildlife has operated a PIT-tag detection array (LWE) at rkm 754.003 on the Wenatchee River since 2010. Thirty-five PIT-tagged bull trout (one subadult and 34 adults) from the Wenatchee River Subbasin have been detected at that array, during all months of the year except June. At least three of these fish (all adults) entered the Columbia River based on their subsequent detection at mainstem dams. They were detected at the LWE array in September and October. The combined PIT- and radio-tagging data indicate migratory adults move from the Wenatchee River into the Columbia River primarily during the fall and early winter, although they may do so during all months of the year (BioAnalysts, Inc. 2004, 2009; Nelson et al. 2011, 2012; Kelly Ringel et al. 2014).

Estimates of abundance of mainstem migrants

There are no estimates of the abundance of Wenatchee Core Area bull trout that use the mainstem Columbia River.

Bull trout movement/habitat use within the mainstem Columbia River

Based on PIT- and radio-tagging studies, it is evident Wenatchee River bull trout use the Columbia River from below Rock Island Dam to the mouth of the Methow River. Radio-tagged bull trout from the Wenatchee River Subbasin (n=4) have been located in the Columbia River up- and downstream from the mouth of the Wenatchee River during winter, between rkm 750 and 843 (the mouth of the Methow River) (Nelson et al. 2011; Kelly Ringel et al 2014). Three bull trout PIT-tagged in the Wenatchee River Subbasin and detected at rkm 754.003 traveled between that site and Rocky Reach Dam in early October to mid-November, late September to early November, and late October to early November. Three PIT-tagged bull trout detected at both Rocky Reach and Wells dams travelled upstream between those sites in mid-November to early December, mid- to late December, and late December to late June. Finally, one bull trout PIT-tagged in Icicle Creek in November 2009 used the Columbia River to access the Entiat River, where it was located in the fall of 2010 and 2011, between excursions to the Columbia River and Rocky Reach Dam in June 2010-2012.

During radio-telemetry studies of bull trout captured and tagged at Rock Island, Rocky Reach, and Wells dams from 2001-2004 and Rock Island and Rocky Reach dams from 2005-2009 (BioAnalysts, Inc. 2004, 2009), 24 of the tagged bull trout entered the Wenatchee River. Based on the detection histories and locations of these fish (e.g., in the mainstem Wenatchee or non-natal tributaries) it appears a portion of these fish did not originate in the Wenatchee River Subbasin. Nevertheless, the combined results from those studies and of radio-telemetry and PIT-tagging studies of bull trout tagged in the Wenatchee River indicate bull trout exit the Columbia River and enter the Wenatchee River primarily in spring and early summer, but up through September (BioAnalysts, Inc. 2004, 2009; Nelson et al. 2011, 2012; Kelly Ringel et al. 2014).

<u>Bull trout interactions with mainstem Columbia River hydroprojects</u>

Twenty-four bull trout PIT-tagged in the Wenatchee River Subbasin have been detected at mid-Columbia River dams. All of the detections have occurred in adult ladders. Twenty-two were detected at Rocky Reach Dam, three at Wells Dam, and two at Rock Island Dam. All three of the bull trout detected at Wells Dam were first detected at Rocky Reach Dam.

The detections at Rocky Reach Dam occurred in June (n=1), August (n=1), September (n=1), October (n=6), November (n=11), and December (n=6). The detections at Wells Dam occurred in June (n=1) and December (n=2). The detections at Rock Island Dam occurred in May (n=1) and June (n=1). BioAnalysts, Inc. (2004) reported that most bull trout in the mid-Columbia River move past Rock Island, Rocky Reach, and Wells dams in mid-May to late June, although that observation was not specific to Wenatchee River Subbasin bull trout.

Bull trout PIT-tagged in the Wentachee River subbasin have typically been detected briefly at mainstem dams. Detection histories for PIT-tagged bull trout detected at Rocky Reach and Rock Island dams indicate that each fish was only detected at the dam for one day. For PIT-tagged Wenatchee River Subbasin bull trout detected at Wells dam, one was detected for one day, two for two days, and one was detected at the dam for three days.

Recommendations

Given the proximity of the Wenatchee River Subbasin to mid-Columbia River dams, bull trout from that subbasin are among the most likely to utilize the Columbia River and interact with the hydroprojects there. Thus, on-going efforts to PIT tag and monitor the migrations of bull trout exiting the Wenatchee River should be continued. Future studies, including in the Wenatchee River Subbasin, should include subadult bull trout.

Entiat River Subbasin

Entiat River Subbasin summary

Bull trout populations in the subbasin

- The Entiat River Subbasin supports two bull trout local populations within a single core area.
- One local population originates in the Mad River and the other is in the upper mainstem Entiat River.

Migratory bull trout in the subbasin

- Adult and subadult bull trout disperse seasonally throughout the subbasin.
- Entiat River populations exhibit resident, fluvial, and adfluvial (reservoir) life histories.

Bull trout movement/habitat use in the mainstem

- Both adults and subadults have been detected moving into the Columbia River.
- Core area connectivity has been documented with Entiat-origin bull trout.
- Little is known about habitat use in the mainstem Columbia River.

Bull trout interactions with mainstem hydroprojects

- Bull trout from the Entiat River Subbasin have interacted with Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams on the Columbia River; interactions between PIT-tagged bull trout and individual dams have generally been brief.

Entiat River Subbasin bull trout

Subbasin description

The Entiat River originates on the east slope of the Cascade Mountain Range in Central Washington. The Entiat River flows southwest for approximately 84 rkm before discharging into Lake Entiat on the Columbia River at rkm 778 (Figure 1.10). Lake Entiat is the reservoir created by Rocky Reach Dam (rkm 762). Major tributaries are the Mad River (rkm 778.017) and the North Fork Entiat River (rkm 778.055) (USFWS 2002).

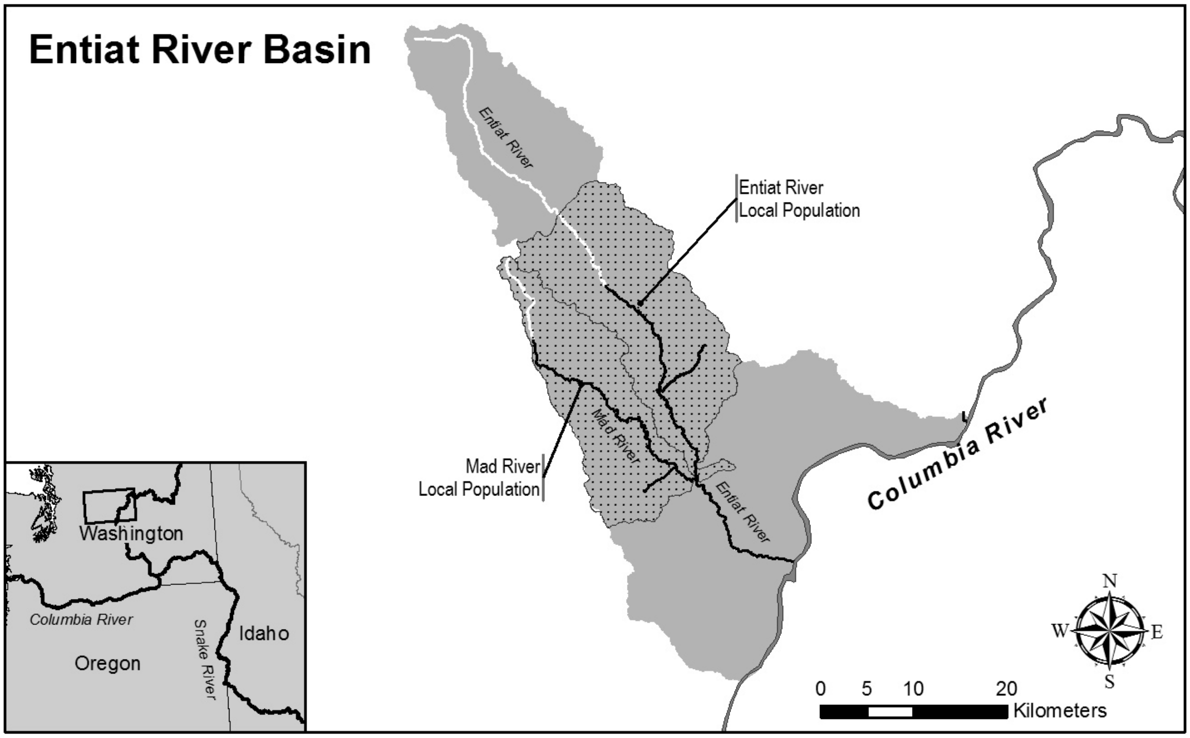

Figure 1.10. Entiat River Subbasin and bull trout local populations.

<u>Bull trout populations in the subbasin</u>

The Entiat River is comprised of a single core area with two local populations. The mainstem Entiat supports one local population with the other being located in the Mad River, a tributary to the Entiat River. Bull trout occupy the entire Entiat River mainstem up to Entiat Falls (rkm 778.054) depending on life stage and time of year. Due to the geology of the subbasin, adult bull trout are vulnerable to natural migration barriers that have been known to block access to spawning grounds (Nelson 2014).

<u>Migratory bull trout in the subbasin</u>

Bull trout exhibit migratory life histories in the Entiat River Core Area with some evidence of a resident population in the Mad River (Nelson 2014). Radio-telemetry studies have shown that adult bull trout begin upstream spawning migrations in spring and summer months on the declining limb of the hydrograph. After spawning, adults moved downstream throughout the fall and winter. Analysis of PIT data shows migratory subadults moving throughout the year (www.ptagis.org [queried Dec. 2014]).

Entiat River Subbasin bull trout in the mainstem Columbia River

Migration to and from the mainstem Columbia River

Radio-telemetry and PIT-tagging studies have documented movement of bull trout into and out of the Columbia River (Nelson 2014; www.ptagis.org [queried Dec. 2014]). Adult bull trout returning from the Columbia River start staging at the mouth of the Entiat River around May and June. After spawning, adults return to the Columbia River in fall and winter months. Subadult bull trout have been detected emigrating into the Columbia River throughout the year.

Estimates of abundance of mainstem migrants

There have been no completed studies to estimate abundance of mainstem migrants out of the Entiat River. However, bull trout observed in mainstem dam adult ladders have been enumerated (BioAnalysts, Inc. 2009). Since 1998, annual counts at Rocky Reach Dam fishway, the first dam downstream from the mouth of the Entiat River, have averaged approximately 152 bull trout per year and ranged from 78-246 through 2014 (www.cbr.washington.edu/dart). Some of these migrants could be from other subbasins such as the Wenatchee or Methow rivers.

Bull trout movement/habitat use within the mainstem Columbia River

Entiat Subbasin origin bull trout have been documented migrating throughout the mid-Columbia River. Connectivity between core areas has been documented with Entiat PIT-tagged bull trout entering the Wenatchee, Methow and Yakima River subbasins (www.ptagis.org [queried Dec. 2014]).

Bull trout interactions with mainstem Columbia River hydroprojects

Bull trout from the Entiat River have been documented interacting with mainstem hydroprojects. Several radio-telemetry studies have investigated the effects of hydroproject operations on bull trout migration in the Columbia River (BioAnalysts, Inc. 2004, 2009). Additionally, bull trout PIT-tagged in the Entiat River have been detected in the juvenile bypass and adult ladders at Wells, Rocky Reach, Rock Island, and Priest Rapids dams (www.ptagis.org [queried Dec. 2014]). Bull trout observations are more numerous at Rocky Reach than any other mid-Columbia River project. Most PIT-tagged bull trout detected at Rocky Reach are Entiat origin bull trout.

Most adult observations at dams occur in the ladders from April to July during upstream migration to spawning tributaries (BioAnalysts, Inc. 2004, 2009). Timing of downstream passage for adults occurs from October through December based on radio-telemetry data. Subadult observations and detections at mainstem projects are less common than adults. There are some observations and detections in ladders; however ladders are only monitored from mid-April/May through mid-November. There are also a few observations and detections of subadult bull trout in the Rocky Reach surface bypass samples. The surface bypass is operated from April into September with most detections occurring during spring months.

Recommendations

While several studies have investigated the timing and migration of adult bull trout in the Columbia River, few have been completed that detail subadult behavior. Radio-telemetry studies should be initiated to describe subadult migration and use of the Columbia River. Tagging of adults and subadults with PIT tags should continue in the Entiat and Mad rivers to provide a tagged population of bull trout that would be available for detection at other out-of-subbasin PIT detection arrays and at the mainstem hydroprojects. In addition, maintaining a PIT-tagged population could allow estimation of the abundance of mainstem migrants.

Methow River Subbasin

Methow River Subbasin summary

<u>Bull trout populations in the subbasin</u>

- The Methow River Subbasin supports 10 bull trout local populations within one core area. These occur in Gold Creek, Beaver Creek, Twisp River, Chewuch River, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, and Goat Creek.

- Fluvial, adfluvial, and resident life history strategies are all present in the Methow River Subbasin.

<u>Migratory bull trout in the subbasin</u>

- Subadult migration downstream occurs in peaks centered on spring and fall, with greater than half of these fish moving downstream in the spring.

- Adult migration downstream occurs in rapid, incremental movements following spawning, with the majority of this movement occurring between September and December.

- Adult migration upstream begins in May with most migratory adult bull trout reaching spawning areas by mid-July.

<u>Bull trout movement/habitat use in the mainstem</u>

- Subadult bull trout move into the Columbia River in the spring and fall.

- Adult bull trout move into the Columbia River shortly after spawning into December.

- Evidence indicates use of the Columbia River by Methow River Subbasin bull trout from below Rock Island Dam upstream to the Okanogan River Subbasin.

- Type of habitat used and extent of movement exhibited by bull trout in the mainstem Columbia River depends on whether fish are actively migrating or overwintering.

Bull trout interactions with mainstem hydroprojects

- Evidence indicates migratory Methow River bull trout pass downstream and upstream through three mainstem hydroprojects: Wells Dam, Rocky Reach Dam, and Rock Island Dam.

- Pre-spawning and post-spawning migrations often involve passage through one or more projects in the same year and in subsequent years.

- While few subadult bull trout have been observed or detected at Wells Dam, the numbers of adults that are observed migrating upstream through the project implies passage of an unknown number of subadults downstream through Wells Dam.

Methow River Subbasin bull trout

Subbasin description

The Methow River is located in north-central Washington. The Methow River headwaters drain from eastern side of the Cascade Range to its confluence with the Columbia River at rkm 843 approximately 13 rkm above Wells Dam (Figure 1.11). The drainage area is 4,895 km².

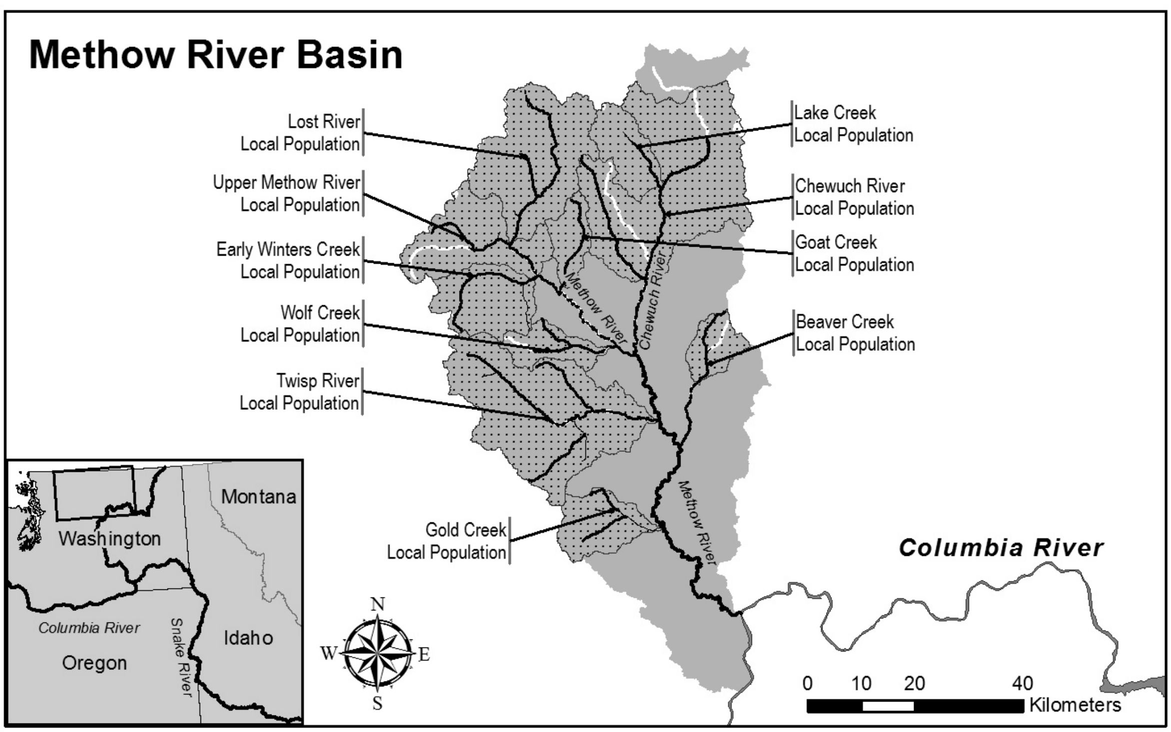

Figure 1.11. Bull trout local populations in the Methow River Subbasin.

Bull trout populations in the subbasin

The Methow River Subbasin supports 10 bull trout local populations within one core area. These occur in Gold Creek, Beaver Creek, Twisp River, Chewuch River, Wolf Creek, Early Winters Creek, Upper Methow River, Lost River, and Goat Creek. Information on bull trout spawning and life history has been collected for the Methow River through a number of monitoring efforts (Mullan et al. 1992; BioAnalysts, Inc. 2002, 2004; Nelson 2004; Nelson and Nelle 2007; Nelson et al. 2007; Nelson and Johnsen 2012; Martens et al. 2014a, 2014b). Redd surveys have been conducted throughout the subbasin regularly since 1992 (USFWS 2002), but the results of those are largely contained in unpublished reports (e.g., USFS 2001, 2002, 2009). These populations support adfluvial, fluvial, and resident life history strategies (USFWS 2002). Genetic structure of the Methow River Subbasin in the context of the range of bull trout in the coterminous United States has been described (Ardren et al. 2011).

Migratory bull trout in the subbasin

Several efforts over the past two decades have led to an increasing dataset documenting movement of migratory bull trout in the Methow River Subbasin. Most information has been collected through a series of radio-telemetry studies conducted by the FWS – Mid-Columbia River Fishery Resource Office (Nelson and Nelle 2007; Nelson et al. 2007; Nelson and Johnsen 2012). This information has been supplemented by monitoring conducted by Chelan County Public Utility District No. 1 (PUD), Douglas County PUD, and Grant County PUD (BioAnalysts, Inc. 2002, 2004; Le 2010; Douglas County PUD 2011, 2012, 2013, 2014).

The collective consideration of all of this information provides some insight on the timing of bull trout movement within the subbasin and to and from the Columbia River. The following are descriptions of subadult and adult bull trout migration patterns derived from the previously mentioned movement studies.

Subadult downstream migration ─ There is limited information available for subadult downstream migration. Screw traps are operated by WDFW and Douglas County PUD on the Methow and Twisp rivers (http://www.cbr.washington.edu/mcpud/). While few bull trout are captured in these efforts, those that are indicate pulses of downstream migration in spring and fall, with more than half of the fish leaving in the spring during most years. These spring and fall peaks are supported by data from the nearby Entiat and Wenatchee subbasins (Murdoch et al. 2001; Mallas and Nelson 2005). Subadult movement patterns in some Methow River bull trout local populations (i.e., Twisp River) can be confounded by seasonal dry reaches that can occur in the fall and last until rains re-water the river (Nelson and Johnsen 2012).

Adult downstream migration ─ Following spawning, fluvial bull trout move downstream from spawning areas to lower portions of the Methow River and to the Columbia River. To reach overwintering areas, bull trout make rapid, incremental downstream movements through migratory corridors. The majority of this movement occurs between September and December.

Adult upstream migration ─ After overwintering, adult bull trout in the Columbia River move rapidly through the Columbia River reservoirs and enter the Methow beginning in May. Bull trout that overwintered in lower Methow River Subbasin reaches also begin migrating upstream in May. Most bull trout enter spawning tributaries by July and are detected on or near spawning areas by mid-July.

Methow River Subbasin bull trout in the mainstem Columbia River

Evidence indicates Methow River Subbasin bull trout use the mainstem Columbia River. Subadult bull trout (< 300 mm) may predominantly move into the mainstem Columbia River in spring and fall (Nelson and Johnsen 2012; http://www.cbr.washington.edu/mcpud/) and adults are detected returning to the mainstem Columbia River shortly after spawning (Nelson and Nelle 2007; Nelson et al. 2007; Nelson and Johnsen 2012). Use of the mainstem Columbia River has been described through several monitoring efforts (BioAnalysts, Inc. 2002, 2004; Nelson and Nelle 2007; Nelson et al. 2007; Le 2010; Douglas County PUD 2011; Nelson and Johnsen 2012; Douglas County PUD 2012; Douglas County PUD 2013; Douglas County PUD 2014).

Migration to and from the mainstem Columbia River

PIT detection arrays ─ There are several PIT detection arrays in the Methow River Subbasin that provide information on bull trout populations. Those include arrays located in the Methow River (LMR – rkm 843.003; MRT – rkm 843.067; MHB – rkm 843.070; MSC – rkm 843.071; M3R – rkm 843.075; MWF – rkm 843.076; MRW – rkm 843.085), Gold Creek (GLC – rkm 843.035.001; GL2 – rkm 843.035.002.004), Beaver Creek (BVC – rkm 843.057.003), Twisp River (TWR – rkm 843.066.002; LBT – rkm 943.066.014.001), Chewuch River (CRW – rkm 843.080.001; EMC – rkm 843.080.018.001; CRU – rkm 843.080.028), Wolf Creek (WFC – rkm 843.085.001), Early Winters Creek (EWC – rkm 843.113.001), and Lost River (LOR – rkm 843.112.001). Since 2004, approximately 1,338 bull trout have been PIT-tagged in the Methow River Subbasin (www.ptagis.org [queried Dec. 2014]). Detections in the lower Methow River at Pateros LMR (rkm 843.003) PIT array support migration to and from the mainstem Columbia River at times reported in previous sections.

Radio-telemetry ─ Multiple studies support the movement and associated timing reported in previous sections and supported by PIT tag technology (BioAnalysts, Inc. 2002, 2004; Nelson and Nelle 2007; Nelson et al. 2007; Nelson and Johnsen 2012; Le 2010; Douglas County PUD 2011; Douglas County PUD 2012; Douglas County PUD 2013; Douglas County PUD 2014). The distribution of Methow River bull trout that overwinter in the Columbia River, overlaps with the distribution of bull trout populations from the Entiat and the Wenatchee rivers that overwinter in the mainstem. In addition, Methow River bull trout overwinter in areas downstream of the confluences of all three subbasins with the Columbia River.

Estimates of abundance of mainstem migrants

No estimates of abundance of mainstem migrants from the Methow River Subbasin are available.

Bull trout movement/habitat use within the mainstem Columbia River

Methow River Subbasin bull trout move in the Columbia River from as far upstream as the Okanagan River to downstream of the Wenatchee River. BioAnalysts, Inc. (2002) investigated bull trout habitat use in Rock Island Reservoir and Rocky Reach Reservoir.

Radio-telemetry ─ BioAnalysts, Inc. (2002) radio-tagged 30 bull trout at Rock Island and Rocky Reach dams during the 2000 migration season. Between June 2001 and March 2002, habitat use in Rock Island and Rocky Reach reservoirs was investigated with a series of boat surveys. Fish migrating toward tributaries in Rock Island Reservoir occurred in 5.5 m of water, on average, approximately 90 m from shore, over relatively flat river bottom and in areas of relatively high water velocity. In Rocky Reach Reservoir, bull trout migrating toward tributaries occupied deeper water (12.6 m on average) approximately 110 m from shore. Bull trout that were overwintering in these reservoirs occupied waters 5.5 m in depth (on average in Rock Island Reservoir) to 7.8 m in depth (on average in Rocky Reach Reservoir) approximately 40 m from shore. Fish (n = 5) were detected multiple times while overwintering in Rock Island Reservoir in the same general area, indicating little movement during this time.

Detections of Methow River Subbasin bull trout in other subbasins ─ Use of other subbasins by Methow River migratory bull trout has been documented through PIT tag technology and radio-telemetry. PIT tag detections near the mouths of the Entiat (n=1) and Okanogan (n=5) rivers have detected bull trout entering those subbasins subsequent to leaving the Methow River in September through November (www.ptagis.org [queried Dec. 2014]). Radio-telemetry investigations have documented migratory adult bull trout that exhibit spawning behavior (i.e., upstream movements to spawning areas in the fall) in the Methow River, exhibiting the same type of behavior in the Wenatchee and the Entiat subbasins in other years (Nelson et al. 2007; Nelson and Johnsen 2012). In addition, Methow River bull trout have been detected entering the Okanogan River for short times before entering the Methow River to spawn (BioAnalysts, Inc. 2002, 2004; Nelson and Johnsen 2012). Also, in November 2007, a bull trout was observed moving upstream through Zosel Dam to Osoyoos Lake on the Okanogan River over 140 rkm from the mouth of the Methow River (a likely source), indicating that some exploratory migrations to nonnatal subbasins might be more extensive (M. Rayton, Confederated Tribes of the Colville Reservation, *in litt*. 2007).

Bull trout interactions with mainstem Columbia River hydroprojects

There are four hydroprojects which migratory Methow River bull trout are most likely to interact with: Chief Joseph (rkm 877; 34 rkm upstream of Methow River confluence); Wells (rkm 830; 13 rkm downstream of Methow River confluence); Rocky Reach (rkm 763; 80 rkm downstream of Methow River confluence); and Rock Island (rkm 730; 113 rkm downstream of Methow River confluence). Evidence from the literature previously cited indicates that migratory Methow River bull trout pass downstream and upstream through the three lower hydroprojects. Pre-spawning and post-spawning migrations often involve passage through one or more projects in the same year and in subsequent years. Monitoring at each of these projects provides counts for migratory adult bull trout, but these likely represent fish from the Entiat and Wenatchee river subbasins in addition to the Methow River Subbasin. Count information for Wells Dam is provided in Table 1.6 because this is the closest hydroproject to the Methow River and has the highest potential for interaction with Methow River bull trout. The PIT tag array at Wells Dam has detected 58 unique individual bull trout between 2010 and the end of 2014 (www.ptagis.org [queried Dec. 2014]). While few subadult bull trout have been observed or detected at the project, the numbers of adults that are observed migrating upstream through the project implies passage of an unknown number of subadults downstream through Wells Dam.

Table 1.6. Bull trout observed passing through adult fish ladder at Wells Dam, 2005-2013 (Douglas County PUD 2010, 2011, 2012, 2013, 2014).

	2005-2008	2008	2009	2010	2011	2012	2013
Adult	214	43	43	44	66	74	113
Subadult	0	0	0	0	0	1	0

Recommendations

We recommend to continue cooperative monitoring efforts among partners (i.e., FWS, U.S. Forest Service, U.S. Geological Survey, WDFW, Chelan County PUD, Douglas County PUD, and Grant County PUD) currently being implemented in the Methow River Subbasin. Research is also needed to further understand timing of migratory juvenile and subadult emigration from the Methow River Subbasin.

Lower Snake River

Tucannon River Subbasin

Tucannon River Subbasin summary

Bull trout populations in the subbasin

- The Tucannon River Subbasin supports nine bull trout local populations in one core area.
- Migratory bull trout are present in the core area in all of the local populations.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout disperse seasonally throughout the length of the Tucannon River.

Bull trout movement/habitat use in the mainstem

- Bull trout from the Tucannon River Subbasin use the Snake River primarily as overwintering habitat and a migratory corridor.

Bull trout interactions with mainstem hydroprojects

- Bull trout from the Tucannon River Subbasin have been detected at all of the lower Snake River dams; interactions between bull trout and individual dams have generally been brief, but in some cases have occurred over two to four weeks.

Tucannon River Subbasin bull trout

Subbasin description

The Tucannon River flows northwest for about 100 rkm before it enters the Snake River at rkm 522.100 in southeastern Washington (Figure 1.12), 33 rkm upstream from Lower Monumental Dam and 13 rkm downstream from Little Goose Dam. The Tucannon River and its tributaries drain the north slope of the Blue Mountains. The drainage area is 1,300 km^2.

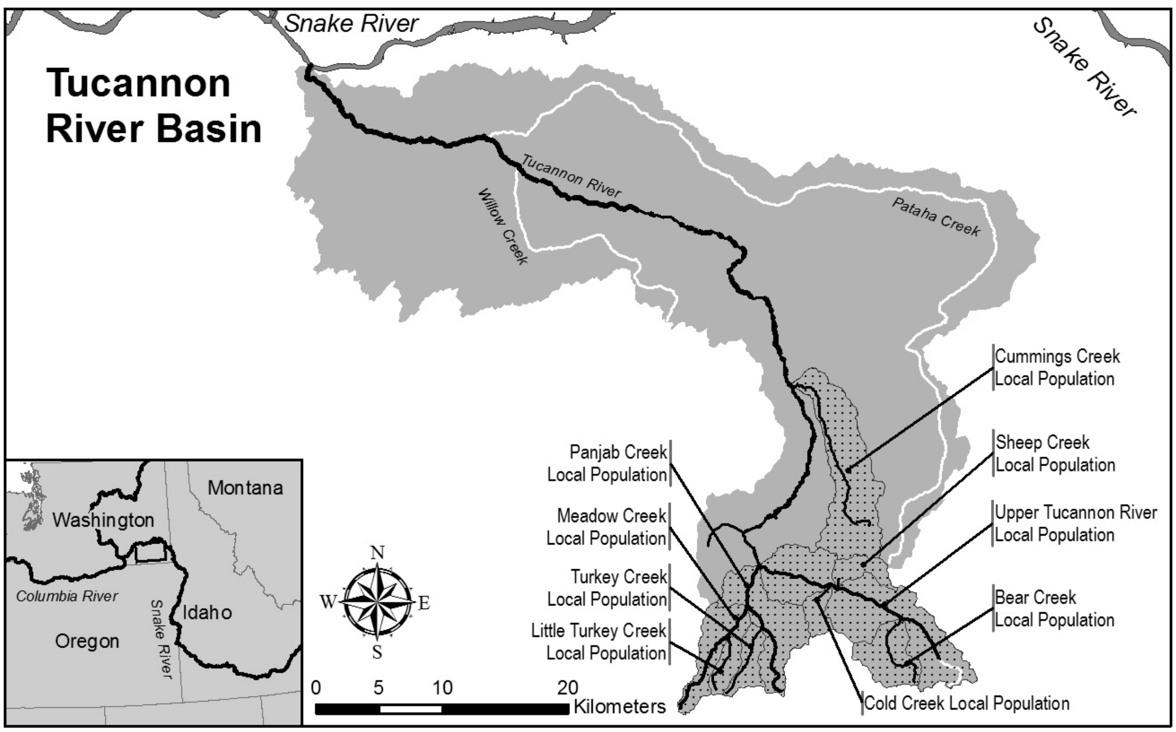

Figure 1.12. Tucannon River Subbasin and bull trout local populations.

Bull trout populations in the subbasin

The Tucannon River Subbasin contains one core area, the Tucannon River Core Area, which encompasses the entire subbasin (Figure 1.12). The Tucannon River Core Area supports nine local populations. They reside in Cummings, Sheep, Bear, Panjab, Meadow, Turkey, Cold, and Little Turkey creeks, and the upper Tucannon River.

Migratory bull trout in the subbasin

Migratory bull trout are present in all of the bull trout local populations in the Tucannon River Core Area. Migratory adults have been observed returning to all of the known spawning areas (Faler et al. 2008). Migratory subadult and adult bull trout have been shown to emigrate from the Tucannon River into the mainstem Snake River (Lake Herbert G. West – Lower Monumental).

Tucannon River Subbasin bull trout in the mainstem Snake and Columbia rivers

Migration to and from the mainstem Snake River

Multiple lines of evidence indicate that Tucannon River Subbasin bull trout use the mainstem Snake River. From 2002 – 2006, Faler et al. (2008) used radio and PIT tags to monitor the migrations of primarily adult bull trout captured and tagged in the Tucannon River. Six (5%) of 124 radio-tagged bull trout entered the Snake River or the reservoir-influenced section of the lower Tucannon River from late fall through winter. Bretz (2011) captured and PIT-tagged 1,027 subadult and adult bull trout in the Tucannon River and monitored their movements at a remote detection site in the lower Tucannon River (rkm 522.100.003) and detection sites at the mainstem dams from 2005 – 2009. Fifty-seven (6%) of the PIT-tagged fish were detected in the lower Tucannon River. The detections occurred between October and June. Adjusting for PIT tag antenna detection efficiency, Bretz (2011) estimated 6-29% of the tagged population entered the reservoir-influenced section of the lower Tucannon River each year. It is unclear given the fish capture methods employed, whether the tagged population was representative of the entire migratory population each year. The combined findings of Faler et al. (2008) and Bretz (2011) indicated migratory bull trout utilized the full length of the Tucannon River and displayed annual migration patterns typical of the species.

Bull trout movement/habitat use within the mainstem Snake and Columbia rivers

The movements of Tucannon River bull trout within the mainstem Snake River have not been well described. Faler et al. (2008) were unable to adequately document the movements of radio-tagged Tucannon River bull trout within the mainstem Snake River (Lake Herbert G. West) due to a small sample size and the limitations of radio-telemetry in deep water. In that study, four of the six tagged fish that entered the reservoir-influenced section of the lower Tucannon River or Lake Herbert G. West were present in those locations from October through March. One of the tagged fish was located in Lake Herbert G. West about 5 rkm downstream from the mouth of the Tucannon River from April through July, but it never returned to the Tucannon River, and it was not clear whether it had retained its tag or was alive during that time period. The tag of the remaining individual was recovered on the bank of Alkali Flat Creek, about seven rkm upstream from the mouth of the Tucannon River in February. Based on Bretz' (2011) work, noted above, Tucannon River bull trout were present in the reservoir-influenced section of the Tucannon River or Lake Herbert G. West from October through June.

Bull trout PIT-tagged in the Tucannon River have been detected at all four of the lower Snake River dams. Detection histories indicate those fish (n = 6) were in Lake Herbert G. West downstream from the mouth of the Tucannon River between mid-December and late May, in Lake Sacajawea (Ice Harbor) between late March and late June, in Lake Herbert G. West upstream from the mouth of the Tucannon River between early October and early June, and in Lake Bryan (Little Goose) between late July and early August.

In 2010 and 2011, four adult bull trout PIT-tagged and released in the tailrace or spill bay of Little Goose Dam eventually were detected in the lower Tucannon River. Two of those fish migrated through Lake Herbert G. West to the Tucannon River between mid-June and mid-September. One individual migrated upstream to Lower Granite Dam between late June and early July, then returned downstream past Little Goose Dam and into in the lower Tucannon River within three days of being detected at Lower Granite Dam. The final fish was released in mid-June 2010 and not detected until late October 2011, when it migrated downstream past a PIT tag detection array in the upper Tucannon River. In 2006 and 2009, two adult bull trout PIT-tagged and released in the tailrace of Little Goose Dam, and later genetically assigned to the Tucannon River, migrated through Lake Bryan to Lower Granite Dam in mid to late June and late May to early June, respectively. Neither fish was observed after being detected at Lower Granite Dam.

Estimates of abundance of mainstem migrants

There have been no studies to estimate the total abundance of fluvial bull trout emigrating from the Tucannon River subbasin to the Snake River.

Bull trout interactions with mainstem Columbia or Snake River hydroprojects

Nineteen bull trout that can be tied to Tucannon River populations through tagging or genetic assignment studies have been observed at Snake River dams. Six bull trout PIT-tagged in the Tucannon River Subbasin have been detected at Lower Granite (n=1), Little Goose (n=2), Lower Monumental (n = 3), and Ice Harbor (n = 3) dams. DeHaan and Bretz (2012) used genetic markers to determine 11 of 12 bull trout sampled in the juvenile fish facility at Little Goose Dam from 2006 – 2011 were of Tucannon River origin. Among the 11 fish were three that were detected at Lower Granite Dam and two that were detected in the lower Tucannon River after being released in Little Goose Dam's tailrace. Two other PIT-tagged bull trout released in Little Goose Dam's spill bay later entered the Tucannon River, suggesting it was their river of origin. Genetic samples were not collected from those two fish. Although no bull trout from the Tucannon River have been observed at McNary Dam, an individual trapped in the lower Umatilla River was genetically assigned to the Tucannon River (Small et al. 2012). That individual had to pass McNary Dam to access the Umatilla River.

Observations of Tucannon River bull trout at Lower Granite Dam have occurred in June (n = 2), July (n = 1), and August (n = 1). At Little Goose Dam, Tucannon River bull trout have been observed primarily in May and June (n = 14), but also in late July (n = 1) and early September (n = 1). Detections of Tucannon River bull trout at Lower Monumental Dam have occurred in late March and mid- to late May. All detections of Tucannon River bull trout at Ice Harbor Dam have occurred in June.

The six bull trout that were PIT-tagged in the Tucannon River and detected at one or more of the lower Snake River dams typically were observed only briefly at each hydroproject. However, one individual was observed two times over 15 days in the juvenile fish facility at Little Goose Dam, and another was observed four times over a month in that same facility.

Recommendations

Given the proximity of the Tucannon River Subbasin to the lower Snake River dams, bull trout from that subbasin are among the most likely to utilize the lower Snake River and interact with the hydroprojects there. Thus, on-going efforts to PIT-tag and monitor the migrations of bull trout exiting the Tucannon River should be continued. Genetic samples should also continue to be collected from bull trout handled at all of the mainstem hydroprojects, and from bull trout that may be available from other work in the mainstem. To more fully describe bull trout movements and habitat use within the mainstem impoundments, and bull trout interactions with the mainstem dams, radio- and/or acoustic-telemetry studies are warranted.

Clearwater River Subbasin

Clearwater River Subbasin summary

<u>Bull trout populations in the subbasin</u>

- The Clearwater River Subbasin supports 38 bull trout local populations in four core areas.
- Migratory bull trout are present in all of the core areas.

<u>Migratory bull trout in the subbasin</u>

- Migratory adult and subadult bull trout disperse seasonally throughout the major tributaries and throughout the mainstem Clearwater River, with the possible exception of the lower mainstem reaches.

<u>Bull trout movement/habitat use in the mainstem</u>

- Use of the Snake River by migratory bull trout from the Clearwater River Subbasin has not been demonstrated.

<u>Bull trout interactions with mainstem hydroprojects</u>

- N/A

Clearwater River Subbasin bull trout

Subbasin description

The Clearwater River flows west for 120 rkm and enters the Snake River at rkm 522.224 in west-central Idaho (Figure 1.13), 51 rkm upstream from Lower Granite Dam. The Clearwater River and its tributaries drain from the Clearwater and Bitterroot mountains. The drainage area is 24,980 km^2. Major tributaries to the Clearwater River include the Middle Fork Clearwater, South Fork Clearwater, and North Fork Clearwater rivers. The Selway and Lochsa rivers are major tributaries that converge to form the Middle Fork Clearwater River.

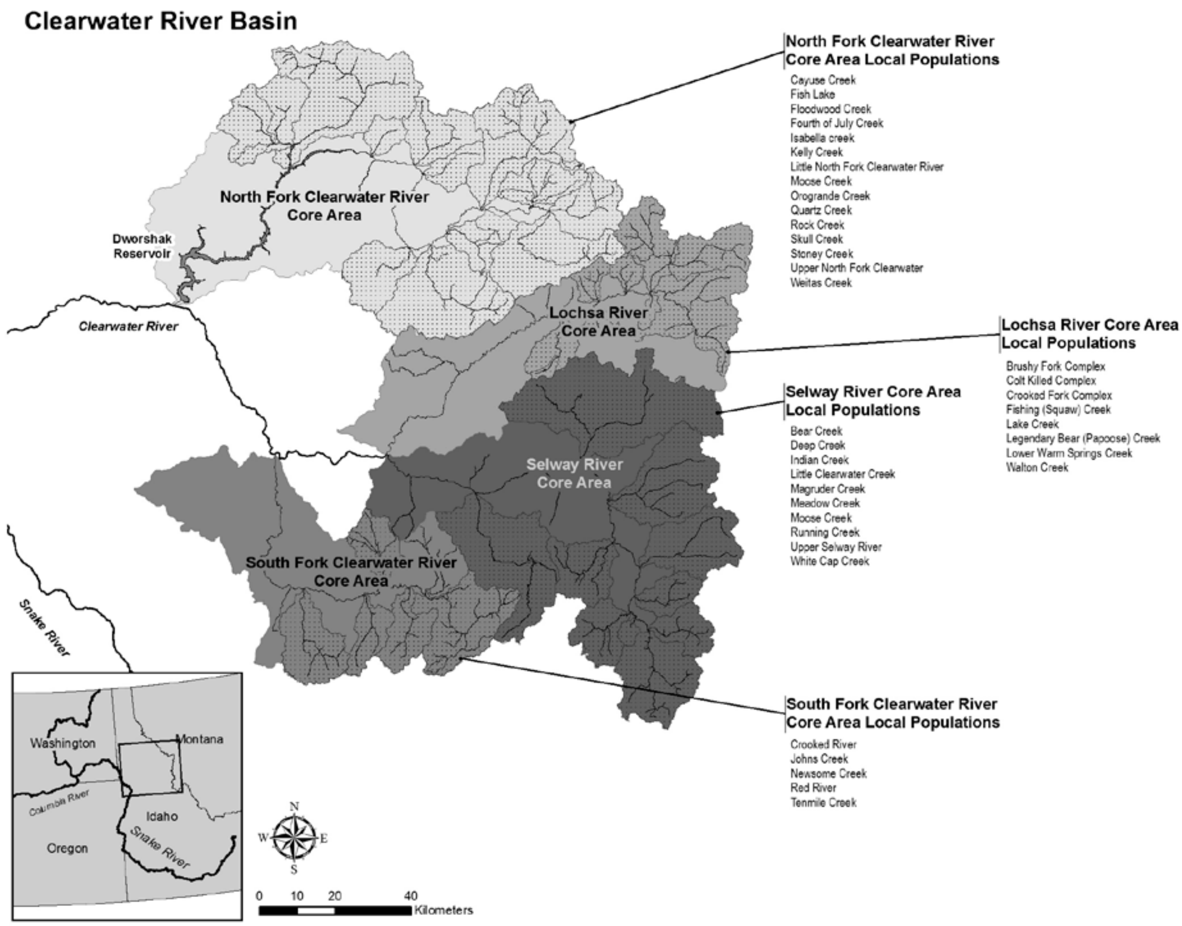

Figure 1.13. Clearwater subbasin and bull trout local populations.

Bull trout populations in the subbasin

The Clearwater River Subbasin contains the North Fork Clearwater River, South Fork Clearwater River, Lochsa River, and Selway River core areas. These four core areas support 38 bull trout local populations.

Migratory bull trout in the subbasin

There is no evidence bull trout from the Clearwater River Subbasin use the Snake River. Migratory bull trout occur in all but perhaps one of the local populations (J. DuPont, Idaho Department of Fish and Game, personal communication). Hanson et al. (2014) and Schiff et al. (2005a) used telemetry to study the migrations of subadult and adult bull trout up- and downstream from Dworshak Dam (rkm 522.224.003 on the North Fork Clearwater River) from 2000 – 2006. Schiff et al. (2005a, 2005b) and Hanson and Schriever (2006) used radio-telemetry to study the migrations of primarily adult bull trout (all but two of 111 individuals were ≥ 325 mm FL) from the Lochsa River from 2003-2005. Telemetry was also used to study the migrations of adult bull trout from the South Fork Clearwater River drainage from 1998 – 1999 (Idaho Department of Fish and Game, unpublished report). During these studies, all but one of the tagged fish remained upstream from the mouth of the North Fork Clearwater River (rkm 65 on the Clearwater River) or its vicinity. One individual tagged on the Lochsa River migrated as far downstream as rkm 522.224.007 on the Clearwater River.

No bull trout have been captured in a downstream migrant trap operated in the Clearwater River at rkm 10 since 1989 (S. Putnam, Idaho Department of Fish and Game, personal communication). The trap has operated during the spring anadromous salmonid smolt migration each year.

Clearwater River Subbasin bull trout in the mainstem Snake River

Migration to and from the mainstem Snake River

Bull trout migration to and from the mainstem Snake River is unknown for Clearwater River bull trout.

Estimates of abundance of mainstem migrants

Abundance of fish entering or returning from the Snake River has not been estimated for Clearwater River bull trout.

Bull trout movement/habitat use within the mainstem Snake River

Bull trout movements and habitat use in the lower Snake River are largely unknown for Clearwater River bull trout.

Bull trout interactions with mainstem Snake River hydroprojects

- N/A

Recommendations

The lower Clearwater River is broad and deep; therefore, installing a PIT tag antenna array near the mouth and undertaking a large-scale PIT-tagging effort to establish the timing and magnitude of use (if any) of the Snake River by bull trout from the Clearwater River Subbasin is likely not a reasonable approach. An alternative would be to attempt to capture bull trout in the lower Clearwater River during fall/winter, outfit them with PIT and radio or acoustic tags, and track their movements in the hydro-system. Genetic samples should continue to be taken from bull trout collected at the lower Snake River dams so that genetic markers can be used to identify the river of origin of those fish.

Asotin Creek Subbasin

Asotin Creek Subbasin summary

Bull trout populations in the subbasin

- The Asotin Creek Subbasin supports two local populations within the Asotin Creek Core Area.
- Current knowledge indicates that the local populations within the Asotin Creek Core Area have a resident and migratory (fluvial) component.
- Current information indicates that bull trout populations within the Asotin Creek Subbasin may be relatively small, possibly at critically low levels.

Migratory bull trout in the subbasin

- Subadult downstream migration in the Asotin Creek Subbasin occurs from April through December, but generally peaks from April through June and in the fall from October through December.
- Following spawning, some adult bull trout migrate from the headwaters into larger streams and downriver reaches to utilize more abundant resources and overwintering habitat. This generally occurs during September and October in the Asotin Creek Subbasin. Other bull trout appear to be resident in the upper subbasin.
- Adult upstream migration generally begins in May in middle and lower subbasin reaches (i.e., lower two-thirds of the subbasin) and may continue through the fall in headwater reaches.

Bull trout movement/habitat use in the mainstem

- Subadult bull trout move into the lower Snake River during both the spring and fall.

- Adult bull trout move into the lower Snake River following spawning in the fall.

- Migratory adult bull trout have been regularly captured while moving upstream at the weir (rkm 522.234.005 – 522.234.007) suggesting fish may return to Asotin Creek from the lower Snake River during the spring and early summer. This movement pattern has not been documented via PIT array detections, although there may not be sufficient numbers of PIT-tagged bull trout in the subbasin to detect this movement pattern.

- On 31 October 2014, an adult bull trout from the Imnaha subbasin was detected entering the Asotin River at the PIT detection array near the mouth, possibly to overwinter. This supports findings from previous genetic work conducted in the subbasin, but the proportion of the lower river fish in winter and spring from outside the subbasin remains unknown.

- Abundance of fish entering or returning from the Snake River has not been estimated for Asotin Creek bull trout.

Bull trout interactions with mainstem hydroprojects

- Asotin Creek bull trout interactions with mainstem hydroprojects are unknown.

Asotin Creek Subbasin bull trout

Subbasin description

Asotin Creek in southeast Washington is one of several tributaries to the Snake River that contain bull trout populations. The headwaters of Asotin creek drain from narrow, steep-sided, coniferous forested canyons in the northeastern part of the Blue Mountains (USFWS 2002). Downstream from the headwaters, the narrow canyons give way to wider, alluvial valley bottoms and the mainstem Asotin Creek reaches its confluence with the Snake River at about rkm 522.234 (Figure 1.14). This portion of the Snake River is often refered to as Lower Granite Lake, which is the reservoir formed by Lower Granite Dam.

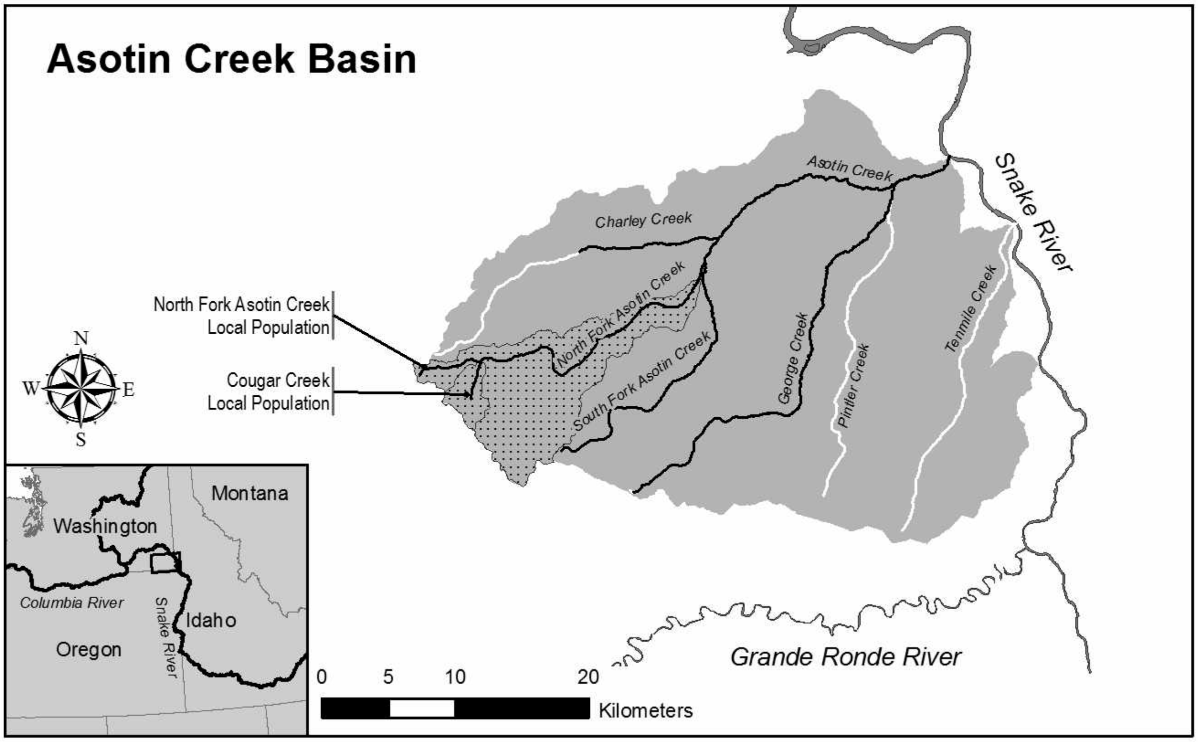

Figure 1.14. Asotin Creek Subbasin and bull trout local populations.

<u>Bull trout populations in the subbasin</u>

The Asotin Creek Subbasin supports two local populations within the Asotin Creek Core Area. The only known spawning populations of bull trout in the subbasin are found in upper North Fork Asotin Creek and in Cougar Canyon (literature and personal communication cited in USFWS 2002; Kassler and Mendel 2008; J. Trump, WDFW, personal communication). The Bull Trout Draft Recovery Plan (USFWS 2002) indicates that the local populations within the Asotin Creek Core Area are believed to be isolated resident fish. Recent information confirms the populations also have a migratory (fluvial) component (Kassler and Mendel 2008; Mayer and Schuck 2004; Mayer et al. 2006, 2007, 2008, 2009, 2010; Crawford et al. 2011, 2012, 2013, 2014; www.ptagis.org [queried December 2014]).

Bull trout spawning and early life history have been studied in the Asotin Creek headwaters (Mendel et al. 2006; Martin et al. 1992; Underwood et al. 1995; USFWS 2002). Additional monitoring and evaluation work in the Asotin Creek Subbasin has also been conducted (Bennett and Bouwes 2009; Bennett et al. 2010, 2012). Current information indicates bull trout populations within the Asotin Creek Subbasin may be small and possibly at critically low levels (Mendel et al. 2006; Martin et al. 1992; USFWS 2002). Redd surveys conducted in the North Fork Asotin Creek and Cougar Canyon during 2005, 2006 and 2012 resulted in 10, 12 and 13 redds, respectively (J. Trump, WDFW, personal communication). In addition, the genetic composition of bull trout collected from upper North Fork Asotin Creek and the lower mainstem of Asotin Creek was described and compared to other bull trout populations (Kassler and Mendel 2008). Further genetic analysis described how different bull trout from the Wenaha River, Tucannon River, Asotin Creek and the Walla Walla River subbasin are from one another (Kassler et al. 2013).

Migratory bull trout in the subbasin

A considerable amount of effort has gone into developing a long-term bull trout movement dataset in some subbasins (e.g., Walla Walla River Subbasin), but migratory bull trout in the Asotin Creek Subbasin have not received the same degree of study. However, incidental bull trout data has been collected in association with steelhead studies in the Asotin Creek Subbasin (Mayer and Schuck 2004; Mayer et al. 2006, 2007, 2008, 2009, 2010; Crawford et al. 2011, 2012, 2013, 2014; www.ptagis.org [queried Dec. 2014]). During 2004 and 2005, 14 subadult bull trout were captured in a rotary screw trap (Mayer and Schuck 2004; Mayer et al. 2006). Since 2005, 67 bull trout have been PIT-tagged within the Asotin Creek Subbasin (Table 1.7). During this timeframe 26, 14 and 27 fish have been captured and subsequently PIT-tagged via rotary screw trap (between rkm 522.234.003 and rkm 522.234.007, depending upon the year), weir trap (between rkm 522.234.005 and rkm 522.234.007, depending upon the year), and electrofishing (headwater reaches), respectively (www.ptagis.org [queried December 2014]). Migratory subadult and adult bull trout have also been detected at the PIT array (AFC-Mainstem) near the confluence of the North and South Fork Asotin creeks from 2011 through 2014 (Tables 1.8 and 1.9).

Table 1.7. Bull trout captured and PIT-tagged within the Asotin Creek Subbasin from 2005 through 2014 (www.ptagis.org [queried Dec. 2014]).

Stream	Adults			Subadults			Total
	Screw Trap	Electro-Shock	Weir	Screw Trap	Electro-Shock	Weir	
NF Asotin Cr.	0	1	0	0	18	0	**19**
SF Asotin Cr.	0	0	0	0	3	0	**3**
Asotin Cr.	8	0	14	18	2	0	**42**
Charley Cr.	0	0	0	0	3	0	**3**
Total	**8**	**1**	**14**	**18**	**26**	**0**	**67**

Table 1.8. Downstream detections for subadult and adult bull trout at the PIT array (AFC-Mainstem) near the confluence of the North and South Fork Asotin creeks from 2011 through 2014 (www.ptagis.org [queried December 2014]).

Month	Subadult				Adult				Total
	2011	2012	2013	2014	2011	2012	2013	2014	
July			1						**1**
August									**0**
September			2				1		**3**
October	1	2				1			**4**
Total	**1**	**2**	**3**	**0**	**0**	**1**	**1**	**0**	**8**

Table 1.9. Upstream detections for subadult and adult bull trout at the PIT array (AFC-Mainstem) near the confluence of the North and South Fork Asotin creeks from 2011 through 2014 (www.ptagis.org [queried December 2014]).

Month	Subadult				Adult				Total
	2011	2012	2013	2014	2011	2012	2013	2014	
May					1		2	1	**4**
June		1			1		2	2	**6**
July					1			1	**2**
Total	**0**	**1**	**0**	**0**	**3**	**0**	**4**	**4**	**12**

Collectively, this information provides some insight on bull trout movement within the Asotin Creek Subbasin and to and from the lower Snake River. The following are descriptions of subadult and adult bull trout migration patterns derived from the previously mentioned studies and an examination of PIT tag detection histories.

Subadult downstream migration — The results from screw trap and weir captures, along with PIT tag detection histories indicate that migratory subadult bull trout in the Asotin Creek Subbasin move downstream from headwater spawning and juvenile rearing areas from April through December, but generally peak from April through June, and again in the fall from October through December (www.ptagis.org [queried Dec. 2014]). In addition, PIT-tagged subadult bull trout have been detected passing downstream of the PIT detection array (ACM) near the mouth of Asotin Creek during the fall suggesting movement into the lower Snake River (www.ptagis.org [queried Dec. 2014]).

Adult downstream migration — Following spawning, the migratory component of the population moves from headwater stream reaches into larger streams and downriver reaches. To reach overwintering areas, migratory bull trout make rapid, incremental downstream movements through migratory corridors (Schaller et al. 2014; Barrows et al. 2012a, 2012b, 2014a; Koch 2014; Ratliff et al. 1996). This generally occurs during September and October in the Asotin Creek Subbasin (Table 1.8).

Adult upstream migration — After overwintering, adult bull trout in lower reaches of Asotin Creek or from the Snake River, and other sources (e.g., Imnaha, etc.) begin migrating upstream in May, continuing into July (Table 1.9). The timing of adult upstream migration through many of the reaches is critical because many of the streams within the subbasin have some degree of dry channels with subsurface flows from late spring to early fall (Mendel et al. 2006). Even short delays may prove costly to a bull trout attempting to ascend the river during the limited migration window.

Asotin Creek Subbasin bull trout in the mainstem Snake River

Use of the lower Snake River by Asotin Creek bull trout has not been specifically investigated, and movements within the mainstem are currently unknown. However, there is evidence suggesting Asotin Creek Subbasin bull trout use the mainstem Snake River and that bull trout from other source populations that forage in the Snake River also use the Asotin Creek Subbasin.

Migration to and from the mainstem Snake River

PIT detection arrays ─ The Bonneville Power Administration (BPA) funded the installation and operation of a PIT detection array (ACM) near the mouth of Asotin Creek (rkm 522.234.001) from 1 August 2011 through 2014 as part of the Asotin Creek Salmonid Assessment (Crawford et al. 2012). A total of eight individual bull trout were detected at this PIT array, of which five were subadults (< 300 mm FL) and three were adults (≥ 300 mm FL). Seven of the eight fish were detected while moving downstream toward the lower Snake River and one was detected moving upstream (Table 1.10). Subadult PIT-tagged bull trout (< 300 mm FL) were detected moving downstream past the PIT array from September through December. In addition, two adult PIT-tagged bull trout were detected moving downstream, one in October and the other in May. The downstream detection in May was inconsistent with typical movement patterns observed by migratory adult bull trout in other subbasins (e.g., Walla Walla River Subbasin). It may have been affected /influenced by its recent capture and tagging at an upstream weir prior to its detection or this may have been an overwintering fish from another subbasin. There has only been one upstream detection at the ACM PIT array, and it occurred on 31 October 2014. The timing of this detection is also atypical for adult bull trout. The bull trout was originally tagged on 26 June 2014 (585 mm FL) at rkm 522.308.084 in the Imnaha River Subbasin. It is possible that this bull trout moved out of the Imnaha River Subbasin following spawning and moved into lower Asotin Creek to overwinter. Table 1.10 provides a summary of individual downstream migrant PIT-tagged bull trout detected at the ACM PIT array.

Table 1.10. Downstream detections for subadult and adult bull trout at the PIT array (ACM) near the mouth of Asotin Creek from 2011 through 2014.

Month	Subadult				Adult				Total
	2011	2012	2013	2014	2011	2012	2013	2014	
September			1	1					**2**
October	1			1		1			**3**
November									**0**
December		1							**1**
January									**0**
February									**0**
March									**0**
April									**0**
May							1		**1**
Total	**1**	**1**	**1**	**2**	**0**	**1**	**1**	**0**	**7**

Rotary screw trap ─ A rotary screw trap was operated in lower Asotin Creek at approximately rkm 522.234.003 from 2004 through 2010. The location of this trap was moved to rkm 522.234.007 following 2010. The close proximity of the trap to the mouth of Asotin Creek suggests bull trout captured may have been intercepted en route to the lower Snake River. Downstream migrating bull trout were captured while heading toward the lower Snake River from April through June and from October through December (Figure 1.15). This migration pattern is consistent with bull trout migrations observed in other subbasins (e.g., Walla Walla River Subbasin).

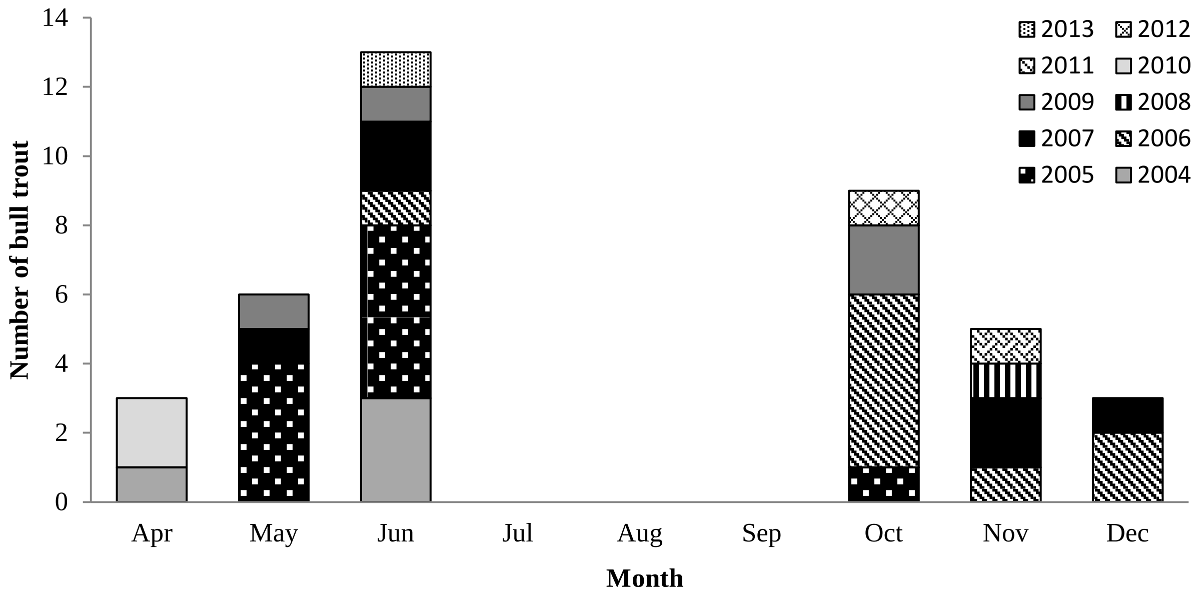

Figure 1.15. Downstream migrating bull trout captured via rotary screw trap in lower Asotin Creek from 2004 through 2013 (www.ptagis.org [queried Dec. 2014]; Mayer and Schuck 2004; Mayer et al. 2006; E. Crawford, WDFW, personal communication) .

Anecdotal information ─ Anglers have been observed catching bull trout while fishing on the Snake River between Asotin, WA and Clarkston, WA (E. Crawford, WDFW, personal communication). It is unknown if bull trout angled in the lower Snake River originated in the Asotin Creek Subbasin, but the close proximity suggests the possibility.

Estimates of abundance of mainstem migrants

Abundance of fish entering or returning from the Snake River has not been estimated for Asotin Creek bull trout.

Bull trout movement/habitat use within the mainstem Snake River

Bull trout movements and habitat use in the lower Snake River are largely unknown. Limited information exists to describe the spatial and temporal migration patterns of bull trout within the Asotin Creek Subbasin.

Bull trout interactions with mainstem Snake River hydroprojects

There have been no detections of Asotin Creek Subbasin bull trout at mainstem hydroprojects or in other subbasins.

Recommendations

Bull trout abundance in the Asotin Creek Subbasin may be at critically low levels. Current and future studies involving bull trout should be implemented with caution to avoid adversely affecting the existing population. Bull trout are captured incidentally through other studies in the subbasin and PIT-tagged. These tagging efforts should be augmented in the lower reaches of Asotin Creek to increase the size of the migratory PIT-tagged population for subsequent detection at existing PIT arrays throughout the drainage, potentially in other drainages, or at mainstem dams. In addition, genetic assignment tests should be conducted on migratory fish captured in lower reaches of the Asotin Creek Subbasin to better understand the composition of the bull trout using lower Asotin Creek during the fall, winter and spring. Additional work is also needed to better understand Asotin Creek bull trout connectivity and habitat use in the Snake River mainstem migratory corridor and connectivity with other subbasin populations. This may involve additional tagging (PIT, radio, acoustic) and associated monitoring efforts.

Grande Ronde River Subbasin

Grande Ronde River Subbasin summary

Bull trout populations in the subbasin

- The Grande Ronde River Subbasin supports nine bull trout local populations in four core areas.

- Migratory bull trout are present in three of the core areas, and in at least seven local populations.

Migratory bull trout in the subbasin

- Migratory adult and subadult bull trout disperse seasonally throughout the major tributaries to the Grande Ronde River and throughout most of the mainstem Grande Ronde River.

Bull trout movement/habitat use in the mainstem Snake River

- Although use of the mainstem Snake River by migratory bull trout from the Grande Ronde River Subbasin has not been directly observed, sampling near the mouth suggests it is likely.

Bull trout interactions with mainstem hydroprojects

- N/A

Grande Ronde River Subbasin bull trout

Subbasin description

The Grande Ronde River flows northeast for 336 rkm and enters the Snake River at rkm 522.271 in southeastern Washington (Figure 1.16), 163 rkm upstream from Lower Granite Dam, and 127 rkm downstream from Hells Canyon Dam. The Grande Ronde River and its tributaries drain the Blue and Wallowa mountains. The drainage area is 10,240 km^2. Major tributaries to the Grande Ronde River include the Wenaha River, Lookingglass Creek, the Wallowa River, and Catherine Creek. The Lostine and Minam rivers are major tributaries to the Wallowa River that support bull trout.

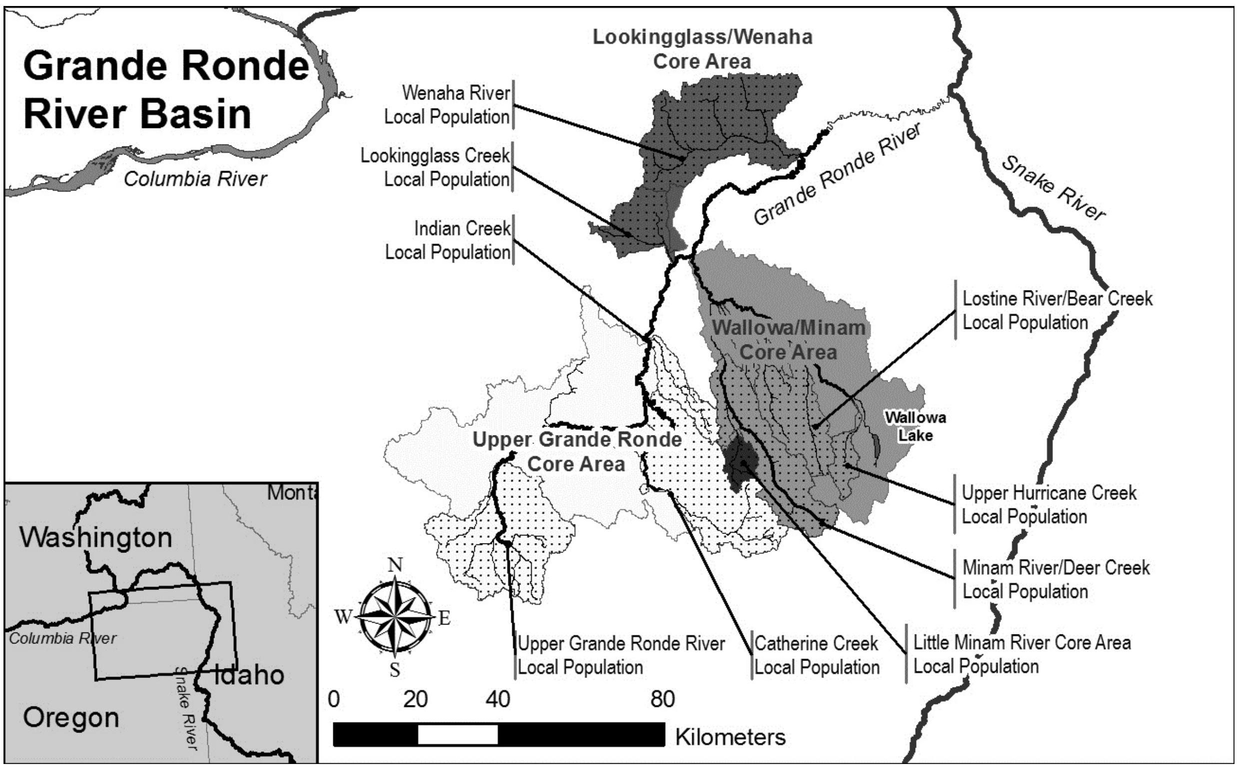

Figure 1.16. Grande Ronde River Subbasin and bull trout local populations.

Bull trout populations in the subbasin

The Grande Ronde River Subbasin contains four core areas and nine local populations (Figure 1.16). In the Upper Grande Ronde, Catherine Creek, and Indian Creek local populations, spawning/early rearing areas appear to be located in a number of smaller headwater tributaries, and the Grande Ronde and Catherine Creek mainstems are likely used as a migratory corridor for movements among the various tributaries, and for foraging. Bull trout in Indian Creek are likely relegated to the headwaters because of the severely degraded conditions in the lower reaches. Local populations in the two main tributaries to the Wallowa River, the Minam and Lostine rivers, include both resident and fluvial bull trout that may overwinter in the Wallowa, Grande Ronde, or Snake rivers. The Hurricane Creek local population is also included in this core area.

This local population also likely includes fluvial bull trout that may overwinter in the Wallowa, Grande Ronde, or Snake rivers. Bull trout in the Wenaha River and Lookingglass Creek local populations are well distributed throughout both tributaries, and the Wenaha drainage may have the most abundant and well-distributed local population in the subbasin. Fish from these two local populations are thought to include fluvial individuals that may overwinter in the mainstem Grande Ronde or Snake rivers. The Little Minam River local population supports only resident bull trout above a barrier falls (USFWS 2002).

Migratory bull trout in the subbasin

Migratory bull trout are present in at least seven of the local populations in the Grande Ronde River Subbasin. The Little Minam River supports only resident bull trout above a barrier falls (USFWS 2002), and the Indian Creek local population is also likely comprised of only resident bull trout. Researchers from ODFW and the US Forest Service cooperatively studied the migrations of bull trout from the Wenaha, Grande Ronde, and Lostine rivers, and Lookingglass and Catherine creeks from 1997 – 2001 (Hemmingsen et al. 2001a, 2001b, 2001c, 2001d; Starcevich et al. 2012). The two agencies further studied the migrations of bull trout from the Lostine River in 2004 – 2005 (Starcevich et al. 2005; Moore et al. 2006; Howell et al. 2010; Starcevich et al. 2012). The earlier study focused primarily on bull trout from the Wenaha River (the lowermost tributary to the Grande Ronde River [rkm 522.271.074] supporting bull trout) and on migratory adults, but some subadult-sized bull trout were also included. The later Lostine River study focused exclusively on migratory adults. Both studies employed radio-telemetry to describe migratory patterns. The downstream-most observation of a bull trout in the two studies occurred at rkm 522.271.038 on the Grande Ronde River. Baxter (2002) reported locating radio-tagged bull trout from the Wenaha River in the Snake River, however, ODFW researchers later determined the Snake River observations were not of bull trout, but of bighorn sheep outfitted with radio collars that had the same frequencies as some of the radio tags implanted in bull trout in the Wenaha River (S. Starcevich, ODFW, personal communication).

Since 1997, ODFW has operated a scoop trap, sometimes in conjunction with a screw trap, at rkm 522.271.002 on the Grande Ronde River and has incidentally captured 15 bull trout (three in 1999, one each in 2001, 2008, and 2009, four in 2010, three in 2011, and one each in 2012 and 2013; P. Keniry, ODFW, personal communication). The trap(s) operated from early March to late May each year. Bull trout were captured between mid-March and mid-May from 2008 – 2014. No records were kept of the timing of capture of bull trout from 1997 – 2007. Bull trout were not measured during any of these efforts, so it is not possible to determine whether they were the size of migratory adults or subadults. Given the proximity of the trap to the mouth of the Grande Ronde River (i.e., within 2 rkm), it is likely that some of the captured bull trout subsequently entered the Snake River, and that the telemetry studies did not fully describe the movements of bull trout from the Grande Ronde River Subbasin.

Migratory bull trout movements within the mainstem Snake River

No direct observations of Grande Ronde subbasin bull trout have been made in the mainstem Snake River.

Migration to and from the mainstem Snake River

Bull trout migration to and from the mainstem Snake River is unknown for Grande Ronde River bull trout.

Estimates of abundance of mainstem migrants

Abundance of fish entering or returning from the Snake River has not been estimated for Grande Ronde River Subbasin bull trout.

Bull trout movement/habitat use within the mainstem Snake River

Bull trout movements and habitat use in the lower Snake River are largely unknown for Grande Ronde River Subbasin bull trout.

Bull trout interactions with mainstem Snake River hydroprojects

No Grande Ronde River Subbasin bull trout have been observed at mainstem Snake River hydroprojects.

Recommendations

Past telemetry studies in the Grande Ronde River Subbasin involved bull trout from the nearest tributary to the Snake River that supports bull trout (the Wenaha River) and a moderately large sample (n = 51) of the bull trout from that tributary were used, yet movement into the Snake River was not documented. Considering that many of the local populations in the Grande Ronde River Subbasin include fluvial individuals that migrate into larger mainstem tributaries, we recommend additional telemetry studies (including PIT tags) that focus on capturing bull trout for tagging in the fall and winter in the lower Grande Ronde River (downstream from the Wenaha River). Bull trout captured at this time of year and location would be the most likely to migrate to, and use the Snake River. Bull trout captured in spring at ODFW's downstream migrant trap site near the mouth of the Grande Ronde River also would be likely to use the Snake River and should be PIT- and radio- or acoustic-tagged.

Salmon River Subbasin

Salmon River Subbasin summary

Bull trout populations in the subbasin

- The Salmon River Subbasin supports 133 bull trout local populations in 10 core areas.
- Migratory bull trout are present in all but perhaps one of the core areas.
- There is a migratory component to many, but an unknown number of the local populations.

Migratory bull trout in the subbasin

- Migratory adult bull trout disperse seasonally throughout the major tributaries to the Salmon River and throughout the mainstem Salmon River, with the possible exception of its lower reaches; subadult bull trout migrations have not been investigated.

Bull trout movement/habitat use in the mainstem

- Use of the Snake River by migratory bull trout from the Salmon River Subbasin has not been demonstrated.

Bull trout interactions with mainstem hydroprojects

- N/A

Salmon River Subbasin bull trout

Subbasin description

The Salmon River flows for 684 rkm and enters the Snake River at rkm 522.303 in west-central Idaho (Figure 1.17), 130 rkm upstream from Lower Granite Dam and 95 rkm downstream from Hells Canyon Dam. The Salmon River and its tributaries drain the Lemhi, Clearwater, and Bitterroot ranges, and Salmon and Sawtooth mountains. The drainage area is 36,278 km^2. Major tributaries include the Yankee Fork of the Salmon, East Fork Salmon, Pahsimeroi, Lemhi, and North Fork Salmon rivers, Panther Creek, and the Middle Fork Salmon, South Fork Salmon, and Little Salmon rivers.

Bull trout populations in the subbasin

The Salmon River Subbasin contains the Little-Lower Salmon River, Middle Salmon-Chamberlain River, Middle Salmon-Panther River, Lake Creek, Opal Lake, Lemhi River, Pahsimeroi River, Upper Salmon River, Middle Fork Salmon River, and South Fork Salmon River core areas (Figure 1.17) (USFWS 2002). These 10 core areas encompass the entire Salmon River Subbasin and support 133 bull trout local populations.

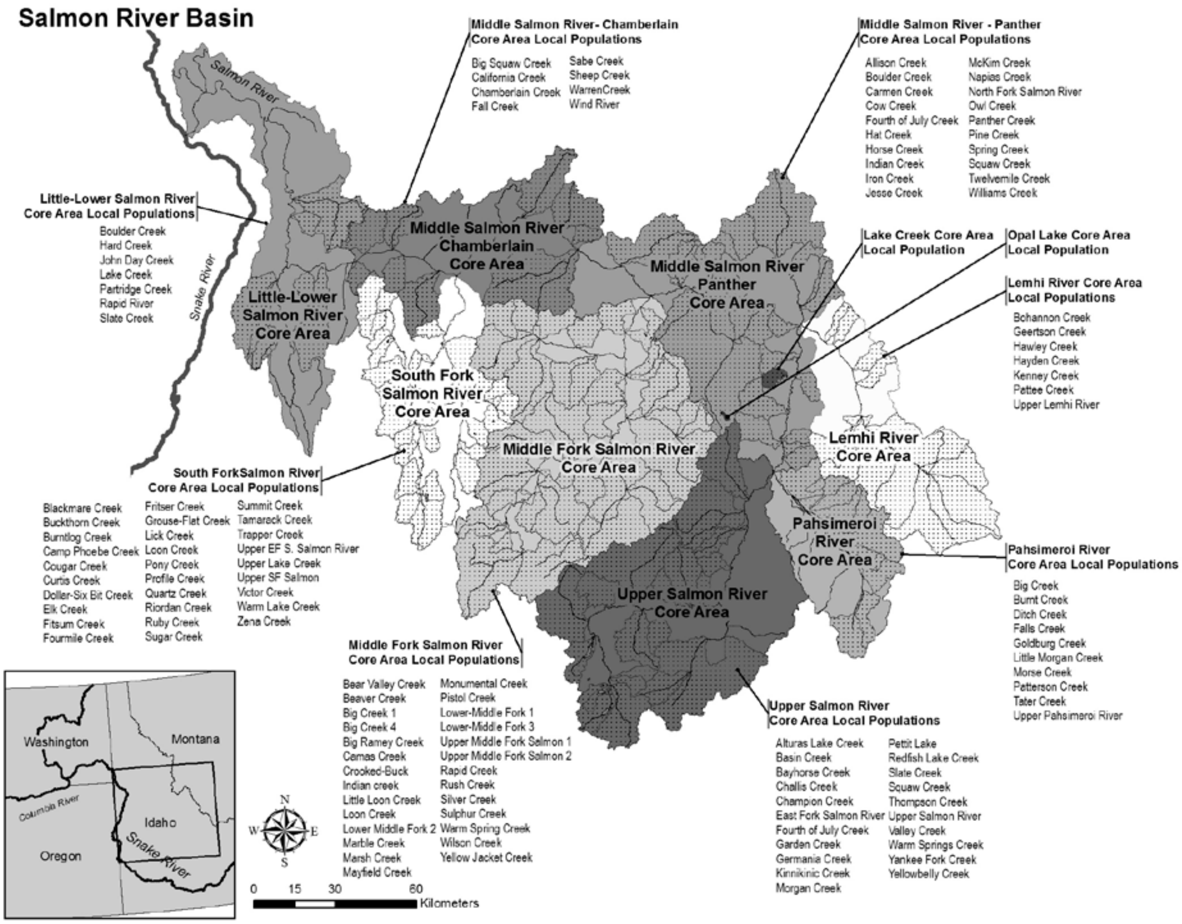

Figure 1.17. Salmon River Subbasin and bull trout local populations.

<u>Migratory bull trout in the subbasin</u>

Migratory bull trout occur in many, but an unknown number of the local populations. Radio-telemetry studies of bull trout migrations were conducted on the Rapid River from 1992 – 1994 (Schill et al. 1994; Elle et al. 1994; Elle 1995), the East Fork South Fork Salmon River from 1999-2000 (Hogen and Scarnecchia 2006), the Secesh River from 2003 – 2004 (Watry and Scarnecchia 2008), the upper Salmon River from 2003 – 2006 (Schoby and Curet 2007; Schoby and Keeley 2011), and the Lemhi River in 2006 (Lamperth et al. 2007). The bull trout tagged in these studies were all > 330 mm FL and were likely adults. The downstream-most observation of a tagged bull trout in the Salmon River occurred at approximately rkm 522.303.090, near the town of Whitebird, 90 rkm from the Snake River.

Two bull trout (size unrecorded) have been captured in a downstream migrant trap operated in the Salmon River at rkm 103 since 1993 (S. Putnam, Idaho Department of Fish and Game, personal communication). The trap has operated during the spring anadromous salmonid smolt migration each year. Anglers have recently reported occasionally catching migratory adult-sized bull trout in the river reach near the trap (S. Putnam, Idaho Deparment of Fish and Game, personal communication).

Salmon River Subbasin bull trout in the mainstem Snake River

There is no evidence bull trout from the Salmon River Subbasin use the mainstem Snake River.

<u>Migration to and from the mainstem Snake River</u>

Bull trout migration to and from the mainstem Snake River is unknown for Salmon River Subbasin bull trout.

<u>Estimates of abundance of mainstem migrants</u>

Abundance of fish entering or returning from the Snake River has not been estimated for Salmon River Subbasin bull trout.

<u>Bull trout movement/habitat use within the mainstem Snake River</u>

Bull trout movements and habitat use in the lower Snake River are largely unknown for Salmon River Subbasin bull trout.

<u>Bull trout interactions with mainstem Snake River hydroprojects</u>

No Salmon River Subbasin bull trout have been observed at mainstem Snake River hydroprojects.

Recommendations

Most of the bull trout telemetry studies in the Salmon River Subbasin have included individuals from populations that originate in upstream areas of the subbasin which are long distances from the lower Salmon River and the Snake River. The study involving Rapid River bull trout was an exception. Future studies could focus on bull trout local populations occurring downstream from Rapid River (i.e., nearer the Snake River) or on collecting, PIT-tagging, and radio- or acoustic-tagging bull trout in the lower Salmon River in fall/winter. If bull trout from the Salmon River Subbasin are using the Snake River, individuals captured during fall/winter in the lower Salmon River would be the most likely to migrate to the Snake River. Any bull trout captured in the downstream migrant trap at rkm 522.303.103 would also be the most likely to use the Snake River and should be tagged with PIT and radio or acoustic tags.

Imnaha River Subbasin

Imnaha River Subbasin summary

<u>Bull trout populations in the subbasin</u>

- The Imnaha River Subbasin is comprised of five bull trout local populations within a single core area.

- Three of these five local populations have a resident and migratory (fluvial) component.

Migratory bull trout in the subbasin

- Subadult migration downstream occurs throughout the year, with the majority of fish moving out of the lower Imnaha River in the fall.
- Adult migration downstream occurs in rapid, incremental movements following spawning, with the majority of this movement occurring between October and January.
- Adult migration upstream begins in March and continues into the fall spawning season.

Bull trout movement/habitat use in the mainstem Snake River

- Subadult bull trout move into the lower Snake River predominantly in the fall.
- Adult bull trout move into the lower Snake River shortly after spawning into January.
- Estimates of abundance for adult bull trout returning from the lower Snake River to the Imnaha River range from approximately 800-1200 individuals each year.
- Estimates of abundance for adult bull trout overwintering in the 80 rkm reach of the lower Snake River below Hells Canyon Dam range from approximately 500-1200 individuals. These estimates do not account for other reaches of the lower Snake River that are likely used as well.
- Radio-telemetry indicates use of the lower Snake River by Imnaha River Subbasin bull trout from just below the confluence of the two rivers upstream to Hells Canyon Dam.

Bull trout interactions with mainstem hydroprojects

- Imnaha River bull trout interactions with mainstem lower Snake River hydroprojects are largely unknown.

Imnaha River Subbasin bull trout

Subbasin description

The Imnaha River Subbasin is located in northeast Oregon. The Imnaha River headwaters drain from Eagle Cap Wilderness of the Wallowa Mountains to its confluence with the lower Snake River at rkm 522.308, approximately 90 rkm below Hells Canyon Dam (Figure 1.18). The drainage area is 2,202 km^2.

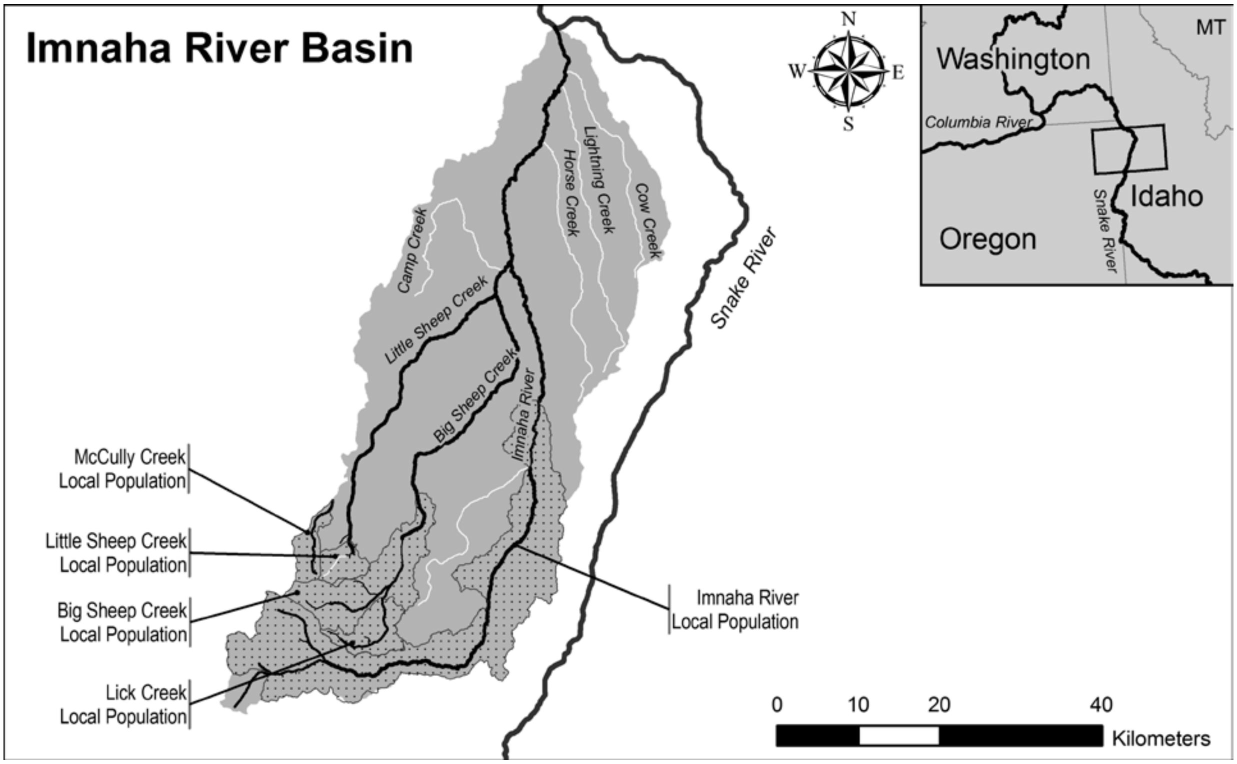

Figure 1.18. Bull trout local populations in the Imnaha River Subbasin.

Bull trout populations in the subbasin

The Imnaha River Subbasin supports five bull trout local populations within one core area. Three of the local populations (Imnaha River, Big Sheep Creek, and Lick Creek) have a resident and migratory (fluvial) component (USFWS 2004). Information on bull trout spawning and life history have been collected for the Imnaha River through a variety of efforts (Ashe et al. 1995; Blenden et al. 1996, 1997, 1998; Buchanan et al. 1997; Cook and Hudson 2008; Cook et al. 2010; Cleary et al. 2000, 2002a, 2002b, 2003, 2004; Hatch et al. 2013, 2014; IPC, personal communication; Michaels et al. 2006, 2007a, 2007b, 2009, 2010; Sausen 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014; Starcevich et al. 2012; FWS unpublished data). In addition, genetic structure of these local populations has been described (Hudson et al. 2013).

Migratory bull trout in the subbasin

Several efforts over the past two decades have led to an increasing dataset documenting movement of migratory bull trout in the Imnaha River Subbasin. Most notable is the steelhead and Chinook salmon juvenile monitoring efforts of the Nez Perce Tribe associated with the Lower Snake River Compensation program. Screw trapping in fall and spring since fall 1997 resulted in incidental catch of emigrating subadult bull trout (Blenden et al. 1997, 1998; Cleary et al. 2000, 2002a, 2002b, 2003, 2004; Hatch et al. 2013, 2014; Michaels and Espinoza 2007a, 2007b, 2009, 2010; Michaels et al. 2006). Supplementing that information on subadults were population assessments conducted in the headwaters of Big Sheep Creek, Lick Creek and McCully Creek that incorporated PIT tag technology (Cook and Hudson 2008; Cook et al. 2010; FWS unpublished data) and the addition of PIT tag arrays on the mainstem Imnaha River and

Big Sheep Creek by the Nez Perce Tribe beginning in 2010. A more clear understanding of adult bull trout movement and timing has been gained by a few radio-telemetry studies in more recent years (Starcevich et al. 2012; IPC, personal communication).

The collective consideration of all of this information provides some insight on the timing of bull trout movement within the subbasin and to and from the lower Snake River. The following are descriptions of subadult and adult bull trout migration patterns derived from the previously mentioned movement studies.

Subadult downstream migration ─ In the Imnaha River Subbasin, migratory subadult bull trout move downstream from headwater spawning and juvenile rearing areas throughout the year. There is limited information to determine when the peak of this migration may occur. However, fall and spring screw trapping conducted by the Nez Perce tribe clearly indicates the majority of subadult bull trout move below the lower trap site (rkm 522.308.007) in the fall, rather than the spring, suggesting movement into the lower Snake River. The pattern of this movement is unknown for the winter and summer.

Adult downstream migration ─ Following spawning, migratory bull trout move downstream from spawning areas to lower portions of the Imnaha River and into the lower Snake River. To reach overwintering areas, bull trout make rapid, incremental downstream movements through migratory corridors. The majority of this movement occurs between October and January.

Adult upstream migration ─ After overwintering, adult bull trout in lower subbasin reaches (i.e., lower one-third of the subbasin) and the lower Snake River begin migrating upstream in March, continuing into July. Access to upstream spawning areas is unimpeded by migration barriers throughout the year for two of three local populations that support a migratory component to the population. The majority of spawning habitat in Big Sheep Creek is above the Wallowa Valley Improvement Canal and water is diverted beginning in May/June until as late as mid-October.

Imnaha River Subbasin bull trout in the mainstem Snake River

Multiple lines of evidence indicate that Imnaha River Subbasin bull trout use the mainstem lower Snake River. Subadult bull trout (< 300 mm total length [TL]) may predominantly move into the mainstem lower Snake River in fall (Blenden et al. 1997, 1998; Cleary et al. 2000, 2002a, 2002b, 2003, 2004; Hatch et al. 2013, 2014; Michaels and Espinoza 2007a, 2007b, 2009, 2010; Michaels et al. 2006) and adults are detected returning to the mainstem lower Snake River shortly after spawning (IPC, personal communication; Starcevich et al. 2012).

Migration to and from the mainstem lower Snake River

PIT detection arrays ─ Bonneville Power Administration funded the installation of two PIT detection arrays near the mouth of the Imnaha River beginning in 2010 (rkm 522.308.007 and rkm 522.308.010). Additional arrays were installed at the Imnaha weir (rkm 522.308.041) in 2011 and near the mouth of Big Sheep Creek (rkm 6) in 2010. These continue to be operated by the Integrated Status and Effectiveness Monitoring Project. Since 2006, 692 subadult and adult bull trout have been PIT-tagged at the Imnaha weir (rkm 522.308.041), the lower Imnaha River screw trap (rkm 522.308.007), and in the mainstem lower Snake River (IPC, personal communication). An additional 1,376 predominantly subadult bull trout were PIT-tagged in Big Sheep Creek and its tributaries (Cook and Hudson 2008; Cook et al. 2010; FWS unpublished data). Detections of these fish at the lower Imnaha River IR2 PIT array (rkm 522.308.010) generally support migration to and from the mainstem lower Snake River at times reported in previous sections (Figure 1.19).

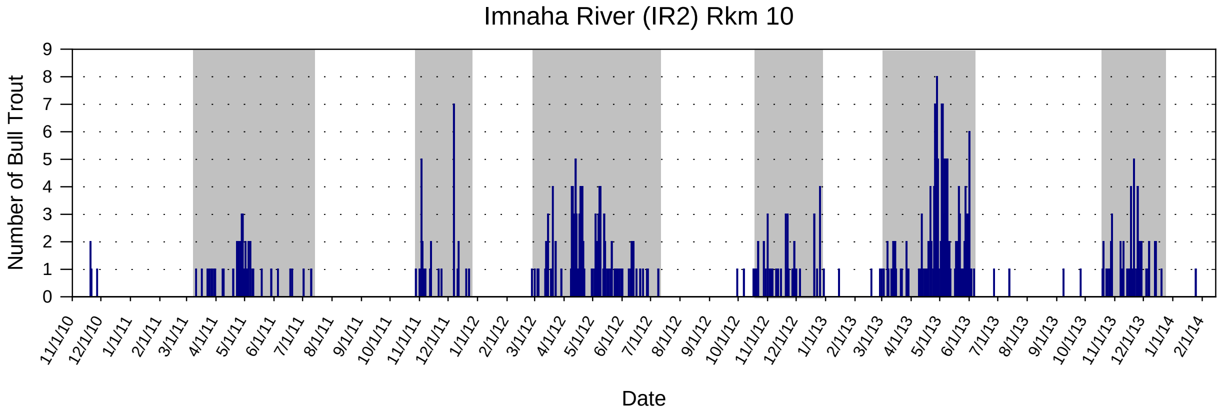

Figure 1.19. Detections of PIT-tagged bull trout at the lower Imnaha River IR2 PIT detection site (rkm 10) from 1 November 2010 to 1 February 2014 (Idaho Power Company, personal communication).

Radio-telemetry ─ Studies conducted by Starcevich et al. (2012) and IPC (personal communication) support the movement and associated timing determined from PIT tag technology. Radio-telemetry locations (and PIT-tagged bull trout recaptures) have also shown that bull trout move very little in the mainstem lower Snake River during the overwinter period (Dec-Feb) and demonstrate high fidelity for overwinter habitat locations from year to year (IPC, personal communication).

Estimates of abundance of mainstem migrants

Migratory bull trout (> 300 mm [TL]) abundance estimates at the PIT arrays from Petersen mark-recapture studies are available for the four arrays identified here from 2012 – 2014 (Table 1.11; IPC, personal communication). In addition, a Huggins robust-design estimate of abundance has been calculated from this data for the Snake River overwintering population of Imnaha River migratory bull trout (Table 1.12; IPC, personal communication). These estimates are for bull trout > 300 mm TL within six index reaches covering about 19 rkm of the 80 rkm reach of the lower Snake River from Hells Canyon Dam to the confluence of the Salmon River. An expansion factor was used to extrapolate to the remaining 61 rkm of this reach. The relationship for this expansion factor comes from 5 – 6 years of angling data that found about 80% of the bull trout captured were within the six index reaches, and from telemetry and recapture data that showed that overwintering bull trout do not move much once they set up winter residency in the lower Snake River. It is likely a significant proportion of adult bull trout from the Imnaha River population overwinters in the lower Snake River below the mouth of the Salmon River.

Table 1.11. Petersen mark-recapture estimates of abundance (95% confidence intervals) at PIT arrays on the Imnaha River and Big Sheep Creek (2012-2014; Idaho Power Company, personal communication).

Year	Migration	PIT-Tag Antenna Array Site	Estimated Tags	95% CI Tags (+/-)	Detection Probability	Weir/Screw Trap Proportion Tagged (N_{tag}) / (N_{total})	Abundance (Est Tags)/(Proportion Tagged)	95% CI Abundance
2012	Spring	IR1	169	12	0.55	0.200	846	785 - 905
		IR2	193	22	0.57	0.200	964	855 - 1,075
		IR3	189	62	0.29	0.200	944	555 - 1,560
		BSC	15	0	1.00	0.200	75	
2013	Spring	IR1	210	7	0.73	0.216	974	939 - 1,004
		IR2	220	14	0.67	0.216	1020	953 - 1,083
		IR3	271	63	0.37	0.216	1254	962 - 1,546
		BSC	18	0	1.00	0.216	83	
	Fall	IR2	119	24	0.46	0.125	954	760 - 1,144
		IR3	104	79	0.33	0.125	832	200 - 1,464
		BSC	2		1.00	0.125	16	
2014	Spring	IR1	291	16	0.59	0.243	1199	1,131 - 1,263
		IR2	257	16	0.60	0.243	1059	991 - 1,123
		IR3	370	92	0.29	0.243	1526	1,041 - 2,193
		BSC	12	0	1.00	0.243	49	

Table 1.12. Huggins robust-design estimate of abundance (95% confidence intervals) for mainstem lower Snake River population of Imnaha River migratory bull trout (2010-2014; Idaho Power, personal communication).

Year	Population Estimate (Nhat)	Std Error	95% CI	Coefficient of Variation	Reach Expansion Factor	Expanded Reach Estimate	95% CI
2010-2011	624	316	4 - 1,244	51%	1.200	749	5 - 1,493
2011-2012	985	271	454 - 1,516	27%	1.200	1182	545 - 1,819
2012-2013	929	248	444 - 1,415	27%	1.200	1115	533 - 1,698
2013-2014	397	96	209 - 585	24%	1.195	474	251 - 702

Bull trout movement/habitat use within the mainstem lower Snake River

A few studies have investigated the use of the mainstem lower Snake River by Imnaha River migratory bull trout (Starcevich et al. 2012; IPC, personal communication). Information regarding these movements is hereafter summarized.

Radio-telemetry ─ Starcevich et al. (2012) radio-tagged 22 adult bull trout in the Imnaha River in 2001. One of these fish was detected moving in the mainstem lower Snake River below the confluence with the Imnaha River for overwintering. Idaho Power Company radio-tagged 47 adult bull trout in the mainstem lower Snake River below Hells Canyon Dam from 1999 – 2006 (IDP, personal communication). Of these, 27 were detected moving into the Imnaha River during the upstream migration period identified in an earlier section. The other 20 tags had inadequate battery life, were lost to predators, or were expelled. Of the 27 detected moving into the Imnaha River, all with remaining active radio tags were detected moving back into the mainstem lower Snake River for overwintering. The distribution of the bull trout from these two studies ranged from just below the confluence with the Imnaha River all the way up to Hells Canyon Dam in the mainstem lower Snake River.

Detections of Imnaha River Subbasin bull trout in other subbasins ─ Use of other subbasins by Imnaha River migratory bull trout is largely unknown. One fall out-migrating bull trout tagged by the Nez Perce Tribe in 2011 at their Imnaha River screw trap was detected in Joseph Creek, a tributary to the lower Grande Ronde River, in spring 2012, and then subsequently detected multiple times in 2013 and 2014 in the Imnaha River. A second adult tagged at the Imnaha River weir in June 2014 was detected leaving the Imnaha River in fall 2014 and subsequently detected in Asotin Creek a week later.

Bull trout interactions with mainstem Snake River hydroprojects

Imnaha River bull trout interactions with mainstem lower Snake River hydroprojects are largely unknown. There are no detections of these fish at any PIT detection array on any of the four lower Snake River dams. However, from 2006 through 2011, 12 bull trout were collected at the Little Goose Dam juvenile fish facility, and samples were taken for genetic analysis. Of these fish, DeHaan and Bretz (2012) determined one was from the Imnaha River. It is known that adult migratory Imnaha River bull trout distribution in the mainstem lower Snake River does range all the way upstream to Hells Canyon Dam, but the hydroproject does not have a fish ladder.

Recommendations

We recommend continued cooperative monitoring efforts among partners (i.e., Nez Perce Tribe, IPC, ODFW, FWS) currently being implemented. Habitat use of Imnaha River bull trout should be determined in the lower Snake River between the Imnaha River and Lower Granite Dam. Research is also needed to evaluate whether the presence of Lower Granite Dam and reservoir, and their operations, affect upstream or downstream passage by Imnaha River bull trout.

Sheep Creek Subbasin

Sheep Creek Subbasin summary

Bull trout populations in the subbasin

- The Sheep Creek Subbasin contains one core area and one bull trout local population.

- Migratory bull trout from an unknown source population have been documented using the core area.

Migratory bull trout in the subbasin

- Migratory bull trout have been shown to emigrate from Sheep Creek into the Snake River in the fall; they presumably enter Sheep Creek in spring or summer as stream temperatures in the Snake River increase.

Bull trout movement/habitat use in the mainstem

- Four bull trout radio-tagged in Sheep Creek overwintered in the Snake River between Sheep Creek and the Imnaha River (Chandler et al. 2003). None migrated upstream toward Hells Canyon Dam (rkm 522.398).

Bull trout interactions with mainstem hydroprojects

- There are no known interactions between migratory bull trout from Sheep Creek and the Snake River hydroprojects.

Sheep Creek Subbasin bull trout

Subbasin description

Sheep Creek flows for approximately 16 rkm and enters the Snake River at rkm 522.368 in west-central Idaho (Figure 1.20), 195 rkm upstream from Lower Granite Dam and 30 rkm downstream from Hells Canyon Dam. Sheep Creek and its tributaries drain the west slope of the Seven Devils Mountains in Idaho. The drainage area is 105 km^2. Major tributaries to Sheep Creek include the West Fork of Sheep Creek and the East Fork of Sheep Creek.

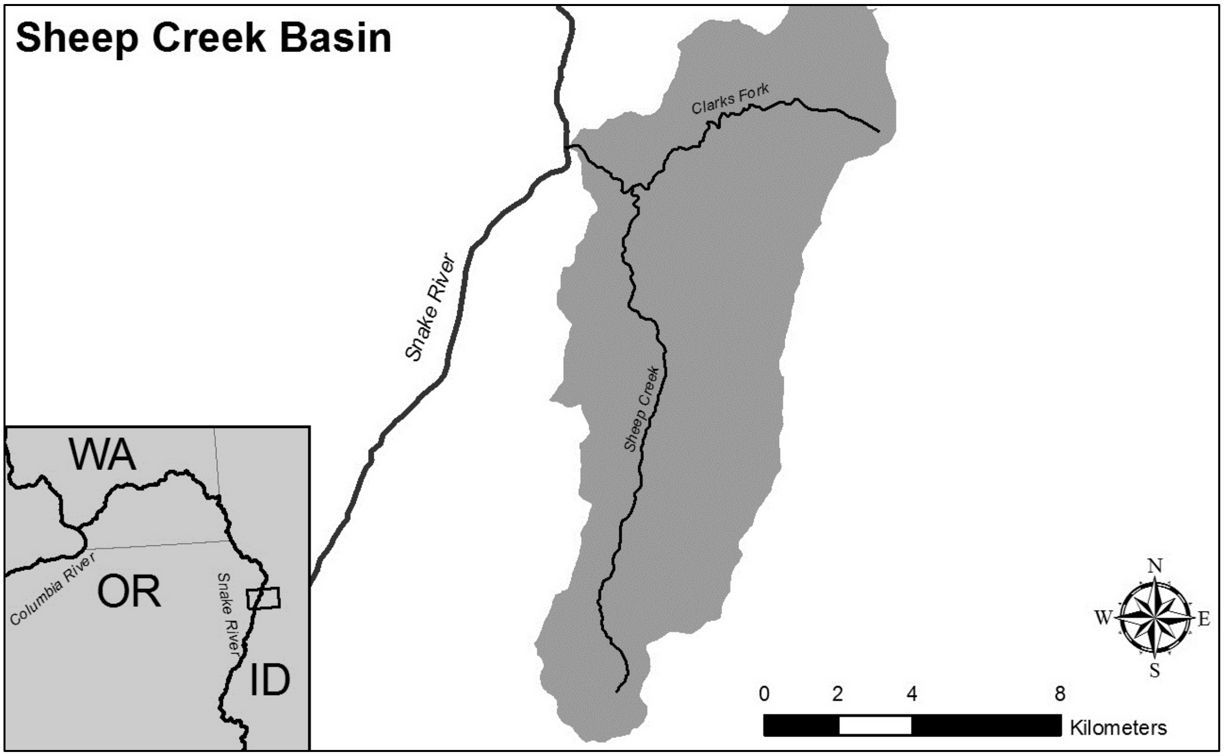

Figure 1.20. Sheep Creek Subbasin and bull trout local populations.

Bull trout populations in the subbasin

The Sheep Creek Subbasin contains one core area, the Sheep Creek Core Area (USFWS 2002), which encompasses the entire subbasin (Figure 1.20). The Sheep Creek Core Area was believed to potentially support a bull trout local population when the draft recovery plan was written (USFWS 2002), but the available evidence suggests the small number of bull trout observed in Sheep Creek in the recent past were immigrants from an unknown source population (but most likely from the Imnaha River). Idaho Power Company biologists extensively electro-fished and snorkeled the entire Sheep Creek drainage in 1999 and 2000 and found only one bull trout (286 mm TL; Chandler et al. 2003). In sampling conducted between 1986 and 2004, Idaho Fish and Game (IDFG) biologists observed only nine bull trout in Sheep Creek, and all were > 200 mm (Brett Bowersox, IDFG, personal communication). Chandler et al. (2003) captured only five bull trout (352-432 mm TL) in a downstream migrant trap near the mouth of Sheep Creek in fall 1999, and no bull trout were captured in that trap in fall 2000. No juvenile-sized bull trout, indicative of adult reproduction, have been observed in Sheep Creek. One of the bull trout Chandler et al. (2003) captured appeared to be a spawned out female, so some spawning by stray fish may occur infrequently.

Migratory bull trout in the subbasin

Very limited information is available on the movement of migratory bull trout in Sheep Creek. As noted above, Chandler et al. (2003) captured five migratory adult-sized bull trout in a downstream migrant trap near the mouth of Sheep Creek in fall 1999. Four of those fish were outfitted with radio tags and subsequently entered the Snake River.

Sheep Creek Subbasin bull trout in the mainstem Snake River

The four bull trout Chandler et al. (2003) radio-tagged overwintered in the Snake River between Sheep Creek and the Imnaha River. None migrated upstream toward Hells Canyon Dam (rkm 522.398).

<u>Migration to and from the mainstem Snake River</u>

Bull trout migration to and from the mainstem Snake River is unknown for Sheep Creek Subbasin bull trout.

<u>Estimates of abundance of mainstem migrants</u>

Abundance of fish entering or returning from the Snake River has not been estimated for Sheep Creek Subbasin bull trout.

<u>Bull trout movement/habitat use within the mainstem Snake River</u>

Bull trout movements and habitat use in the lower Snake River are largely unknown for Sheep Creek Subbasin bull trout.

<u>Bull trout interactions with mainstem Snake River hydroprojects</u>

There is no information suggesting that migratory bull trout from Sheep Creek have interacted with any of the lower Snake River hydroprojects.

Recommendations

Biologists from IPC currently are investigating the movements of migratory bull trout captured and PIT and radio-tagged in the Snake River between Hells Canyon Dam and the Grande Ronde River. Their study could include bull trout that use Sheep Creek for at least a portion of their life cycle and may shed more light on the role Sheep Creek plays for bull trout that use the Snake River. Given the current presumed absence of a viable spawning population of bull trout in Sheep Creek, we recommend no further research into that “population”.

Granite Creek Subbasin

Granite Creek Subbasin summary

<u>Bull trout populations in the subbasin</u>

- The Granite Creek Subbasin contains one core area and one bull trout local population.

- Migratory bull trout have been documented in the core area.

Migratory bull trout in the subbasin

- There have been no studies of the migratory behavior of bull trout in Granite Creek.

Bull trout movement/habitat use in the mainstem

- Use of the Snake River by bull trout from Granite Creek has not been investigated.

Bull trout interactions with mainstem hydroprojects

- N/A

Granite Creek Subbasin bull trout

Subbasin description

Granite Creek flows for approximately 19 rkm and enters the Snake River at rkm 522.385 in west-central Idaho (Figure 1.21), 212 rkm upstream from Lower Granite Dam and 13 rkm downstream from Hells Canyon Dam. Granite Creek and its tributaries drain the west slope of the Seven Devils Mountains in Idaho. The drainage area is 86 km^2. Little Granite Creek is a major tributary to Granite Creek.

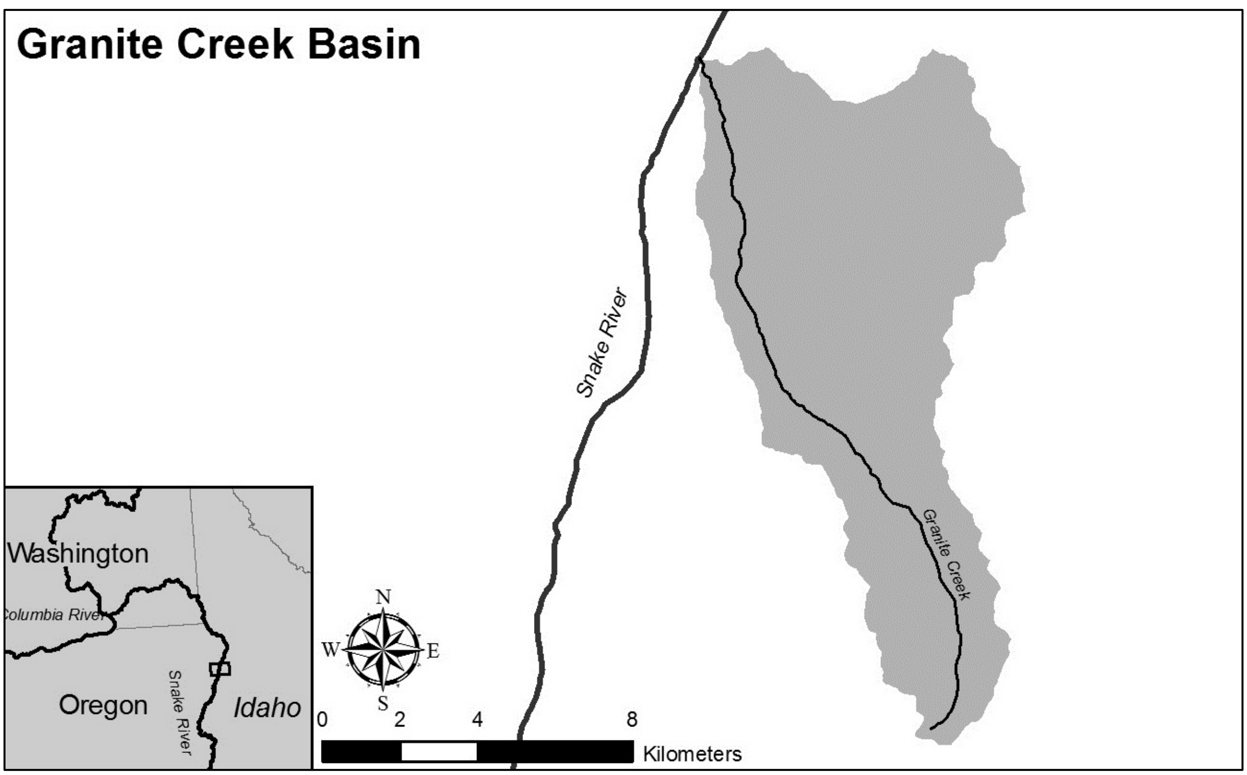

Figure 1.21. Granite Creek Subbasin and bull trout local populations.

Bull trout populations in the subbasin

The Granite Creek Subbasin contains one core area, the Granite Creek Core Area (USFWS 2002), which encompasses the entire subbasin. The Granite Creek Core Area was believed to potentially support a bull trout local population when the draft recovery plan was written (USFWS 2002), but the currently available evidence suggests the small number of bull trout observed in Granite Creek in the recent past were immigrants from an unknown source population (but most likely the Imnaha River). In sampling conducted between 1986 and 2004, IDFG biologists observed only eight bull trout in Granite Creek, and all were > 200 mm (Brett Bowersox, IDFG, personal communication). No juvenile-sized bull trout, indicative of adult reproduction, have been observed in Granite Creek. Granite Creek is a high gradient stream with limited bull trout juvenile rearing and spawning habitat (J. Chandler, IPC, personal communication). It is colder than the Snake River during the summer, however, and may be used by migratory bull trout to avoid increasing water temperatures in the Snake River. A small number of bull trout captured and radio-tagged in the Snake River at the mouth of Granite Creek have subsequently entered Granite Creek (R. Wilkison, IPC, personal communication). The migratory behavior of bull trout within Granite Creek has not been investigated

Granite Creek Subbasin bull trout in the mainstem Snake River

The small number of radio-tagged bull trout that used Granite Creek remained near its mouth while in the Snake River (R. Wilkison, IPC, personal communication).

Migration to and from the mainstem Snake River

Bull trout migration to and from the mainstem Snake River is unknown for Granite Creek Subbasin bull trout.

Estimates of abundance of mainstem migrants

Abundance of fish entering or returning from the Snake River has not been estimated for Granite Creek Subbasin bull trout.

Bull trout movement/habitat use within the mainstem Snake River

Bull trout movements and habitat use in the lower Snake River are largely unknown for Granite Creek Subbasin bull trout.

Bull trout interactions with mainstem Snake River hydroprojects

There is no information suggesting that migratory bull trout from Granite Creek have interacted with any of the lower Snake River hydroprojects.

Recommendations

Biologists from IPC currently are investigating the movements of migratory bull trout captured and PIT- and radio-tagged in the Snake River between Hells Canyon Dam and the Grande Ronde

River. Their study could include bull trout that use Granite Creek for at least a portion of their life cycle and may shed more light on the role Granite Creek plays for bull trout that use the lower Snake River. Although there is no evidence a viable spawning population of bull trout exists in Granite Creek, a rigorous presence/absence survey has not been conducted. We recommend one be conducted.

Chapter 2 : Potential Impacts of Mainstem Dams, Their Operation, and Associated Impoundments on Bull Trout

Mainstem Columbia and Snake river dams and reservoirs have the potential to affect both bull trout connectivity within migratory corridors as well as connectivity between core area populations. These mainstem habitats have been designated as critical habitat (FMO) and they serve an important role in bull trout recovery (USFWS 2002, 2010, 2015; Barrows et al. 2014a; Small et al. 2012). Mainstem dams that lack sufficient upstream and downstream passage routes for bull trout including appropriate seasonal operations, may impact migration and contribute to the isolation of populations that were historically connected (Barrows et al. 2014a; DeHaan et al. 2011). In addition, dams have significantly altered the natural hydrograph, and their respective impoundments are now slow velocity, seasonally warm-water reservoirs compared to natural river conditions (Keefer et al. 2004; Petrosky and Schaller 2010). These reservoirs provide beneficial seasonal environments where subadult and adult bull trout forage, migrate, mature or overwinter (USFWS 2010). However, the lacustrine habitats within these reservoirs no longer resemble the migration corridors historically used by migratory bull trout, and these modified habitat conditions may affect survival and/or migration timing. Reservoir environments are also more suitable for avian and aquatic predators (Williams et al. 2005; Ferguson et al. 2005). Seasonal operations at FCRPS dams include measures to spill various proportions of river flow to facilitate downstream migration by salmon and steelhead smolts. These operations can result in elevated total dissolved gas (TDG) levels in the mainstem corridor. Elevated TDG levels could affect survival of bull trout in the mainstem, but no evaluations have been conducted. In this chapter, we describe the configuration, operations, and upstream and downstream passage routes of 14 mainstem Columbia and Snake River dams including their respective impoundments (Figure 2.1). We discuss documented interactions between these projects and migratory bull trout, and link these interactions with observations at other mainstem FCRPS dams and with observations and movement patterns from the tributary subbasin of origin when possible. We also discuss potential effects of the mainstem FCRPS hydroprojects on connectivity, migration delay, and survival within the mainstem FMO critical habitat. We have included data and analyses for bull trout interactions with non-FCRPS projects (i.e., mid-Columbia River) (Figure 2.1) in this chapter to provide a more complete synthesis of mainstem use and to help make inferences about potential interactions between bull trout and the FCRPS projects, and the effects of the FCRPS on bull trout life history and connectivity.

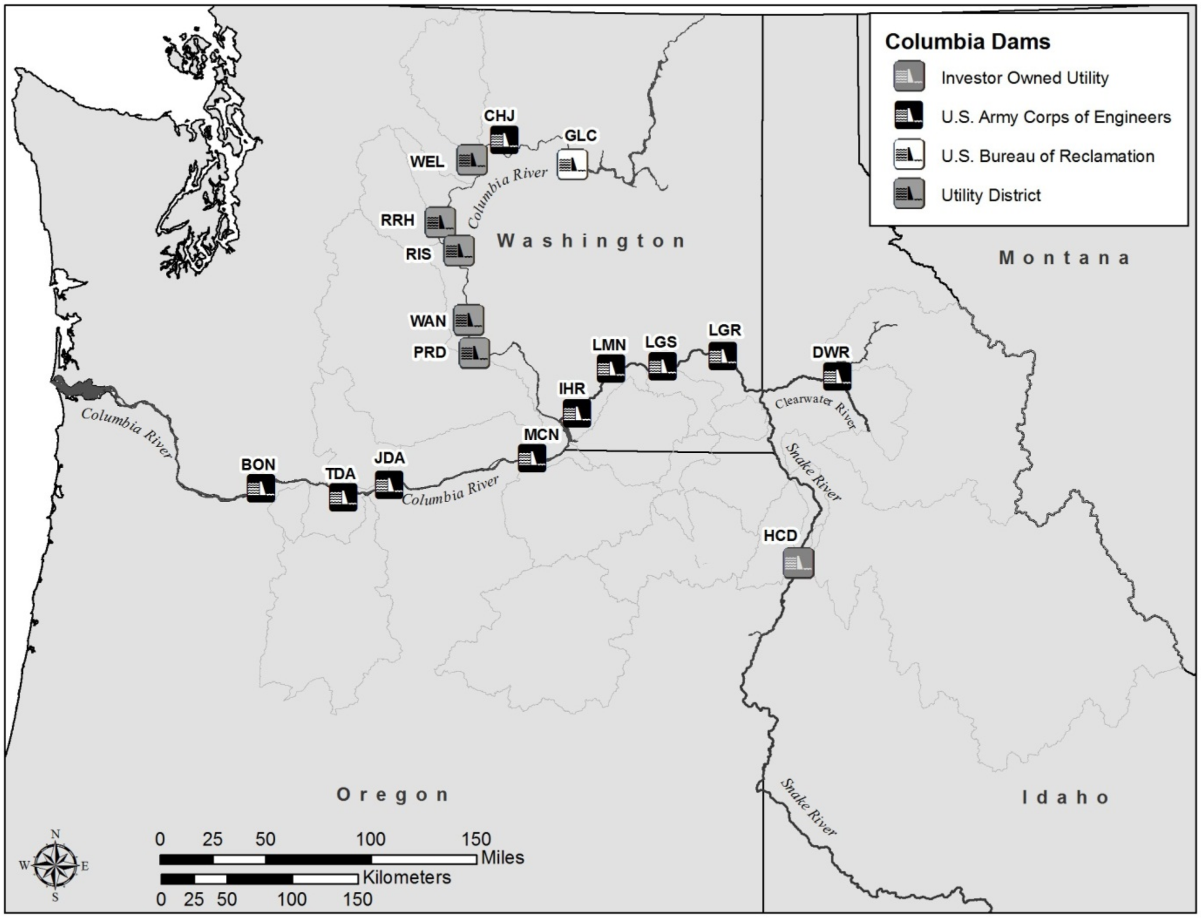

Figure 2.1. Columbia River Basin overview with locations of the mainstem FCRPS dams (U.S. Army Corps of Engineers and Bureau of Reclamation) along with public utility district dams. (BON = Bonneville Dam, TDA = The Dalles Dam, JDA = John Day Dam, MCN = McNary Dam, IHR = Ice Harbor Dam, LMN = Lower Monumental Dam, LGS = Little Goose Dam, LGR = Lower Granite Dam, CHJ = Chief Joseph Dam, GLC = Grand Coulee Dam, PRD = Priest Rapids Dam, WAN = Wanapum Dam, RIS = Rock Island Dam, RRH = Rocky Reach Dam, WEL = Wells Dam, and HCD = Hells Canyon Dam).

Lower Columbia River

Bull trout use of the lower Columbia River has been documented from observations in the fish ladders at mainstem FCRPS projects, PIT tag detections in the fish ladders and juvenile bypass systems at mainstem FCRPS projects, various research projects in the mainstem Columbia River, PIT tag detections from bull trout entering the mainstem from tributary subbasins, and anecdotal accounts. Much of this information was dispersed throughout various technical or monitoring reports from a number of federal, state, and tribal agencies, as well as several non-governmental entities, and other information was included as incidental in work conducted, and reports produced that focused on anadromous salmonids.

Bonneville Dam

Bonneville Dam (rkm 234) is the lowermost mainstem hydroproject and is part of the FCRPS in the lower Columbia River (Figures 2.1 and 2.2). The reservoir impounded by Bonneville Dam is known as Lake Bonneville and extends 74 rkm upstream to The Dalles Dam. Bull trout populations in the project area include those residing in the Hood and Klickitat River subbasins, 39 rkm and 56 rkm upstream from Bonneville Dam, respectively.

Figure 2.2. Bonneville Dam on the Columbia River looking upstream during the spring spill season.

Connectivity

Bonneville Dam represents a potential migration impediment, primarily for Hood River and Klickitat River subbasin bull trout. Lewis River bull trout could be present in the mainstem downstream from Bonneville Dam, but the three Lewis River dams and reservoirs restrict downstream movement and it is likely that very few individuals are able to migrate to the Columbia River.

Both subadult and adult migratory bull trout from the Hood River Subbasin enter the mainstem Columbia River, but migration timing to the mainstem is poorly understood. If Hood River bull trout exhibit similar movement patterns to bull trout from other, more rigorously monitored subbasins (e.g., Walla Walla, Tucannon, and Entiat rivers), they would likely enter the Columbia River during the fall, winter and possibly spring months. Bull trout return to the Hood River Subbasin from the mainstem Columbia River during the spring and early summer months, but could potentially be migrating throughout the mainstem during all months. Thus, Bonneville Dam may have the potential to affect bull trout migration during most months of the year. For more detail regarding observations of bull trout in the mainstem Columbia River upstream and downstream from Bonneville Dam, and in Lake Bonneville, please refer to the Hood River Subbasin summary section in Chapter 1 of this report.

Downstream bull trout passage at Bonneville Dam has not been evaluated, but bull trout passage would likely be through spill gates, turbines, or the juvenile fish bypass system. In addition, a modification and extension of an existing trash and ice sluiceway on the second powerhouse called the "corner collector" was completed in 2004 as a means of increasing downstream fish passage efficiency at the dam. A PIT tag detection system has been installed in the corner collector to monitor downstream passage of PIT-tagged salmonids. The fish bypass system is monitored for PIT tags, but the spill gates and turbines are not. Spill typically occurs during the spring and summer months. The corner collector is also operated during the spring and summer months. The fish bypass is actively monitored from the beginning of March through the end of October and is not operated during the winter. Limited data for bull trout at Bonneville Dam and within Lake Bonneville suggest downstream movement potentially occurs throughout the year. If bull trout passage through Bonneville Dam is similar to other upstream hydroprojects, fish are likely to move downstream undetected through the turbines during the fall and winter months. This downstream migration timing is also consistent with post-spawn adult and subadult bull trout expressing an anadromous life history, potentially affecting the expression or reexpression of this life history behavior in the lower Columbia River (J. Chan, FWS, personal communication).

Bull trout intending to return to the Hood River Subbasin from downstream of Bonneville Dam must pass upstream via one of several fish ladders. The fish ladders were designed primarily for anadromous salmonid passage, and bull trout passage efficiency has not been specifically evaluated. Very limited passage data at Bonneville Dam suggest bull trout pass upstream during the spring. The ladders are alternately shut down briefly for maintenance during the winter. Routine maintenance typically lasts only a few weeks and is unlikely to significantly impact bull trout migration since some ladders are always operational. The ladders are constantly monitored for full duplex PIT tags by multiple PIT antennas and fish are enumerated at the counting windows from 1 April through 31 October between 0400 and 2000 hours. Anadromous salmonids and lamprey are counted by video during some of the periods when manual counts do not occur, but video counts are not done for bull trout. Thus, any bull trout that pass through the Bonneville Dam fish ladders from 2000 to 0400 hours, or outside the counting season, will not be enumerated.

Migration delay

Upstream and downstream migration delay for bull trout has not been specifically assessed at Bonneville Dam. Only one PIT-tagged bull trout has been detected moving upstream through the fish ladders at Bonneville Dam. The detection history of this fish suggested it passed upstream through the ladder without being delayed and subsequently returned to the Hood River Subbasin. There is no evidence of downstream migration delay for bull trout at Bonneville Dam, but it has not been evaluated. The low water velocity and seasonally warm water temperatures in Lake Bonneville compared to natural river conditions have the potential to affect (e.g., delay) bull trout migration, but information to evaluate this is lacking.

Survival

Bonneville Dam has the potential to impact bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, the impact of mainstem habitat conditions on bull trout survival has not been assessed, but relatively high reservoir water temperatures during the summer months may have an effect. Bull trout that migrate to the lower reaches of their respective subbasins and those that enter the mainstem reservoir may also be impacted by unnaturally high numbers of aquatic predators (native and exotic). The impact of high numbers of northern pikeminnow and smallmouth bass on bull trout in Lake Bonneville has not been evaluated.

The Dalles Dam

The Dalles Dam (rkm 308) is part of the FCRPS in the lower Columbia River (Figures 2.1 and 2.3). The reservoir impounded by The Dalles Dam is known as Lake Celilo and extends 39 rkm upstream to the John Day Dam tailrace. There are three subbasins with bull trout populations in the vicinity of The Dalles Dam. The Deschutes River Subbasin is approximately 20 rkm upstream of the dam, and the Klickitat River and Hood River Subbasins are approximately 19 rkm and 36 rkm downstream, respectively.

Figure 2.3. The Dalles Dam located on the Columbia River. (Photo from https://www.flickr.com/photos).

Connectivity

The Dalles Dam represents a potential migration impediment between downstream bull trout populations in the Hood River and Klickitat River subbasins and upstream populations in the Deschutes River Subbasin. Migratory bull trout from the relatively large populations in the Metolius/Lake Billy Chinook complex, Shitike Creek, and the Warm Springs River move into the lower Deschutes River, and both adults and subadults have been detected moving into the Columbia River (Graham et al. 2011; CTWSRO 2013; www.ptagis.org [queried Dec. 2014]).

This behavior has rarely been observed, although few studies have been conducted to specifically investigate the use of the mainstem Columbia River by Deschutes River bull trout. Similarly, movements and migration patterns of Deschutes river bull trout within the mainstem Columbia River have not been evaluated. Subadult and adult bull trout from the Hood River Subbasin enter the mainstem Columbia River (www.ptagis.org [queried Dec. 2014]), but emigration timing is poorly understood. Use of the mainstem by Klickitat River Subbasin bull trout is currently unknown. We are aware of only one observation of a bull trout at The Dalles Dam. A subadult-sized fish was recovered from the east fish ladder during winter maintenance in 1997. If bull trout from the Hood River and Deschutes River subbasins exhibit similar movement patterns to bull trout from other subbasins (e.g., Tucannon River and Walla Walla River), they likely enter the Columbia River during the fall, winter and possibly spring months. Bull trout likely return to the Deschutes and Hood River subbasins from the mainstem during the spring and early summer months (Hood River Subbasin – May-July; see *Hood River Subbasin Summary*.

Bull trout could potentially move throughout the mainstem during most months of the year. For example, a subadult bull trout was detected at a PIT detection array near the mouth of the Deschutes River on 11 August 2013, but it was unclear whether this fish was moving into or out of the Deschutes River at that time. Thus, The Dalles Dam and its associated impoundment may potentially affect migrating bull trout throughout the year.

Downstream bull trout passage at The Dalles Dam has not been evaluated, but passage would likely be through spill gates, turbines or the ice and trash sluiceway that is now being used as a downstream fish bypass system. The spill gates, turbines and the ice and trash sluiceway are not monitored for PIT tags. Spill typically occurs during the spring and summer months. This is also the time period that the ice and trash sluiceway is operated. If bull trout movement patterns in the mainstem near The Dalles Dam are similar to bull trout movement patterns in upper reaches of the Columbia and Snake rivers, downstream passage could potentially occur throughout the year, and fish may pass downstream of the dam via multiple routes undetected. If downstream movement occurs during the fall and winter, the most likely route of passage may be through the turbines.

Bull trout intending to return to the Deschutes River Subbasin from downstream of The Dalles Dam must pass upstream via either the North or East fish ladders. Bull trout passage through the fish ladders has not been evaluated. Very limited passage data at The Dalles Dam suggests bull trout pass upstream during the spring. The ladders are alternately shut down at times for winter maintenance from 1 December through 28 February. The shutdowns are unlikely to significantly impact bull trout migration. Prior to 2013, the fish ladders were not wired to detect PIT tags. Currently, both ladders are monitored for full duplex PIT tags by multiple “thin body type” pass through PIT antennas. Fish are enumerated at counting windows from 1 April through 31 October for approximately 16 hours per day (0400 to 2000). Anadromous salmonids and lamprey are counted by video during some of the time periods when manual counts do not occur, but bull trout are not enumerated during video counts. Since some bull trout move at night and may migrate after 31 October and before 1 April, it is likely that not all bull trout that pass through The Dalles Dam fish ladders are enumerated.

Migration delay

Upstream and downstream migration delay for bull trout has not been assessed at The Dalles Dam. Compared to natural river conditions, the low water velocity and seasonally warm water temperatures in Lake Celilo have the potential to impact bull trout migration, but information to evaluate this is lacking.

Survival

The Dalles Dam and its impoundment have the potential to impact bull trout survival. Survival during upstream and downstream passage at the dam, and the impact of mainstem habitat conditions on bull trout survival has not been assessed. Reservoir water temperatures during the summer months may be unsuitable, and could influence bull trout survival if the reservoir is used during this time period. Bull trout that enter Lake Celilo may also be impacted by native and exotic avian and aquatic predators.

John Day Dam

John Day Dam (rkm 347) is part of the FCRPS in the lower Columbia River (Figures 2.1 and 2.4). The reservoir impounded by John Day Dam is known as Lake Umatilla and extends 123 rkm upstream to McNary Dam. There are three subbasins with bull trout populations in the generally vicinity of John Day Dam. The Deschutes River Subbasin is approximately 18 rkm downstream of the dam, the John Day River Subbasin is only 4 rkm upstream of the dam, and the Umatilla River Subbasin is approximately 118 rkm upstream.

Figure 2.4. John Day Dam located on the Columbia River (Photo from https://www.flickr.com/photos/60161247@N03/11954503235/sizes/l).

Connectivity

John Day Dam represents a potential migration impediment between downstream bull trout populations in the Deschutes River Subbasin and upstream bull trout populations in the John Day River and/or Umatilla River subbasins. There is also the possibility that migratory bull trout from other upriver populations may range downstream far enough to be impacted by John Day Dam. There is empirical evidence that confirms bull trout from the Walla Walla River and Tucannon River subbasins have entered at least the upstream portion of Lake Umatilla and subsequently entered the Umatilla River Subbasin.

Migratory bull trout from local populations in the Deschutes River Subbasin move into the lower Deschutes River, and both adults and subadults have also been detected moving into the Columbia River (Graham et al. 2011; CTWSRO 2013). Movements and migration patterns of Deschutes River bull trout within the mainstem Columbia River have not been evaluated. Migratory bull trout are present within each of the three core areas in the John Day River Subbasin, but they appear for the most part to remain in the upper portion of the subbasin during their seasonal migrations. Use of the Columbia River by migratory bull trout from the John Day River and Umatilla River subbasins has not been demonstrated. If bull trout from the abovementioned subbasins migrate to the mainstem Columbia River and have similar movement patterns to bull trout from other, more rigorously monitored subbasins (e.g., Walla Walla River and Tucannon River), they could potentially be migrating throughout the mainstem during most months of the year. Although information is lacking on bull trout use of the mainstem Columbia River from subbasins in the vicinity of John Day Dam, bull trout have occasionally been observed moving upstream during the spring and summer (e.g., April-July) through the fish ladders and downstream during the spring (e.g., May) at the fish bypass and smolt monitoring facility.

Downstream bull trout passage has not been specifically evaluated at John Day Dam, but passage would likely be through spill gates, turbines or the juvenile fish bypass/monitoring facility. The spill gates and turbines are not monitored for PIT tags. The fish bypass facility is monitored for PIT tags when operated. Spill typically occurs during the spring and summer months. If bull trout movement patterns throughout the mainstem corridor near John Day Dam are similar to bull trout movement patterns in upper reaches of the Columbia and Snake rivers, downstream movement could potentially occur throughout the year and fish may pass downstream of the dam undetected. If downstream movement occurs during the fall and winter, the most likely route of passage may be through the turbines.

Bull trout intending to move upstream of John Day Dam must pass via one of two fish ladders. The fish ladders were designed for adult anadromous salmonid passage, and bull trout passage efficiency has not been specifically assessed. Very limited passage data at John Day Dam suggests bull trout pass upstream during the spring and summer months (e.g., April – July). The ladders are shut down at times for maintenance during the winter, but the brief shutdowns are unlikely to significantly impact bull trout migration. The fish ladders are not monitored for PIT tags. Fish are manually enumerated at counting windows from 1 April through 31 October for approximately 16 hours per day (0400 to 2000). Anadromous salmonids and lamprey are counted by video during some of the periods when manual counts do not occur, but video counts are not done for bull trout. It may be likely that not all bull trout that pass through John Day Dam fish ladders are enumerated since some bull trout may pass at night and others may migrate from November through March.

Migration delay

Upstream and downstream migration delay for bull trout has not been investigated at John Day Dam. The low water velocity and seasonally warm water temperatures in Lake Umatilla compared to natural river conditions have the potential to impact (e.g., delay) bull trout migration but information to evaluate this is lacking.

Survival

John Day Dam has the potential to impact bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, the impact of mainstem habitat conditions on bull trout survival has not been assessed, but reservoir temperatures during the summer months may be unsuitable. Bull trout that migrate to the lower reaches of their respective subbasins and those that enter Lake Umatilla may be impacted by unnaturally high numbers of aquatic predators (native and exotic). The impact of high numbers of northern pikeminnow, walleye and smallmouth bass in Lake Umatilla on bull trout has not been evaluated.

McNary Dam

McNary Dam (rkm 470) is part of the FCRPS in the lower Columbia River (Figures 2.1 and 2.5). The reservoir impounded by McNary Dam is known as Lake Wallula and extends approximately 87 rkm upstream towards Priest Rapids Dam (rkm 639) on the Columbia River and approximately 67 rkm to the tailrace of Ice Harbor Dam (rkm 522.016) on the Snake River. The Hanford Reach is the 82 rkm portion of the Columbia River upstream from Lake Wallula, and downstream from Priest Rapids Dam and is the only free-flowing, non-tidal stretch of the Columbia River in the United States.

Figure 2.5. McNary Dam located on the Columbia River (Photo from http://www.panoramio.com/photo/11290139).

Connectivity

McNary Dam is located between the Umatilla River and Walla Walla River subbasins, and represents a potential migration impediment between bull trout from the Umatilla River Subbasin and upstream populations including the Walla Walla River, Yakima River, Tucannon River, and possibly other subbasins.

Bull trout intending to return to upstream subbasins (e.g., Walla Walla River, Tucannon River subbasins) from downstream of McNary Dam must pass upstream of the dam via either the north bank or south bank fish ladders. The fish ladders were designed primarily for anadromous salmonid passage, and bull trout passage efficiency has not been specifically evaluated. The majority of bull trout movement upstream past McNary Dam typically occurs in the spring and early summer months (e.g., April – July; Appendix A), but could potentially occur throughout the year. The ladders are alternately shut down for maintenance during the winter. Routine maintenance typically lasts only a few days and is unlikely to significantly impact bull trout migration. The ladders are constantly monitored for full duplex PIT tags by multiple PIT antennas and fish are enumerated at the counting windows from 1 April to 31 October. During this time, enumeration occurs from 0400 to 2000 hours PST. Since bull trout sometimes move at night, and during the fall and winter (November through March), all bull trout that pass through the McNary Dam fish ladders may not be enumerated.

Downstream passage routes at McNary Dam include the spillway, temporary spillway weirs (TSW), turbines, and the juvenile bypass facility. Spill usually occurs from April 10 through the end of August, the TSWs are typically in operation from April 10 through early June, and the juvenile bypass facility is open from early April through December 15. The bypass facility includes monitoring for PIT tags, but the other downstream passage routes do not. The only opportunity to observe untagged bull trout moving downstream past McNary Dam is on the separator or in condition samples, and no observations have been recorded at these locations.

Despite the lack of records, bull trout have been observed on the separator (November 2011, C. Duggar, ACOE, personal communication).

Most of the bull trout from the Walla Walla River Subbasin that enter the mainstem Columbia River do so from October through February, and they subsequently return to the subbasin from March through June, but they could potentially be migrating throughout the mainstem during all months of the year. Downstream migrant bull trout that attempt to move downstream past McNary Dam during the winter would pass through the turbines since there is no spill or TSW, and the juvenile bypass facility is closed.

Migration delay

Upstream passage success and potential migration delay for bull trout have not been specifically assessed at McNary Dam. A total of four bull trout (two PIT-tagged) have been observed passing upstream at McNary Dam, all in the Oregon shore fish ladder. Two individuals were observed in April and June 2007 at the fish counting window. The other two observations were actually detections of PIT-tagged bull trout. In 2009, a PIT-tagged bull trout from the Walla Walla Basin apparently made two attempts to pass the ladder at McNary. This fish entered the mainstem in January 2009, and passed downstream of McNary sometime between January and May without being detected. The first upstream passage attempt was in May, and the only detections were on the antennas at the counting window. We assume it successfully passed upstream into the forebay, and then subsequently passed downstream without being detected. The second upstream passage attempt was three weeks later in June. This fish was detected moving upstream, then downstream in the ladder on the weir PIT antennas. There were no further detections of this bull trout. We assume it did not pass upstream since it was not detected on the PIT antennas at the counting window. It is likely that this bull trout dropped back downstream out of the ladder, but with no further detections, its fate is unknown. A second PIT-tagged bull trout from the Walla Walla Basin made several attempts to pass the Oregon shore ladder at McNary in 2012. This fish entered the mainstem in November 2011, and passed downstream from McNary sometime between November and June 2012 without being detected. This bull trout was detected at the PIT antennas in the overflow weirs, then the antennas at the counting window on four consecutive days from 26 June through 29 June. Apparently, this fish successfully passed the ladder into the forebay, then passed downstream without being detected (spill, TSW, turbines), followed by three additional ascensions of the ladder. After successfully passing upstream through the ladder into the forebay for the fourth time, it was not subsequently detected at any other locations. Most Walla Walla-origin bull trout re-enter and ascend the lower Walla Walla River prior to June (Anglin et al. 2010; Barrows et al. 2012a, 2012b). Ascending the Walla Walla River successfully in June or early July is usually not possible because streamflows have been reduced as a result of irrigation diversions to the point that fish passage through the lower river is difficult or impossible. If we assume the timing for these bull trout should have been similar to other observations of bull trout that re-enter the Walla Walla River, the fact that these fish were detected at McNary Dam at the end of June and took multiple days to pass upstream through the fish ladder may suggest they experienced some difficulty and were delayed while attempting to find or navigate the ladder (Barrows et al. 2014a). This sample size is not sufficient to determine whether bull trout upstream passage at McNary is problematic, but it does suggest further evaluation is in order.

Downstream passage success and potential migration delay for bull trout have not been specifically assessed at McNary Dam. Observations of unmarked downstream migrant bull trout are only possible on the separator or in condition samples in the juvenile bypass system, and none of these observations have been recorded. PIT-tagged bull trout are the other potential data source for downstream migrant fish, and PIT detections are only possible in the juvenile bypass system. There have only been two PIT-tagged bull trout detected in the bypass system at McNary Dam. In January 2009, a PIT-tagged Walla Walla River bull trout entered the Columbia River and was detected four months later in April in the full flow bypass at McNary. We assume it was routed to the tailrace through the primary bypass, but since there were no further detections, its ultimate fate is unknown. A second bull trout was PIT-tagged in the Touchet River (Walla Walla Subbasin) as a subadult in 2013, and the first detection was in the full flow bypass at McNary Dam in June 2014. This fish was then delayed for over 17 hours before detection at the B-raceway diversion. The detection history for this bull trout indicates that the delay likely happened at the fish separator. The last detection for this fish was at the river exit to the tailrace.

Migration through McNary Pool (Lake Wallula) could be affected by the relatively low water velocities and seasonally warm water temperatures compared to natural river conditions but information to evaluate this is lacking.

Survival

McNary Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, the effect of mainstem habitat conditions on bull trout survival has not been assessed, but reservoir temperatures during the summer months may be unsuitable. Migratory bull trout from the Walla Walla River, Tucannon River and Entiat River subbasins have been documented entering Lake Wallula. Bull trout that migrate to mainstem Columbia and Snake river reservoirs may also be impacted by unnaturally high numbers of avian and aquatic predators (native and exotic). In recent years, PIT tags from migratory bull trout have been recovered from avian nesting colonies on islands located in the upper portion of Lake Wallula. Most of the recovered tags were from fish that were originally tagged within the Walla Walla River Subbasin. At least 57 bull trout PIT tags have been detected/recovered from piscivorous bird colony sites in various locations in eastern Washington. From 2007 through 2011, the FWS PIT-tagged a total of 869 migratory bull trout in the middle and lower subbasin reaches (i.e., lower two-thirds of the subbasin) of the Walla Walla River. Thirty-one of these PIT tags (3.6%) were subsequently recovered on avian nesting islands in Lake Wallula. During 2008, 223 bull trout were PIT-tagged in middle and lower reaches of the Walla Walla River, and 13 (5.8%) of those PIT tags were subsequently recovered on the avian nesting islands. The number of PIT tags recovered is a minimum because not all tags are deposited on the islands, and not all tags deposited on the islands are recovered. In addition, the number of bull trout consumed by avian predators is likely larger than indicated by recovered PIT tags because only a small portion of the total number of migratory bull trout are PIT-tagged.

Mid-Columbia River

Bull trout use of the mid-Columbia River has been documented through ladder counts, radio-telemetry studies, ongoing PIT tagging studies, creel censuses, and monitoring plans. Much of the information is dispersed throughout various technical or monitoring reports from several agencies that may be difficult to locate, so an abstracted bibliography of radio-telemetry studies on bull trout in the mid-Columbia River was created to simplify information retrieval (Nelson and Christopherson 2015). Other information from current or ongoing studies, such as movements and survival of PIT-tagged subadult bull trout, is preliminary and not yet available for use in this document (e.g., Nelson and Nelle 2013).

Each Public Utility District (PUD) dam on the mid-Columbia River has a Bull Trout Monitoring and Management Plan that is specific to that hydroproject and was developed under FWS Biological Opinions, Habitat Conservation Plans, or FERC relicensing requirements (LGL and DCPUD 2008; BioAnalysts, Inc. 2009; Turner 2013). These plans were implemented to identify, develop, and implement measures to monitor and address ongoing impacts on bull trout resulting from project operations and facilities and include an annual monitoring report detailing incidental take.

Priest Rapids Dam

Priest Rapids Dam (rkm 639) is not part of the FCRPS and is located at the upstream end of the Hanford Reach of the Columbia River (Figures 2.1 and 2.6). The Hanford Reach is the only unimpounded, non-tidal stretch of the Columbia River in the United States. Bull trout use of the Hanford Reach has been documented during monitoring of fish populations in the river (Gray and Dauble 1977). Priest Rapids Dam is owned and operated by the Public Utility District No. 2 of Grant County. The reservoir impounded by Priest Rapids Dam is referred to as Priest Rapids Lake and extends 30 rkm upstream to the tailrace of Wanapum Dam. The closest bull trout core area populations to this dam are located downstream in the Walla Walla River and Yakima River subbasins (rkm 509 and 539, respectively) and upstream in the Wenatchee River Subbasin (rkm 754).

Figure 2.6. Priest Rapids Dam located on the mid-Columbia River. (Photo from Grant PUD).

Connectivity

Priest Rapids Dam fish passage is necessary for bull trout from upstream subbasins (e.g., Wenatchee River, Entiat River and Methow River subbasins) to interact with bull trout from other downstream subbasins (e.g., Yakima River and Walla Walla River subbasins). Bull trout that attempt to move downstream of Priest Rapids Dam could use several routes for passage while upstream migrating bull trout must pass via the fish ladders.

Bull trout attempting to migrate upstream in the Columbia River over Priest Rapids Dam may be dispersing from downstream populations including fish from the Walla Walla River Subbasin (Barrows et al. 2014a) or returning upstream to mid-Columbia River subbasins such as the Entiat River Subbasin (www.ptagis.org [queried Dec. 2014]). Bull trout intending to move upstream past Priest Rapids Dam must pass via either the left or right bank fish ladders. The fish ladders were designed primarily for anadromous salmonid passage and fish passage efficiency has not been evaluated for bull trout. The ladders are constantly monitored for full duplex PIT tags and fish are enumerated via video from 15 April to 15 November. Only two PIT-tagged bull trout have been detected moving upstream through the Priest Rapids Dam fish ladders. One was originally tagged in the Entiat River by FWS staff during an ongoing subadult bull trout movement study (Nelson and Nelle 2013) and was detected passing upstream through the fish ladder on 21 November 2009 (www.ptagis.org [queried Dec. 2014]). This fish eventually returned to the Entiat River. The other PIT-tagged bull trout was tagged just prior to exiting the Walla Walla River on 28 January 2009 and was detected while passing upstream of Priest Rapids Dam on 5 July 2009, but was not subsequently detected (www.ptagis.org [queried Dec. 2014]). This individual’s ultimate fate is unknown. In addition to PIT tag detections, bull trout moving through the fish ladders are enumerated via video from 15 April to 15 November. From April 2007 to November 2014, a total of 44 bull trout have been observed moving upstream through the fish ladders at Priest Rapids Dam with an annual mean count of six bull trout (range 1-9; www.cbr.washington.edu). The majority of bull trout movement upstream past Priest Rapids Dam typically occurs from May through July, and generally peaks during June (Figure 2.7). Estimated sizes of bull trout from photographs in the counting windows indicate most are adults ranging from 450 to 800 mm (Turner 2013; GCPUD 2013, 2014). Although these fish were not marked and their source population is unknown, the movement timing suggests the majority of these fish are destined for upstream subbasins to spawn or to upstream reservoirs to access additional FMO habitat. Since bull trout may be in the vicinity of Priest Rapids Dam during all months (including after 15 November and before 15 April), all bull trout that pass through the Priest Rapids fish ladders may not be enumerated. In addition, fish ladders are routinely maintained, but this typically lasts only a few days and is unlikely to substantially impact bull trout migration.

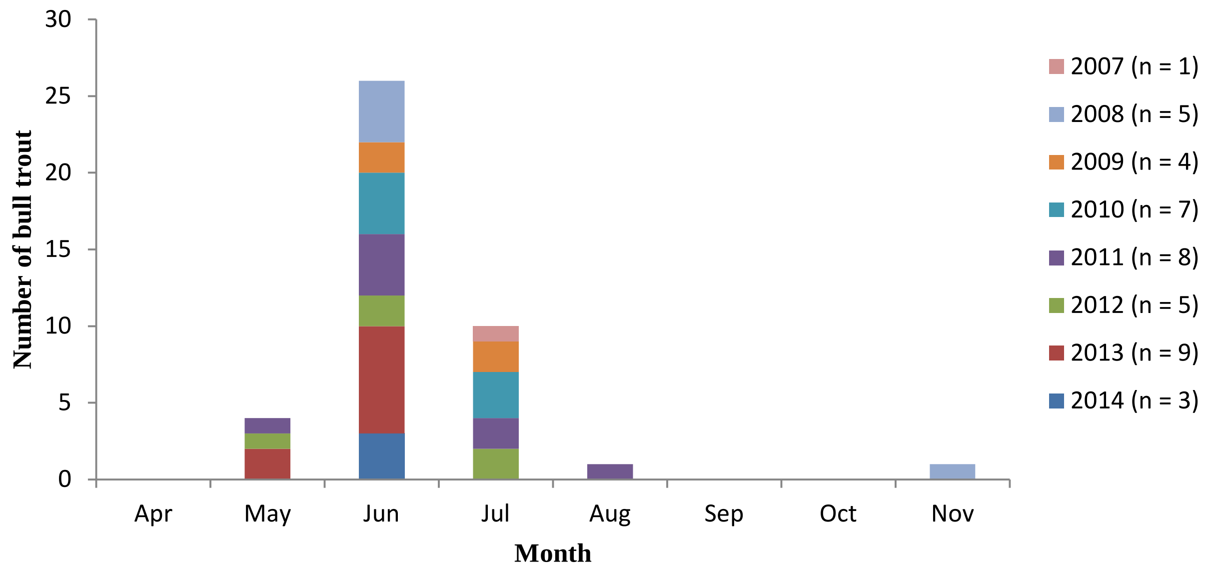

Figure 2.7. Bull trout observations at Priest Rapids Dam adult ladders from April 2007 through November 2014 (www.cbr.washington.edu).

As discussed previously, post-spawning adult bull trout from subbasins in the general vicinity of Priest Rapids Dam primarily enter the mainstem Columbia River from October through February. Subadult outmigration has occurred both during spring and fall months in some subbasins (e.g., Entiat River). Adult bull trout generally return to their respective subbasins from May through July, but could potentially be migrating throughout the mainstem during all months (BioAnalysts 2004,2009; Nelson and Nelle 2008; Nelson and Johnsen 2012; Nelson 2014).

Downstream bull trout passage at Priest Rapids Dam has not been specifically evaluated, but bull trout attempting to migrate downstream in the Columbia River over Priest Rapids Dam could do so using several routes. Bull trout passage would likely be through the spillways, turbines, or recently completed fish bypass structures/modifications to three of the spillways, none of which are monitored for PIT tags. Limited data suggests that the majority of adult bull trout downstream movement in the mainstem from mid-Columbia River subbasins appears to occur during the fall and winter months (Nelson et al. 2011; Kelly Ringel et al. 2014). This migration timing suggests that bull trout may move downstream past Priest Rapids Dam during the fall and winter. Since spill generally occurs during the spring and summer months, the most likely route of passage may be through the turbines.

Migration delay

Observations of bull trout movements at and around Priest Rapids Dam and through its impoundment are not sufficient to determine whether there are delays associated with upstream or downstream passage at the project or through the reservoir. Additionally, studies designed to specifically assess bull trout passage efficiency or delay have not been conducted, but telemetry studies documenting delays at other mid-Columbia hydroprojects (BioAnalysts 2004, 2009; Nelson and Nelle 2008; LGL and DPUD 2008; Nelson and Johnsen 2012; Nelson 2014) indicate some delay probably occurs at Priest Rapids as well. An examination of detection histories of two PIT-tagged subadult bull trout that have passed upstream of Priest Rapids Dam does not suggest movement delays while navigating the ladder but there are insufficient data to address overall delay at the project. The low water velocity and seasonally warm water temperatures in Priest Rapids Lake have the potential to impact (e.g., delay) bull trout migration but information to evaluate this is lacking.

Survival

Priest Rapids Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, the impact of mainstem habitat conditions on bull trout survival has not been assessed, but reservoir temperatures during the summer months may be high enough to potentially affect survival. In addition, reservoir conditions have created suitable habitat for both native and exotic aquatic predators (e.g., pikeminnow and smallmouth bass). The effect of high numbers of aquatic predators on bull trout has not been evaluated, but it is a known threat to migrating juvenile anadromous salmonids. To increase survival of migrating juvenile salmonids, Grant PUD implemented a control program that focuses on northern pikeminnow removal. In addition, avian predation on bull trout has been documented in the lower Columbia River (Barrows et al. 2014a), but the impact of avian predation on bull trout in the vicinity of Priest Rapids Dam is unknown.

Wanapum Dam

Wanapum Dam (rkm 669) is not part of the FCRPS and is located 30 rkm upstream of Priest Rapids Dam on the Columbia River (Figures 2.1 and 2.8). Wanapum Dam is owned and operated by the Public Utility District No. 2 of Grant County. The reservoir impounded by Wanapum Dam is referred to as Lake Wanapum and extends approximately 61 rkm upstream to the tailrace of Rock Island Dam. The closest bull trout core area populations to Wanapum Dam are located downstream in the Walla Walla River and Yakima River subbasins (rkm 509 and 539, respectively) and upstream in the Wenatchee River Subbasin (rkm 754).

Figure 2.8. Wanapum Dam located on the mid-Columbia River. (Photo from Grant PUD).

Connectivity

Fish passage at Wanapum Dam is important for downstream migrating bull trout from several core area populations in upstream subbasins including the Wenatchee River, Entiat River and Methow River subbasins to utilize foraging and overwintering habitat and to connect with other downstream bull trout populations, possibly in the Yakima River and/or Walla Walla River subbasins. Unimpeded passage at Wanapum Dam for upstream migrant bull trout attempting to return to core areas within upstream subbasins, or attempting to connect with upstream core areas is required to maintain connectivity within the migratory corridor and connectivity between core area populations.

Bull trout attempting to move upstream in the Columbia River over Wanapum Dam must pass via one of the two fish ladders. The fish ladders were primarily designed for anadromous salmonid passage, and passage efficiency has not been specifically evaluated for bull trout. Wanapum Dam fish ladders are not monitored for full duplex PIT tags but fish are enumerated via video from 15 April to 15 November. From April 2007 to November 2014, a total of 37 bull trout were observed moving upstream through the fish ladders at Wanapum Dam with a mean annual count of five bull trout (range 0 – 13; www.cbr.washington.edu). Most upstream movement has been observed from April through October and generally peaks in June (Figure 2.9). Estimated sizes of bull trout from photographs in the counting windows indicate most are adults ranging from 400 to 800 mm (Turner 2013; GCPUD 2013, 2014). Since bull trout may be in the vicinity of Wanapum Dam during all months (including after 15 November and before 15 April), all bull trout that pass through the Wanapum Dam fish ladders may not be enumerated. Routine maintenance typically is conducted during the winter but is unlikely to substantially influence bull trout migration.

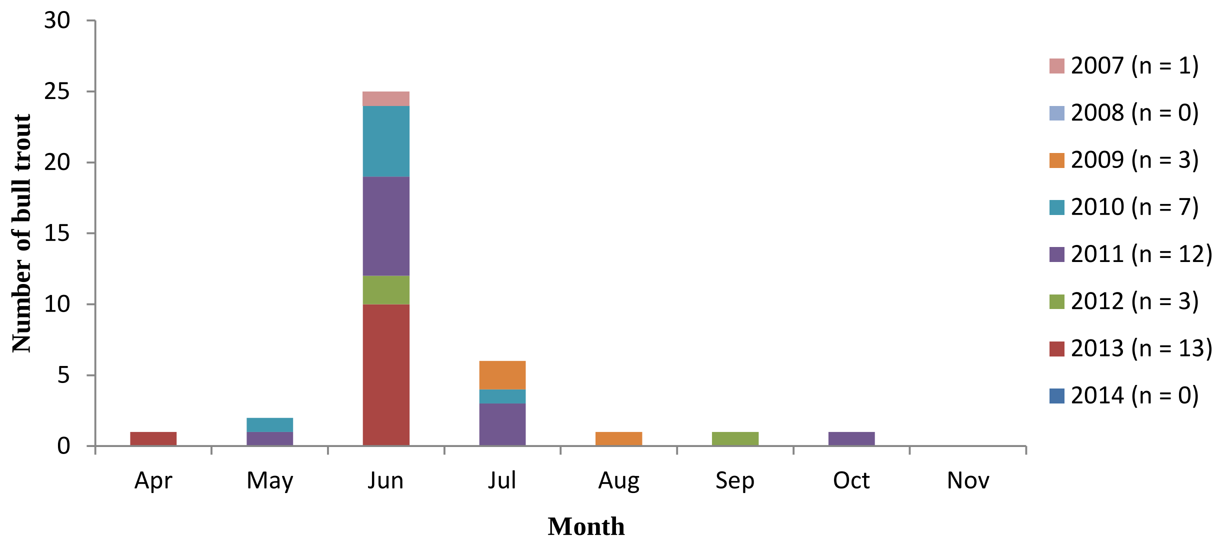

Figure 2.9. Bull trout observations at Wanapum Dam adult ladders from April 2007 through November 2014 (www.cbr.washington.edu).

Fish attempting to migrate downstream over Wanapum Dam could do so using several different routes including the spillways, the fish bypass or through the turbines, none of which are monitored for PIT tags. Passage would likely be influenced by seasonal operations at the hydroproject, but downstream passage for bull trout has not been specifically evaluated. As discussed previously, bull trout from subbasins in the general vicinity of Wanapum Dam enter the mainstem Columbia River primarily from October through February, but outmigration has also occurred during spring months from some subbasins. Subadult bull trout outmigration peaks during both spring and fall, but can occur year round and subadults may be present in the Columbia River throughout the year (Nelson and Nelle 2013). The majority of downstream bull trout movement in the mainstem from mid-Columbia River subbasins appears to occur during the fall and winter months (BioAnalysts, Inc. 2004, 2009; LGL and DPUD 2008; Nelson and Nelle 2008; Nelson et al. 2011; Kelly Ringel et al. 2014). This migration timing suggests that some bull trout may move downstream past Wanapum Dam during the fall and winter. Since spill generally occurs during the spring and summer months, the most likely route of passage during the fall and winter may be through the turbines.

Migration delay

There have been no studies designed or conducted to specifically investigate whether there are delays associated with upstream or downstream passage at Wanapum Dam, and observations of bull trout movements at the hydroproject or through the reservoir are not sufficient to determine if delays occur. Telemetry studies documenting delays at other mid-Columbia hydroprojects (BioAnalysts, Inc. 2004, 2009; Nelson and Nelle 2008; LGL and DPUD 2008; Nelson and Johnsen 2012; Nelson 2014) indicate some delay probably occurs at Wanapum Dam as well. The reservoir is wider, slower and deeper than the natural river and the resulting conditions would be expected to alter the temperature regime and may have the potential to affect bull trout migration, but information to evaluate this does not exist.

Survival

Wanapum Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been investigated. Reservoir temperatures may be high enough to potentially affect bull trout survival, but this has not been assessed. Reservoir conditions have also created suitable habitat for both native and non-native aquatic and avian predators. Increased predation has the potential to affect bull trout survival, but information to evaluate this does not exist.

Rock Island Dam

Rock Island Dam (rkm 730) is not part of the FCRPS and is located 61 rkm upstream of Wanapum Dam on the Columbia River (Figures 2.1 and 2.10). Rock Island Dam is owned and operated by Chelan County Public Utility District. The reservoir impounded by Rock Island Dam is commonly referred to as the Rock Island Pool and extends 33 rkm upstream to the tailrace of Rocky Reach Dam. The closest bull trout core area populations to this dam are located downstream in the Walla Walla River and Yakima River subbasins (rkm 509 and 539, respectively) and upstream in the Wenatchee River Subbasin (rkm 754).

Figure 2.10. Rock Island Dam located on the mid-Columbia River. (Photo from http://www.aneclecticmind.com).

Connectivity

Unimpeded fish passage at Rock Island Dam is necessary to allow migratory bull trout from core areas in the Wenatchee, Entiat and Methow subbasins to return to their natal areas to spawn as well as to provide the opportunity to interact with downstream populations in the Yakima River and/or Walla Walla River subbasins. Rock Island fish passage is also important to allow both subadult and adult migratory bull trout to move freely throughout the river and utilize critical FMO habitat.

Adult bull trout that migrate upstream through Rock Island Dam could be returning upstream to their mid-Columbia River subbasin of origin to spawn, or they could be individuals from downstream core ares attempting to connect to the mid-Columbia River core areas. Based on telemetry data from adult-sized bull trout tagged at the dam during 2005 to 2007 (n = 15), the majority migrated upstream to the Wenatchee River (60%) or over Rocky Reach Dam to the Entiat River (17%), while 19% were last located in the Columbia River and 4% migrated over Rocky Reach and Wells dams to the Methow River (data from BioAnalysts, Inc. 2009). Bull trout intending to move upstream past Rock Island Dam must pass via one of three fish ladders. Fish are enumerated via video from 15 April to 15 November. Since bull trout may be in the vicinity of Rock Island Dam during all months (including after 15 November and before 15 April), all bull trout that pass through the Rock Island Dam fish ladders may not be enumerated. From April 1998 to November 2014, a total of 1,195 bull trout have been observed moving upstream through the fish ladders at Rock Island Dam, with a mean annual count of 59 bull trout (range 35-121; www.cbr.washington.edu). Upstream movement of adults primarily occurs from May through August and generally peaks during June (Figure 2.11).

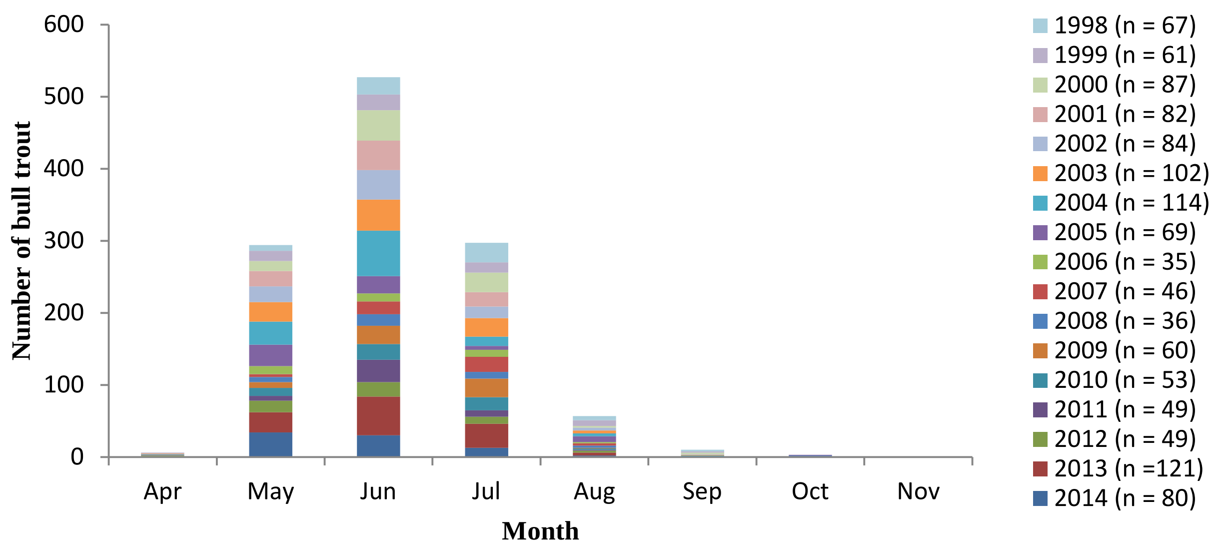

Figure 2.11. Bull trout observations at Rock Island Dam adult ladders from April 1998 through November 2014 (www.cbr.washington.edu).

Rock Island Dam fish ladders have PIT tag detection capability. Since 2009, a total of 31 individual PIT-tagged bull trout have been detected passing through the ladders (www.ptagis.org [queried Jul. 2015]). The majority of the PIT-tagged bull trout were originally tagged in the Entiat River Subbasin during an ongoing study of out-migrating subadults (Nelson and Nelle 2013), but fish tagged in the Wenatchee River and Methow River subbasins were also detected (Figure 2.12). Of the 31 individual PIT-tagged bull trout, five were detected migrating past the dam during two separate years and one was detected during three different years. PIT-tagged bull trout were detected from May through November, but primarily during May, June and July (Figure 2.13).

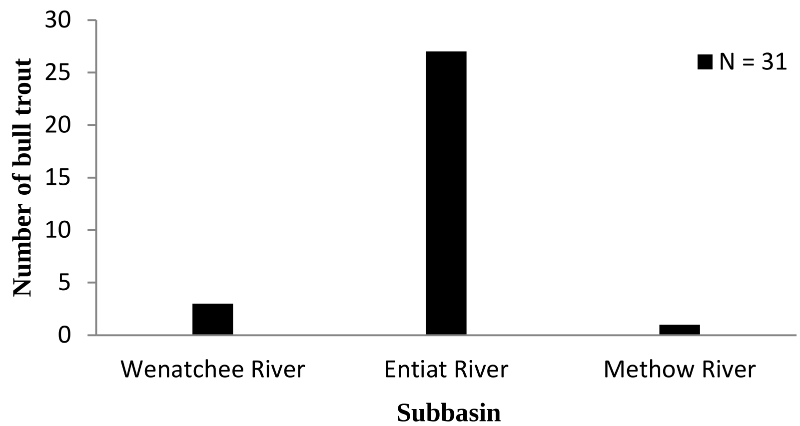

Figure 2.12. The number of PIT-tagged bull trout detected in the adult ladders at Rock Island Dam originally tagged in the Wenatchee River, Entiat River and Methow River subbasins from 2009 to 2015 (www.ptagis.org [queried Jul. 2015]).

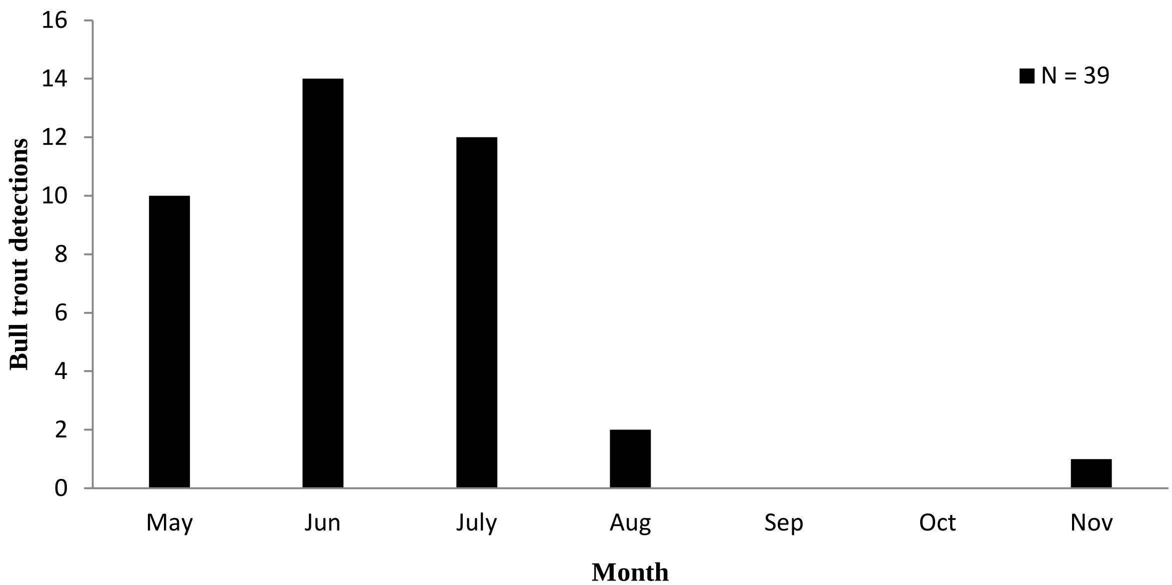

Figure 2.13. PIT-tagged bull trout detections by month in the adult ladders at Rock Island Dam from 2009 to 2015 (www.ptagis.org [queried Jul. 2015]).

In addition to ladder observations and PIT detection information, BioAnalysts, Inc. (2004, 2009) used radio-telemetry to evaluate bull trout passage at Rock Island Dam. Results from these radio-telemetry studies and ladder counts also showed that bull trout commonly pass upstream over Rock Island Dam during the summer months. Routine fish ladder maintenance typically is conducted during the winter and is unlikely to significantly impact bull trout migration.

Downstream passage routes at Rock Island Dam include the spillway, turbines and the gatewell bypass. The spillway and turbines are not monitored, but the bypass system is monitored from April through August. From May 1998 to July 2015, 89 bull trout have been observed at the juvenile sampling facility (www.fpc.org). Bull trout observations were most common during June and least common during April.

Migration Delay

Downstream passage for adult-sized bull trout at Rock Island Dam has been documented and assessed via radio-telemetry (BioAnalysts, Inc. 2004, 2009). From 2005 to 2009, there were nine downstream passage events of radio-tagged bull trout at Rock Island Dam (BioAnalysts, Inc. 2009). Of the nine downstream passage events, two were through the powerhouses, one was through the spillway, and six passed undetected. No mortality or injury was documented due to downstream passage. Most of the events occurred during the fall and winter, but some fish migrated downstream during the spring and summer as well (BioAnalysts, Inc. 2009) and there did not appear to be any passage delay for downstream migrating bull trout. The mean fork length for these radio-tagged, adult-sized bull trout in this study was 500 mm and ranged from 430 mm to 650 mm. There have been no studies conducted specifically to assess downstream passage efficiency or delay for small adult and subadult bull trout at Rock Island Dam.

The fish ladders were designed primarily for the upstream passage of anadromous salmonids. From 2005 to 2009, four of the nine individual radio-tagged bull trout that passed downstream of Rock Island Dam during fall were detected while passing back upstream through the fish ladders the following spring, one of which was detected in two subsequent years (BioAnalysts, Inc. 2009). On average, bull trout spent approximately one day (range of 0.04 – 3.43 days) in the tailrace before attempting to ascend the ladder. Fish moved into and out of the ladder for an average of 6.42 days (range of 0.02 – 18.40 days) before migrating through the ladder. Migration time through the ladder averaged 0.26 days (range of 0.07 – 0.47 days). Overall migration past Rock Island Dam from first entering the tailrace to exiting the fishway averaged 5.24 days and ranged from a minimum of 0.29 days to 18.93 days (BioAnalysts, Inc. 2009). Although this passage assessment was based on only a few detections, it suggests that passage delays may occur for adult bull trout moving upstream past Rock Island Dam.

The low water velocity and seasonally warm water temperatures in the Rock Island Pool compared to natural river conditions also have the potential to affect bull trout migration. Downstream movement of adult-sized and subadult bull trout through Rock Island Pool has not been thoroughly evaluated.

Survival

Rock Island Dam has the potential to affect bull trout survival during upstream and downstream passage. From 2001 to 2004, BioAnalysts, Inc. (2004) determined that 10 radio-tagged bull trout moved downstream of Rock Island Dam, one of which moved downstream in two separate years. Of the 11 downstream movement events during the fall, six were followed by subsequent upstream passage the following spring. At least one of the bull trout appears to have died downstream of Rock Island Dam, but the final fate of the others was not determined. The mortality observed from these data could not be attributed to operations of the hydroproject. BioAnalysts, Inc. (2009) reported similar findings from 2005 to 2009, where four of the nine individual radio-tagged bull trout that passed downstream of Rock Island Dam were subsequently detected while passing back upstream through the fish ladders, one of which was detected in two subsequent years. The fate of the five bull trout that were not subsequently detected passing upstream of Rock Island Dam is unknown. Without the recovery of the radio tags and the associated carcasses of these five bull trout, the true ultimate fate cannot be assigned (BioAnalysts Inc. 2009). There does not appear to be direct evidence to suggest upstream or downstream passage at Rock Island Dam affected the survival of the radio-tagged bull trout during either of these studies (BioAnalysts, Inc. 2009).

Although the effect of mainstem Columbia River habitat conditions in the Rock Island Pool on bull trout survival has not been assessed, reservoir temperatures during the summer months may be high enough to potentially affect survival. BioAnalysts, Inc. (2004) concluded that most of the radio-tagged adult bull trout that entered tributaries did so during May, June and July, before the Columbia River reached a mean temperature of 15°C. Based on ladder counts, adult telemetry studies, and ongoing subadult PIT tag studies, some bull trout are present in Rock Island Pool throughout the year but the impact of summer reservoir temperatures on these fish has not been thoroughly evaluated.

Reservoir conditions have also created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species. These reservoir conditions may have also increased the vulnerability of bull trout to avian predators. The influence of predation in the Rock Island Pool on bull trout survival has not been specifically evaluated.

Rocky Reach Dam

Rocky Reach Dam (rkm 763) is not part of the FCRPS and is located 33 rkm upstream of Rock Island Dam on the Columbia River (Figures 2.1 and 2.14). Rocky Reach Dam is owned and operated by Chelan County Public Utility District. The reservoir impounded by Rocky Reach Dam is referred to as Lake Entiat and extends 63 rkm upstream to the tailrace of Wells Dam. Rocky Reach Dam is located 9 rkm upstream from bull trout populations within the Wenatchee River Subbasin (rkm 754) and 16 rkm downstream from populations located in the Entiat River Subbasin (rkm 779).

Figure 2.14. Rocky Reach Dam located on the mid-Columbia River. (Photo from http://www.chelanpud.org).

Connectivity

Fish passage at Rocky Reach Dam is required for migratory bull trout populations in the Wenatchee to interact with Entiat and Methow populations, to allow for unrestricted movement and the full expression of life history strategies, and to access FMO habitat throughout the mid-Columbia River.

Bull trout that migrate upstream through Rocky Reach Dam are either returning upstream to mid-Columbia River subbasins such as the Entiat and Methow subbasins, or they may be migrating upstream from the Wenatchee River Subbasin or other downstream subbasins. Based on radio-telemetry data from adult bull trout tagged at the dam from 2005 to 2007 (n = 71), the majority migrated to the Entiat River (78%) or the Methow River (14%), while 8% were last located in the Columbia River (data from BioAnalysts, Inc. 2009). It is possible that bull trout from downstream subbasins (e.g., Walla Walla River Subbasin) may encounter Rocky Reach Dam, but this is probably uncommon. Bull trout attempting to migrate upstream past Rocky Reach Dam must pass via the fish ladder. There is a single fish ladder at Rocky Reach Dam, with three entrances located at the base of the spillway, the center dam, and along the downstream face of the powerhouse. The fish ladder was designed primarily for anadromous salmonid passage. BioAnalysts, Inc. (2004, 2009) used radio-telemetry to evaluate bull trout passage at Rocky Reach Dam and found that bull trout commonly move upstream of Rocky Reach Dam during the spring and summer months. In addition, PIT-tagged bull trout have been detected while moving through the fish ladder from May through December (Figure 2.15). A total of 81 PIT-tagged bull trout were detected in the adult ladder at Rocky Reach Dam from 2009 to 2015 (www.ptagis.org [queried July 2015]), and most of these bull trout were originally tagged in the Entiat River, but fish PIT-tagged in the Wenatchee and Methow rivers were also detected (Figure 2.16). Bull trout are routinely observed in the Rocky Reach fish ladder passing the project each year, and are enumerated via video from 15 April to 15 November (www.fpc.org). Since bull trout may be in the vicinity of Rocky Reach Dam during all months (including after 15 November and before 15 April), all bull trout that pass through the Rocky Reach Dam fish ladder may not be enumerated. From April 2001 to November 2014, a total of 2,214 bull trout have been observed moving upstream through the fish ladder at Rocky Reach Dam with a mean annual count of 138 bull trout (range 77 – 246; www.cbr.washington.edu). Upstream movement primarily peaks during May and June, but continues through November (Figure 2.17). Bull trout less than 305 mm in size comprise over 50% of the total count during the fall months compared to less than 5% of the count during the spring and summer (M. Nelson, FWS, personal communication).

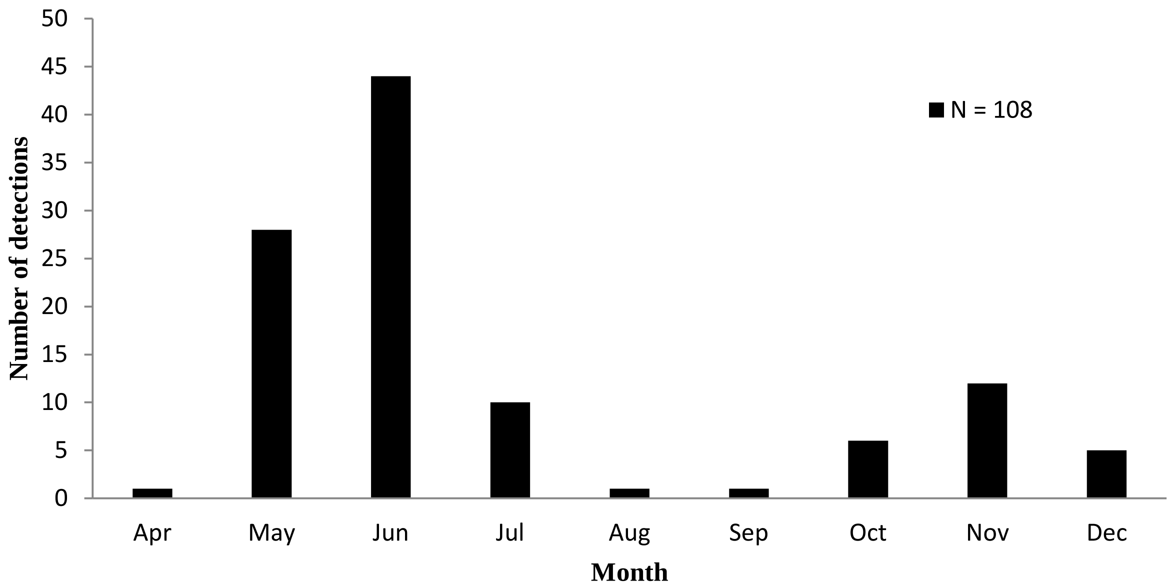

Figure 2.15. PIT-tagged bull trout detections by month in the adult ladders at Rocky Reach Dam from 2009 to 2015 (www.ptagis.org [queried Jul. 2015]).

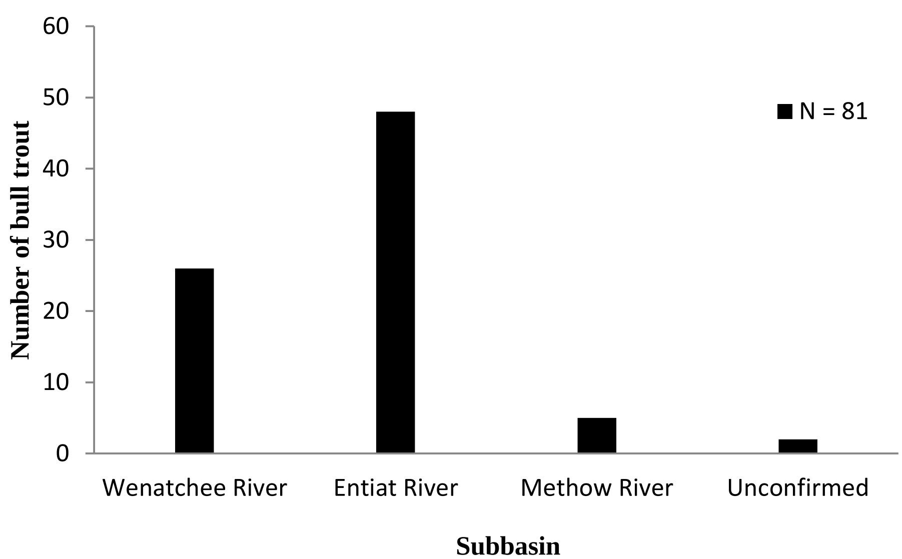

Figure 2.16. The number of PIT-tagged bull trout detected in the adult ladders at Rocky Reach Dam originally tagged in the Wenatchee River, Entiat River and Methow River subbasins from 2009 to 2015 (www.ptagis.org [queried Jul. 2015]).

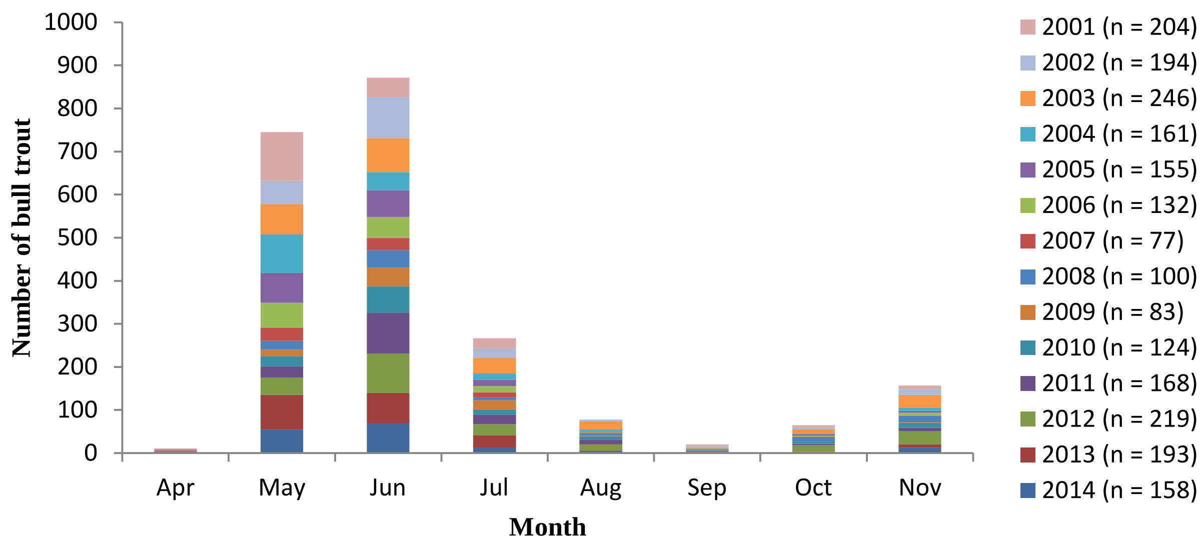

Figure 2.17. Bull trout observations at Rocky Reach Dam adult ladder from April 2001 through November 2014 (www.cbr.washington.edu).

Downstream passage routes available for downstream passage include spillways, turbines, the adult fish ladder and the juvenile fish bypass sytem. The bypass system is monitored for PIT tags. Both PIT-tagged adult and subadult bull trout have been detected in the juvenile bypass during April, May, June, July and September.

Migration delay

Downstream passage for adult-sized bull trout at Rocky Reach Dam has been documented and assessed via radio-telemetry (BioAnalysts, Inc. 2004, 2009). From 2005 to 2009, there were 31 tagged adult bull trout that accounted for 47 downstream passage events at Rocky Reach Dam (BioAnalysts, Inc. 2009). Of the 47 downstream passage events, 35 occurred through the powerhouse, two through the spillway, two through the surface collector and eight were not assigned a specific route of passage (BioAnalysts, Inc. 2009). No mortality or injury due to hydroproject operations was documented. The mean fork length for radio-tagged bull trout tagged at Rocky Reach Dam in this study was 561 mm and ranged from 400 mm to 830 mm. During 2002 and 2003, BioAnalysts, Inc. (2004) recorded nine downstream bull trout passage events exhibited by six bull trout. Fish moved downstream through the dam via the spill bays and through the powerhouse. It is unclear why bull trout that moved upstream of the dam often passed back downstream, but it may have been related to releasing fish too close to the dam (BioAnalysts, Inc. 2004). The downstream movement of smaller adult and subadult bull trout has not been thoroughly investigated at Rocky Reach Dam. There appears to be no evidence from this study of migration passage delay for bull trout moving downstream of Rocky Reach Dam, but this was not specifically addressed (BioAnalysts, Inc. 2004, 2009).

From 2005 to 2009, there were 41 upstream passage events by 29 individual radio-tagged bull trout (BioAnalysts, Inc. 2009). On average, bull trout spent 1.12 days (range of 0.03 – 5.07

days) in the tailrace before attempting to ascend the ladder. Fish moved into and out of the ladder for an average of 3.82 days (range of 0.00 – 14.82 days) before migrating through the ladder. Migration time through the ladder averaged 0.36 days (range of 0.12 – 2.07 days). Overall migration past Rocky Reach Dam from first entering the tailrace to exiting the fishway averaged 5.02 days and ranged from a minimum of 0.93 days to 17.20 days (BioAnalysts, Inc. 2009). This passage assessment is based on a relatively small number of detections, but indicates a passage delay for adult bull trout moving upstream past Rocky Reach Dam.

The low water velocity and seasonally warm water temperatures in Lake Entiat compared to natural river conditions also have the potential to affect bull trout migration. BioAnalysts, Inc. (2009) found that inriver upstream migration rates for tagged bull trout were slower from Rocky Reach Dam to the Entiat River than from Rocky Reach Dam to Wells Dam. BioAnalysts, Inc. (2009) accounts for this disparity by noting that many adult bull trout stage near the Entiat River confluence prior to entering the river (Nelson and Nelle 2008; Nelson 2014). BioAnalysts, Inc. (2004) suggest that bull trout appear to have adequate time to find spawning tributaries after passing Rocky Reach Dam and appear to reach spawning grounds in those tributaries in a timely manner. Downstream movement timing for adult-sized and subadult bull trout through Lake Entiat has not been thoroughly evaluated.

Survival

Rocky Reach Dam has the potential to affect bull trout survival during upstream and downstream passage. BioAnalysts, Inc. (2004) reported that of the 45 bull trout radio-tagged while ascending the fish ladder at Rocky Reach Dam during 2001 and 2002, all but two subsequently entered the Entiat, Wenatchee or Methow rivers relatively quickly following capture. Of the 43 that entered tributaries, only 23 were detected returning to the mainstem the following fall. Of the 23 radio-tagged fish that reentered the Columbia River, at least 14 survived to enter tributaries during the following spring (BioAnalysts, Inc. 2004). The fate of most of the fish that did not enter tributaries is largely unknown and could be due to many factors including mortality, tag loss, missed detections and migration out of the study area.

Although the effect of mainstem Columbia River habitat conditions in Lake Entiat on bull trout survival has not been assessed, reservoir temperatures during the summer months may be high enough to potentially affect survival. BioAnalysts, Inc. (2004) concluded that most of the radio-tagged adult bull trout that entered tributaries did so during May, June and July, before the Columbia River reached a mean temperature of 15°C. However, the impact of summer reservoir temperatures on bull trout that may not have entered tributaries (e.g., subadult fish) has not been thoroughly evaluated.

Reservoir conditions have also created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species. These reservoir conditions may have also increased the vulnerability of bull trout to avian predators. The influence of predation in Lake Entiat on bull trout survival has not been specifically evaluated.

Wells Dam

Wells Dam (rkm 830) is not part of the FCRPS and is located 67 rkm upstream of Rocky Reach Dam on the Columbia River (Figures 2.1 and 2.18). Wells Dam is owned and operated by the Douglas County Public Utility District. The reservoir impounded by Wells Dam is known as Lake Pateros and extends 47 rkm upstream to the tailrace of Chief Joseph Dam (rkm 877). Upstream fish passage in the mid-Columbia River ends at Chief Joseph Dam. Wells Dam is located 51 rkm upstream from bull trout populations within the Entiat River Subbasin (rkm 779) and 13 rkm downstream from populations located in the Methow River Subbasin (rkm 843).

Figure 2.18. Wells Dam located on the mid-Columbia River. (Photo from http://www.douglaspud.org/wells-project/wells-dam).

Connectivity

Wells Dam represents a potential migration impediment between downstream bull trout populations (e.g., Wenatchee River, Entiat River) and upstream populations in the Methow River Subbasin. Fish passage at Wells Dam is required for migratory bull trout populations in the Wenatchee and Entiat subbasins to interact with populations in the Methow River Subbasin, to facilitate exploratory movements into the Okanogan River, to allow for unrestricted movement and the full expression of life history strategies, and to access FMO habitat throughout the mid-Columbia River.

Bull trout that migrate upstream through Wells Dam are likely either returning upstream to the Methow River Subbasin or they may be dispersing upstream from downstream populations (e.g., Wenatchee River, Entiat River). Observed tributaries entered by bull trout radio-tagged at Wells Dam from 2005 to 2008 (n = 26) were the Methow River (90%) and Entiat River (10%) (LGL and DPUD 2008). Three bull trout entered and apparently explored the Okanogan River before migrating to the Methow River (Nelson and Johnsen 2012). Bull trout intending to move upstream past Wells Dam must pass via the fish ladders. There are two fish ladders, one located on each end of the dam. They were designed primarily for anadromous salmonid passage. From May 2005 to November 2014, a total of 706 bull trout have been observed moving upstream through the fish ladders at Wells Dam, with a mean annual count of 64 bull trout (range 43-113;

www.cbr.washington.edu). Upstream movement primarily occurs from May through July and peaks in June (Figure 2.19). BioAnalysts, Inc. (2004, 2009) evaluated bull trout passage at Wells Dam and found that radio-tagged adult bull trout commonly move upstream of Wells Dam during the spring and early summer months. This is consistent with information reported in LGL and DPUD (2008). In addition, PIT-tagged adult bull trout have been primarily detected while moving through the fish ladders during May and June, but have also been detected in July, November, December, and January (Figure 2.20). Fish are enumerated via video and posted to the Columbia River DART website (www.cbr.washington.edu) from 1 May to 15 November. Since bull trout may be in the vicinity of Wells Dam during all months (including after 15 November and before 1 May), all bull trout that pass through the fish ladders may not be enumerated. No subadult bull trout were observed using the ladders at Wells Dam during off-season (November 16 to April 30) video monitoring conducted from 2004 through 2007 (LGL and DPUD 2008). Routine maintenance typically is conducted during the winter, but at least one ladder remains operational at all times.

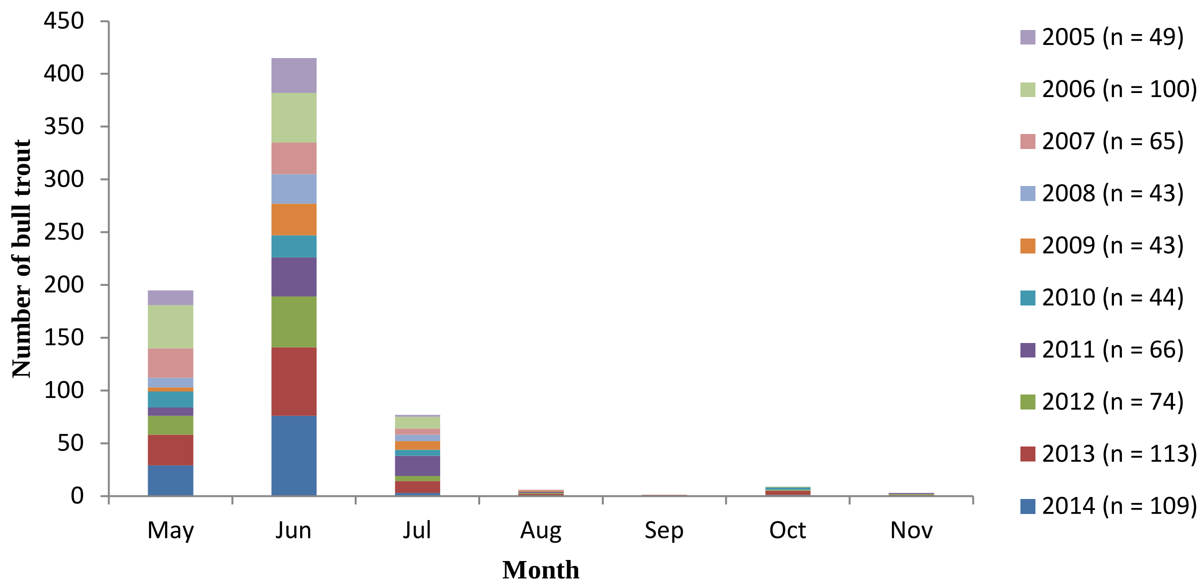

Figure 2.19. Bull trout observations at Wells Dam adult ladders from April 2005 through November 2014 (www.cbr.washington.edu).

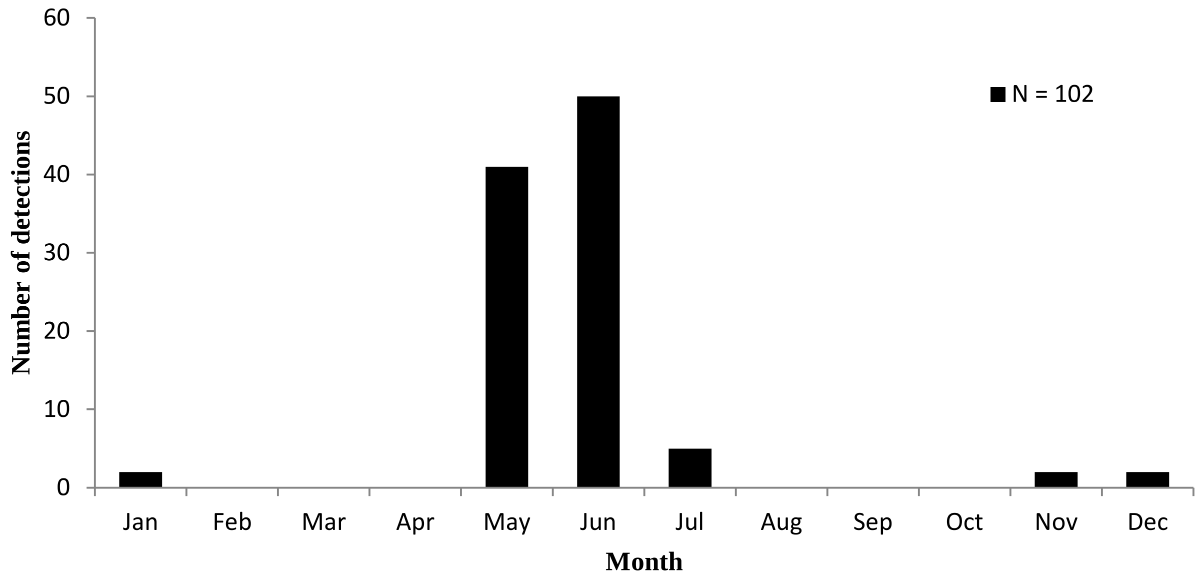

Figure 2.20. PIT-tagged bull trout detections by month in the adult ladders at Wells Dam from 2009 to 2015 (www.ptagis.org [queried Jul. 2015]).

Migration delay

BioAnalysts, Inc. (2004, 2009) documented downstream passage for primarily adult-sized bull trout at Wells Dam via radio-telemetry during the fall (e.g., November) and summer (e.g., June). Routes of passage were not reported, but available downstream routes of passage at Wells Dam include the spillways and turbines. No passage problems for radio-tagged bull trout were identified during this study. Wells Dam has a unique spillbay design which lies over the turbine intakes (www.nwcouncil.org). The spillway was modified in 1991 to provide a bypass route for downstream migrants. This modification may have improved downstream passage for bull trout, but this was not investigated. During the development of the Wells Hydroelectric Project Bull Trout Monitoring and Management Plan, stakeholders agreed that a sufficient sample size could not be collected to feasibly assess passage for subadult bull trout (LGL and DPUD (2008). Instead, 67 subadult bull trout were PIT-tagged in the Methow River Subbasin. No PIT-tagged subadult bull trout were detected at the Wells Project during this study (LGL and DPUD (2008).

Upstream passage/delay at Wells dam was examined by BioAnalysts, Inc. (2004). They reported that 11 individual bull trout were responsible for 12 passage events at Wells Dam in 2002, with two bull trout ascending the right bank ladder and 10 ascending the left bank ladder. They also reported that mean tailrace residence was 9.27 days (range of 1.64 – 18.35); mean fishway residence was 0.21 days (range of 0.20-0.23 days) and 0.32 days in the right and left bank ladders, respectively. The mean overall elapsed time (tailrace residence and fishway residence combined) was 9.89 days (range of 1.83-24.87). BioAnalysts, Inc. (2004) concluded that the presence of the dams may have slowed migration times. Upstream passage was also assessed by LGL and DPUD (2008). Investigators concluded that although the dam may delay upstream migration of bull trout, passage times upstream through the fishway appeared reasonable relative to the species migration and spawn timing.

Water velocity and seasonally warm water temperatures (when compared to natural river conditions) in Lake Pateros may have the potential to affect bull trout migration. BioAnalysts, Inc. (2004) found that radio-tagged bull trout that entered the Methow River upstream of Wells Dam did so during May and June, shortly following tagging at mainstem dams. This information suggests that adult upstream migrants appear to enter the Methow prior to the onset of seasonally warm water temperature conditions in the mainstem. The influence of seasonal reservoir conditions in Lake Pateros on downstream movement timing for adult-sized and subadult bull trout has not been thoroughly evaluated.

Survival

Wells Dam has the potential to affect bull trout survival during upstream and downstream passage, but no injury or mortality was observed during various bull trout passage studies (BioAnalysts Inc. 2004, 2009; LGL and DPUD 2008). Although the effect of mainstem Columbia River habitat conditions in Lake Pateros on bull trout survival has not been assessed, reservoir temperatures during the summer months may be high enough to potentially affect survival. BioAnalysts, Inc. (2004) concluded that most of the radio-tagged adult bull trout that entered the Methow River did so during May and June, before reservoir temperatures reached maximum levels. However, the effect of summer reservoir temperatures on bull trout that may not have entered tributaries (e.g., subadult fish) has not been thoroughly evaluated. In addition, reservoir conditions have created suitable habitat for both native and non-native predator species, but it is currently unknown how mainstem predation influences bull trout survival in Lake Pateros.

Chief Joseph Dam

Chief Joseph Dam (rkm 877) is part of the FCRPS and is located 47 rkm upstream from Wells Dam on the Columbia River (Figure 2.1 and 2.21). The reservoir impounded by Chief Joseph Dam is known as Rufus Woods Lake and extends upstream approximately 84 rkm to the tailrace of Grand Coulee Dam (rkm 961). Chief Joseph Dam is located 34 rkm upstream from bull trout populations within the Methow River Subbasin (rkm 843).

Figure 2.21. Chief Joseph Dam located on the Columbia River. (Photo from En.wikipedia.org).

Connectivity

Chief Joseph Dam is where upstream fish passage terminates on the mid-Columbia River and it represents a barrier to connectivity between downstream bull trout populations in the Methow, Entiat, and Wenatchee subbasins and upriver bull trout populations. Due to its relatively close proximity to the Methow River Subbasin, migratory bull trout likely encounter Chief Joseph Dam, but this has not been specifically investigated or documented in related studies (e.g., BioAnalysts, Inc. 2004, 2009). If movement patterns of bull trout from the Methow River Subbasin are similar to bull trout movements from other subbasin populations (e.g., Entiat, Walla Walla, Tucannon), then bull trout may be in the vicinity of Chief Joseph Dam during all months.

Migration delay

Downstream bull trout passage at Chief Joseph Dam from upriver populations is unknown and may be unlikely. Upstream bull trout passage is not possible at Chief Joseph Dam. The low water velocity and seasonally warm water temperatures in Rufus Woods Lake compared to natural river conditions have the potential to impact bull trout migration, but bull trout presence in the reservoir from upriver populations is unknown.

Survival

Downstream bull trout passage at Chief Joseph Dam from upriver populations is unknown, therefore survival is also unknown. The impact of habitat conditions in Rufus Woods Lake on bull trout survival is also unknown. If bull trout are present within the reservoir from upriver populations, reservoir temperatures during the summer months may influence bull trout survival. If bull trout from upriver populations are present in Rufus Woods Lake, they may also be impacted by avian and/or aquatic predators.

Lower Snake River

Bull trout use of the lower Snake River has been documented from observations in the fish ladders at mainstem FCRPS projects, PIT tag detections in the fish ladders and juvenile bypass systems at mainstem FCRPS projects, various research projects in the mainstem Snake River, PIT tag detections from bull trout entering the mainstem from tributary subbasins, and anecdotal accounts. Much of this information was dispersed throughout various technical or monitoring reports from a number of federal, state, and tribal agencies, as well as several non-governmental entities, and other information was included as incidental in work conducted, and reports produced that focused on anadromous salmonids.

Ice Harbor Dam

Ice Harbor Dam (rkm 522.010) is the farthest downstream mainstem hydroproject in the lower Snake River (Figures 2.1 and 2.22). The dam impounds a reservoir 51.5 rkm long that is referred to as Lake Sacajawea and extends upstream to the Lower Monumental Dam tailrace. The Dam is fitted with two fish ladders, a removable spillway weir (RSW), and a juvenile bypass system. The Columbia River backwater from McNary Dam and Lake Wallula extends upstream to Ice Harbor Dam. The Tucannon River bull trout core area is located upstream, in the Tucannon River Subbasin at rkm 522.100, approximately 90 rkm upstream from Ice Harbor Dam. The Touchet River and Walla Walla River core areas are located downstream, in the Walla Walla River Subbasin which enters the Columbia River at rkm 509, approximately 22 rkm downstream from Ice Harbor Dam. The Yakima Core Area is located in the Yakima River Subbasin, which enters the Columbia River at rkm 539, approximately 27 rkm downstream from Ice Harbor Dam.

Figure 2.22. Ice Harbor Dam on the lower Snake River. (www.nwd.usace.army.mil/Media/Images.aspx).

Connectivity

Ice Harbor Dam fish passage is important for downstream migrant bull trout from several core area populations including the Tucannon River Core Area, and possibly other core areas farther upstream in other lower Snake River subbasins. Passage at the dam is also important for upstream migrant bull trout, possibly from the Yakima River or Walla Walla River core areas, or bull trout attempting to return to upstream Snake River subbasin populations.

Both adult and subadult bull trout use the Snake and Columbia rivers in areas near Ice Harbor Dam. Migratory bull trout from the Walla Walla River Subbasin populations have been studied intensively for many years, and bull trout have been documented leaving the subbasin and entering the Columbia River in significant numbers. Barrows et al. (2014a) estimated nearly 500 bull trout left the Walla Walla subbasin for the Columbia River over a 5-year period from 2007 – 2012. PIT tag detections from a detection array located in the lower Walla Walla River near the mouth indicated most bull trout were leaving the subbasin from October through February, and returning to the subbasin from March through June. This timing indicates bull trout were likely present somewhere in the mainstem in all but the warmest summer months (July – September). Some of these individuals were fitted with acoustic tags and tracked both upstream to the mouth of the Snake River, and downstream towards McNary Dam. Considering that some of these individuals moved to within 10 rkm of Ice Harbor Dam, there is a reasonable likelihood that other unmarked individuals from the Walla Walla River populations may be moving into the Snake River, and may encounter Ice Harbor Dam.

Bull trout attempting to migrate upstream in the Snake River over Ice Harbor Dam must do so through one of the two fish ladders. The ladders were designed primarily for anadromous fish, and fish passage efficiency has not been evaluated for bull trout. In addition, the suitability of physical and hydraulic conditions for bull trout in the approaches and conveyance channels leading to the ladder entrances, and within the two ladders is unknown. Fish ladder outages usually occur in January and February, however, at least one of the two ladders is open continuously. Four bull trout were observed moving through the south ladder at Ice Harbor Dam in June 2011 (3) and May 2013 (1). These fish were not marked, thus their source population is unknown. The timing of these movements is consistent with the timing typically observed for subadult and adult bull trout returning to their natal streams for spawning or rearing. These individuals could have been returning upstream to the Tucannon subbasin, or other subbasins with bull trout populations further upstream in the Snake River. Alternatively, these fish could have originated in the Walla Walla River Subbasin, the Yakima River Subbasin, or one of the mid-Columbia River subbasins.

There were two additional bull trout detected by PIT detection arrays in the south ladder at Ice Harbor Dam. Both of these individuals were PIT-tagged in the Tucannon River Subbasin, one when subadult-sized and one when adult- sized. The adult left the Tucannon River in November and was detected four months later in March in the full flow bypass moving downstream over Lower Monumental Dam. The next detection of this fish was three months later in June, moving back upstream through the south ladder at Ice Harbor Dam. This fish was not detected passing downstream over Ice Harbor Dam. Since spring spill at Ice Harbor Dam typically starts on 3 April, this individual could have passed undetected over or through Ice Harbor Dam via the spillway, the RSW, or the turbines. When this bull trout passed downstream over Lower Monumental Dam in March, the spill program had not yet started, thus the only downstream passage routes would have been the bypass or turbines, and it was detected in the bypass. There were no further observations or detections of this bull trout, so it is unknown whether it returned to the Tucannon River where it was tagged. This migratory bull trout used at least 84.5 rkm of Snake River habitats over at least a seven month time period from November through June.

The subadult-sized bull trout was PIT-tagged in the Tucannon River in December, and was next detected six months later in June in the south ladder at Ice Harbor Dam. With no detections or observations of this fish for six months, the extent of its movements in the lower Snake River, or possibly the Columbia River is unknown. This bull trout could have passed downstream over Lower Monumental and Ice Harbor dams via spill or the RSWs if the timing was after 3 April when the spill program begins. If it passed downstream prior to the start of the spill program, turbine passage is likely since it was not detected in the bypass systems at Lower Monumental or Ice Harbor dams. This bull trout subsequently re-entered the Tucannon River in late June and was detected at several PIT detection arrays moving upriver towards the spawning grounds. This migratory bull trout used at least 84.5 rkm of Snake River habitats over at least a six month time period from December through June.

Fish passage monitoring in the ladders at Ice Harbor Dam is conducted manually from 0400 to 2000 hours between 1 April and 31 October when fish are enumerated at the counting windows. Since video counts are not conducted at the Ice Harbor fish Dam ladders, any untagged bull trout that pass at night or during the off season (November through March) will not be documented. The three PIT-tagged bull trout detected at Ice Harbor Dam all entered the Snake River from the Tucannon River in November and December. Since manual counting is not conducted during these, or subsequent months until April, unmarked bull trout with the same Snake River entry timing as the PIT-tagged fish could move through the ladders prior to April without being observed. Considering that the fish ladders at Ice Harbor Dam are constantly monitored to detect PIT-tagged fish by multiple PIT detection antennas, most PIT-tagged bull trout movement through the ladders will be documented.

Bull trout attempting to migrate downstream in the Snake River over Ice Harbor Dam could do so using several different routes, depending on the time of year. Downstream migrants can pass over the spillway, over the RSW, through the bypass system, or through the turbines. Passage through the turbines is possible at any time, and may be the most likely route for bull trout because of their affinity for structure and cover that is most commonly found at the bottom of the river or along the river banks (Montana Bull Trout Restoration Team 2000; Al-Chokhachy and Budy 2007; USFWS 2007). There is no way to observe movement through the turbines or to detect PIT-tagged fish. Passage over the spillway or through the RSW is possible from about 3 April through 31 August, but again, there is no way to observe or detect PIT-tagged fish through these routes. The juvenile bypass system is operational from 1 April through 15 December. The only opportunity to observe unmarked downstream migrants is within the bypass system either on the separator or when juvenile fish are sampled to monitor descaling and other condition parameters. Since these condition sampling periods are infrequent, and only cover a very small proportion of the bypassed fish, it may be unlikely that bull trout would be observed in these samples. To date, no bull trout have been observed either on the separator or in condition samples at the Ice Harbor Dam bypass. Any PIT-tagged bull trout that pass through the bypass system will be detected in the full flow bypass. During the fall, after spill operations are terminated, downstream passage options become limited to the bypass system or the turbines. And during the winter, the only choice for downstream passage is the turbines. As discussed previously, bull trout use of the mainstem Snake and Columbia rivers near Ice Harbor Dam could occur from October through June. Within this time period, there is no ability to monitor bull trout downstream passage over Ice Harbor from 16 December through 31 March because the bypass system with PIT detection capability is shut down. In addition, from 16 December through 31 March with no spill and no bypass system, turbine passage is the primary option.

Downstream migrant PIT-tagged bull trout that are entrained into the bypass system during the operational time period from 1 April through 15 December will likely be detected by the multiple PIT detection arrays installed within the system. PIT-tagged downstream migrant bull trout have only been detected on a single occasion moving through the bypass system at Ice Harbor Dam. This fish was tagged in the Tucannon River in December and was detected moving downstream through the full flow bypasses at both Lower Monumental and Ice Harbor dams in May and June, respectively. There are no observations for this individual between December and May. The last detection for the PIT tag from this bull trout was on Foundation Island following consumption by an avian predator. A second PIT-tagged downstream migrant bull trout discussed earlier entered the Snake River from the Tucannon River in November and was detected in the full flow bypass at Lower Monumental Dam in March but not in the bypass at Ice Harbor prior to the last detection moving back upstream through the Ice Harbor ladder in June. This individual likely passed downstream over Ice Harbor via spill, the RSW, or the turbines. The third previously discussed PIT-tagged bull trout entered the Snake River from the Tucannon River in December and was not detected in the bypasses at Lower Monumental or Ice Harbor prior to being detected moving back upstream through the Ice Harbor ladder in June. With no observations or detections for six months between December and June, the extent and timing of the movements for this fish are unknown. From December through March, the only downstream passage route for this bull trout was the turbines at both projects. If this individual did not move until April, then spill and the RSW were available for downstream passage along with the turbines and the bypass. The routes actually used are unknown.

Migration delay

Observations of bull trout movements at and around Ice Harbor Dam and Lake Sacajawea are not sufficient to determine whether there are delays associated with upstream or downstream passage at the project or through the reservoir. In addition, there have been no studies designed and conducted specifically to assess passage efficiency or delay. Detection histories for PIT-tagged bull trout that passed upstream through the Ice Harbor Dam fish ladders did not indicate any delay.

Survival

Ice Harbor Dam has the potential to affect bull trout survival during upstream and downstream passage, but studies to investigate survival have not been conducted. Similarly, although the effect of mainstem Snake River habitat conditions in Lake Sacajawea on bull trout survival has not been assessed, reservoir temperatures during the summer months are high enough to potentially affect survival. In addition, reservoir conditions have created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species. The interaction and/or effect of high numbers of predators in Lake Sacajawea on bull trout have not been evaluated.

Avian predation is another factor that affects survival of bull trout from several source populations (Appendix A). A PIT-tagged bull trout discussed earlier from the Tucannon River Subbasin, left the subbasin and moved downstream past Lower Monumental and Ice Harbor through the bypasses at each project in May and June, respectively. The PIT tag from this individual was subsequently retrieved from Foundation Island four months later in September where a cormorant nesting colony is located. It is unknown where the predation occurred, but with the last detection of this fish moving downstream past Ice Harbor, we assume it occurred in the lower Snake River, or near the confluence of the Snake and Columbia rivers. Whether there was a correlation between passage at Ice Harbor by this bull trout and its subsequent removal by an avian predator is unknown. The impact of avian predation on the Tucannon local population has not been quantified.

Lower Monumental Dam

Lower Monumental Dam (rkm 522.067) is part of the FCRPS in the lower Snake River (Figures 2.1 and 2.23), and is located 57 rkm upstream from Ice Harbor Dam. The reservoir impounded by Lower Monumental Dam is known as Lake Herbert G. West and extends approximately 45 rkm upstream to the tailwater of Little Goose Dam (rkm 522.113). There are two fish ladders, one each on the north and south shores for upstream passage, and a removable spillway weir (RSW) and juvenile bypass system for downstream passage. The Walla Walla River and Touchet River bull trout core areas are located in the Walla Walla River Subbasin which enters the Columbia River approximately 80 rkm downstream from Lower Monumental Dam, and the Tucannon River bull trout core area is located in the Tucannon River Subbasin which enters the Snake River approximately 33 rkm upstream from the dam.

Figure 2.23. Lower Monumental Dam located on the lower Snake River (Photo from www.nwd.usace.army.mil/Media/Images.aspx).

Connectivity

Lower Monumental Dam fish passage is required for bull trout in the Tucannon River Subbasin to interact with bull trout from other downstream subbasins (e.g., Walla Walla River Subbasin). The Tucannon River Subbasin is the most likely origin of bull trout observed at Lower Monumental Dam because of its relatively healthy migratory population and proximity (33 rkm upstream). Tucannon River Subbasin origin bull trout that attempt to move downstream of Lower Monumental Dam could use one of several routes for passage. Those bull trout that successfully pass downstream must return upstream via the fish ladders to return to the Tucannon River. In addition, any Walla Walla River Subbasin bull trout that move into the Snake River and continue upstream must also pass Lower Monumental via the fish ladders.

Both adult and subadult bull trout use the Snake River in areas near Lower Monumental Dam. Bull trout from the Tucannon River Subbasin primarily enter the mainstem Snake River from October through February and return to the subbasin from March through July. The time periods of mainstem use by Walla Walla River Subbasin bull trout are nearly identical. This timing indicates bull trout are likely present somewhere in the mainstem Snake River in all but the warmest summer months (August – September).

Bull trout attempting to migrate upstream in the Snake River over Lower Monumental Dam must do so through one of the two fish ladders. The ladders were designed primarily for anadromous fish, and fish passage efficiency has not been evaluated for bull trout. In addition, the suitability of physical and hydraulic conditions for bull trout in the approaches and conveyance channels leading to the ladder entrances and within the two ladders is unknown. Fish ladder outages for maintenance usually occur in January and February; however, at least one of the two ladders is open continuously. The majority of observed bull trout movement upstream past Lower Monumental Dam typically occurs from April through July, but could potentially occur throughout the year (Figure 2.24). Although these fish were not marked and their source population is unknown, the large number of observations in the Lower Monumental fish ladders relative to observations at Ice Harbor is likely a function of the proximity of Lower Monumental to the Tucannon River Subbasin and the relatively large numbers of migratory bull trout from the subbasin that use the mainstem Snake River. The timing of these observations and movements is consistent with the timing typically observed for subadult and adult bull trout returning to their natal subbasin for spawning and/or rearing.

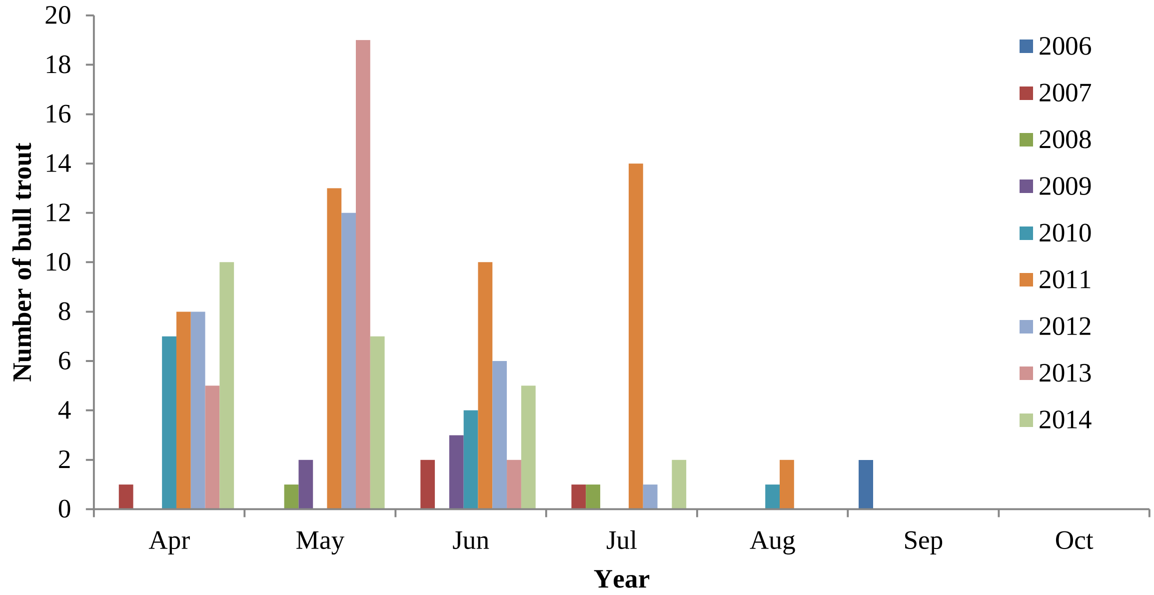

Figure 2.24. Bull trout observations at Lower Monumental Dam adult ladders. Data from http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx.

The fish ladders at Lower Monumental Dam have been wired for full duplex PIT tag detections only since 2014. To date, there has been only one PIT-tagged bull trout detected. The detection occurred in May 2014, and was likely a bull trout on a presumed spawning migration returning to the Tucannon River. This fish was tagged in the Tucannon River as a subadult in December 2012, and subsequently entered the Snake River. The next detection was a year later in the lower Tucannon River in December 2013. Movements and locations during this time period are unknown. The next detection for this bull trout was while ascending the north ladder at Lower Monumental Dam in late May 2014. This fish passed downstream of Lower Monumental Dam undetected sometime between December 2013 and May 2014. If downstream passage occurred earlier during this time period, the turbines would have been the most likely route used. If downstream passage occurred in April or May, the RSW, spillway, and fish bypass system would also have been available. Following the detection in the Lower Monumental fish ladder, this fish was detected entering the Tucannon River in late May, with subsequent detections on three instream arrays as it moved upstream towards the spawning grounds. The last detection was 11 June 2014 near the Tucannon Fish Hatchery.

Fish are enumerated at the Lower Monumental fish ladder counting windows from 1 April to 31 October from 0400 to 2000 hours PST. If unmarked bull trout move through the ladders at night, they may not be enumerated since nighttime video counts are not conducted at Lower Monumental Dam. Outside of the active counting season, daytime video monitoring is conducted from 1 November to 28 February, but bull trout are not enumerated. Since manual counting is not conducted from November through March, unmarked bull trout with the same Snake River entry timing as the PIT-tagged fish (December) could move through the ladders prior to April without being observed. Considering that the fish ladders at Lower Monumental

Dam are now wired with PIT detection arrays, most PIT-tagged bull trout movement through the ladders will be documented.

Bull trout attempting to migrate downstream in the Snake River over Lower Monumental Dam could do so using several different routes, depending on the time of year. Downstream migrants can pass over the spillway, over the RSW, through the bypass system, or through the turbines. Passage through the turbines is possible at any time, and may be the most likely route for bull trout because of their affinity for structure and cover that is most commonly found at the bottom of the river or along the river banks (Montana Bull Trout Restoration Team 2000; Al-Chokhachy and Budy 2007; USFWS 2007). There is no way to observe movement through the turbines or to detect PIT-tagged fish. Passage over the spillway or through the RSW is possible from about 3 April through 31 August, but again, there is no way to observe or detect PIT-tagged fish through these routes. The juvenile bypass system is operational from 25 March through 15 December. The only opportunity to observe unmarked downstream migrants is within the bypass system, either on the separator or when juvenile fish are sampled to monitor descaling and other condition parameters. A total of seven bull trout were observed on the separator at Lower Monumental Dam between 1999 and 2002 (Anglea et al. 2004). These observations occurred between May and mid-July. Nine bull trout have been observed in condition samples between 1999 and 2011 at Lower Monumental Dam (Appendix A). All of these observations except one occurred between April and June. One observation occurred in October. Any PIT-tagged bull trout will be detected in the full flow bypass. During the fall, after spill operations are terminated, downstream passage options become limited to the bypass system or the turbines. And during the winter, the only choice for downstream passage is the turbines. As discussed previously, bull trout use of the mainstem Snake and Columbia rivers near Lower Monumental Dam could occur from October through July. Within this time period, there is no ability to monitor bull trout downstream passage over Lower Monumental Dam from 16 December through 24 March because the bypass system which includes PIT detection capability is shut down. In addition, from 16 December through 24 March with no spill and no bypass system, turbine passage is the only route available.

Downstream migrant PIT-tagged bull trout that are entrained into the bypass system during the operational time period from 25 March through 15 December will likely be detected by the multiple PIT detection arrays installed within the system. Two bull trout have been detected moving through the fish bypass at Lower Monumental, both in 2011. The first fish was a subadult tagged in the Tucannon River in December and detected in the full flow bypass at Lower Monumental Dam in May. This individual continued moving downstream, and was detected two weeks later in the full flow bypass at Ice Harbor in June. Before this bull trout attempted to return back upstream to the Tucannon River, it was taken by an avian predator, and the PIT tag was located on Foundation Island. The second fish was an adult tagged in the Tucannon River in November. After entering the Snake River in November, this bull trout was detected four months later moving downstream through the full flow bypass at Lower Monumental in late March. It subsequently passed downstream of Ice Harbor without being detected (via the RSW, spillway, or turbines), and was then detected moving back upstream through the south ladder in late June. This fish was not detected passing upstream at Lower Monumental or at the detection arrays at the mouth of the Tucannon River. Its ultimate fate is unknown.

The Juvenile Fish Transportation Program was developed to provide a downstream migration alternative for juvenile anadromous fish to avoid passing through multiple FCRPS hydroprojects. Barge and/or truck transportation is typically implemented from late April through September at Lower Monumental Dam. All juvenile fish are transported with the exception of those marked for in-river studies. Any bull trout that are entrained into the bypass system and not removed on the separator would likely be transported along with the anadromous fish to a release site below Bonneville Dam. Fish sampling is conducted when fish are bypassed for transportation, but considering the likely low relative abundance of bull trout in the bypassed fish, the chance of observing them in the samples is low. As discussed previously, there were nine bull trout observations in the samples over a 13-year period. The disposition of any bull trout captured, transported, and released below Bonneville Dam is unknown, but they may be lost to the population of origin.

Migration delay

Observations of bull trout movements at and around Lower Monumental Dam and through Lake Herbert G. West are not sufficient to determine whether there are delays associated with upstream or downstream passage at the project or through the reservoir. In addition, there have been no studies designed and conducted specifically to assess passage efficiency or delay. The detection history for the single PIT-tagged bull trout that passed upstream through the Lower Monumental north ladder did not indicate any delay. The low water velocity and seasonally warm water temperatures in Lake Herbert G. West compared to natural river conditions have the potential to affect bull trout migration but information to evaluate this does not exist.

Survival

Lower Monumental Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, although the effect of mainstem Snake River habitat conditions in Lake Herbert G. West on bull trout survival has not been assessed, reservoir temperatures during the summer months may be high enough to potentially affect survival. Reservoir conditions have also created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species. These reservoir conditions along with passage at the dam itself may have also increased the vulnerability of bull trout to avian predators (see *Survival* discussion in previous section).

Little Goose Dam

Little Goose Dam (rkm 522.113) is part of the FCRPS in the lower Snake River (Figures 2.1 and 2.25) and is located 46 rkm upstream from Lower Monumental Dam. The reservoir impounded by Little Goose Dam is known as Lake Bryan and extends approximately 60 rkm upstream to the tailrace of Lower Granite Dam (rkm 522.173). There is a single fish ladder present on the south shore of the dam for upstream passage with entrances on the north shore, a powerhouse collection system, and a transportation channel under the spillway. For juvenile fish passage, Little Goose Dam has a juvenile bypass system as well as a temporary spillway weir (TSW). Bull trout core areas nearest to Little Goose Dam include the Walla Walla River and Touchet

River core areas located in the Walla Walla River Subbasin which enters the Columbia River approximately 126 rkm downstream from Little Goose Dam, and the Tucannon River Core Area located in the Tucannon River Subbasin which enters the Snake River approximately 13 rkm downstream from the dam. Bull trout core areas are also located 121.5 rkm upstream in the Asotin Creek Subbasin, 158.4 rkm upstream in the Grande Ronde River Subbasin, and 195.4 rkm upstream in the Imnaha River Subbasin.

Figure 2.25. Little Goose Dam located on the lower Snake River (Photo from www.nwd.usace.army.mil/Media/Images.aspx).

Connectivity

Little Goose Dam fish passage is required for migratory bull trout from core areas in the Walla Walla River and Tucannon River subbasins to interact with migratory bull trout from core areas in the Asotin Creek, Grande Ronde River, or Imnaha River subbasins. The Tucannon River is the most likely origin of many of the bull trout observed at Little Goose Dam because of its relatively healthy migratory population and proximity (13 rkm downstream). DeHaan and Bretz (2012) used genetic markers to determine that Tucannon River origin bull trout move upstream and downstream past Little Goose Dam. They also assigned a bull trout sampled at the Little Goose Dam separator to the Imnaha River Subbasin. Bull trout from the Tucannon River or Walla Walla River subbasins must use one of several entrances and transportation channels to access the single fish ladder on the south shore to ascend the dam. The fish ladder was designed primarily for anadromous salmonid passage, and the suitability of those conditions for bull trout is unknown. Downstream migrant bull trout can pass Little Goose Dam via the TSW, spillway, bypass system, or turbines. Downstream passage efficiency or delay has not been evaluated.

Both adult and subadult bull trout use the Snake River in areas near Little Goose Dam. Bull trout from the Tucannon River Subbasin enter the mainstem Snake River from October through February and return to the subbasin from March through July. The time periods of mainstem use by Walla Walla River Subbasin bull trout are nearly identical. This timing indicates bull trout are likely present somewhere in the mainstem Snake River near Little Goose Dam in all but the warmest summer months (August – September). Use of the mainstem Snake River by adult and subadult bull trout from upstream subbasins (e.g., Asotin, Grande Ronde) has not been thoroughly studied or documented. The relatively sparse data that have been collected indicate mainstem use timing is likely similar to that observed for bull trout from the Walla Walla River and Tucannon River subbasins.

Bull trout attempting to migrate upstream in the Snake River over Little Goose Dam must do so through the south shore fish ladder. Fish ladder outages for maintenance usually occur in January and February, and for 2015, they occurred from 7 January through 20 February. During this time period, upstream passage over Little Goose Dam was not possible. The majority of bull trout observations within the ladder typically occured from April through July, but could potentially occur throughout the year (Figure 2.26). Although these fish were not marked and their source population is unknown, the relatively large number of observations could be related to the proximity of Little Goose Dam to the Tucannon River Subbasin and the relatively large numbers of migratory bull trout from that subbasin that use the mainstem Snake River. The timing of the observations and movements through the fish ladder are consistent with the timing typically observed for subadult and adult bull trout returning to their natal subbasin for spawning or rearing. Many of these bull trout are likely Tucannon River bull trout that are either moving upstream in the Snake River to spawn in other subbasins, or simply engaging in local movements over the dam and then subsequently returning downstream to the Tucannon River.

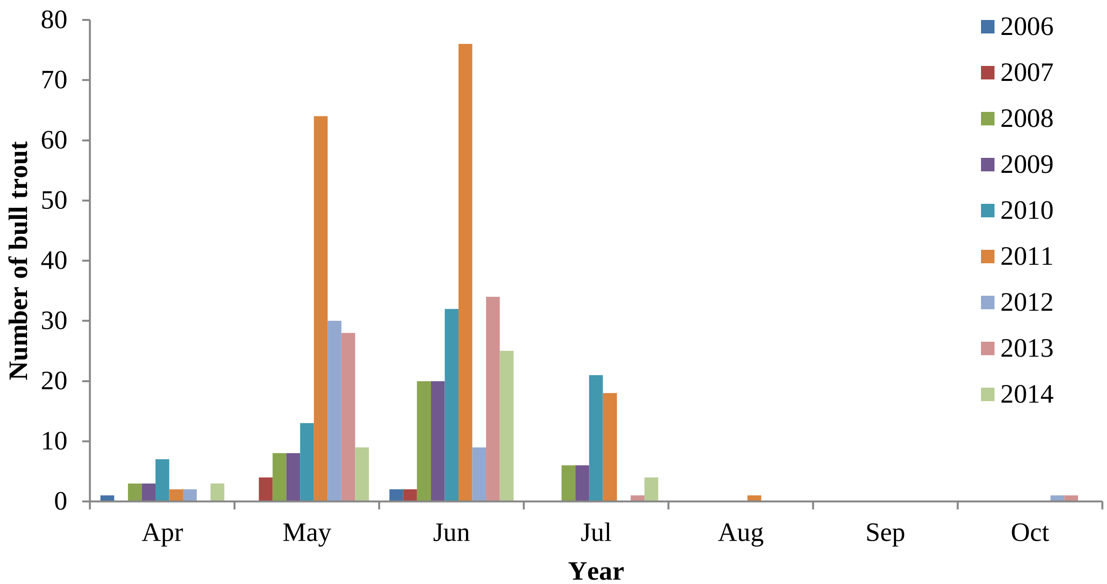

Figure 2.26. Bull trout observations at Little Goose Dam adult ladder. Data from http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx.

The fish ladder at Little Goose Dam was wired for full duplex PIT tag detection in March 2014. Since then, a single bull trout originally tagged in the Tucannon River in November 2013 was detected ascending the fish ladder a total of four occasions during June 2014. It is likely this bull trout moved back downstream prior to each of the sequential movements up and over the ladder to the forebay. Since it was not detected in the bypass system, downstream passage could have occurred through the turbines or over the spillway or TSW. This behavior could indicate local foraging and associated movements, or it could be an indication of a delay or a problem re-locating the Tucannon River associated with the dam or operations. After exiting the Little Goose adult ladder on the fourth ascent, the fish was last detected eight days later on 5 August moving through the fish ladder at Lower Granite Dam. Since this bull trout was originally tagged as a subadult in the Tucannon River, we presume it was a Tucannon River origin fish moving into the mainstem to overwinter, a common pattern for migratory bull trout. Detecting this fish moving upstream in the Snake River over Lower Granite Dam might indicate eventual connectivity between Tucannon River Subbasin bull trout and other core areas further upstream in Snake River subbasins (e.g., Asotin, Imnaha). This may be an example of the importance of maintaining the migratory corridor in the lower Snake River to allow gene flow between core area bull trout populations.

Upstream passage in the Little Goose fish ladder is monitored from 1 April to 31 October. During this time, enumeration occurs from 0400 to 2000 hours PST. During night time hours and outside of the active counting season no monitoring is conducted for upstream passage through the ladder. Since neither manual nor video counting occurs at the ladder from 1 November through January, and from late February through March, unmarked bull trout could be moving through the ladder without being observed. In addition, based on the Snake River timing discussed previously, bull trout are likely present in the mainstem and could be using the ladder during most of the time period when fish ladder monitoring is not conducted. Any PIT-tagged bull trout moving through the ladder will likely be detected with the exception of the maintenance period in January and February.

Bull trout attempting to migrate downstream in the Snake River over Little Goose Dam could do so using several different routes, depending on the time of year. These routes include the spillway, the TSW, the bypass system, or the turbines. Passage through the turbines is possible at any time, and may be the most likely route for bull trout because of their affinity for structure and cover that is most commonly found at the bottom of the river or along the river banks (Montana Bull Trout Restoration Team 2000; Al-Chokhachy and Budy 2007; USFWS 2007). There is no way to observe movement through the turbines or to detect PIT-tagged fish. Passage over the spillway or through the TSW is possible from about 3 April through 31 August, but again, there is no way to observe or detect PIT-tagged fish through these routes. The only opportunity to observe unmarked downstream migrants is when juvenile fish are entrained into the bypass system during the operational time period from 1 April through 15 December, and observations are possible at the separator or in samples to monitor descaling and other condition parameters. A total of 45 bull trout were observed on the separator at Little Goose Dam between 1991 and 2003 (Anglea et al. 2004). Most of these observations occurred between May and mid-July. Two of these bull trout were observed on 29 July and 1 August. Nine bull trout have been observed in condition samples between 1983 and 2007 at Little Goose (Anglea et al. 2004; Appendix A). All of these observations except one occurred between April and August. One observation occurred in October. Downstream migrant PIT-tagged bull trout that are entrained into the bypass system at Little Goose Dam during the operational time period from 1 April through 15 December will likely be detected by the multiple PIT detection arrays installed within the system. During the fall, after spill operations are terminated, downstream passage options become limited to the bypass system or the turbines. And during the winter, the only choice for downstream passage is the turbines. As discussed previously, bull trout use of the mainstem Snake and Columbia rivers could occur from October through July. There is no ability to monitor bull trout downstream passage over Little Goose from 16 December through 31 March because the bypass system with PIT detection capability is shut down. During this winter period with no spill, and no bypass system, turbine passage is the only choice.

To date, there have been 11 PIT-tagged bull trout detected in the fish bypass system. Ten of the 11 bull trout were tagged after being observed at the fish separator and one bull trout was previously tagged in the Tucannon River. One of the bull trout tagged at the separator was genetically assigned to the Imnaha River (DeHaan and Bretz 2012). The other nine fish tagged at the separator were assigned to the Tucannon River. Although sample size was low (n=10), the assignment of 90% of fish sampled at the separator to the Tucannon River may indicate that most of the bull trout passing downstream over Little Goose Dam are of Tucannon River origin. Conversely, the bull trout assigned to the Imnaha subbasin underscores the importance of maintaining the migratory corridor in the lower Snake River to allow gene flow from other populations.

Several movement patterns based on PIT detections were observed for these 11 PIT-tagged bull trout. Six fish (five tagged at the separator, one tagged in the Tucannon River) made one or more loops up the Little Goose Dam fish ladder, then back down through the bypass system to the tailrace, never to be detected again. This pattern may represent local movements of foraging fish with the exception of the Imnaha fish. Three additional bull trout exhibited a similar movement pattern, but were later detected in the Tucannon River. The remaining two bull trout that were tagged at the separator and released to the tailrace, subsequently moved back up the ladder at Little Goose Dam, and then moved upstream and through the ladder at Lower Granite Dam. One of these fish continued upstream in the Snake River, while the other passed back downstream over Lower Granite and Little Goose dams without being detected, then entered the Tucannon River. Both of these fish had been genetically assigned to the Tucannon River Core Area. The individual that continued upstream in the Snake River after passing Lower Granite Dam may be yet another example of connectivity between core areas and the importance of maintaining this connectivity.

The Juvenile Fish Transportation Program is typically implemented from late April through October at Little Goose Dam. All juvenile fish are transported with the exception of those marked for in-river studies. Any bull trout that are entrained into the bypass system and not removed on the separator would likely be transported along with the anadromous fish to a release site below Bonneville Dam. Fish sampling is conducted when fish are bypassed for transportation, but considering the likely low relative abundance of bull trout in the bypassed fish, the chance of observing them in the samples is low. As discussed previously, there were nine bull trout observations in the samples over a 25-year period. The disposition of any bull trout captured, transported, and released below Bonneville Dam is unknown, but they may be lost to the population of origin.

Migration delay

There have been no studies designed and conducted specifically to assess passage efficiency or delay in the fish ladder, juvenile bypass system, or other possible passage routes at Little Goose Dam. Upstream passage through the fish ladder is not possible for most of January and February when bull trout are present and potentially migrating in the lower Snake River. Any bull trout intending to migrate upstream of Little Goose Dam during this time period will be delayed.

Detections of PIT-tagged bull trout at Little Goose Dam have demonstrated that some fish pass upstream and downstream of the dam multiple times (as many as four times) during the spring and summer migration period. Some of these fish were adult-sized and genetically assigned to the Tucannon River. It is unclear why these fish did not enter the Tucannon River after their initial downstream passage. This behavior could indicate local foraging and associated movements, or it could be an indication of delay associated with the dam or operations.

Detections for three of the 11 downstream migrant bull trout discussed previously indicated delays at the separator at Little Goose. The elapsed time between detections on the PIT antennas in the full flow bypass system from the powerhouse, and detections in the adult fish return to the tailrace were one day, two days, and 16 days. The cause of these delays is unknown, but is a concern since there are no holding facilities at the separator, and large (adult) fish should be removed and returned to the river as soon as possible.

The low water velocity and seasonally warm water temperatures in Lake Bryan compared to natural river conditions also have the potential to affect bull trout migration, but no studies have been conducted to evaluate this.

Survival

Little Goose Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, although the effect of mainstem Snake River habitat conditions in Lake Bryan on bull trout survival has not been assessed, reservoir temperatures during the summer months may be high enough to potentially affect survival. Reservoir conditions have also created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species. These reservoir conditions along with passage at the dam itself may have also increased the vulnerability of bull trout to avian predators (see *Survival* discussion in previous section).

Lower Granite Dam

Lower Granite Dam (rkm 522.173 on the Snake River) is part of the FCRPS in the lower Snake River (Figure 2.27). The reservoir impounded by Lower Granite Dam is known as Lower Granite Lake and extends upstream approximately 51 rkm to the town of Lewiston, Idaho. Lower Granite Dam is fitted with a single fish ladder on the south shore of the dam for upstream passage with both south and north shore entrances, a powerhouse collection system, and a transportation channel under the spillway. For downstream fish passage, Lower Granite Dam has a juvenile bypass system and a removable spillway weir (RSW). From Lower Granite Lake upstream to Hells Canyon Dam (174 rkm), the Snake River is regulated by the Hells Canyon Complex, but within this regulation, it is free-flowing. There is no upstream passage at Hells Canyon Dam, and downstream passage facilities are not present. It is unknown whether migratory bull trout from upstream populations pass downstream through the turbines at Hells Canyon Dam. The dam is a barrier to connectivity between downstream bull trout populations (e.g., Imnaha) and upstream populations (e.g., Indian Creek). Bull trout core areas nearest to Lower Granite Dam include the Tucannon River Core Area located in the Tucannon River Subbasin which enters the Snake River approximately 73 rkm downstream from the dam, and the Clearwater River Core Areas located in the Clearwater River Subbasin which enters the Snake River approximately 51 rkm upstream from the dam. Additional bull trout core areas are located upstream from Lower Granite Dam and include the Asotin Creek Core Area (61.6 rkm upstream), the Grande Ronde Core Areas (98.5 rkm upstream), and the Imnaha Core Area (135.5 rkm upstream).

Figure 2.27. Lower Granite Dam located on the lower Snake River (Photo from www.nwd.usace.army.mil/Media/Images.aspx).

Connectivity

Lower Granite Dam fish passage is required for bull trout from the Tucannon River Subbasin to interact with bull trout from upstream subbasins (e.g., Clearwater, Asotin, Imnaha). Both adult and subadult bull trout use the Snake River in areas near Lower Granite Dam. Bull trout that enter the mainstem Snake River typically do so during the fall and winter (e.g., October – February) and return to tributary subbasins in spring and early summer (e.g., March – July). This timing indicates bull trout are likely present somewhere in the mainstem Snake River near Lower Granite Dam in all but the warmest summer months (August – September).

Bull trout attempting to migrate upstream in the Snake River over Lower Granite Dam must do so through the single, south shore fish ladder via entrances on both the north and south shores, or through the powerhouse collection system. The ladders were designed primarily for anadromous fish, and fish passage efficiency has not been evaluated for bull trout. Fish ladder outages for maintenance usually occur in January and February, and for 2015, they occurred from 7 January through 4 March. During this time period, upstream passage over Lower Granite Dam was not possible. The majority of observed bull trout movement upstream past Lower Granite Dam typically occurs from April through July, but could potentially occur throughout the year (Figure 2.28). This timing is similar to observations at the other lower Snake River dams, although the number of observations at Lower Granite Dam is far fewer, ranging from 7% – 23% of the total observations at Lower Monumental and Little Goose dams. This could possibly be a function of the greater distance from the Tucannon River, the likely source of most of the observations at the downstream dams. Since the fish observed in the Lower Granite Dam ladder were not marked, their source population is unknown. They could have been upstream migrants from the Tucannon River, or fish that originated in upstream core areas that were returning to those subbasins. All of the PIT-tagged bull trout detected in the Lower Granite Dam fish ladder were from the Tucannon River, thus it may be reasonable to assume that many of the unmarked fish observed in the ladder also originated in the Tucannon River. Since the timing of these observations and movements is consistent with the timing typically observed for subadult and adult bull trout returning to a subbasin for spawning and/or rearing, these observations may suggest these likely Tucannon fish were headed upstream to a different core area, although they could have returned back downstream over Lower Granite and Little Goose dams, and eventually to the Tucannon River without being observed.

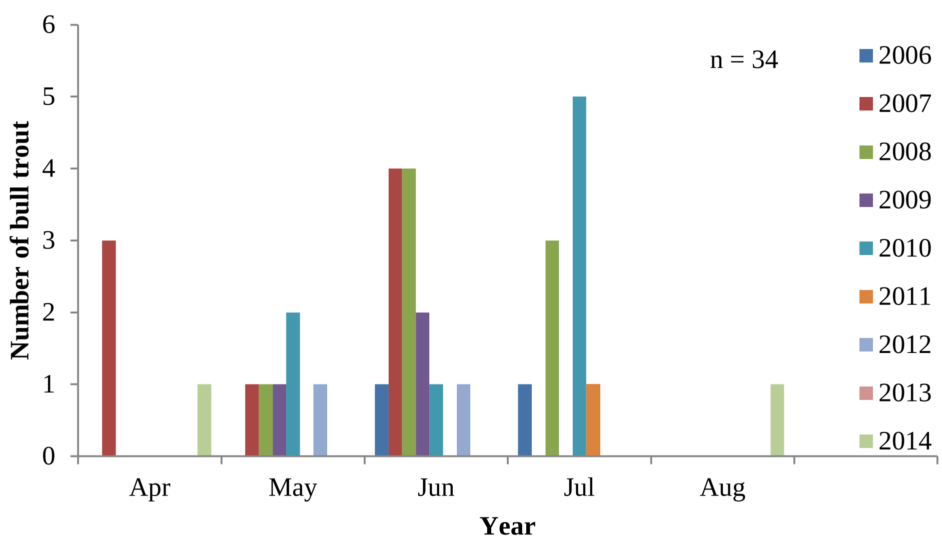

Figure 2.28. Bull trout observations at Lower Granite Dam adult fish ladders. Data from http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx.

The fish ladder at Lower Granite has been wired for full duplex PIT tag detections since 2000, with additional antenna coils added in 2003. Four PIT-tagged, adult-sized (>300 mm) bull trout have been detected in the fish ladder at Lower Granite Dam, all of Tucannon River origin. One of these fish was tagged in the Tucannon River, and the other three were tagged on the separator at Little Goose and subsequently identified as Tucannon River bull trout from genetic analyses.

Two of these bull trout showed a similar migratory pattern. They ascended the fish ladder at Little Goose Dam following tagging at the separator and release to the tailrace, and then moved upstream through Lake Bryant and ascended the Lower Granite Dam fish ladder. Only one of these bull trout was detected eventually returning to the Tucannon River. Since it was not detected moving back downstream over Lower Granite and Little Goose Dams, it likely passed via spill, the spillway weirs, or through the turbines. The other bull trout was not subsequently detected following exit from the Lower Granite Dam fish ladder into the Snake River. As discussed previously, this individual could have continued upstream and entered a different core area (e.g., Asotin, Imnaha) establishing core area connectivity. It is also possible that this fish could have moved back downstream over Lower Granite and Little Goose dams undetected via spill, the spillway weirs, or the turbines to return to the Tucannon River. However, since it was not subsequently detected at any of the Tucannon River PIT detection sites, or anywhere else, its location and fate are unknown. The third bull trout detected in the Lower Granite Dam ladder was the individual that was tagged in the Tucannon River. This individual was detected on four separate dates between 4 June and 28 July ascending the fish ladder at Little Goose Dam. It is likely that this fish was spilled back over the dam (or passed through the turbines) following each ascension of the fish ladder, then re-entered the ladder again. Following the last detection at Little Goose Dam, it was detected in the Lower Granite Dam fish ladder approximately one week later. This bull trout then either continued upstream in the Snake River or returned downstream without being detected. With no further detections, this individual's location and fate are unknown. The last bull trout was detected in the Lower Granite Dam fish ladder following tagging at the Little Goose Dam separator and release in the tailrace. It was detected a week later in the Lower Granite Dam ladder for the first time. This individual ascended the ladder, exited upstream, and was likely spilled back over the dam (or passed through the turbines) before entering the ladder a second time. This cycle of entering the ladder, passing back downstream, then re-entering the ladder occurred four times from 25 June to 30 June. The last detection for this fish was when it exited the Lower Granite Dam ladder on 30 June. It could have continued upstream in the Snake River, or returned downstream without being detected. Its ultimate fate and location are unknown.

Fish are enumerated during the day (0400 to 2000 hours PST) from 1 March to 30 December at the Lower Granite Dam fish ladder counting windows. Visual counts are conducted from 1 April through 31 October, and video counts are conducted in March, November, and December. Fish are enumerated at night (2000 to 0400 PST) from 15 June to 30 September using only video counts. Since fish ladder outages for maintenance usually occur in January and February, and upstream passage over Lower Granite Dam is not possible, no monitoring for ladder passage is necessary. Since night monitoring (video) is only conducted from 15 June to 30 September, bull trout passage at night outside of this time period will not be documented. The Lower Granite Dam fish ladder is equipped with two sets of PIT detection antennas, thus most bull trout movement through the ladder will be documented during the operational time period from March through December.

Bull trout attempting to migrate downstream in the Snake River over Lower Granite Dam can do so via the juvenile fish bypass system, the turbines, RSW, or spillway depending on the time of year. The juvenile fish bypass is operational from 25 March through 15 December. The only opportunity to observe unmarked downstream migrants is when juvenile fish are entrained into the bypass system and could be observed on the separator or in samples to monitor descaling and other condition parameters. A single bull trout was observed on the separator at Lower Granite Dam in July 2003 (Anglea et al. 2004). Six bull trout have been observed in condition samples between 1993 and 2003 at Lower Granite Dam (Anglea et al. 2004; Appendix A). Four of these observations occurred between July and early September. The month of observation was not available for the other two bull trout. Any PIT-tagged bull trout that enter the bypass system will likely be detected by the multiple PIT detection arrays installed within the system. No PIT-tagged bull trout have been detected in the juvenile bypass system at Lower Granite Dam. Downstream passage through the turbines can occur at any time throughout the year, and downstream passage via the spillway or RSW could occur from about 3 April through 31 August. During the winter time period from 16 December through 24 March with no juvenile bypass or spill operations, downstream passage is only possible through the turbines. There is currently no capability to either observe or detect bull trout through these passage routes.

The Juvenile Fish Transportation Program is typically implemented from April through October at Lower Granite Dam. All juvenile fish are transported with the exception of those marked for in-river studies. Any bull trout that are entrained into the bypass system and not removed on the separator would likely be transported along with the anadromous fish to a release site below Bonneville Dam. Fish sampling is conducted when fish are bypassed for transportation, but considering the likely low relative abundance of bull trout in the bypassed fish, the chance of observing them in the samples is low. As discussed previously, there were six bull trout observations in the samples over an 11-year period. The disposition of any bull trout captured, transported, and released below Bonneville Dam is unknown, but they may be lost to the population of origin.

Migration delay

There have been no studies designed and conducted specifically to assess passage efficiency or delay in the fish ladder, juvenile bypass system, or other possible passage routes at Lower Granite Dam. Upstream passage through the fish ladder is not possible for most of January and February when bull trout are present and potentially migrating in the lower Snake River. Any bull trout intending to migrate upstream of Lower Granite Dam during this time period will be delayed.

Detections of one of the PIT-tagged bull trout at Lower Granite Dam have demonstrated that some fish pass upstream and downstream of the dam multiple times (as many as four times) during the spring and summer migration period, similar to observations at Little Goose Dam. This fish was adult-sized and genetically assigned to the Tucannon River. It is unclear why this fish repeated the cycle of upstream passage through the fish ladder, pass back downstream, then re-entering the ladder a total of four times. This behavior could indicate local foraging and associated movements, or it could be an indication of delay associated with the dam or operations. The Lower Granite Dam fish ladder has PIT detection antennas near the bottom and near the top of the ladder. The timing of detections within the ladder during the four ascensions by this fish did not indicate any delay or difficulty navigating the ladder itself.

Low water velocities and seasonally warm water temperatures in Lower Granite Lake and Lake Bryan have the potential to affect bull trout migration, but no studies have been conducted to evaluate this.

Survival

Lower Granite Dam has the potential to affect bull trout survival during upstream and downstream passage, but this has not been specifically investigated. Similarly, the effect of mainstem habitat conditions on bull trout survival has not been assessed, but reservoir temperatures during the summer months may be high enough to influence bull trout survival. Reservoir conditions have also created suitable habitat for both native (e.g., pikeminnow) and non-native (e.g., smallmouth bass) predator species.

Chapter 3 : Synthesis of Available Information and Research

This chapter summarizes the available information, including the results of various research efforts, on migratory bull trout use of the mainstem Columbia and Snake rivers. The synthesis covers 18 tributary subbasins, 9 FCRPS hydroprojects, 5 mid-Columbia PUD hydroprojects, and over 1000 river kilometers of the mainstem Columbia and Snake rivers. Portions of these subbasins and the entire mainstem Columbia River upstream to Chief Joseph Dam and mainstem Snake River upstream to Brownlee Dam have been designated as critical habitat for bull trout (USFWS 2010). The mainstem was designated as critical habitat for bull trout in recognition of its important role as foraging, migration, and overwintering habitat in the recovery of bull trout (USFWS 2010). The consequences of a migratory life history involve tradeoffs between the benefits of increased growth and fecundity and the cost of lower survival (Schaller et al. 2014). Following metapopulation theory, relatively isolated, spatially distributed local populations of bull trout are bound together by the potential for dispersal between populations (Whitesel et al. 2004). While dispersal has been documented within some subbasins (e.g., Schaller et al. 2014), connectivity between subbasins has been observed to a lesser degree. Long-range migrants have been observed to be a relatively small component of bull trout populations (Warnock et al. 2011; Schaller et al. 2014), but represent the only opportunity for genetic connectivity among subbasins and possible recolonization of areas where bull trout have been extirpated. Providing opportunities to disperse by eliminating impediments to migration and improving migratory corridor habitat conditions is critical for maintaining genetic diversity and the persistence of bull trout local populations and metapopulations, particularly considering the anticipated future conditions associated with climate change. We address the following three questions and identify data gaps and research needs to reduce uncertainties in the future:

1) Do bull trout from subbasin tributary populations migrate to mainstem areas of the Columbia or Snake rivers, and if so, when?

2) If migratory bull trout enter the mainstem Columbia or Snake rivers, what is the temporal and spatial extent of their migrations?

3) Do FCRPS dams and reservoirs and their associated operation affect bull trout in the mainstem Columbia and Snake rivers?

Specific types of information that collectively address these questions include bull trout distribution, life history, spatial and temporal movement patterns, connectivity of suitable habitat within subbasin and mainstem migratory corridors and connectivity between local populations and core areas, and interactions with mainstem hydropower projects. We define connectivity as the conservation of suitable stream conditions that allow bull trout to move freely upstream and downstream with habitat linkages to other habitat areas (Schaller et al. 2014). We assessed connectivity from two perspectives: (1) connectivity within the migratory corridor (i.e., allowing for unrestricted bull trout movement and the full expression of life history strategies) and (2) connectivity (i.e., dispersal) among core area populations (Schaller et al 2014). Connectivity is essential to maintain genetic exchange amongst core area populations; provide resiliency against environmental and anthropogenic perturbations; and provide a high likelihood for viability of these bull trout populations. These migratory individuals, even in small numbers, are likely important to population resiliency and ultimately viability (Schaller et al. 2014).

Data relevant to our three questions have been collected periodically by various agencies and entities. Studies specifically targeting bull trout have been conducted in a portion of the subbasins that we reviewed, but in other subbasins, data have been collected opportunistically, mostly associated with anadromous salmonid studies. Despite the limited number of focused bull trout studies, the available data can collectively help describe bull trout life history, movement and migration patterns, use of the mainstem Columbia and Snake rivers, potential impacts of mainstem hydroprojects, data gaps and uncertainties, and future research needs that are necessary to develop and implement management actions for bull trout recovery.

Subbasin Populations and Use of the Mainstem by Migratory Bull Trout

Bull trout tributary subbasin populations

The study area includes 18 tributary subbasins in the lower Columbia River upstream of Bonneville Dam, the mid-Columbia River downstream of Chief Joseph Dam, and the lower Snake River downstream from Hells Canyon Dam. Bull trout local populations with evidence of reproduction occur in at least 16 of the 18 subbasins. Only the Sheep Creek and Granite Creek subbasins do not appear to be occupied by reproducing bull trout local populations. While some subbasins only have a single local population within a single core area, others contain many local populations within numerous core areas (Table 3.1).

Table 3.1. Summary of subbasin core areas and local populations.

Subbasin	Core Areas	Local Populations
Lower Columbia River		
Hood River	1	2
Klickitat River	1	1
Deschutes River*	1	5
John Day River	3	11
Umatilla River	1	1
Walla Walla River	2	6
Yakima River	1	15
Mid-Columbia River		
Wenatchee River	1	7
Entiat River	1	2
Methow River	1	10
Lower Snake River		
Tucannon River	1	9
Clearwater River	4	38
Asotin Creek	1	2
Grande Ronde River	4	9
Salmon River	10	133
Imnaha River	1	9
Sheep Creek	1	1**
Granite Creek	1	1**

* The Odell Lake Core Area within the Deschutes River Subbasin is completely isolated, and will not be included in this synthesis.

** Bull trout found within the subbasin may only be immigrants from unknown source populations.

Bull trout life history

Bull trout exhibit a continuum of complex life histories involving movements, migrations, spawning, rearing and foraging on time scales ranging from daily to annually or longer, and over different spatial scales (Schaller et al. 2014). Resident bull trout complete their entire life cycle in the headwater streams in which they spawn and rear (Rieman and McIntyre 1995; Fraley and Shepard 1989). Many bull trout populations have an additional migratory component to their life history. Migratory bull trout forage and rear in lower subbasin reaches and the mainstem Columbia and Snake rivers and return from these areas to spawn in headwater streams along with resident bull trout (Fraley and Shepard 1989). Sixteen of the 18 subbasins we reviewed contain one or more reproducing bull trout populations, with the exception of the Sheep Creek and Granite Creek subbasins. All of the bull trout populations within the remaining 16 subbasins include a resident component and have at least one, and often multiple local populations with a migratory component (Table 3.2).

Table 3.2. The presence or absence of resident and migratory bull trout within each of the 18 subbasins in the lower Columbia, mid-Columbia and lower Snake river reaches. The presence of immigrants from other known or unknown source populations of bull trout within each subbasin is also indicated.

Subbasin	Resident Component (present/absent)	Migratory Component (present/absent)	Immigrants from Other Subbasins (present/unknown)
Lower Columbia River			
Hood River	present	present	unknown
Klickitat River	present	present***	unknown
Deschutes River	present	present	unknown
John Day River	present	present	unknown
Umatilla River	present	present	present*
Walla Walla River	present	present	unknown
Yakima River	present	present	present
Mid-Columbia River			
Wenatchee River	present	present	present*
Entiat River	present	present	present*
Methow River	present	present	present*
Lower Snake River			
Tucannon River	present	present	unknown
Clearwater River	present	present	unknown
Asotin Creek	present	present	present*
Grande Ronde River	present	present	present*
Salmon River	present	present	unknown
Imnaha River	present	present	unknown
Sheep Creek	absent	absent	present**
Granite Creek	absent	absent	present**

* Immigrants from other known subbasins have been detected within the subbasin.
** Immigrants from other unknown source populations appear to be present within the subbasin.
*** Migratory individuals have been observed in the subbasin, but source has not been confirmed.

General movement patterns

A considerable amount of research has been conducted to describe movement patterns of migratory bull trout in a portion of the subbasins we reviewed. In-depth studies have been conducted to describe migratory bull trout movement patterns in the Walla Walla, Wenatchee, Entiat, Methow, Tucannon and Imnaha subbasins, while bull trout movements in other subbasins have been studied to a much lesser degree (e.g., Asotin Creek, Klickitat River). Rotary screw traps, weirs, video monitoring, radio-telemetry, acoustic-telemetry, and PIT detection technology have commonly been used in subbasins where long-term bull trout movement datasets have been developed. Multiple electrofishing and snorkeling studies have also contributed to a better understanding of bull trout movements. The following are general descriptions that summarize subadult and adult bull trout migration patterns found in many of the subbasins we reviewed.

Subadult downstream migration

Subadult bull trout downstream migration from the headwater areas occurs during most months, but generally peaks during the spring and early summer (March – June), and again during the fall (September – December). In some subbasins irrigation diversions draw surface water to summer base flow levels in late spring or early summer (May – June), resulting in low flows and elevated water temperatures. The result is the cessation of downstream movement by bull trout over a relatively short timeframe. In these situations, downstream migrants attempting to move into middle and lower subbasin reaches (i.e., lower two-thirds of the subbasin) often retreat upstream to find more tolerable habitat conditions to oversummer. Some of these individuals subsequently continue to migrate downstream in fall and winter when conditions become more conducive. Migration into lower subbasin reaches and the mainstem Columbia and Snake rivers continues in the fall and winter through approximately February. Subbasins that we reviewed vary in size, and smaller subbasins with shorter and less impacted migration corridors may allow for relatively less impeded downstream migration throughout the system during most months when compared to larger subbasins, particularly those subbasins with higher levels of consumptive water use.

Adult downstream migration

Following spawning, resident bull trout remain in the headwaters while the migratory component of the population moves into downriver reaches (and in some cases into the mainstem Columbia and Snake rivers) to find more abundant resources (e.g., forage) and to overwinter. These downriver movements generally occur in many of the subbasins from September through February.

Adult upstream migration

Migratory adult bull trout that have overwintered in downriver subbasin reaches or in the mainstem Columbia or Snake rivers, generally begin migrating upstream in March. In subbasins with highly degraded and seasonally dewatered migratory corridors, upstream migration timing through lower and middle subbasin reaches (i.e., lower two-thirds of the subbasin) is critical to reach upstream areas before conditions are prohibitive. Upstream migration through such reaches generally is not possible after late June or early July. In the Wenatchee, Entiat and Methow rivers, upstream migration through lower subbasins reaches is common during June and July, but has been observed from April through September (BioAnalysts, Inc. 2004; Nelson and Nelle 2007; Nelson et al. 2012).

Bull trout movement to and from the mainstem

Many factors may influence whether bull trout from a particular population migrate to and from mainstem habitat. While the resident component of a bull trout population only experiences headwater conditions, migratory fish are generally exposed to a wider spectrum of anthropogenic impacts including channel modifications, riparian habitat degradation, consumptive water use resulting in insufficient streamflows, dams, and other impacts throughout their respective subbasins that may impede migration to lower subbasin reaches and to the Columbia or Snake rivers. Studies specifically designed to monitor and assess bull trout movement into mainstem habitats have not been conducted in most of the 18 subbasins in the study area. In some of these subbasins with small, imperiled populations, too few migratory bull trout may be available for use of the mainstem to be readily observed, if it occurs.

Subbasin populations that use the mainstem

The movement of migratory bull trout from multiple subbasins into the mainstem Columbia and Snake rivers has been documented (Table 3.3). In the lower Columbia River, bull trout movement into the mainstem has only been explicitly studied in the Walla Walla River Subbasin (Anglin et al. 2009a, 2009b, 2010; Barrows et al. 2012a, 2012b, 2014a). Bull trout movement from the Hood River Subbasin to the Columbia River has been studied to a lesser degree (Pribyl et al. 1996; Buchanan et al. 1997, USFWS 2002, Coccoli 2004). Mainstem use by Deschutes River bull trout has also been documented. Migratory fish from other tributaries in the lower Columbia River (e.g., Umatilla River) have been observed in the lower reaches of their respective subbasins, but movement into the mainstem has not been confirmed (Table 3.3). There are multiple lines of evidence confirming that bull trout from mid-Columbia River subbasins move into the mainstem Columbia River (BioAnalysts, Inc. 2004; Nelson and Nelle 2008; DeHaan and Neibauer 2012; Nelson et al. 2012; Nelson and Johnsen 2012; DeHaan et al. 2014). Bull trout movement from the Tucannon River and Imnaha River subbasins into the lower Snake River has been explicitly studied (Blenden et al. 1997, 1998; Cleary et al. 2000, 2002a, 2002b, 2003, 2004; Faler et al. 2004, 2005, 2008; Bretz 2011; Michaels et al. 2006; Michaels and Espinoza 2007a, 2007b, 2009, 2010; DeHaan and Bretz 2012; Starcevich et al. 2012; Hatch et al. 2013, 2014; IPC, personal communication). Bull trout from Asotin Creek have been detected moving toward (and likely into) the mainstem Snake River as well (www.ptagis.org [queried Dec. 2014]; Mayer and Schuck 2004; Mayer et al. 2006). Migratory bull trout from other lower Snake River tributaries (e.g., the Grande Ronde River) have been observed in the lower one-third of their respective subbasins, but migration to the mainstem Snake River has not been observed (Table 3.3). For many subbasins, no direct tagging studies have been conducted to evaluate mainstem use.

Table 3.3. Bull trout observed in lower subbasin reaches (lower one-third), evidence of movement to and from the mainstem, and detections of fish from each subbasin in the mainstem Columbia and Snake rivers.

Subbasin	Bull Trout Observed In Lower Subbasin? (Yes/No)	Evidence of Movement to the Mainstem? (Yes/No)	Detections in the Mainstem? (Yes/No)	Immigration from the Mainstem? (Yes/No)
Lower Columbia River				
Hood River	YES	YES	YES	YES
Klickitat River***	YES	NO	NO	NO
Deschutes River***	YES	YES	YES	YES
John Day River***	NO	NO	NO	NO
Umatilla River***	YES	NO	NO	YES**
Walla Walla River	YES	YES	YES	YES
Yakima River***	YES**	YES**	YES**	YES**
Mid-Columbia River				
Wenatchee River	YES	YES	YES	YES
Entiat River	YES	YES	YES	YES
Methow River	YES	YES	YES	YES
Lower Snake River				
Tucannon River	YES	YES	YES	YES
Clearwater River***	YES	NO	NO	NO
Asotin Creek***	YES	YES	NO	YES
Grande Ronde River***	YES	NO	NO	YES
Salmon River***	YES	NO	NO	NO
Imnaha River	YES	YES	YES	YES
Sheep Creek	YES*	YES*	YES*	YES*
Granite Creek	YES*	YES*	YES*	YES*

* Immigrants from other unknown source populations appear to be the only bull trout present within the subbasin.
** Immigrants known to be from other subbasins are the only evidence of movement to and/or from the subbasin.
*** Subbasins with no direct tagging studies to specifically evaluate mainstem use.

Migration timing to mainstem

The timing of bull trout movements from a particular subbasin to the mainstem Columbia or Snake rivers may be influenced by a multitude of factors. The timing of bull trout migration to the mainstem from smaller subbasins (i.e., shorter migration corridors) may differ from larger subbasins. Further, subbasins with fewer anthropogenic impacts and alterations to migratory corridors may allow for less impeded migration. Specific data concerning the migration of bull trout to the mainstem from most of the 18 subbasins in the study area are sparse, but information for other subbasins (e.g., Walla Walla River) is relatively abundant. A general summary of bull trout movement timing to and from the Columbia and Snake rivers is provided in Table 3.4.

Table 3.4. General summary of bull trout movement timing to and from the Columbia and Snake rivers.

Subbasin	Migration to Mainstem		Immigration from Mainstem
	Subadults	Adults	Adults
Lower Columbia River			
Hood River	Not Assessed	Not Assessed	May - Jul
Klickitat River	Not Assessed	Not Assessed	Not Assessed
Deschutes River	Not Assessed	Not Assessed	Not Assessed
John Day River	Not Assessed	Not Assessed	Not Assessed
Umatilla River	Not Assessed	Not Assessed	Not Assessed
Walla Walla River	Oct – Feb	Oct - Feb	Feb - Jun
Yakima River	Not Assessed	Not Assessed	Not Assessed
Mid-Columbia River			
Wenatchee River	Not Assessed	Sep - Dec	May - Sep
Entiat River	Aug – May (2 peaks; Apr-June, Oct-Dec)	Sep - Dec	Apr – Jul (90% May – Jun)
Methow River	Apr – Jun, Aug - Nov	Sep - Dec	May - Jul
Lower Snake River			
Tucannon River	Oct - Jun	Oct - Jun	Mar - Jul
Clearwater River	Not Assessed	Not Assessed	Not Assessed
Asotin Creek	Apr – Jun, Sep – Dec	Oct, May	Oct
Grande Ronde River	Not Assessed	Not Assessed	Not Assessed
Salmon River	Not Assessed	Not Assessed	Not Assessed
Imnaha River	Mar – Jun, Sep - Dec	Sep - Feb	Feb - Jun
Sheep Creek	NA*	NA*	NA*
Granite Creek	NA*	NA*	NA*

* Bull trout from this subbasin may only be immigrants from unknown source populations.

Subadult migration timing ─ The migration of subadult bull trout to the mainstem Columbia and Snake rivers has primarily been observed during the fall and winter months (i.e., September through February), but has been documented during the spring and early summer (i.e., March through June) in some subbasins (e.g., Imnaha River, Asotin Creek, Entiat River). Subadult bull trout may also migrate from additional subbasins during the spring (e.g., Walla Walla River, Tucannon River), but the number of tagged fish (e.g., PIT- or radio-tagged) may not have been adequate to observe this behavior. As mentioned above, irrigation diversions in some subbasins (e.g., Walla Walla River) draw surface water to summer base flows in late spring or early summer (i.e., May through June), resulting in low flows and elevated water temperatures, and a cessation of downstream movement by bull trout until conditions for downstream migration improve in the fall and winter.

Adult migration timing ─ Adult bull trout migration to the mainstem Columbia and Snake rivers has been primarily observed following the spawning period from September through February. Many subbasin-specific factors (e.g., subbasin size, channel modifications, instream flow) may influence the timing of adult bull trout migration to the mainstem. Adult bull trout have also been observed while exiting tributaries during spring and summer months, but these observations are much less common.

Abundance estimates

Mainstem use abundance has only been estimated for migratory bull trout from the Walla Walla River and Imnaha River subbasins. The relatively low number of migratory individuals and the variability in movement patterns contribute to the difficulty of estimating migratory bull trout abundance in the mainstem.

Walla Walla River Subbasin ─ The number of outmigrants from the Walla Walla River Subbasin was estimated from 2007 through 2011 (Anglin et al. 2010; Barrows et al. 2012a, 2012b, 2014a). The quantitative estimate of the number of Walla Walla River Subbasin bull trout that may have used the Columbia River from January 2007 through February 2012 was 496 (95% CI 130-898). Annual estimates are provided in Chapter 1, Table 1.4.

Imnaha River Subbasin ─ Abundance for the mainstem lower Snake River population of Imnaha River migratory bull trout was estimated from 2010 through 2014 (IPC, personal communication). Expanded reach estimates ranged from 474 fish (95% CI 251 -702) in 2013-2014 to 1182 fish (95% CI 545 – 1,819) in 2011-2012. Annual estimates are provided in Chapter 1, Table 1.11.

Immigration from the mainstem

Multiple lines of evidence indicate migratory bull trout move from the mainstem into tributary subbasins. Immigration information is relatively sparse for most of the 18 subbasins in the study area. The most robust datasets were from the Methow River, Entiat River, Wenatchee River, Walla Walla River, Tucannon River, and Imnaha River subbasins. More limited data from the Umatilla River, Hood River, and Asotin Creek subbasins are also available.

Immigration to natal subbasins

Bull trout that reared or overwintered in the mainstem commonly returned to spawn in the headwaters of their natal subbasin. Bull trout that exhibited this migration pattern generally returned from the mainstem during the spring and early summer months (March – June) in most subbasins, but this movement pattern may occur as late as September in others. Migration timing is critical in some subbasins (e.g., Walla Walla River). Low flow barriers that block upstream bull trout passage develop most years during the late spring and early summer months (May – June) in middle subbasin areas (i.e., middle one-third of the subbasin) within the mainstem Walla Walla River (Barrows et al. 2014a; Schaller et al. 2014), due primarily to irrigation diversions and habitat degradation. Depressed instream flow conditions and elevated water temperatures negatively influence upstream migration of adult bull trout (Schaller et al. 2014). If adult fish fail to migrate upstream through these reaches prior to the onset of summer base flows, their ability to successfully reach headwater spawning areas may be compromised.

Immigration to non-natal subbasins

Occasionally, bull trout dispersed to non-natal subbasins and potentially contributed genetically to a different local population or colonize vacant habitat. Immigration of bull trout into non-natal subbasins has most commonly been observed in the mid-Columbia River, but has also been observed in the Umatilla River and the Grande Ronde River subbasins. Bull trout that exhibited this migration pattern generally immigrated from the mainstem during the spring and early summer months. A possible anecdotal example of this behavior occurred during August 2012 when a bull trout was angled in the White Salmon River upstream of where Condit Dam was removed, where there are no known bull trout populations (B. Allen, U.S. Geological Survey, *in litt*. 2012).

Migratory bull trout have also been known to forage and overwinter within non-natal tributaries (Ratliff et al. 1996; Mahoney et al. 2006; Barrows et al. 2014b). There are very limited data for the 18 subbasins in the study area that demonstrate this migration pattern. Evidence of this migration pattern exists between the Imnaha River and Asotin Creek and between the Methow and Okanogan rivers.

In some areas, summer habitat conditions in mainstem reservoirs (e.g., elevated temperatures) may not be favorable for bull trout, and migratory fish may seek refuge in cooler tributaries, but this has not been widely investigated. In addition, dams lacking sufficient passage for bull trout may impede/delay migration and possibly influence subbasin selection by bull trout (Barrows et al. 2014a; BioAnalysts, Inc. 2004), but this has also not been thoroughly assessed.

Bull Trout Movement within the Mainstem

Mainstem connectivity

Connectivity refers to the conservation of suitable river conditions that allow bull trout to move freely upstream and downstream to: (1) effectively disperse among local populations; and (2) utilize the migratory corridor associated with each population for the full expression of life history strategies (USFWS 2008a). While many instream alterations that impact migratory bull trout connectivity occur within tributary subbasins, mainstem Columbia and Snake River dams and their associated impoundments have the potential to impact bull trout connectivity and dispersal between core area populations as well as movement throughout critical FMO habitat in the mainstem. Mainstem FMO habitat was designated as critical habitat in recognition of the important role it plays in bull trout recovery.

Bull trout from a given population may migrate hundreds of kilometers from natal spawning grounds to utilize additional resources in the mainstem, or to connect with local populations in other subbasins, or both. Functional mainstem connectivity is required for these migrations to be successful. For example, a bull trout from the South Fork Walla Walla River local population migrated over 285 rkm to enter spawning grounds in the North Fork Umatilla River (Small et al. 2012; Sankovich et al. 2014). Bull trout may also embark on extensive migrations without connecting with other populations before returning to ascend their natal subbasin. For example, a bull trout tagged as a subadult-sized fish (243 mm FL) near the mouth of the Entiat River subsequently entered the mainstem Columbia River and moved downstream and entered the Yakima River Subbasin. This fish then migrated 76 rkm upstream in the Yakima River to Prosser Diversion Dam (rkm 539.076) before eventually returning to ascend the Entiat River for a roundtrip of over 665 rkm.

Bull trout movements within the mainstem

We used available acoustic- and radio-telemetry information and results and analysis from research conducted on bull trout use of the mainstem Columbia and Snake rivers in conjunction with PIT detections and observations at mainstem dams and within the mainstem to summarize the range and timing of mainstem movements by bull trout from each subbasin. We also used this information to estimate the proportion of the mainstem lower Columbia, mid-Columbia and lower Snake rivers known to be used by bull trout.

Range of mainstem movements

It is evident that bull trout from multiple subbasins migrate extensively throughout the Columbia and lower Snake rivers, utilizing mainstem FMO habitat and in some cases dispersing to other subbasins. Direct studies to evaluate mainstem movement of bull trout have only been conducted for populations in a portion of the subbasins, but detections of PIT-tagged bull trout at mainstem dams and at instream PIT arrays along with genetic assignment studies help elucidate the extent of mainstem use by bull trout. The distance a bull trout ventures from the mouth of their natal subbasin varies widely ranging from at least 240 rkm downstream to 130 rkm upstream of the mouth of their natal subbasin (Table 3.5). Maximum upstream and downstream movements observed for migratory bull trout from each of the 18 subbasins in the lower Columbia, mid-Columbia and lower Snake rivers are summarized in Table 3.5. The total river kilometers of the mainstem migration corridor used by bull trout originating from each subbasin are also provided.

Table 3.5. The maximum upstream and downstream movement observed for migratory bull trout from each of the reviewed subbasins in the lower Columbia, mid-Columbia and lower Snake rivers. The total river kilometers of the mainstem migration corridor used are also provided.

Subbasin	Bull Trout Observed within the Mainstem? (Yes/No)	Maximum Upstream Movement in Mainstem Observed (rkm)	Maximum Downstream Movement in Mainstem Observed (rkm)	Total of Mainstem Migration Corridor Used (rkm)
Lower Columbia River				
Hood River	YES	-	39	39
Klickitat River*	NO	-	-	-
Deschutes River*	YES	18	22	40
John Day River*	NO	-	-	-
Umatilla River*	NO	-	-	-
Walla Walla River	YES	130	44	174
Yakima River*	NO	-	-	-
Mid-Columbia River				
Wenatchee River	YES	25	24	49
Entiat River	YES	64	240	304
Methow River	YES	15	113	128
Lower Snake River				
Tucannon River	YES	73	157	230
Clearwater River*	NO	-	-	-
Asotin Creek*	NO	-	-	-
Grande Ronde River*	NO	-	-	-
Salmon River*	NO	-	-	-
Imnaha River	YES	90	195	285
Sheep Creek**	YES	-	-	-
Granite Creek**	YES	-	-	-

* Subbasins with no direct tagging studies to specifically evaluate mainstem use.
** Immigrants from other unknown source populations appear to be the only bull trout present within the subbasin.

We used telemetry (acoustic and radio) data in conjunction with PIT detections, observations at mainstem dams, and other information to estimate the proportion of the mainstem lower Columbia, mid-Columbia and lower Snake rivers known to be used by bull trout. The percentage of the mainstem migration corridors (linear distance) used by bull trout is 63%, 93%, and 100%, respectively (Figure 3.1).

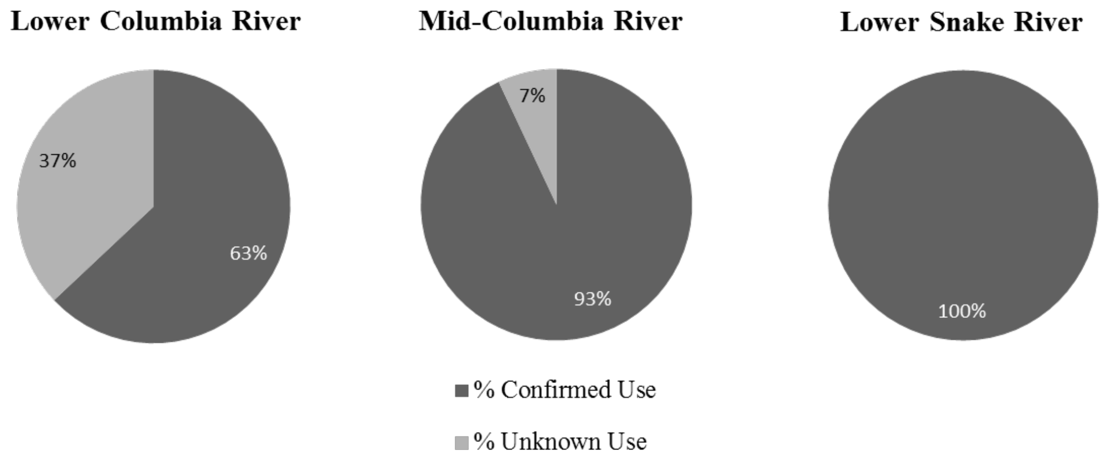

Figure 3.1. The proportion of confirmed use and unknown use of the mainstem lower Columbia, mid-Columbia and lower Snake rivers by migratory bull trout.

<u>Mainstem movement timing</u>

Very limited data are available to describe movement timing within the mainstem. Bull trout observations, telemetry data, and PIT detections at mainstem dams and near the mouths of the subbasins were used to describe bull trout movement timing in the mainstem. All three of these data types consist of bull trout locations at a specific point in time. Presence can be established with these locations, but multiple locations for an individual fish are needed to describe movement. We also describe movements in some cases using our understanding of general bull trout movement patterns, professional judgment, and interpretation. Descriptions of bull trout movements in the mainstem include the direction of movement (upstream, downstream) when possible. In many cases, there was only a single location for an individual bull trout. As discussed previously, we used our understanding of general bull trout movement patterns and context to establish direction of movement when possible. For example, many PIT detection arrays within the lower reaches of various subbasins consist of a single line of antennas so that direction of movement cannot be determined. When detection histories were available, multiple locations allowed us to determine direction of movement. With only a single detection/location at the mouth of a subbasin, our knowledge of bull trout movement patterns and timing within that subbasin were used to assign direction of travel. The same logic was applied to PIT detection data from the mainstem.

In general, subadult bull trout migrate from their respective subbasins to the mainstem Columbia and lower Snake rivers during the fall and winter months (e.g., October – February), or during the spring and early summer (e.g., April – June). Fall outmigration by subadult bull trout is more commonly observed than spring outmigration (Table 3.4). Adult bull trout primarily migrate from their respective subbasins to the mainstem in the fall (e.g., September – December) following the spawning period. Movement into the mainstem from some subbasin populations continues through February (Table 3.4). Migration into the mainstem has been documented during most other months for both adult and subadult bull trout, but these observations appear to be much less common. Following fall/winter entry into the mainstem Columbia or lower Snake rivers, observations of downstream movements were more frequent than upstream movements, occasionally resulting in connectivity with a non-natal downstream subbasin. Movements within the mainstem during the winter were less frequent than either fall or spring movements. During the spring and early summer, movement frequency in the mainstem increases in an upstream direction towards subbasin spawning areas. In the following sections, we summarize mainstem movement timing for each of the three study reaches. We used all of the data presented in Chapters 1 and 2 to create the summary. Many of the observations from that data did not indicate lifestage (adult, subadult), particularly for detections of PIT-tagged individuals. As a result, movement timing for the study reaches is not always summarized by lifestage. In addition, observations of bull trout at the mainstem FCRPS projects and the mid-Columbia PUD projects are a function of monitoring schedules. Thus, the presence or absence of bull trout at the mainstem projects during time periods when no monitoring was conducted is unknown. And finally, details associated with the following summaries of mainstem movement timing can be found in the relevant sections of Chapters 1 and 2.

Lower Columbia River Reach

Movement of subadult and adult bull trout into the mainstem lower Columbia River has been observed during all months except September. The majority of these movements occurred during the fall and winter with fewer movements observed during spring and early summer. Observations of bull trout in the mainstem have occurred from December through September, and presence during October and November can be inferred from mainstem entry timing. Limited data suggest movements within the mainstem are less common during the winter months when water temperatures are cooler and day length is shorter. Most of the mainstem observations of bull trout have occurred around Bonneville and McNary dams, and were likely associated with Hood River and Walla Walla subbasin bull trout populations, respectively.

Bull trout have been observed moving upstream through one of the ladders at Bonneville Dam during the spring and summer (March – September), and they have only been observed on a single occasion (March) moving downstream through the bypass system. Bull trout have also been observed downstream from Bonneville Dam near Hamilton Island and in the lower Sandy River, as well as upstream from the dam in Bonneville Pool from May through August. Observation locations in Bonneville Pool ranged from near Cascade Locks, upstream to Drano Lake and the mouth of the Klickitat River.

Bull trout have been observed and detected (PIT-tagged) moving upstream through the fish ladders at McNary Dam during the spring and summer (April – July), and PIT-tagged individuals have been detected in the juvenile bypass in April and June. In addition, one untagged bull trout was observed on the separator in the juvenile bypass during November, and a bull trout mortality was recovered from the transportation raceways in August when fish transport was still active at McNary. Observations of bull trout in McNary Pool have occurred primarily during the winter from December through March. Extensive data sets documenting bull trout entry into McNary Pool from the Walla Walla River, and return from McNary Pool to the Walla Walla River along with the observations described above, indicate overall bull trout presence in the mainstem from October through June.

The timing of other observations/detections of bull trout in the mainstem lower Columbia River include a capture of an individual in the fish ladder at The Dalles Dam in December, several bull trout detections and observations in the fish ladder at John Day Dam from April through August, and one detection in May in the juvenile bypass at John Day.

Mid-Columbia River Reach

Movement of subadult and adult bull trout into the mainstem mid-Columbia River has been observed during all months. The majority of these movements occured during the fall and winter for both adult and subadult bull trout, but subadult movement into the mainstem also occured less frequently during the spring and summer. Observations of bull trout within the mainstem have also occurred during all months. Adult bull trout presence in the mainstem generally spans from the fall, following spawning, through the winter, continuing until it is time to return to subbasin spawning areas (September – July). Subadult bull trout were present in the mainstem during all months, but movements within the mainstem were more common during the fall and spring months.

Bull trout have been observed and/or detected at all five mid-Columbia River PUD hydroprojects. Observations were less frequent at Priest Rapids and Wanapum Dams at the lower end of the mid-Columbia Reach. The primary time period for observations and detections of bull trout in the fish ladders at all of the mainstem projects was during the spring and summer (April-July). This timing coincides with the time period when adult bull trout are returning to headwater spawning areas in the relevant subbasins. Observations and detections also occurred in all of the fish ladders during the fall and early winter (October – January), but were less frequent than spring/summer observations. Subadult bull trout movement through the ladders was much more common during the fall than during the spring. Downstream passage at all five projects occurred primarily during the fall and early winter (October – December). The mid-Columbia hydroprojects have various strategies for facilitating downstream fish movement. Observations and PIT detections are available for several of the projects, but much of the data on downstream movements was a result of radio telemetry studies. These studies showed bull trout movement downstream at the hydroprojects during the spring and early summer (March – July) as well as during the fall and early winter (October – December). Many of these individuals were tracked through the powerhouses and turbines, but routes of passage were unknown for many others. Over-winter surveys in the mainstem mid-Columbia River identified specific locations for bull trout radio-tagged in the Entiat River Subbasin that ranged from mid-Wanapum Pool upstream, to Chelan Falls near Lake Chelan. These locations were identified from November through April.

Lower Snake River Reach

Movement of subadult and adult bull trout into the mainstem lower Snake River has been observed from the fall through the early summer (September – June). The majority of these movements occur during the fall and winter for both adults and subadults, but there is also a spring window of activity (March – June) for subadult bull trout movement into the mainstem. Observations of bull trout in the mainstem have occurred during all months. Observations/detections of bull trout moving upstream through the fish ladders were more common during spring and summer (April – August), and the timing of downstream movement through the bypass systems was similar during spring and summer, but also continued into the fall (March – October). Bull trout were observed or detected moving both upstream and downstream at all four lower Snake River projects. Most of the data on mainstem Snake River locations for bull trout were associated with the Imnaha River and Tucannon River subbasin populations. Although the origin of many of the bull trout observed at the lower Snake dams is unknown, the Tucannon River Subbasin populations were the most likely source. Radio telemetry data indicated that Imnaha River bull trout overwinter at various locations from the mouth of the Imnaha, upstream to Hells Canyon Dam from December through February. Observations of movements within the mainstem were less common during the winter months when water temperatures are cooler and day length is shorter.

Most of the data for mainstem Snake River bull trout movements was associated with Lower Monumental and Little Goose dams. And most of the bull trout observed or detected were from the Tucannon River Subbasin. Upstream movement through the fish ladders at these projects occurred from April through October. Most of these upstream movements occurred during the spring and summer (April – July), and coincide with the timing for adult movement back towards headwater spawning areas in relevant subbasins. This timing was similar at Ice Harbor and Lower Granite Dams, but with far fewer observations. Observations of downstream migrant bull trout in the juvenile bypass systems at all four lower Snake River dams occurred primarily from April through August. Many of these individuals were also eventually detected returning to spawning areas.

Connectivity between subbasins

Bull trout exhibit multiple life histories involving movements and migrations over different temporal and spatial scales (Schaller et al. 2014). Individuals that migrate over relatively long distances may disperse to other populations. This connectivity may increase genetic variation and contribute to the persistence of the recipient population (Rieman and McIntyre 1993). In addition, long-distance migrants may move into non-natal tributaries and recolonize habitat where bull trout have been extirpated, or possibly establish new populations.

Migratory bull trout may encounter a range of influences within and along migratory corridors that collectively affect their ability to reach rearing, foraging and overwintering habitat, or to connect with local populations in other subbasins. Bull trout that migrate to the mainstem encounter dams and reservoirs that have created conditions much different than the riverine habitats that were historically present. Spatial patterns of dispersal are known to be influenced by interactions with environmental (e.g., water temperature, water velocity, physical habitat) and biotic (e.g., predation, competition) conditions (Bascompte 2009; Wisz et al. 2013). Migrating fish have behavioral, physiological and energetic limitations that determine their temporal and spatial movement capabilities (Cooke et al. 2008). Bull trout evolved within largely unimpeded migratory corridors, but with the development of the FCRPS mainstem dams and their associated impoundments, numerous potential impediments to migration are now present. The energetic costs associated with passage at mainstem FCRPS hydroprojects and exposure to various biotic interactions and altered environmental conditions in the mainstem reservoirs may affect bull trout movements and could reduce survival.

We examined PIT detection data, bull trout recaptures and observations, radio- and acoustic-telemetry results, and genetic assignment studies to help describe bull trout connectivity between the 18 subbasins we reviewed. Our ability to summarize connectivity between subbasins was a function of several factors: (1) the number of migratory bull trout tagged (e.g., PIT-tagged, radio-tagged) in each subbasin, (2) the ability to detect tagged fish within a given subbasin, and (3) the availability of genetic assignment information for bull trout captured within each subbasin. Bull trout that entered the mainstem and survived appeared to return primarily to their natal stream. However, empirical evidence confirms fish have occasionally ascended tributaries in non-natal subbasins demonstrating connectivity with other populations (Table 3.6). Based on PIT-detection and genetic data, bull trout movement from an upstream subbasin to a downstream subbasin was observed more often than movement from a downstream subbasin to an upstream subbasin. Because of the observed tendency of migratory bull trout to move in a downstream direction when they enter the mainstem, those that do not return to their natal subbasin continue downstream, sometimes resulting in connectivity with a downstream subbasin. If fewer individuals tend to venture upstream from their natal subbasin once in the mainstem, a lower rate of connectivity with other upstream subbasins may be expected. Occasionally, bull trout from a given subbasin may enter tributaries to the Columbia and Snake rivers that do not currently support reproducing bull trout populations. For example, several migratory bull trout from the Methow River Subbasin have been detected in the Okanogan River subbasin. Similarly, bull trout that may be immigrants from other source populations have occasionally been observed within the Sheep Creek and Granite Creek subbasins, where no known reproducing populations currently exist. Based on limited information and variability in natural migration patterns, it is unclear if mainstem hydroprojects and their impoundments have influenced directional connectivity between subbasins or affect tributary selection.

Table 3.6. Confirmed connectivity between subbasins is indicated by a "X". Cells highlighted in green indicate connectivity from an upstream subbasin with a downstream subbasin. Cells highlighted in pink indicate connectivity from a downstream subbasin to an upstream subbasin.

	Hood	**Klickitat**	**Deschutes**	**John Day**	**Umatilla**	**Walla Walla**	**Yakima**	**Wenatchee**	**Entiat**	**Methow**	**Tucannon**	**Clearwater**	**Asotin**	**Grande Ronde**	**Salmon**	**Imnaha**	**Sheep**	**Granite**
Hood																		
Klickitat																		
Deschutes																		
John Day																		
Umatilla																		
Walla Walla					X													
Yakima																		
Wenatchee									X									
Entiat							X	X		X								
Methow									X									
Tucannon					X													
Clearwater																		
Asotin																		
Grande Ronde																		
Salmon																		
Imnaha													X	X				
Sheep																		
Granite																		

The level of isolation of one bull trout population from another appears to be influenced by the stream distance between populations and by biological and ecological limits to the expression of the migratory life history strategy (Dunham and Rieman 1999; Whitesel et al. 2004; Burns et al. 2005). In addition, man-made impediments can also contribute to isolation. To assess dispersal distance, we used the distance between the mouths of the 18 subbasins rather than the distance between individual populations. Our geographic scale, which included 18 subbasins, 34 core areas, and 260 local populations, precluded the use of distances between all of the individual local populations. We observed connectivity between subbasins more frequently when subbasins were closer together rather than more distant from one another. For example, connectivity between two subbasins was documented seven times when the distance between them was less than 100 rkm, and only two times when the distance between them was greater than 100 rkm (Table 3.7). The average distance where downstream connectivity has been documented was 92 rkm (SD = 79; range: 25 – 240 rkm). The average distance between subbasins where upstream connectivity has been observed was 46 rkm (SD = 28; range: 25 – 64 rkm).

Table 3.7. The stream distance (rkm) between each of the 18 Columbia and Snake River subbasins that were reviewed. Cells highlighted in green indicate confirmed connectivity from an upstream subbasin with a downstream subbasin. Cells highlighted in pink indicate connectivity from a downstream subbasin with an upstream subbasin.

	Hood	Klickitat	Deschutes	John Day	Umatilla	Walla Walla	Yakima	Wenatchee	Entiat	Methow	Tucannon	Clearwater	Asotin	Grande Ronde	Salmon	Imnaha	Sheep	Granite
Hood		17	57	78	192	236	266	481	506	570	349	473	483	520	552	557	617	634
Klickitat	17		40	61	175	219	249	464	489	553	332	456	466	503	535	540	600	617
Deschutes	57	40		21	135	179	209	424	449	513	292	416	426	463	495	500	560	577
John Day	78	61	21		114	158	188	403	428	492	271	395	405	442	474	479	539	556
Umatilla	192	175	135	114		44	74	289	314	378	157	281	291	328	360	365	425	442
Walla Walla	236	219	179	158	44		30	245	270	334	113	237	247	284	316	321	381	398
Yakima	266	249	209	188	74	30		215	240	304	117	241	251	288	320	325	385	402
Wenatchee	481	464	424	403	289	245	215		25	89	332	456	466	503	535	540	600	617
Entiat	506	489	449	428	314	270	240	25		64	357	481	491	528	560	565	625	642
Methow	570	553	513	492	378	334	304	89	64		421	545	555	592	624	629	689	706
Tucannon	349	332	292	271	157	113	117	332	357	421		124	134	171	203	208	268	285
Clearwater	473	456	416	395	281	237	241	456	481	545	124		10	47	79	84	144	161
Asotin	483	466	426	405	291	247	251	466	491	555	134	10		37	69	74	134	151
Grande Ronde	520	503	463	442	328	284	288	503	528	592	171	47	37		32	37	97	114
Salmon	552	535	495	474	360	316	320	535	560	624	203	79	69	32		5	65	82
Imnaha	557	540	500	479	365	321	325	540	565	629	208	84	74	37	5		60	77
Sheep	617	600	560	539	425	381	385	600	625	689	268	144	134	97	65	60		17
Granite	634	617	577	556	442	398	402	617	642	706	285	161	151	114	82	77	17	

Physical barriers are known to impede the movement of salmonids through migratory corridors (Powers and Orsborn 1985; Rieman and McIntyre 1993; Caudill et al. 2007). Similarly, the existence of both natural and anthropogenic barriers can adversely influence connectivity between bull trout populations (Rieman and McIntyre 1993; DeHann et al. 2011). Dams lacking sufficient passage routes for bull trout may impede migration and contribute to the isolation of historically connected populations (Barrows et al. 2014a). Upriver migration of anadromous salmonids can be energetically expensive when travel distances are long and river conditions are adverse (Bernatchez and Dodson 1987; Leonard and McCormick 1999; Standen et al. 2002; USFWS 2008a). Bull trout may be energetically compromised as a result of moving upriver in the mainstem where there are potential migration impediments associated with the mainstem dams. The energetic costs associated with passing a single mainstem hydroproject may negatively affect bull trout movement capabilities, growth and survival. The cumulative effects of attempting to pass multiple mainstem dams could be even more limiting to connectivity between subbasins; however, there is evidence from studies in the mid-Columbia River (BioAnalysts, Inc. 2004, 2009) that bull trout frequently pass multiple dams successfully.

Bull trout that attempt long-distance migrations within the mainstem Columbia and Snake rivers are likely to encounter a greater number of mainstem dams than fish that make shorter migrations. We observed connectivity between subbasins on five occasions when only one mainstem dam was present between them (Table 3.8). Connectivity was only observed on two occasions when more than one mainstem dam was present between two subbasins. Since there are behavioral and/or biological limitations to the spatial extent of bull trout migrations, limited numbers of marked fish, and limitations on detecting marked fish, it is difficult to relate the influence of the number of mainstem hydroprojects between subbasins to observed connectivity.

Table 3.8. The number of mainstem dams between each of the 18 Columbia and Snake River subbasins that were reviewed. Cells highlighted in green indicate confirmed connectivity from an upstream subbasin with a downstream subbasin. Cells highlighted in pink indicate connectivity from a downstream subbasin with an upstream subbasin.

	Hood	Klickitat	Deschutes	John Day	Umatilla	Walla Walla	Yakima	Wenatchee	Entiat	Methow	Tucannon	Clearwater	Asotin	Grande Ronde	Salmon	Imnaha	Sheep	Granite
Hood		0	1	2	2	3	3	6	7	8	5	7	7	7	7	7	7	7
Klickitat	0		1	2	2	3	3	6	7	8	5	7	7	7	7	7	7	7
Deschutes	1	1		1	1	2	2	5	6	7	4	6	6	6	6	6	6	6
John Day	2	2	1		0	1	1	4	5	6	3	5	5	5	5	5	5	5
Umatilla	2	2	1	0		1	1	4	5	6	3	5	5	5	5	5	5	5
Walla Walla	3	3	2	1	1		0	3	4	5	2	4	4	4	4	4	4	4
Yakima	3	3	2	1	1	0		3	4	5	2	4	4	4	4	4	4	4
Wenatchee	6	6	5	4	4	3	3		1	2	5	7	7	7	7	7	7	7
Entiat	7	7	6	5	5	4	4	1		1	6	8	8	8	8	8	8	8
Methow	8	8	7	6	6	5	5	2	1		7	9	9	9	9	9	9	9
Tucannon	5	5	4	3	3	2	2	5	6	7		2	2	2	2	2	2	2
Clearwater	7	7	6	5	5	4	4	7	8	9	2		0	0	0	0	0	0
Asotin	7	7	6	5	5	4	4	7	8	9	2	0		0	0	0	0	0
Grande Ronde	7	7	6	5	5	4	4	7	8	9	2	0	0		0	0	0	0
Salmon	7	7	6	5	5	4	4	7	8	9	2	0	0	0		0	0	0
Imnaha	7	7	6	5	5	4	4	7	8	9	2	0	0	0	0		0	0
Sheep	7	7	6	5	5	4	4	7	8	9	2	0	0	0	0	0		0
Granite	7	7	6	5	5	4	4	7	8	9	2	0	0	0	0	0	0	

Interactions and Potential Effects of Mainstem Dams and Impoundments

Bull trout interactions with mainstem Columbia and lower Snake River dams

Evidence confirms that bull trout interact with all 13 of the mainstem dams that have fish passage structures in the lower and mid-Columbia and lower Snake rivers. Bull trout that move upstream past a given dam most likely must pass via one or more fish ladders. Upstream passage has been confirmed at all 13 of the mainstem dams that have fish passage facilities.

Bull trout have moved downstream through all 13 of the mainstem dams that have fish passage structures. Individuals that pass downstream over or through a dam may pass via spillways, modified spillways, fish bypass facilities, enhanced ice and trash sluiceways or through the turbines. Downstream passage is also possible through the fish ladders and locks, albeit less likely. Passage routes and configurations are specific to each hydroproject. There is also the potential for bull trout that use the fish bypass facilities to be inadvertently transported by truck or barge from the lower Snake River to below Bonneville Dam.

Chief Joseph and Hells Canyon dams lack fish passage structures and are impassable barriers to upstream movement of bull trout. Historically, bull trout populations upstream and downstream of these two dam sites were connected via the mainstem. The current presence of migratory individuals in the vicinity of both dams suggests that they might "connect" with upstream populations in the absence of these impassable barriers.

Migratory bull trout from seven of the 16 (44%) subbasins in the study area that have reproducing bull trout populations also have confirmed interactions with mainstem dams. Of the seven subbasins with confirmed bull trout interactions with hydroprojects, all but one (Hood River Subbasin) involve interactions with more than a single mainstem dam. Bull trout from two (29%) of the seven subbasins (Entiat River and Tucannon River subbasins) had confirmed interactions with five hydroprojects each. Table 3.9 is a summary of upstream and downstream passage that has been confirmed at each of the mainstem dams.

Table 3.9. Summary of upstream and downstream passage that has been confirmed at each of the mainstem dams by bull trout from each of the reviewed subbasins. The occurrence of upstream passage is signified by "↑" and , downstream passage is signified by "↓". If the occurrence of both upstream and downstream bull trout passage has been confirmed, a "↕" was used.

	Bonneville Dam	The Dalles Dam	John Day Dam	McNary Dam	Priest Rapids Dam	Wanapum Dam	Rock Island Dam	Rocky Reach Dam	Wells Dam	Chief Joseph Dam	Ice harbor Dam	Lower Mon. Dam	Little Goose Dam	Lower Granite Dam	Hells Canyon Dam
Hood River	↕	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Klickitat River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschutes River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
John Day River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Umatilla River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walla Walla River	-	-	-	↕	↑	-	-	-	-	-	-	-	-	-	-
Yakima River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wenatchee River	-	-	-	-	-	-	-	↑	↑	-	-	-	-	-	-
Entiat River	-	-	-	-	↕	↕	↕	↕	↑	-	-	-	-	-	-
Methow River	-	-	-	-	-	-	↕	↕	↕	-	-	-	-	-	-
Tucannon River	-	-	-	↓	-	-	-	-	-	-	↓	↓	↕	↑	-
Clearwater River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asotin Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grande Ronde River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salmon River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Imnaha River	-	-	-	-	-	-	-	-	-	-	-	-	↓	↓	-
Sheep Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Granite Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Potential effects of mainstem dams, their operation and impoundments on bull trout

Mainstem habitats and connectivity likely serve an important role in bull trout recovery (FWS 2002; FWS 2010; FWS 2014; Barrows et al. 2014a; Small et al. 2012). Mainstem FCRPS dams have the potential to adversely impact bull trout connectivity within migratory corridors as well as between core area populations. Mainstem dams that lack appropriate temporal bull trout passage may impact migration and contribute to the isolation of populations that were connected historically (Barrows et al. 2014a; DeHaan et al. 2011). In addition, FCRPS dams have altered the natural hydrograph, and their respective impoundments are now slow velocity, seasonally warm-water reservoirs compared to natural river conditions (Keefer et al. 2004; Petrosky and Schaller 2010). The lacustrine habitats within these reservoirs no longer resemble the riverine migration corridors that were historically used by migratory bull trout, and these altered conditions may affect migration timing. Historically, these mainstem river reaches provided seasonal environments for migratory bull trout to forage and overwinter. However, we have evidence that species composition has changed after impoundment, and it is unknown whether this is beneficial for bull trout growth, maturation, and fecundity. The reservoir habitat is also more suitable for native and exotic avian and aquatic predators (Williams et al. 2005; Ferguson et al. 2005).

Connectivity

Each of the mainstem Columbia and Snake river dams represents a potential migration impediment between bull trout core area populations in different subbasins, and between mainstem habitats upstream and downstream from the dams. Dams with adequate upstream and downstream passage routes may allow for unimpeded movement and connectivity between populations, but dams that lack functional passage for bull trout may adversely impact (i.e., impede) migration and connectivity (Barrows et al. 2014a). The relatively small amount of data that describes movements and disposition for bull trout in the FCRPS is discussed in Chapter 2, however, these data are lacking for the vast majority of individuals that enter the mainstem Columbia and Snake rivers including the specific temporal and spatial aspects of migration over or through each dam and through each reservoir.

<u>Migration/passage delay</u>

Project operations and monitoring capabilities, in addition to upstream and downstream passage routes vary between each mainstem dam (Chapter 2, Appendix A). Migratory behavior and forebay delay of juvenile anadromous salmonids have been evaluated (Venditti et al. 2000, Budy et al. 2002) but similar evaluations have not been conducted for migratory bull trout. Although information to evaluate passage routes and the potential effects on bull trout passage success and migration patterns is limited, we use the available information to qualitatively describe what is known about bull trout passage at the mainstem FCRPS hydroprojects. Extensive changes to FCRPS hydroproject configurations and operations in the study area have taken place over the last two decades, primarily to increase passage efficiency for downstream migrating anadromous salmonids. It is possible that many of the changes and improvements to dam configurations and operations have also benefitted the downstream passage of bull trout, but this has not been specifically evaluated. Most of the improvements have been made to pass salmon and steelhead smolts more effectively and efficiently. Adult and subadult bull trout migrate both upstream and downstream in the FCRPS, and most are larger in size than salmon and steelhead smolts. Nonetheless, downstream passage improvements made for smolts could also benefit both adult and subadult bull trout that move downstream in a similar manner. However, both adult and subadult bull trout may migrate at a wider range of depths and locations within the river channel than downstream migrating salmon and steelhead. Surface passage routes for downstream migrant anadromous salmonids, including removable spillway weirs, top spill weirs, adjustable spillway weirs, and enhanced ice and trash sluiceways have been installed at many of the FCRPS projects in the lower Columbia and Snake rivers. In addition, juvenile fish bypass systems that divert downstream migrants away from the turbines have been installed in seven of the eight lower Columbia and lower Snake River FCRPS projects. Similar changes to benefit downstream migrant salmonids have been incorporated into mainstem dams in the mid-Columbia River reach.

Bull trout may pass downstream through or over the mainstem dams during most months. Available information from PIT detections, observations at the separators, and observations in condition samples in the fish bypass systems suggest downstream passage at the dams may be common during the spring and early summer (March – June), but also likely occurs during the fall/winter when observations and/or detections are not conducted or possible. The period of operation for the juvenile bypass systems at the mainstem FCRPS dams varies, and typically only occurs from March or April through either the end of November or through mid-December, depending on the specific project (for details see Chapter 2). Thus, from November or December through February or March there are only two primary routes of downstream passage available: (1) fish ladders which are designed primarily for upstream passage, and (2) turbines which are not monitored for PIT tags. Considering that bull trout most commonly enter the mainstem from their subbasin of origin in the fall and winter (October – February) and available telemetry information indicates the majority utilize FMO habitat downstream from their natal subbasin, often passing downstream of mainstem dams during this time period (BioAnalysts, Inc. 2004, 2009; Nelson and Nelle 2008; Barrows et al. 2014a), downstream passage may be most common during winter months. These individuals may pass unobserved or undetected during this time period when the turbines are the most likely route for downstream migrants, and when the bypass system is not available. In addition, during this time period, spillways and spillway weirs are not in operation. Thus, it is largely unknown to what extent bull trout pass downstream through the dams (e.g., turbines) successfully but undetected, attempt to pass the dams and fail, or are fatally injured while attempting to pass the dams, particularly during the fall and winter when the only routes available are the turbines, fish ladders, and ice and trash sluiceways where they exist.

The only data available to evaluate downstream passage delay at the mainstem FCRPS hydroprojects is from PIT-tagged bull trout detected within the bypass systems. A total of 16 PIT-tagged bull trout have been detected in juvenile bypass systems at the FCRPS projects. Detections within the bypass systems indicated that four (25%) of these individuals were delayed on the separators at two projects. A PIT-tagged Touchet River bull trout was detected in the full flow bypass in June 2014 at McNary Dam. This fish was delayed for over 17 hours before being detected on the B-raceway diversion PIT antennas, and subsequently at the antennas indicating exit to the tailrace. The delay likely occurred on the separator where there is no holding facility. Detection histories for downstream migrant bull trout at Little Goose Dam indicated delays of one day, two days, and 16 days on the separator. These three individuals were detected on the full flow bypass PIT antennas in May 2010, and early July in 2009 and 2011. Delays were observed in the elapsed time from detection on the full flow bypass antennas to detection in the adult fish return to the tailrace. The cause of these delays is unknown, but is a concern since there are no holding facilities at the separator, and large (adult) fish should be removed and returned to the river as soon as possible.

The available information suggests bull trout upstream migration over most FCRPS mainstem dams primarily occurs during the spring and early summer (i.e., April through July), but has also occurred during other months. Fish counting seasons (visual) at mainstem adult fishways vary slightly, but generally occur from April through October at FCRPS dams (Chapter 2, Appendix A). Fish are counted from 0400 until 2000 each day. Video counts are conducted before April and after October but bull trout are not enumerated. An examination of the detection histories for 11 PIT-tagged bull trout detected within the FCRPS fishways only indicated a potential passage delay for a single individual. This bull trout passed upstream through the Oregon shore fish ladder at McNary Dam in May 2009. The only detections were at the PIT antennas on either side of the counting window. It was not detected on the weir antennas further downstream in the ladder. The elapsed time between the first and last detections at the counting window was 17 hours. We assumed this individual subsequently exited into the McNary forebay. Three weeks later in June, this bull trout was detected on the weir antennas in the Oregon shore ladder after passing back downstream of McNary, undetected. Over the course of 24 hours, this fish first moved upstream through the weirs, then downstream. The last detection was on the furthest downstream weir, and we assume this individual exited to the tailrace. There were no further detections for this fish, and its ultimate fate is unknown.

Most FCRPS projects have multiple fish ladders for upstream passage. When annual maintenance is conducted, there is typically at least one fish ladder open continuously. Two of the lower Snake River projects (Little Goose and Lower Granite dams) have a single fish ladder, and when annual maintenance takes place in January and February, upstream passage is not possible. Since bull trout are likely in the mainstem Snake River near these projects during this time period, any that attempt to migrate upstream will be delayed.

Detections of PIT-tagged bull trout at Little Goose and Lower Granite dams have demonstrated that some fish pass upstream and downstream (i.e., both bypass and spill) of the dams multiple times (as many as four times) during the spring and summer migration period. Most of these fish were adult-sized and were of Tucannon River origin. Relative to observations of this pattern at Little Goose, it is unclear why these fish did not enter the Tucannon River after their initial upstream/downstream passage. The timing of these events was similar to the timing that would be expected for adult bull trout returning to their subbasins for fall spawning. In addition, at Little Goose Dam, six of 11 individuals that followed this pattern were never detected again in the Tucannon River or elsewhere following their last downstream passage. This behavior could indicate local foraging and associated movements, or it could be an indication of migration delay associated with the dam or operations.

Although upstream passage delay at most mainstem FCRPS dams for bull trout has not been evaluated, passage delay in the mid-Columbia at non-FCRPS projects has been assessed (BioAnalysts, Inc. 2004, 2009). The investigators concluded that bull trout may experience a relatively short delay while passing upstream of Rock Island, Rocky Reach and Wells dams, but the delays do not appear to affect migration timing or the ability of fish to reach spawning tributaries prior to the spawning period. It is unclear whether this is true in other subbasins (e.g., Walla Walla River, Umatilla River) where habitat conditions detrimental to migration that result from irrigation diversions and low flow barriers to bull trout passage develop during the late spring and early summer months in some middle and lower subbasin areas (Barrows et al. 2014a; Schaller et al. 2014). These conditions usually develop by late June, but in some subbasins (e.g., Walla Walla River Subbasin) during low flow years, these conditions can develop as early as late May. Even a short passage delay at a mainstem dam may affect the ability of a bull trout to migrate to the mouth and through the lower reaches of a given subbasin and reach upstream spawning areas before the window of passage opportunity closes.

Juvenile Fish Transportation Program

The Juvenile Fish Transportation Program was developed to provide a downstream migration alternative for juvenile anadromous fish to avoid passing through multiple FCRPS hydroprojects. Barge and truck transportation is implemented from April through September at Lower Monumental Dam, and through October at Little Goose and Lower Granite dams each year. Transport begins soon after the juvenile bypass systems begin operation on April 1 (March 26 for Lower Granite). All juvenile fish are transported with the exception of those marked for in-river studies. Any bull trout that are entrained into the bypass system and not removed on the separator would likely be transported along with the anadromous fish to a release site below Bonneville Dam. Fish sampling is conducted when fish are bypassed for transportation, but considering the low relative abundance of bull trout in the bypassed fish, the chance of observing them in the samples is likely to be low. From 1983 – 2011, a total of 24 bull trout were observed in condition samples at the three lower Snake River transport projects. There is no way to estimate the total number of bull trout that may have been transported over the years, but the impact on the migratory component of the population could be significant. The disposition of any bull trout captured, transported, and released below Bonneville Dam is unknown, but they are most likely lost to the population of origin.

Survival

The survival of bull trout that migrate to the mainstem Columbia and Snake rivers from each subbasin is largely unknown. Upstream and downstream passage at the FCRPS dams and through the FCRPS reservoirs could potentially affect bull trout survival, but this has not been specifically evaluated. Information from studies conducted in the Walla Walla River Subbasin suggests the majority of bull trout that enter the mainstem may not survive to return to the subbasin, but data to evaluate mainstem survival for bull trout from the Walla Walla River and other subbasins is lacking.

Dam passage

The survival of bull trout following upstream passage at the FCRPS mainstem dams has not been evaluated. Detection histories for 11 PIT-tagged bull trout that successfully passed upstream through FCRPS fish ladders only indicated delay for one individual. However, three of these fish (27%) were never detected again at any location, and they may not have survived their passage events. BioAnalysts, Inc. (2004, 2009) have investigated passage at multiple non-FCRPS dams in the mid-Columbia River reach using radio-telemetry and concluded that hydroproject operations did not appear to negatively affect survival of bull trout, and that no tagged adult bull trout were killed during upstream passage through the mid-Columbia dams. Post-passage survival was not specifically evaluated, but following dam passage, many of the bull trout subsequently moved into tributaries and no adverse effects due to upstream passage were documented (Nelson et al. 2007; Nelson and Nelle 2008; BioAnalysts, Inc. 2009; Nelson and Johnsen 2012).

The survival of bull trout following downstream passage at the FCRPS mainstem dams has not been investigated. Detection histories for 16 PIT-tagged bull trout that passed downstream through FCRPS fish bypass systems indicated that four individuals were delayed on the separator, but were eventually passed downstream. However, 10 of the 16 fish (62.5%) were never detected again at any location, and they may not have survived their passage events. Six of these bull trout were never detected again following downstream passage at Little Goose Dam. Since these individuals were Tucannon subbasin-origin fish, and the Tucannon River mouth is only 16 rkm downstream, the expectation would have been to eventually see detections for these fish on the PIT arrays near the mouth of the Tucannon. These bull trout could have migrated elsewhere, but considering the proximity of the Tucannon River to Little Goose Dam, the question of survival or not is more relevant. No studies have been conducted to evaluate survival through the other downstream passage routes (i.e. spill, turbines).

One possible explanation regarding these bull trout that were never detected again following upstream and downstream passage at FCRPS dams is that they entered and resided in non-natal, unmonitored tributary subbasins. Another explanation could be mortality resulting from avian and/or piscivorous predators. And yet another alternative hypothesis could follow the concept of delayed mortality for anadromous salmonids that has been linked to their hydrosystem experience and dam passage (Budy et al. 2002, Haeseker et al. 2012). If bull trout are similarly affected by their hydrosystem experience and dam passage, we may be observing delayed mortality for at least some of these fish.

Most of the available information concerning bull trout passage downstream through mainstem hydroprojects is for adults in the mid-Columbia River (BioAnalysts, Inc. 2004, 2009) and no mortality has been documented. For example, Chelan PUD investigated the downstream passage of adult bull trout at their mainstem dams in in the mid-Columbia River. From 2005 to 2009, there were 31 radio-tagged bull trout that accounted for 47 downstream passage events at Rocky Reach Dam (BioAnalysts, Inc. 2009). Of the 47 downstream passage events, 35 occurred through the powerhouse (i.e., turbines), two through the spillway, two through the surface collector and eight were not assigned a specific route of passage. During 2002 and 2003, BioAnalysts, Inc. (2004) recorded nine downstream bull trout passage events exhibited by six bull trout. Fish moved downstream through the dam via the spill bays and through the powerhouse (i.e., turbines). The authors concluded no adult bull trout were killed during downstream passage through the dams. Many of the radio-tagged fish eventually were detected in other locations following passage, and no subsequent or delayed effects were noted (BioAnalysts, Inc. 2004, 2009; Nelson and Nelle 2008; Nelson et al. 2007; Nelson and Johnsen 2012; Nelson 2014).

Mainstem impoundments

The slow, seasonally warm-water reservoirs impounded by dams throughout the mainstem Columbia and Snake rivers no longer resemble the free-flowing riverine habitats (i.e., migration corridors) historically used by migratory bull trout and may be more suitable for avian and aquatic predators (Keefer et al. 2004; Petrosky and Schaller 2010). Slow water velocities and warm seasonal water temperatures in FCRPS reservoirs may affect the timing of bull trout migration and influence bull trout survival, but information to evaluate this is lacking.

Bull trout that migrate to the mainstem may also be impacted by aquatic predators (native and exotic) that have become more widespread and abundant in the lacustrine habitats that are characteristic of the mainstem impoundments. The impact of aquatic predators (e.g., northern pikeminnow, walleye, and smallmouth bass) on bull trout survival in mainstem FCRPS reservoirs has not been evaluated.

Avian predation impacts on bull trout have been observed dating back to 2002. PIT tags from bull trout presumed to have been preyed upon have been detected at piscivorous bird colony sites (cormorant, gull, pelican, tern) in various locations in eastern Washington (Figure 3.2). A total of 57 bull trout PIT tags have been detected at these sites; 56 originating from the Walla Walla River Subbasin and one from the Tucannon River Subbasin (www.ptagis.org [queried Dec. 2014]). The date of the predation event and the location from which the fish was taken cannot be determined from the data, but the tagging location and date, or the last known location and date of detection (if available) before the discovery date at the bird colony, place bounds on the predation event. A summary of available PIT tag recovery data is presented in Table 3.10. Most of the tags were detected at Foundation Island which is primarily a cormorant nesting colony located in the Columbia River (rkm 518) just downstream from the mouth of the Snake River (rkm 522). Most of these fish were originally PIT-tagged near the Burlingame Dam and Canal on the Walla Walla River (rkm 509.059). Two PIT tags were recovered at Swallow's Nest Park (rkm 522.229) near Lewiston, Idaho from bull trout that were tagged near the Burlingame Dam and Canal.

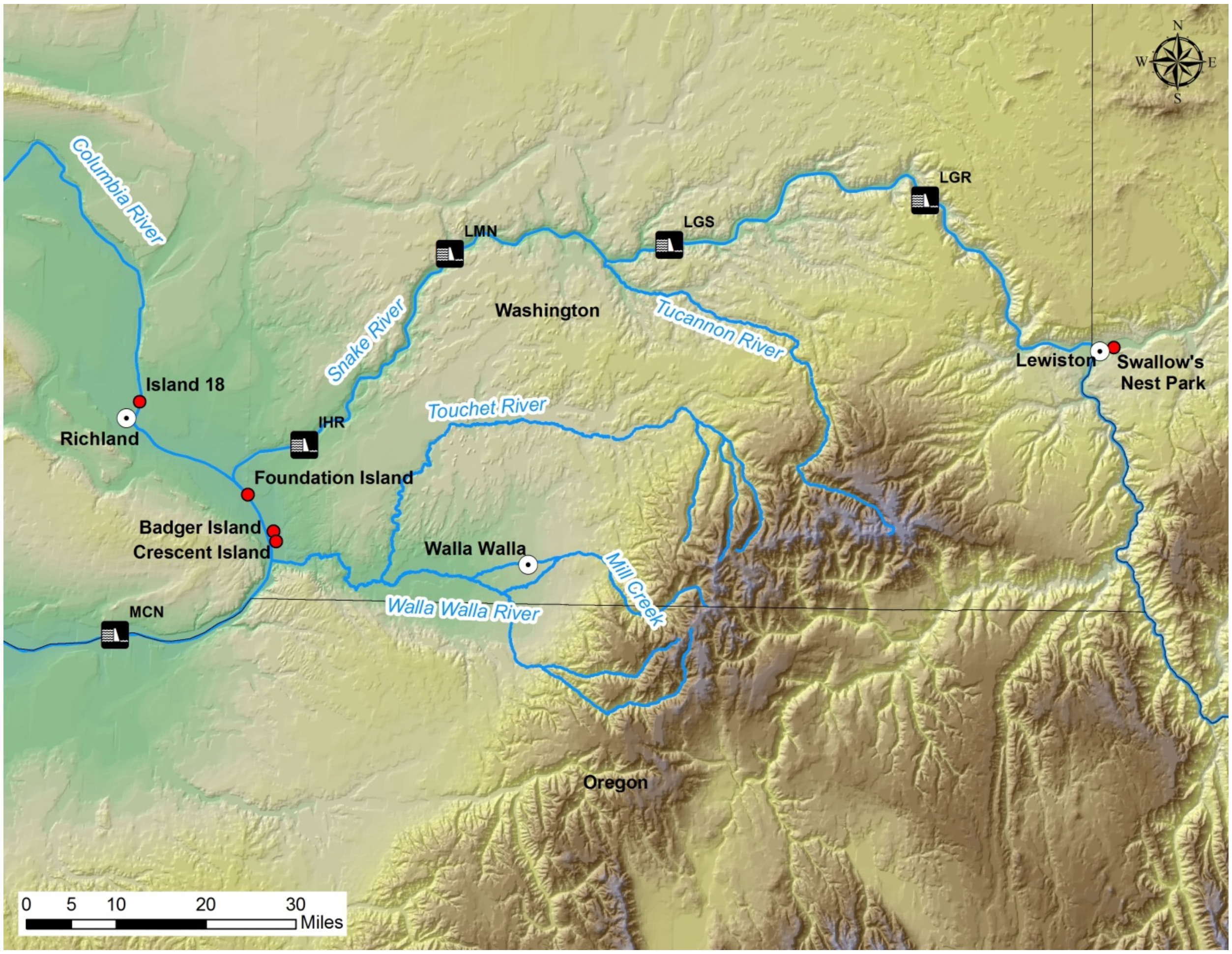

Figure 3.2. Locations of avian colonies in the Columbia River Basin (●) where PIT tags from bull trout have been recovered.

Table 3.10. Summary of bull trout PIT tag recoveries through 2013 at Columbia River Basin avian breeding colonies. Data from www.ptagis.org [queried Dec. 2014].

Bull Trout PIT Tag Release Sites of Recovered PIT Tags at Avian Colonies

Tag Release Site	Unique PIT Recoveries	Percent of Total
Mill Creek	15	26.3 %
Touchet River	3	5.3 %
Tucannon River	1	1.8 %
Walla Walla River	32	56.1 %
South Fork Walla Walla River	6	10.5 %
	57	**100 %**

Last Detection Site of Bull Trout PIT Tag Before Recovery at Avian Colony Site

PIT Site Code	Site Description	rkm*	PIT Tags
BGM	Burlingame Dam and Canal, Walla Walla River	509.059	21
ICH	Ice Harbor Dam (combined adult and full flow bypass)	522.016	1
KCB	Kiwanis Camp Bridge, Mill Creek, Walla Walla Basin	509.054.035	3
MCD	Mill Creek Diversion Project, Walla Walla Basin	509.054.019	5
NBA	Nursery Bridge Dam – adult fishway, Walla Walla River	509.072	2
ORB	Oasis Road Bridge, Walla Walla River	509.010	5
WW1	Harris Park Bridge, South Fork Walla Walla River	509.081.013	3
WW2	South Fork Walla Walla River at Bear Creek	509.081.021	1
YHC	Yellowhawk Creek, Walla Walla Basin	509.063.013	2
No Detection	------	------	14
			57

Bird Colony/Recovery Site of Bull Trout PIT Tag

Recovery Site	Primary Colony Type	PIT Recoveries	Percent of Total	rkm*
Badger Island	Pelican	13	22.8 %	512
Crescent Island	Tern/Gull	4	7.0 %	510
Foundation Island	Cormorant	37	64.9 %	518
Island 18	Cormorant	1	1.8 %	549
Swallows Park	Gull/Cormorant	2	3.5 %	522.229
		57	**100.0 %**	

* *rkm for Columbia River and tributaries*

In recent years, the recovery of bull trout PIT tags on Foundation, Badger and Crescent Islands has been noteworthy given their relatively low abundance compared to other salmonid species (Barrows et al. 2014a). From 2007 through 2011, the FWS PIT-tagged a total of 869 migratory bull trout in the middle and lower portions of the Walla Walla River Subbasin (Anglin et al. 2010; Barrows et al. 2012a, 2012b, 2014a; www.ptagis.org [queried Dec. 2014]) (Table 3.11). Of the 869 tagged bull trout, PIT tags from 31 (3.6%) were recovered at avian nesting colonies (www.ptagis.org [queried Dec. 2014]). The percentage per tagging year ranged from 0.0% in 2011 to 5.8% in 2008 (M. Barrows, unpublished data; www.ptagis.org [queried Dec. 2014]). It is unclear why no PIT tags from bull trout tagged in 2011 were recovered at avian nesting colonies and it appears to be an anomaly. The number of PIT tags recovered should be considered a minimum because not all tags from bull trout consumed by avian predators are deposited on the islands, and not all tags that are deposited on the islands are recovered. In addition, since only a relatively small proportion of the migratory bull trout population is PIT-tagged, the actual number of fish taken by avian predators is likely much higher. Detection histories indicate that consumption of bull trout by predatory birds occurs in the lower Walla Walla River Subbasin or in the Columbia River. The termination of funding for the bull trout PIT-tagging program in the Walla Walla River Subbasin following 2012 coincides with a relative absence of bull trout PIT tags recovered from nesting colonies in subsequent years. Without a population of PIT-tagged migratory bull trout, the impact of avian predators (American white pelicans, double crested cormorants, Caspian terns, California and ring-billed gulls) will be difficult to monitor.

Table 3.11. PIT tags from Walla Walla subbasin migratory bull trout recovered from avian nesting colonies on Foundation, Badger and Crescent Islands.

Tagging Year	Migratory Bull Trout Tagged (FWS)	Tags Recovered on Islands	Percentage Recovered on Islands
2007	83	3	3.6 %
2008	223	13	5.8 %
2009	154	4	2.5 %
2010	263	11	4.2 %
2011	146	0	0.0 %
Totals	***869***	***31***	***3.6 %***

Conclusions and Research, Monitoring, and Evaluation Needs

Effective management and the eventual recovery of bull trout will require a thorough understanding of migratory patterns and spatial and temporal habitat use ranging from headwater spawning and rearing areas to critical FMO habitat within migratory corridors in tributary subbasins and in the mainstem Columbia and Snake rivers. When the FWS Biological Opinion on effects of the FCRPS on bull trout was issued in 2000, the extent to which bull trout used the mainstem Columbia and Snake rivers was largely unknown, and the potential impacts of mainstem FCRPS dams and their associated impoundments on bull trout were poorly understood. Since the original Biological Opinion was issued, new information has been collected and new analyses have been produced on bull trout life history, spatial and temporal distribution and migration patterns, and use of both tributary subbasins and the mainstem Columbia and Snake rivers. The findings of this recent research and new information have not only increased our knowledge of bull trout life history and migration patterns, but also highlight the need to conduct further investigations into bull trout use of the mainstem Columbia and Snake rivers to address remaining data gaps, and to evaluate how FCRPS mainstem dams and their reservoirs may affect bull trout, their migration patterns, and mainstem critical FMO habitat.

In summary, bull trout clearly enter the mainstem of the Columbia and Snake rivers, they exhibit movements in these mainstem areas, and they interact with the mainstem dams and reservoirs. Taken together, these movements and interactions occur at all times of the year, and across a broad spatial scale. Existing work should be continued, and new studies are needed to better describe bull trout movements between the various subbasins and the FCRPS in the Columbia and Snake rivers. This synthesis of currently available information clearly indicates our knowledge regarding use of the mainstem FCRPS corridor by bull trout from most of the subbasins with bull trout local populations is limited. In addition, our collective understanding of how bull trout use the mainstem FCRPS and the potential impacts associated with it are largely deficient in many areas. Additional targeted monitoring and evaluation studies on bull trout migration between the relevant subbasins and the mainstem migratory corridors, movement within the mainstem, habitat use, and survival are needed to address these information gaps. We believe the information identified in this report will inform the prioritization of these research, monitoring and evaluation needs.

Collectively, the available information indicates most subbasins with known bull trout populations contain migratory individuals that utilize lower reaches of their respective subbasins, and a portion of these fish also migrate to the mainstem Columbia or Snake rivers. The primary time period for migration into the mainstem appears to be fall/winter (October – February), but also includes the spring/early summer (April – June). Migration into the mainstem has not been regularly observed during the summer months (July – September). Migratory individuals move to larger riverine environments and mainstem reservoirs that may provide additional resources (e.g., an ample forage base) for increased growth and reproductive potential (Faler and Bair 1991; Pratt 1992). In many cases, these large, long-range migrants make up a relatively small portion of a given population, but are more fecund and contribute significantly to the viability of their natal population (Al-Chokhachy and Budy 2008; Johnston and Post 2009; Bowerman 2013; Schaller et al. 2014). The temporal and spatial aspects of migratory bull trout movements from their respective subbasins into the mainstem need a more comprehensive description to identify the relevant mainstem reaches for further study. Abundance estimates and trends in abundance for mainstem migrants should be developed annually for the relevant subbasins to track the status of migratory fish and to help describe the temporal aspects of migration into the various mainstem river reaches. Along with development of the abundance estimates, a marking program should be designed to estimate survival back to the subbasin of origin. Considering that some bull trout may ultimately connect with populations in other subbasins, PIT tags should be part of the marking program in an attempt to document dispersal.

Bull trout exhibit movements in all of the mainstem river reaches, and they interact with all of the mainstem dams and reservoirs in those reaches. These movements and interactions occur at all times of the year, and across a broad spatial scale. Studies to develop a more comprehensive description of the temporal aspects of bull trout movements within the various mainstem river reaches and the spatial extent of mainstem use by migratory individuals should be implemented within the lower Columbia and lower Snake river reaches. Habitat use for mainstem migrants should also be described and evaluated.

Mainstem dams and reservoirs represent potential impediments to migrating bull trout and may impact connectivity within critical mainstem FMO habitat and between subbasin populations (USFWS 2015). Migratory individuals periodically connect with other populations, resulting in gene flow among local populations and core areas, and between recovery units. This occasional connectivity (i.e., dispersal) increases the genetic diversity of recipient populations and may provide resiliency and viability for many core area populations. The potential for increased growth and productivity that could result from use of the mainstem is coupled with potential risks associated with the mainstem migration corridors. Potential risks include the combined effects of the mainstem dams and reservoirs on passage and connectivity within the mainstem and between subbasins, the habitat conditions in the mainstem reservoirs, and predation in the reservoir environment. These potential impacts to connectivity may have a negative effect on the resiliency and viability of many of the core area populations.

Bull trout attempting to migrate upstream in the Columbia and lower Snake rivers over mainstem dams must do so through fish ladders. The ladders were designed primarily for larger adult anadromous fish, and fish passage efficiency, movement patterns, and potential passage delay have not been evaluated for bull trout at FCRPS dams. Thus, the suitability of physical and hydraulic conditions within the various ladders and ladder approaches for bull trout is largely unknown. Detections of marked bull trout showed little delay during upstream passage through FCRPS fish ladders. Bull trout upstream passage at mainstem dams in the mid-Columbia River (Rock Island, Rocky Reach, and Wells dams) has been evaluated via radio-telemetry. Similar studies should be initiated at FCRPS dams in the lower Columbia and lower Snake rivers. These studies should include evaluation of passage success and efficiency of bull trout that use FCRPS fish ladders, as well as an evaluation of the suitability of seasonal fish ladder water temperatures. In addition, protocols for enumeration of bull trout should be similar to methods used to enumerate and report results for salmon, steelhead and lamprey at mainstem dams. Video monitoring at the FCRPS dams should include bull trout, and should be conducted at night during the active monitoring season and 24 hours/day during the non-active monitoring season.

Bull trout attempting to migrate downstream in the Columbia and lower Snake rivers past FCRPS mainstem dams could do so using several site-specific routes, depending on the time of year. From approximately April through August during the spill season, downstream migrants can pass over the spillways or through various removable spillway weirs, top spill weirs, enhanced ice and trash sluiceways, navigation locks, or through the turbines. Monitoring passage through most of these routes is not possible, but circumstantial evidence indicates that bull trout do pass downstream through one or more of these routes. From March or April through November or mid-December, juvenile bypass systems are also available for downstream passage. Bull trout have been observed and/or detected (PIT arrays) in the bypass systems of several FCRPS dams. Detections of marked bull trout in the bypass systems showed various levels of delay on the separators for about one quarter of the marked individuals. From November or December through February or March, downstream passage is limited to the fish ladders or turbines. Bull trout move downstream throughout the mainstem Columbia and Snake rivers during fall and winter months when fish ladders or turbines are the primary passage routes. Very little information exists on the use of fish ladders for downstream migrant bull trout, and passage success and/or mortality associated with turbine passage has not been evaluated at FCRPS dams. Studies to assess how FCRPS mainstem dams affect downstream movement of migratory adult and subadult bull trout are needed. Limited information exists for downstream passage of adult bull trout at some of the mid-Columbia River dams, and those results may be useful for the design of similar studies at FCRPS dams. Evaluations should be conducted to describe passage success and efficiency, and subsequent survival of bull trout that use the various FCRPS downstream passage routes including turbine passage. Monitoring of bull trout passage through the juvenile bypass systems should also be more comprehensive, and the fate of bull trout passing via this route should be evaluated. This should include monitoring and reporting observations at the separators, as well as in the sampling facilities. Bull trout that are small enough to pass through the separators are occasionally observed in condition samples, and some unknown number are likely transported via barge or truck to locations downstream from Bonneville Dam as part of the juvenile transportation program. Efforts should be made to learn more about this process and determine options to avoid transport of bull trout.

Although the suitability of habitat conditions in the mainstem Columbia and Snake River FCRPS reservoirs for bull trout has not been thoroughly assessed, reservoir water temperatures during the summer months may be high enough to potentially affect growth and fecundity. In addition, the suitability of physical habitat features (e.g., water depth, velocity gradients, shoreline structure, etc.) has not been determined. A comprehensive, spatial and temporal description of FCRPS reservoir water temperatures should be completed, including temperatures at locations used by migratory bull trout. Physical habitat used by migratory bull trout within the mainstem FCRPS reservoirs should also be described, and habitat suitability criteria should be developed to identify reservoir locations that are important for bull trout.

The overall survival of migratory bull trout in the FCRPS is largely unknown, but upstream and downstream passage at the FCRPS dams and through the FCRPS reservoirs could potentially affect bull trout survival. The survival of bull trout following upstream passage at the FCRPS mainstem dams has not been evaluated, but detections of tagged bull trout that passed upstream through fish ladders indicated little delay. However, over one quarter of these PIT-tagged fish were never observed again, and they may not have survived their passage events. Similarly, the survival of bull trout following downstream passage at FCRPS dams has also not been evaluated, but nearly two thirds of the marked bull trout that passed downstream through the juvenile bypass systems were never detected again, and they may not have survived their passage events. In addition to passage at the dams, slow water velocities, warm seasonal water temperatures and aquatic and avian predators in FCRPS reservoirs may influence bull trout survival. Predation in the reservoir environment has been observed, but not quantitatively assessed. Reservoir conditions have created habitat for native (e.g., northern pikeminnow) and non-native (e.g., smallmouth bass, walleye) aquatic predators. Avian predation (e.g., cormorants, pelicans, terns, gulls) also affects survival of bull trout from multiple populations, and although there has been documentation of numerous incidents of avian predation on bull trout, the impact has not been quantified. Considering the potential effects of FCRPS dams on passage and the reservoir conditions, studies are needed to determine overall survival of migratory bull trout in the FCRPS, including dam passage and reservoir survival components.

Many of the bull trout encountered both within the lower reaches of various subbasins, and within the mainstem are un-marked, and the population of origin is unknown. Establishing the source population and migration details for these “unknown” origin bull trout would help increase our understanding of the temporal and spatial aspects of mainstem movements and interactions between subbasin bull trout populations. Genetic samples (e.g., fin clips) should be collected from all un-marked bull trout that are handled in the mainstem (e.g., mainstem dams) or lower reaches of tributary subbasins to establish origin. In addition, these same fish should be PIT-tagged if possible so their movements could be determined from the wide array of PIT detection sites at the mainstem dams and within tributary subbasins. A comprehensive evaluation of the PIT detection array infrastructure in lower subbasin areas and at the mainstem dams should also be conducted to determine whether existing sites should be improved, and whether additional sites are needed to track movements of PIT-tagged bull trout.

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Appendix A: Mainstem Columbia and Snake River Hydropower Dams and Bull Trout

Introduction

Following the designation of critical habitat for bull trout in 2010 (USFWS 2010), discussions began regarding re-initiation of Section 7 consultation on effects of the configuration and operation of the FCRPS on threatened bull trout. As part of these discussions, in 2011 the FWS began to assemble all of the bull trout information and research that was available at that time with a focus on the mainstem Columbia and Snake river corridors. That initial effort was updated several times between 2011 and 2014. This Appendix represents the results of these previous efforts, and much of this information is reflected in the analyses and synthesis presented in this report.

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Background

The current U.S. Fish and Wildlife Service (Service) Biological Opinion (BiOp) on the effects of the Federal Columbia River Power System (FCRPS) on ESA-listed bull trout (*Salvelinus confluentus*) was issued 14 years ago in December 2000 (USFWS 2000). At that time there was little research or documentation to clearly describe bull trout use of the mainstem corridors of the Columbia River Basin. Since the 2000 BiOp, a significant amount of new information has been collected on bull trout and their use of the mainstem Columbia and Snake Rivers. Additionally, the Service published the Final Critical Habitat Rule for bull trout in the Columbia River Basin in October 2010 (FR 2010). This Critical Habitat designation included the entire Columbia River mainstem (designated the lower Columbia River and upper Columbia River), as well as the North Fork Clearwater River, the mainstem Snake River (Figure A1), and the Kootenai River. All of these reaches have FCRPS projects located within their boundaries. The importance of this habitat warranted inclusion under the Critical Habitat rule as it provides important foraging, migration, and overwintering (FMO) habitat for bull trout (USFWS 2010).

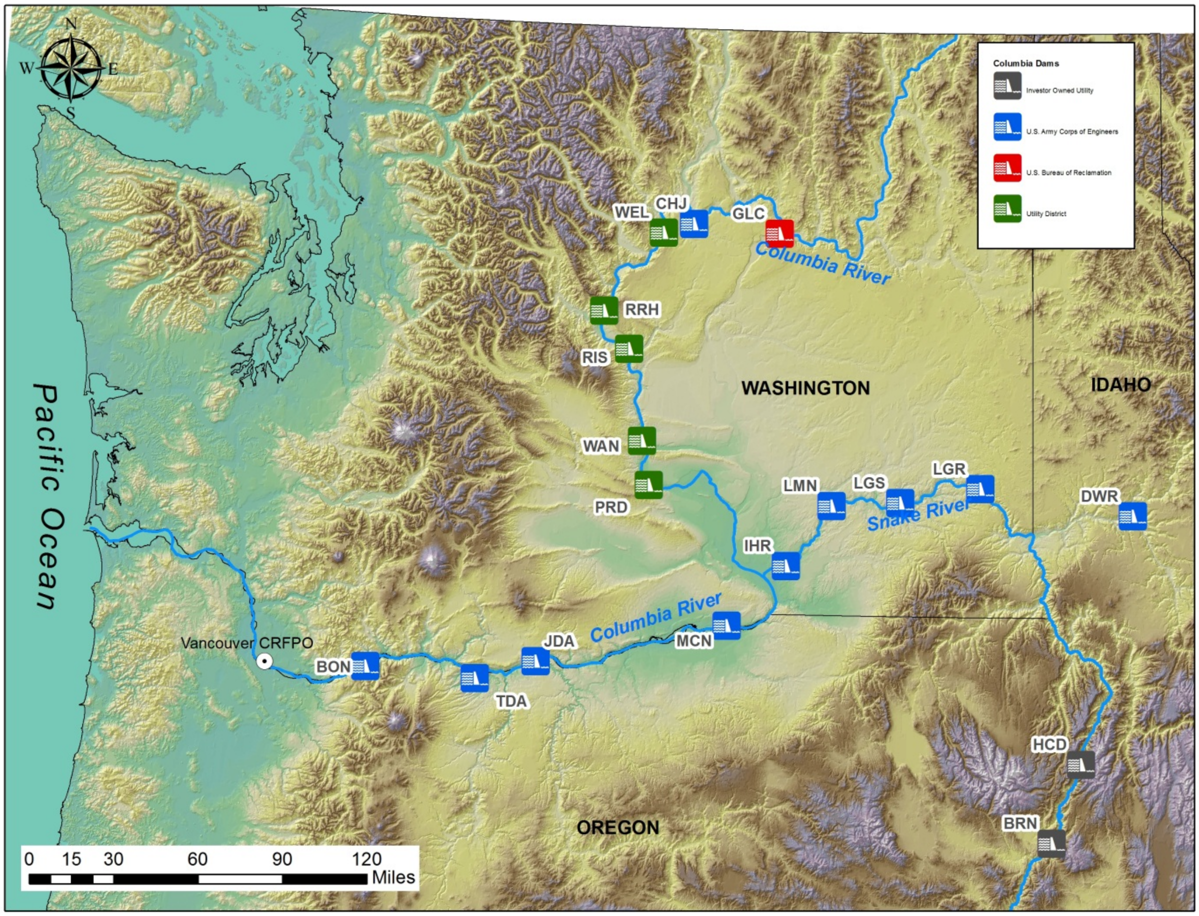

Figure A1. Columbia River Basin overview with locations of the mainstem FCRPS dams (U.S. Army Corps of Engineers and Bureau of Reclamation) along with public utility district dams. (BON = Bonneville Dam, TDA = The Dalles Dam, JDA = john Day Dam, MCN = McNary Dam, IHR = Ice Harbor Dam, LMN = Lower Monumental Dam, LGS = Little Goose Dam, LGR = Lower Granite Dam, CHJ = Chief Joseph Dam, GLC = Grand Coulee Dam, PRD = Priest Rapids Dam, WAN = Wanapum Dam, RIS = Rock Island Dam, RRH = Rocky Reach Dam, WEL = Wells Dam, HCD = Hells Canyon Dam and BRN = Brownlee Dam)

Bull trout use of the mainstem Columbia and Snake Rivers

Extensive changes in FCRPS project configurations and operations have taken place over the last 14 years. Surface passage routes for downstream migrant anadromous salmonids, including removable spillway weirs (RSW), top spill weirs (TSW), adjustable spillway weirs (ASW), and enhanced ice and trash sluiceways, have been put into seven of the eight U.S. Army Corps of Engineers (Corps) operated FCRPS projects in the lower Columbia and lower Snake rivers. Project operations have varied with various levels of spill rates and spill duration being implemented at each project. Spring spill operations began previous to the 2000 BiOp, but summer spill was added by court order in 2005. Along with direct recorded observations at the adult fish ladders, bull trout encounters with the mainstem dams have been documented via the research carried out since 2000 using passive integrated transponder (PIT) tags, radio tags and acoustic tags. Following is a summary of information and other factors relevant to our current understanding of bull trout and their use of the mainstem river corridors affected by the FCRPS projects, as well as information on bull trout passage at public utility district (PUD) dams in the mid-Columbia River.

Bull Trout Observed in FCRPS Adult Ladders

Fish counting at the FCRPS projects has generally occurred for 16 hours per day from 4 A.M. to 8 P.M. PST. The Corps reports all bull trout observations in their 'Miscellaneous Fish Counts' report (http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx) and lists the specific dates counted for each year. The 2014 counting dates are listed in Table A1. The counts are summarized by year and project in Table A2. The bull trout data only extends back to 2006. Video counts are not done for bull trout.

Table A1. 2014 fish counting seasons at FCRPS dams. From Corps 'Miscellaneous Fish Counts' report (http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx).

Dam	Hours	From	To
Bonneville	4 A.M. to 8 P.M. PST	1-Jan	31-Dec
The Dalles	4 A.M. to 8 P.M. PST	1-Apr	31-Oct
John Day	4 A.M. to 8 P.M. PST	1-Apr	31-Dec
McNary	4 A.M. to 8 P.M. PST	1-Apr	31-Oct
Ice Harbor	4 A.M. to 8 P.M. PST	1-Apr	31-Oct
Lower Monumental	4 A.M. to 8 P.M. PST	1-Apr	31-Dec
Little Goose	4 A.M. to 8 P.M. PST	1-Apr	31-Oct
Lower Granite	4 A.M. to 8 P.M. PST	1-Mar	31-Dec

Fish counters take a 10 minute break from counting each hour from 4/1 through 10/31.
Fish counts for anadromous salmonids and lamprey are done by video before 4/1 and after 10/31.
Video counts are not done for bull trout.

Table A2. Summary of bull trout observations in FCRPS adult fishways, 2006-2014. From Corps 'Miscellaneous Fish Counts' report. (http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx).

Year	BON	TDA	JDA	MCN	IHR	LMN	LGS	LWG	Total
2006	0	0	1	0	0	2	3	2	8
2007	0	0	0	2	0	4	6	8	20
2008	0	0	0	0	0	2	27	0	29
2009	3	0	0	0	0	5	37	4	49
2010	0	0	1	0	0	16	73	8	98
2011	0	0	0	0	3	47	161	1	212
2012	0	0	1	0	0	26	41	1	69
2013	0	0	0	0	1	26	64	0	91
2014	0	0	0	0	0	24	41	2	67
Total:	**3**	**0**	**3**	**2**	**4**	**152**	**453**	**26**	**643**

Site name	Code	Site name	Code
Bonneville Dam	BON	Ice Harbor Dam	IHR
The Dalles Dam	TDA	Lower Monumental Dam	LMN
John Day Dam	JDA	Little Goose Dam	LGS
McNary Dam	MCN	Lower Granite Dam	LWG

In 2004 the Corps contracted to have a review of studies done on bull trout use of the lower Snake River and McNary Dam reservoir and associated tributaries, and of observations/detections at FCRPS adult fishways and juvenile bypass systems at the dams prior to 2004 (Anglea et al. 2004). Fish ladder monitoring data, from as far back as 1970, was collected through interviews, searches of old records, and review of published and unpublished reports. Before 2001 most of the effort on monitoring was on anadromous salmonids. However, Table A3 lists the bull trout records that were found.

Table A3. Numbers of bull trout observed in adult fishways at lower Snake River dams. Adapted from Table 2.3 in Anglea et al. (2004).

Dam	Year	Number	Dam	Year	Number
Lower Monumental	2001	1	Little Goose	1991	1
	2003	3		1992	3
				1994	5
				1995	14
				1996	11
				2001	16
				2002	10
				2003	2

Based on available data, Anglea et al. (2004) determined that observations of bull trout at the lower Snake River dams were most common during spring and early summer, though there also appeared to be a small peak in occurrence in the fall. The monthly observations for all years of data available from 1991 through 2014 combined are listed in Table A4. The preponderance of observations are in the spring and early summer, with a small bump in the fall. The current typical fish counting seasons for the PUD projects are listed in Table A5. The annual counts from 1998 through 2014 are presented in Table A6.

Table A4. Bull trout observations by month in FCRPS ladders, 1991-2014.
http://www.nwp.usace.army.mil/Missions/Environment/Fish/Data.aspx

Lower Columbia River Dam Ladder Counts 2006-2014

April	May	June	July	Aug	Sept	Oct	Total
1	1	4	2	0	0	0	8
12.5%	12.5%	50.0%	25.0%	0.0%	0.0%	0.0%	100.0%

Snake River Ladder Counts 1991-2003

April	May	June	July	Aug	Sept	Oct	Total
22	29	7	2	0	2	4	66
33.3%	43.9%	10.6%	3.0%	0.0%	3.0%	6.1%	100.0%

Snake River Ladder Counts 2006-2014

April	May	June	July	Aug	Sept	Oct	Total
78	329	308	84	3	2	3	807
9.7%	40.8%	38.2%	10.4%	0.4%	0.2%	0.4%	100.0%

Snake River Ladder Counts 1991-2003 & 2006-2014

April	May	June	July	Aug	Sept	Oct	Total
100	358	315	86	3	4	7	873
11.5%	41.0%	36.1%	9.9%	0.3%	0.5%	0.8%	100.0%

Bull Trout Observed in FCRPS Ladders

	Apr-July		Aug-Oct		
Columbia 2006-2013	8	100%	0	0%	8
Snake 1991-2003	60	91%	6	9%	66
Snake 2006-2013	799	99%	8	1%	807
Snake 1991-2003 & 2006-2013	859	98%	14	2%	873
Total	**867**	**98%**	**14**	**2%**	**881**

Table A5. Typical fish counting seasons at PUD dams in the mid-Columbia River.
http://www.fpc.org/documents/metadata/FPC_Adult_Metadata.html

Dam	Hours	From	To
Priest Rapids	24 hours/day video	15-Apr	15-Nov
Wanapum	24 hours/day video [1]	15-Apr	15-Nov
Rock Island	24 hours/day video	15-Apr	15-Nov
Rocky Reach	24 hours/day video	15-Apr	15-Nov
Wells	24 hours/day video	1-May	15-Nov

[1] No counting at Wanapum Dam in 2014 due to structural problems.

Table A6. Bull trout observed at adult ladders at PUD dams in the mid-Columbia River, 1998-2014.
http://www.fpc.org/bulltrout/bulltrout_queries/adultladder_bulltrout_query.html and
http://www.cbr.washington.edu/dart/query/adult_graph_text

Year	PRD	WAN	RIS	RRH	WEL	Total
1998	n/a	n/a	67	n/a	14	81
1999	n/a	n/a	61	n/a	11	72
2000	n/a	n/a	87	n/a	0	87
2001	n/a	n/a	82	204	0	286
2002	n/a	n/a	84	194	76	354
2003	n/a	n/a	102	246	53	401
2004	n/a	n/a	114	161	47	322
2005	n/a	n/a	69	155	49	273
2006	0	n/a	35	132	100	277
2007	1	n/a	46	77	65	188
2008	5	0	36	100	43	179
2009	4	1	60	83	43	186
2010	7	7	53	124	44	221
2011	8	12	49	168	66	283
2012	5	3	49	219	74	343
2013	9	11	121	193	113	447
2014	3	n/a	80	158	109	350
Total:	**42**	**34**	**1,195**	**2,214**	**907**	**4,392**

n/a = No data

Site name	Code	Data available
Priest Rapids Dam	PRD	2006 - 2014
Wanapum Dam	WAN	2008 - 2014
Rock Island Dam	RIS	1998 - 2014
Rocky Reach Dam	RRH	2001 - 2014
Wells Dam	WEL	1998 - 2014

Bull Trout Observed in Mainstem Juvenile Bypass Systems

The Northwest Power and Conservation Council (NPCC) established a Fish Passage Center (FPC) and a Fish Passage Center manager to interact with the hydrosystem operators and regulators in managing fish passage. The FPC plans and implements the annual Smolt Monitoring Program (SMP) which provides daily information from samples of fish collected passing certain mainstem dams for in-season management decisions. The SMP sample sites in the mainstem of the lower and middle Columbia and the lower Snake and Clearwater rivers are listed in Table A7. Site operations are variable within a season due to weather and river conditions, with the traps most susceptible to closures due to bad conditions on the river. Bull trout collected in samples at all SMP sites from 1998 through 2014 are listed in Tables A8 and A10.

Table A7. Active smolt monitoring sites on the mainstem Columbia and lower Snake rivers and at traps in tributaries to the lower Snake River.
http://www.fpc.org/documents/metadata/FPC_SMP_Metadata.html

				2014 Monitoring Dates	
Site Name	**Code**	**Location**	**Data Records**	**Start**	**End**
Bonneville Dam - PH2	BO2	Columbia River	2000 to present	5-Mar	31-Oct
John Day Dam	JDA	Columbia River	1985 to present	1-Apr	15-Sep
McNary Dam	MCN	Columbia River	1985 to present	1-Apr	1-Oct
Lower Monumental Dam	LMN	Snake River	1986 to present	1-Apr	1-Oct
Little Goose Dam	LGS	Snake River	1985 to present	1-Apr	31-Oct
Lower Granite Dam	LGR	Snake River	1985 to present	26-Mar	31-Oct
Rock Island Dam	RIS	Columbia River	1985 to present	1-Apr	31-Aug
Lewiston Trap	LEW	Snake River	1985 to present	3-Mar	31-May
Whitebird Trap	WTB	Salmon River	1993 to present	3-Mar	31-May
Grande Ronde Trap	GRN	Grande Ronde River	1994 to present	5-Mar	31-May
Imnaha Trap	IMN	Imnaha River	1994 to present	5-Mar	31-May

Table A8. Bull trout collected at FCRPS smolt monitoring sites on the mainstem Columbia and lower Snake rivers. http://www.fpc.org/bulltrout/bulltrout_queries/smp_bulltrout_query.html

Site	Sample Date	Sample Count
Bonneville Dam	3/21/2005	1
	Total:	**1**
John Day Dam	5/28/2002	1
	Total:	**3**
Little Goose Dam	4/5/2002	1
Little Goose Dam	4/2/2005	1
Little Goose Dam	4/25/2007	1
	Total:	**3**
Lower Monumental Dam	4/3/1999	1
Lower Monumental Dam	4/17/2000	1
Lower Monumental Dam	5/5/2000	1
Lower Monumental Dam	4/5/2001	1
Lower Monumental Dam	10/31/2001	1
Lower Monumental Dam	4/5/2002	1
Lower Monumental Dam	4/6/2002	1
Lower Monumental Dam	6/6/2005	1
Lower Monumental Dam	6/5/2011	1
	Total:	**9**
Lower Granite Dam	7/18/2003	1
Lower Granite Dam	9/5/2003	1
	Total:	**2**

The summary of pre- 2004 juvenile facilities bull trout observations by Anglea et al. (2004) are listed in Table A9. These counts come mostly from fish separator observations, which is downstream of the diversion gate where the SMP samples are taken. Anecdotally it was reported a small number of bull trout were observed at Ice Harbor Dam.

Table A9. Numbers of bull trout observed in juvenile facilities at lower Snake River dams. Adapted from Table 2.3 in Anglea et al. (2004).

Dam	Year	Number
Lower Monumental	1999	4
Lower Monumental	2000	3
Lower Monumental	2001	2
Lower Monumental	2002	5
Little Goose	1983	1
Little Goose	1987	1
Little Goose	1991	8
Little Goose	1992	1
Little Goose	1993	2
Little Goose	1994	2
Little Goose	1995	3
Little Goose	1996	2
Little Goose	1998	6
Little Goose	1999	2
Little Goose	2000	7
Little Goose	2001	10
Little Goose	2002	6
Little Goose	2003	1
Lower Granite	1993	1
Lower Granite	2001	1
Lower Granite	2003	6

Table A10. Bull trout collected monthly at the Rock Island Dam smolt monitoring site on the mainstem mid-Columbia River from 1998 through 2014. http://www.fpc.org/bulltrout/bulltrout_queries/smp_bulltrout_query.html

April	#	May	#	June	#	July	#	August	#
4/11/1999	2	5/8/1998	1	6/10/1998	1	7/4/1999	1	8/8/1998	1
4/18/1999	1	5/16/1998	1	6/16/1998	2	7/12/1999	1	8/11/1999	1
4/12/2001	1	5/17/1998	1	6/1/1999	1	7/24/1999	1	8/26/1999	1
4/29/2012	1	5/19/1999	1	6/2/1999	1	7/8/2001	1	8/26/1999	1
		5/26/1999	1	6/6/1999	1	7/22/2001	1	8/27/1999	1
		5/27/2001	1	6/9/1999	1	7/26/2001	1	8/4/2001	1
		5/23/2002	1	6/12/1999	1	7/18/2002	1	8/22/2001	1
		5/27/2002	1	6/16/1999	1	7/29/2002	1	8/18/2003	1
		5/5/2006	1	6/18/1999	1	8/6/2002	1	8/21/2004	1
		5/17/2008	1	6/24/1999	1	8/24/2002	1	7/26/2006	1
		5/24/2008	1	6/25/1999	1	7/13/2003	1	8/18/2006	1
		5/31/2008	1	6/17/2000	1	7/21/2004	1	8/20/2006	1
		5/24/2011	1	6/22/2000	1	7/28/2004	1	8/1/2007	1
		5/3/2012	1	6/1/2001	1	7/4/2008	1	8/12/2008	1
		5/7/2012	1	6/9/2002	1	7/8/2008	2	8/20/2008	1
		5/31/2012	1	6/17/2002	1	7/18/2008	1	8/31/2009	1
		5/24/2013	1	6/1/2006	1	7/22/2009	1	8/20/2014	1
				6/12/2007	1	7/24/2010	1		
				6/5/2008	1	7/10/2013	1		
				6/6/2008	1				
				6/12/2008	1				
				6/1/2009	1				
				6/8/2009	1				
				6/14/2009	1				
				6/4/2011	1				
				6/21/2011	1				
				6/23/2011	1				
Total:	**5**	**Total:**	**17**	**Total:**	**28**	**Total:**	**20**	**Total:**	**17**

The Corps contracted to have a review of studies done on bull trout use of the lower Snake River and McNary Dam reservoir and associated tributaries, and observations/detections at FCRPS adult fishways and juvenile bypass systems at the dams prior to 2004 (Anglea et al. 2004). Data were collected through interviews, searches of old records, and review of published and unpublished reports. Appendix C of the report presents the records of individual bull trout sightings at FCRPS dams on the lower Snake River and at McNary Dam in the Columbia River. The information includes location, date, fish size, and source of the information.

PIT-tagged Bull Trout Detections at Mainstem Dams

Table A11 lists all PIT-tagged bull trout detected at FCRPS mainstem dams that reside in the PTAGIS database. The recorded detections were from 2006 through 2014. The data are sorted by project (downstream to upstream) and by detection date at a project. Tag release site, release date, detection site and detection date are provided to put distance and time into proper perspective. There have been 22 individual PIT-tagged bull trout detected at FCRPS dam PIT interrogation sites; one from the Hood River detected at Bonneville Dam (37 rkm downstream), four from the Walla Walla/Touchet basins detected at McNary Dam (36 rkm downstream), four fish from the Tucannon River detected at Lower Monumental and/or Ice Harbor dams downstream of the Tucannon River (34 and 84 rkm, respectively), and two fish from the Tucannon River detected upstream at Little Goose and/or Lower Granite Dam (13 and 73 rkm, respectively). There have also been 11 bull trout PIT-tagged at Little Goose dam with three of them being subsequently detected at Lower Granite Dam (60 rkm upstream). The mainstem distances traveled are not unusual as evidenced by recorded movements of PIT-tagged bull trout from the mid-Columbia River.

Bull trout PIT-tagged in mid-Columbia River tributaries and at Wells Dam (Table A12) have been detected at PIT tag interrogation sites at PUD mainstem projects and within mid-Columbia River tributaries (Table A13). The minimum distances traveled have ranged from 13 to 315 rkm (an Entiat River basin tagged bull trout detected at Prosser Dam on the Yakima River). Of the 50 bull trout PIT-tagged and released at Wells Dam, only four were detected again, all at Rocky Reach Dam 67 rkm downstream. One PIT-tagged bull trout detected at Priest Rapids Dam originated from the Walla Walla River basin 191 rkm downstream. The dates of detection ranged from early June to the latter part of November. Considering these PIT-tagged bull trout actually represent a larger number of untagged fish, the total numbers of bull trout using the mainstem habitat and attempting to migrate using adult ladders and juvenile bypass systems is most likely much higher.

Table A11. Mainstem bull trout PIT tag interrogation summary at FCRPS projects. Data downloaded from www.ptagis.org December 2014.

Tag Code	Tag Site Name	First Observation Time	Last Observation Time	Release Site Name	Release Date	Mark Length mm
3D9.1C2DBCF55D	Little Goose Fish Ladder	6/4/2014 2:18:19 PM	7/28/2014 9:37:03 AM	Tucannon River	11/29/2013	265
3D9.1C2C3DAEF6	Little Goose Dam Juvenile	5/25/2010 11:58:11 PM	6/10/2010 1:36:48 AM	Tucannon River	10/7/2009	280
3D9.257C5F32DC	Little Goose Dam Juvenile	5/29/2010 9:28:26 AM	5/29/2010 9:28:27 AM	Little Goose Dam tailrace	5/29/2010	345
3D9.257C5FBD6D	Little Goose Dam Juvenile	6/20/2011 1:28:27 PM	7/10/2011 11:15:38 PM	Little Goose Dam tailrace	5/29/2011	450
3D9.257C5FBD70	Little Goose Dam Juvenile	6/24/2010 2:31:05 PM	6/24/2010 2:31:06 PM	Little Goose Dam tailrace	6/24/2010	580
3D9.257C5FC866	Little Goose Dam Juvenile	6/14/2010 1:13:44 PM	6/14/2010 1:13:44 PM	Little Goose Dam tailrace	6/14/2010	395
3D9.257C5FD7A2	Little Goose Dam Juvenile	5/17/2011 9:46:22 AM	5/17/2011 9:46:23 AM	Little Goose Dam tailrace	6/16/2011	400
3D9.257C5FFA86	Little Goose Dam Juvenile	6/21/2009 6:23:31 AM	7/5/2009 3:48:08 PM	Little Goose Dam tailrace	6/21/2009	350
3D9.257C60042E	Little Goose Dam Juvenile	6/16/2011 10:38:55 AM	6/16/2011 10:38:56 AM	Little Goose Dam tailrace	6/20/2011	395
3D9.257C60066A	Little Goose Dam Juvenile	6/20/2009 6:19:36 AM	6/20/2009 6:19:36 AM	Little Goose Dam tailrace	6/20/2009	333
3D9.257C6012DA	Little Goose Dam Juvenile	5/29/2011 6:51:49 AM	5/29/2011 6:51:49 AM	Little Goose Dam tailrace	5/17/2011	313
3D9.257C648FE1	Little Goose Dam Juvenile	6/18/2006 1:16:14 PM	6/18/2006 1:16:14 PM	Little Goose Dam tailrace	6/18/2006	345
3D9.1C2DBCF55D	Lower Granite Dam Adult	8/5/2014 11:37:41 AM	8/5/2014 11:40:43 AM	Tucannon River	11/29/2013	265
3D9.257C5FBD70	Lower Granite Dam Adult	7/1/2010 4:50:56 PM	7/1/2010 7:14:05 PM	Little Goose Dam tailrace	6/24/2010	580
3D9.257C648C9B	Lower Granite Dam Adult	6/3/2009 9:23:40 AM	6/3/2009 12:57:35 PM	Little Goose Dam tailrace	5/28/2009	410
3D9.257C648FE1	Lower Granite Dam Adult	6/25/2006 4:41:18 AM	6/30/2006 11:38:06 AM	Little Goose Dam tailrace	6/18/2006	345
3D9.1C2CFC542B	Ice Harbor Dam	6/2/2011 11:42:37 AM	6/2/2011 11:42:44 AM	Tucannon River	12/17/2010	234
3D9.1C2CFCCCD8	Ice Harbor Dam	6/25/2011 7:48:47 PM	6/25/2011 7:51:47 PM	Tucannon River	11/22/2010	340
3D9.1C2DF58673	Ice Harbor Dam	6/19/2013 9:37:52 AM	6/19/2013 9:40:27 AM	Tucannon River	12/17/2012	233
3D9.1C2DF5D088	Lower Monumental Adult Ladders	5/23/2014 1:04:56 PM	5/23/2014 1:05:02 PM	Tucannon River	12/17/2012	250
3D9.1C2CFC542B	Lower Monumental Dam Juvenile	5/18/2011 9:08:36 AM	5/18/2011 9:08:42 AM	Tucannon River	12/17/2010	234
3D9.1C2CFCCCD8	Lower Monumental Dam Juvenile	3/28/2011 3:45:43 PM	3/28/2011 3:45:49 PM	Tucannon River	11/22/2010	340
384.1B795B2660	McNary Oregon Shore Ladder	6/26/2012 1:00:35 PM	6/29/2012 8:10:13 AM	Walla Walla River	10/24/2011	314
3D9.1BF1F30D4F	McNary Oregon Shore Ladder	5/25/2009 2:33:30 AM	6/20/2009 4:36:44 PM	Walla Walla River	10/23/2008	269
3D9.1C2C55033A	McNary Dam Juvenile	4/15/2009 8:48:02 AM	4/15/2009 8:48:11 AM	Walla Walla River	7/30/2008	249
3D9.1C2D9DDC4B	McNary Dam Juvenile	6/1/2014 1:03:18 PM	6/2/2014 6:31:07 AM	Touchet River	4/8/2013	144

Table A12. Release sites of PIT-tagged bull trout detected at mainstem PUD and Yakima projects. http://www.ptagis.org/

Mid-Columbia River Release Sites	Site RKM
CHIWAC - Chiwaukum Creek (tributary to Wenatchee River)	754.057
CHIWAT - Chiwawa River Trap, 0.5 rkm below CHIP acclimation pond	754.077.022
ENTIAR - Entiat River	778
ICICLC - Icicle Creek (tributary to Wenatchee River)	754.041
LBRIC - Little Bridge Creek, tributary to Twisp River (Methow basin)	843.066.014
MADRVR - Mad River (Entiat River watershed)	778.017
METHR - Methow River	843
NASONC - Nason Creek (tributary to Wenatchee River)	754.089
TUMFBY - TUM - Tumwater Dam forebay within 0.5 rkm upstream of Dam	754.044
TWISPR - Twisp River	843.066
TWISPW - Twisp River Weir (WDFW)	843.066.013
WELFBY - WEL - Release into the Forebay within 0.5 rkm upstream of Dam	830
WELLD1 - WEL - Release into the East Adult Fish Ladder	830
WELLD2 - WEL - Release into the West Adult Fish Ladder	830

Table A13. Mid-Columbia River mainstem and tributary PIT tag interrogation sites with bull trout PIT tag detections. http://www.ptagis.org/

Mid-Columbia River Interrogation Sites	Site RKM
PRO - Prosser Diversion Dam Combined	539.076
ROZ - Roza Diversion Dam (Combined)	539.206
PRA - Priest Rapids Adult	639
RRF - Rocky Reach Fishway	730
RRJ - Rocky Reach Dam Juvenile	730
WEA - Wells Dam, DCPUD Adult Ladders	830

Acoustic- and radio-tagged bull trout

Walla Walla River

Twelve bull trout were captured in the rotary screw traps between November 2010 and February 2011 in the Walla Walla River and were tagged with both an acoustic transmitter and a PIT tag (Barrows et al. 2012). Seven of the tagged bull trout were detected entering the Columbia River from November through February. Two of these fish were located during mobile tracking surveys between the mouth of the Walla Walla River and McNary Dam (Figure A2). Both fish utilized mainstem habitats that exceeded 40 feet of depth. Four of the seven bull trout that entered the Columbia River were subsequently detected returning to the Walla Walla River from March through June. In 2012 fifteen bull trout were tagged with acoustic transmitters and six immigrated into the Columbia River (Barrows et al. 2014a). Two fish were last detected 13 kilometers upstream of the Walla Walla River and one fish was last detected four kilometers downstream of the Walla Walla River (Figure A2). Acoustic-telemetry and PIT detection data together, indicate previous quantitative estimates of emigration to the Columbia River may have been low.

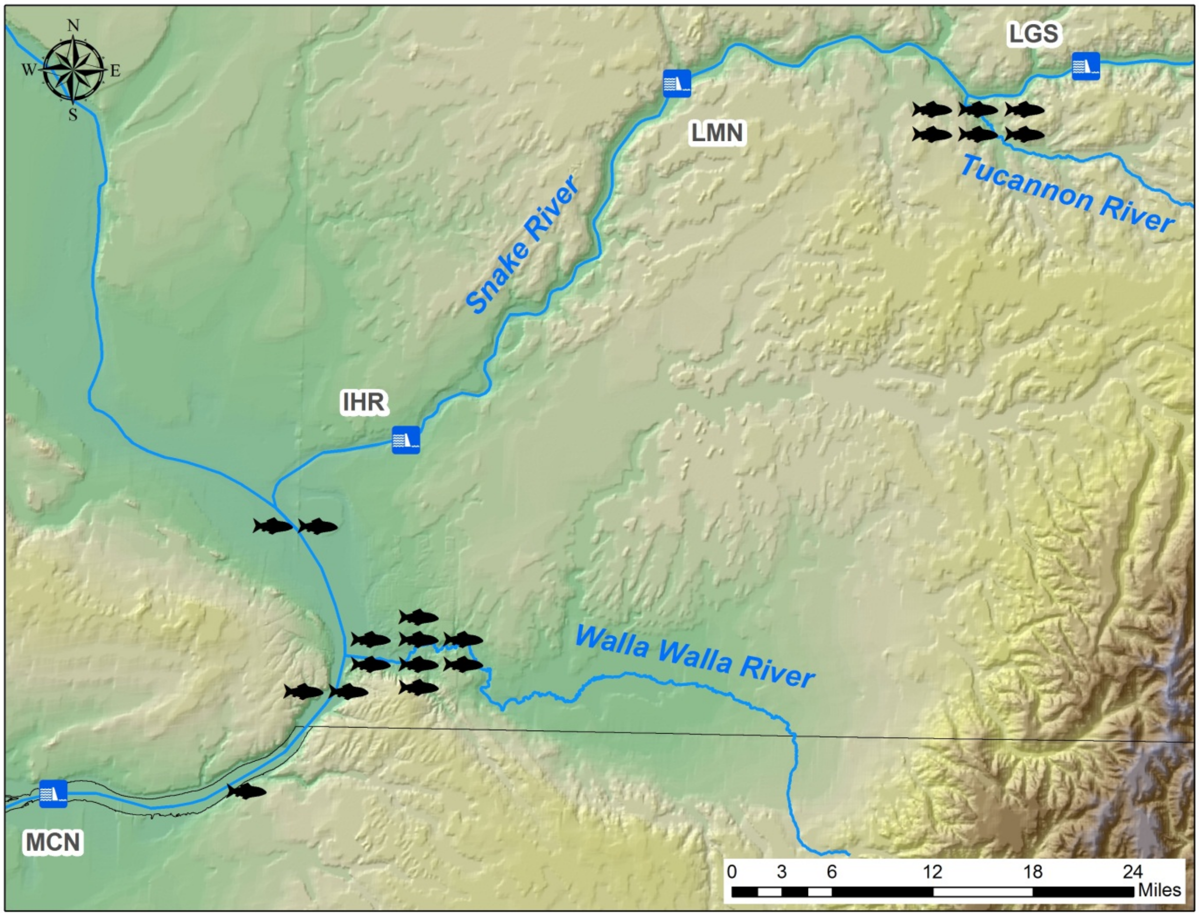

Figure A2. Walla Walla (acoustic tag) and Tucannon (radio tag) origin tag detections.

<u>Tucannon River</u>

Between the years 2002 and 2006 Faler et al. (2008) sampled 1,109 bull trout in the Tucannon River; 124 of these were surgically implanted with radio tags. Of these, 77 were tagged during the spring migration to the spawning grounds, and 47 were tagged in the fall during the post spawn out-migration. Six tagged bull trout did enter the Snake River. These fish were tagged during fall/winter sampling efforts, and represent 18.1% of all fall tagged fish that successfully carried their transmitters through the winter. This radio-telemetry work documented the spawning migration of Tucannon River bull trout beginning in April and ending in July. Those bull trout interrogated in October, November, and December are believed to be outmigrating into the mainstem Snake River for overwintering. The interrogation data suggest a net downstream movement for those bull trout detected from October through December.

"We were unable to adequately radio-track bull trout in the Snake River and evaluate their movements or interactions with the federal hydroelectric dams. One reason for this was none of our radio-tagged fish attempted to pass a Snake River dam. Additionally, our radio tags had little to no transmission capability at depths greater than 12.2 m (Faler et al 2004 and 2005)."

Mid-Columbia River

Further documentation of extensive mainstem use by bull trout comes from the mid-Columbia River reach. Work was performed by the Service's Mid- Columbia FRO (Nelson et al. 2011) to learn about bull trout migration timing and distances moved, identify migration barriers and obstacles, document passage windows at natural and artificial obstacles, and monitor seasonal movements to spawning areas in Icicle Creek. This work documented the movement of four radio-tagged bull trout during the fall from Icicle Creek and the Wenatchee River into the Columbia River where they overwintered, establishing the movement into and use of mainstem reaches (Table A14 and Figure A3). Similar work performed in the Entiat River from 2003-2006 (Nelson and Nelle 2008) has also established extensive movement of bull trout into the Columbia River in the fall and their return in the spring. Several radio-tagged bull trout were documented successfully passing downstream through Rocky Reach and Rock Island dams 16 and 48 rkm downstream (respectively) from the mouth of the Entiat River, and beyond, (Figure A3). Bull trout were tracked as far upstream as the Chelan River at rkm 810 (rm 503).

Table A14. Mid-Columbia River radio tag sites with bull trout detections.

Code	Site	rkm	rm
RIS	Rock Island Dam	730	445
WENATR	Wenatchee River	754	467
RRH	Rocky Reach Dam	763	473
ENTIAR	Entiat River	778	482
CHELAR	Chelan River	810	503
WEL	Wells Dam	830	515

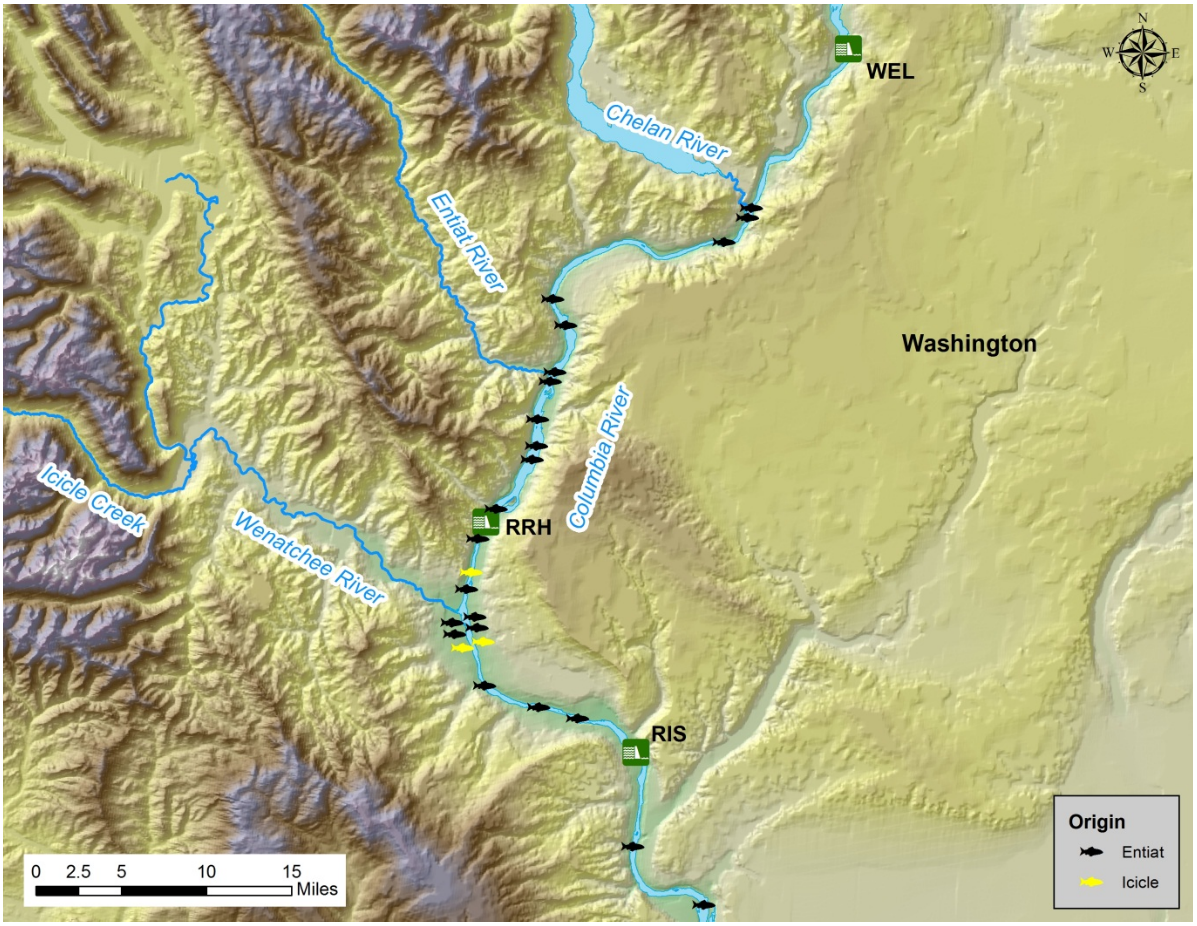

Figure A3. Icicle Creek and Entiat River radio-tagged fish detections.

Bull Trout PIT Tag Recoveries from Presumed Avian Predation

PIT tags from bull trout presumed to have been preyed upon have been detected at piscivorous bird colony sites (cormorant, gull, pelican and tern) in various locations in eastern Washington (Figure A4). A total of 57 bull trout PIT tags have been detected; 56 originating from the Walla Walla River basin and one from the Tucannon River (Table A15). The precise time of predation and the location from which the fish was taken cannot be determined from the data, but the tagging location and date or the last known location and date of detection (if available) before the discovery date at the bird colony place bounds on the date of predation. A summary of the data is listed in Table A16. Most of the tags were detected at Foundation Island, primarily a cormorant colony, located in the Columbia River (rkm 518) just downstream from the mouth of the Snake River (rkm 522). Most of the PIT tags originated at the Burlingame Dam and Canal on the Walla Walla River (rkm 509.059). Two bull trout PIT tags from the Burlingame Dam and Canal were detected at Swallow's Nest Park (rkm 522.229) near Lewiston, Idaho.

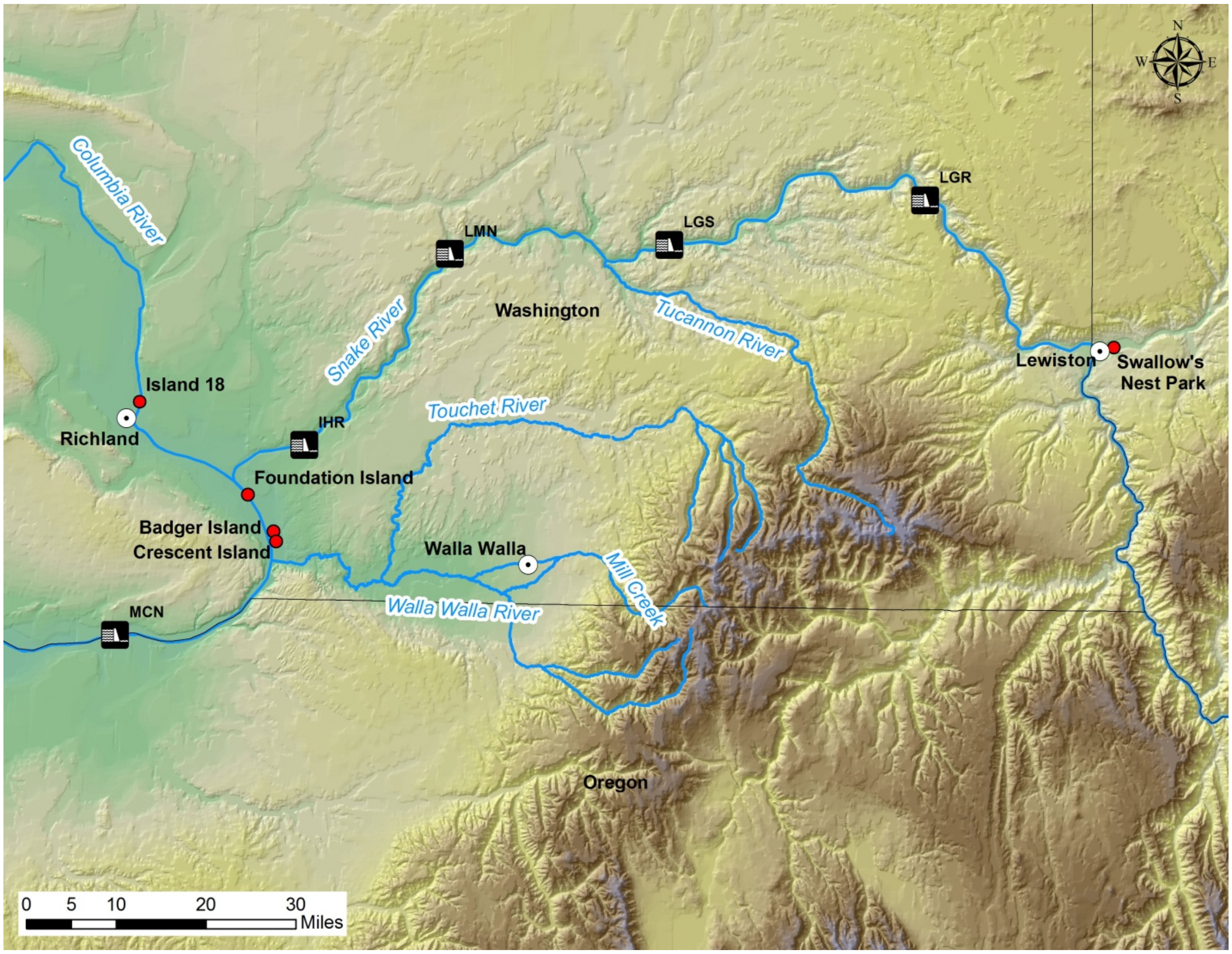

Figure A4. Locations of avian colonies in the Columbia River Basin (●) from which PIT tags from bull trout have been recovered.

Table A15. Unique PIT tag detections at avian colony sites. Data from the PTAGIS database http://www.ptagis.org

total count	unique tag count	number	tag id	tag date	release site	date tag recovered	site tag recovered	river km (Columbia River)	colony type	Days from Tagged to recovery	site of last detection	date of last detection
1	1	1	3D9.1BF1FD126F	5/2/2006 12:00	MILLC (above city water intake)	11/8/2006	BADGER ISLAND	512	PELICAN	190	KCB	5/3/2006 1:51
2	2	3	3D9.1BF1B2F5EC	6/23/2007 10:00	MILLC (above city water intake)	11/11/2009	BADGER ISLAND	512	PELICAN	872	none	none
3	3	4	3D9.1C2C550499	6/3/2008 00:00	WALLAR (Cemetery canal)	11/11/2009	BADGER ISLAND	513	PELICAN	526	none	none
4	4	2	3D9.1BF1B2D210	4/23/2007 00:00	MILLC (above city water intake)	11/11/2009	BADGER ISLAND	512	PELICAN	933	YHC	11/13/2007 6:41
5	5	5	3D9.1C2C6CAE18	4/28/2009 10:45	WALLAR (Joe West Screw Trap)	11/11/2009	BADGER ISLAND	512	PELICAN	197	none	none
6	6	8	3D9.1C2C6C9AB9	10/22/2009 00:00	WALLAR (Nursery Bridge)	9/18/2010	BADGER ISLAND	512	PELICAN	331	BGM	5/25/2010 3:59
7	7	7	3D9.1C2C688309	7/1/2010 00:00	WALLAR (Nursery Bridge)	9/18/2010	BADGER ISLAND	512	PELICAN	79	none	none
8	8	6	3D9.1BF1B2F961	7/15/2009 13:00	WALLSF (reach 83)	9/18/2010	BADGER ISLAND	512	PELICAN	429	WW2	6/5/2010 22:08
9	9	9	384.1B795B268B	10/21/2010 15:10	WALLAR (Cemetery canal)	9/28/2011	BADGER ISLAND	512	PELICAN	342	BGM	11/14/2010 22:51
10	10	11	3D9.1C2C687F65	10/7/2009 10:30	WALLAR (Nursery Bridge)	9/28/2011	BADGER ISLAND	512	PELICAN	721	BGM	5/17/2010 17:12
11	11	10	3D9.1C2C438C56	6/21/2010 00:00	TOUCHET (Dayton pond ladder trap)	9/28/2011	BADGER ISLAND	512	PELICAN	465	none	none
12	12	13	3D9.1C2CBABFCE	5/1/2010 23:00	TOUCHET (screwtrap near Dayton)	9/28/2011	BADGER ISLAND	512	PELICAN	515	none	none
13	13	12	3D9.1C2C6CB62F	9/23/2009 10:30	WALLAR (Nursery Bridge)	9/28/2011	BADGER ISLAND	512	PELICAN	735	ORB	5/28/2010 6:54
14	14	1	3D9.1BF1FC95F6	3/31/2006 12:00	MILLC (above city water intake)	8/7/2006	CRESCENT ISLAND	510	TERN/GULL	129	KCB	4/1/2006 0:10
15	15	2	3D9.1C2C6B97C0	12/2/2008 13:30	WALLAR (Burlingame canal)	8/10/2010	CRESCENT ISLAND	510	TERN/GULL	615	BGM	12/2/2008 19:06
16	16	3	3D9.1BF1FD1FFE	3/11/2006 12:00	MILLC (above city water intake)	8/10/2010	CRESCENT ISLAND	510	TERN/GULL	1,613	none	none
17	17	4	3D9.239F834BA7	7/7/2008	WALLSF (Skiphorton)	8/14/2012	CRESCENT ISLAND	510	TERN/GULL	1,499	BGM	12/17/2010 16:34
18	18	1	3D9.1BF0EDC5F6	5/2/2002 00:00	TOUCHET (Dayton pond ladder trap)	9/24/2002	FOUNDATION ISLAND	518	CORMORANT	145	none	none
19	19	2	1510100A42	4/28/1998 00:00	MILLC (above city water intake)	9/2/2004	FOUNDATION ISLAND	518	CORMORANT	2,319	none	none
20	20	3	3D9.1BF1FDDF97	5/16/2005 00:00	MILLC (above city water intake)	12/14/2005	FOUNDATION ISLAND	518	CORMORANT	212	MCD	5/20/2005 3:45
21	21	4	3D9.1BF1B2B420	5/27/2005 00:00	MILLC (above city water intake)	8/9/2006	FOUNDATION ISLAND	518	CORMORANT	439	MCD	11/9/2005 3:00
22	22	5	3D9.1BF1B2ED3C	4/30/2007 00:00	MILLC (above city water intake)	8/3/2008	FOUNDATION ISLAND	518	CORMORANT	461	MCD	11/17/2007 20:49
23	23	6	3D9.1BF1B2EEDE	8/9/2006 12:30	WALLSF (reach 98)	8/4/2008	FOUNDATION ISLAND	518	CORMORANT	725	WW1	5/3/2007 20:56
24	24	7	3D9.1C2C65BD9F	4/19/2008 12:00	MILLC (above city water intake)	8/5/2008	FOUNDATION ISLAND	518	CORMORANT	108	MCD	5/1/2008 4:26
25	25	8	3D9.1BF1FDD323	7/12/2007 12:30	WALLSF (reach 43)	8/5/2008	FOUNDATION ISLAND	518	CORMORANT	389	WW1	3/15/2008 18:17
26	26	9	3D9.1C2C54F773	11/7/2007 09:50	WALLAR (Burlingame canal)	8/6/2008	FOUNDATION ISLAND	518	CORMORANT	273	BGM	11/9/2007 15:59
27	27	10	3D9.1C2C6886AB	12/2/2008 13:30	WALLAR (Burlingame canal)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	248	BGM	12/29/2008 8:47
28	28	11	3D9.1C2C5505A8	9/13/2007 11:00	WALLAR (Nursery Bridge)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	695	BGM	10/6/2007 1:12
29	29	12	3D9.1C2C6C23DA	11/5/2008 10:15	WALLAR (Nursery Bridge)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	276	BGM	12/28/2008 8:52
30	30	13	3D9.1C2C3CC5D3	6/28/2007 12:30	WALLSF (reach 83)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	771	BGM	12/28/2008 15:09
31	31	14	3D9.1BF1FDD2AA	7/31/2006 12:00	MILLC (above city water intake)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	1,104	MCD	5/25/2008 16:02
32	32	15	3D9.1C2C54F527	10/22/2008 09:00	WALLAR (Cemetery canal)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	290	NBD	1/1/2009 22:18
33	33	16	3D9.1C2C66CC71	4/26/2008 12:00	MILLC (above city water intake)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	469	YHC	12/4/2008 3:17
34	34	17	3D9.1C2C688A5C	12/2/2008 13:30	WALLAR (Burlingame canal)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	249	BGM	12/7/2008 23:43
35	35	18	3D9.1C2C692279	12/2/2008 13:30	WALLAR (Burlingame canal)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	249	BGM	12/31/2008 4:00
36	36	19	3D9.1C2C6C2288	12/2/2008 13:30	WALLAR (Burlingame canal)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	249	BGM	12/8/2008 3:11
37	37	20	3D9.1C2C54FCD3	2/1/2009 12:40	WALLAR (Pieces RV Screw Trap)	8/8/2009	FOUNDATION ISLAND	518	CORMORANT	188	none	none
38	38	21	3D9.1C2C6CD051	10/22/2009 09:00	WALLAR (Burlingame canal)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	330	BGM	12/18/2009 1:04
39	39	22	3D9.1C2C5502B5	7/30/2008 09:00	WALLAR (Nursery Bridge)	9/17/2010	FOUNDATION ISLAND	518	cORMORANT	779	BGM	1/18/2009 20:42
40	40	23	3D9.1C2C6CB1C6	3/2/2009 15:00	MILLC (ctuir lower mill trap)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	563	none	none
41	41	24	3D9.1C2C54FADD	11/28/2007 12:30	WALLAR (Burlingame canal)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	1,023	none	none
42	42	25	3D9.1C2C6CA66C	6/16/2010 11:45	WALLAR (Cemetery canal)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	93	none	none
43	43	26	3D9.1C2C54F68B	10/21/2008 12:00	WALLAR (Cemetery canal)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	696	ORB	2/15/2009 6:54
44	44	27	3D9.1BF1B2A50A	7/21/2009 13:00	WALLSF (reach 8)	9/17/2010	FOUNDATION ISLAND	518	CORMORANT	422	WW1	5/15/2010 20:46
45	45	28	384.1B795B2680	11/5/2010 9:30	WALLAR (Cemetery canal)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	327	BGM	12/22/2010 1:03
46	46	29	3D9.1BF1F30EF1	7/15/2010 10:30	WALLAR (Nursery Bridge)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	440	BGM	12/8/2010 23:49
47	47	30	3D9.1BF1FDD28E	7/15/2010 10:30	WALLAR (Nursery Bridge)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	440	BGM	11/30/2010 8:42
48	48	31	3D9.1C2CFC542B	12/15/2010 9:00	TUCANNON (mouth screw trap)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	287	ICH	6/2/2011 11:42
49	49	32	3D9.1C2C6885AF	6/15/2010 11:45	WALLAR (Cemetery canal)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	470	NBD	1/1/2011 0:32
50	50	33	3D9.1BF1F30AF2	7/15/2010 11:00	WALLAR (Nursery Bridge)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	440	none	none
51	51	34	384.1B795B26A6	11/4/2010 14:45	MILLC (above division dam)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	328	ORB	12/6/2010 1:26
52	52	35	3D9.1BF1FC9448	9/23/2010 15:00	WALLAR (Nursery Bridge)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	370	ORB	5/22/2011 10:15
53	53	36	384.1B795B2679	11/2/2010 13:30	WALLAR (Nursery Bridge)	9/28/2011	FOUNDATION ISLAND	518	CORMORANT	330	BGM	12/2/2010 20:50
54	54	37	3D9.1BF1FDD3D1	10/23/2008	WALLAR (Cemetery canal)	9/22/2012	FOUNDATION ISLAND	518	CORMORANT	1,430	ORB	11/23/2008 3:25
55	55	1	3D9.1BF1FDA4D2	5/13/2005 00:00	MILLC (above city water intake)	8/22/2006	ISLAND 18	549	GULL	466	KCB	5/16/2005 22:03
56	56	1	3D9.1BF1FDCE1F	10/23/2008 09:30	WALLAR (Cemetery canal)	3/26/2009	swallows nest park	522.229 (SR)	CORMORANT	154	BGM	12/26/2008 8:40
57	57	2	3D9.1C2C54FAE1	10/9/2008 13:00	WALLAR (Cemetery canal)	8/1/2009	swallows nest park	522.229 (SR)	CORMORANT	295	BGM	11/13/2008 0:33

Table A16. Summary of bull trout PIT tag detections through 2013 at Columbia River Basin avian colonies.

Bull Trout PIT Tag Release Sites of Recovered PIT Tags at Avian Colonies

Tag Release Site	Unique PIT Recoveries	Percent of Total
Mill Creek	15	26.3 %
Touchet River	3	5.3 %
Tucannon River	1	1.8 %
Walla Walla River	32	56.1 %
South Fork Walla Walla River	6	10.5 %
	57	**100 %**

Last Detection Site of Bull Trout PIT Tag Before Recovery at Avian Colony Site

PIT Site Code	Site Description	rkm*	PIT Tags
BGM	Burlingame Dam and Canal, Walla Walla River	509.059	21
ICH	Ice Harbor Dam (combined adult and full flow bypass)	522.016	1
KCB	Kiwanis Camp Bridge, Mill Creek, Walla Walla Basin	509.054.035	3
MCD	Mill Creek Diversion Project, Walla Walla Basin	509.054.019	5
NBA	Nursery Bridge Dam – adult fishway, Walla Walla River	509.072	2
ORB	Oasis Road Bridge, Walla Walla River	509.010	5
WW1	Harris Park Bridge, South Fork Walla Walla River	509.081.013	3
WW2	South Fork Walla Walla River at Bear Creek	509.081.021	1
YHC	Yellowhawk Creek, Walla Walla Basin	509.063.013	2
No Detection	------	------	14
			57

Bird Colony/Recovery Site of Bull Trout PIT Tag

Recovery Site	Primary Colony Type	PIT Recoveries	Percent of Total	rkm*
Badger Island	Pelican	13	22.8 %	512
Crescent Island	Tern/Gull	4	7.0 %	510
Foundation Island	Cormorant	37	64.9 %	518
Island 18	Cormorant	1	1.8 %	549
Swallows Park	Gull/Cormorant	2	3.5 %	522.229
		57	**100.0 %**	

* *rkm for Columbia River and tributaries*

Genetic ID of Bull Trout Collected at Lower Snake River Mainstem Dams

DeHaan and Bretz (2012) generated a baseline dataset of genetic markers for assigning unknown origin bull trout collected at lower Snake River dams to their most likely population of origin. From 2006 through 2011 twelve bull trout of unknown origin were collected at Little Goose Dam juvenile fish facility. A genetic sample was taken and a PIT tag implanted into each fish. Based on the established baseline data, 11 of the 12 bull trout collected were assigned to the Tucannon River as their origin population (Table A17), nine rkm downstream of the dam. The twelfth fish was assigned to the Imnaha River population, 121 rkm upstream of the dam. These downstream moving fish had been collected off of the juvenile fish separator primarily in May and June.

Table A17. Genetic population assignments (based on 16 microsatellite loci) for 12 bull trout collected at Little Goose Dam from 2006 to 2011. Genetic assignments were made using the program ONCOR. From DeHaan and Bretz, 2012.

PIT Tag	Genetic ID	Date Collected	Most Likely Population of Origin	Probability of Assignment
3D9.257C648FE1	485-001	6/18/2006	Tucannon River	1
3D9.257C5FF084	485-002	9/1/2006	Tucannon River	1
3D9.257C648C9B	485-003	5/28/2009	Tucannon River	1
3D9.257C60066A	485-004	6/20/2009	Tucannon River	1
3D9.257C5FFA86	485-005	6/21/2009	Tucannon River	1
3D9.257C6012DA	485-006	5/29/2011	Tucannon River	1
3D9.257C60042E	485-007	6/16/2011	Tucannon River	1
3D9.257C5F32DC	485-013	5/29/2010	Tucannon River	1
3D9.257C5FD7A2	485-023	5/17/2011	NF Imnaha River	1
3D9.257C5FC866	485-031	6/14/2010	Tucannon River	1
3D9.257C5FBD70	485-032	6/24/2010	Tucannon River	1
3D9.257C5FBD6D	485-033	6/20/2011	Tucannon River	1

The genetic assignment results certainly indicate Tucannon River bull trout are using the mainstem of the lower Snake River and negotiating passage, to some unknown degree of success, past mainstem dams. It is recommended to continue the use of genetic assignment to identify populations of origin of bull trout collected at juvenile fish facilities in the lower Snake River, in addition to expanding the sampling of bull trout to include those collected at juvenile facilities within the lower Columbia River.

Summary

The 2000 BiOp stated, "There are no records of bull trout using fish ladders or juvenile fish bypass systems at any of the lower Columbia River FCRPS projects." Current knowledge of the migratory life history of bull trout from lower Columbia River tributaries, the Walla Walla Basin, mid-Columbia River tributaries, the Tucannon Basin, and other Snake River tributaries indicates there is a significant level of bull trout use of the mainstem Columbia and Snake rivers. From the Service's 2000 BiOp, Reasonable and Prudent Measures (RPM) 10.A.2.2 (lower Columbia River) state that if the information from studies conducted after December 2000 determines, in consultation with the Service, that there is a significant bull trout population in these reaches that is affected by the FCRPS "... then performance standards and appropriate measures shall be developed to ensure that upstream and downstream passage for bull trout is not impeded at FCRPS dams. If the information from these studies warrants consideration of additional modifications to facilities or operations, then the Service will work with the action agencies to implement these measures, as appropriate, or to reinitiate consultation, if necessary. " From RPM 10.A.3.1 (lower Snake and Clearwater Rivers); "If the information from these studies warrants consideration of additional modifications to facilities or operations, as determined by the Service in consultation with the action agencies, then the Service will work with the action agencies to implement these measures, as appropriate, or to reinitiate consultation, if necessary."

Clearly these triggers have been met. Furthermore, Section 13 (Reinitiation) it states "…reinitiation of formal consultation is required where discretionary Federal agency involvement or control of the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; and (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action."

These mainstem areas have been identified as critical habitat for bull trout providing foraging, migration, and overwintering (FMO) needs (FR 2010). These mainstem FMO habitats are critical for maintaining connectivity between bull trout core areas/metapopulations and key to making progress on recovery. Conditions associated with operations at mainstem FCRPS projects across the entire calendar year should be reviewed to determine whether project operations are suitable for the critically important migratory bull trout.

Issues

1. Fall/winter FCRPS operations and bull trout presence/passage — Since we now know that bull trout emigrate from the Hood, Deschutes, Walla Walla, Tucannon and Imnaha rivers and Asotin Creek into the Columbia and Snake rivers, their presence and/or passage at FCRPS projects, fall/winter operations at these projects, and passage conditions should be investigated.

2. Spring FCRPS operations and bull trout presence/passage — Since there are also indications of spring bull trout emigration activity including PIT detections at the FCRPS projects, spring operations and passage conditions should be reviewed. Adult bull trout have also been detected returning to the Hood, Walla Walla, Tucannon, and Imnaha rivers and Asotin Creek from the mainstem in the spring, presumably returning to spawning grounds in the headwaters area.

3. Impacts of avian predation in the mid-Columbia region — The impacts to listed bull trout from avian predation by birds from colonies on lands owned and administered by the Corps is poorly understood.

Questions/Data gaps

1. Bull Trout Life History — Research should be continued to expand knowledge on spatial and temporal migratory bull trout life history and habitat use in mainstem areas, and around FCRPS dams.

2. Operations — Are ladder operations, screened bypass system operations, and spill schedules, appropriate for bull trout life cycle needs? Is turbine passage an issue for bull trout? What are turbine passage injury and mortality rates? What is the extent of bull trout entrainment at FCRPS Dams? If entrainment is determined, in consultation with the Service, to be significant, the action agencies need to explore techniques to deter bull trout entrainment.

3. Monitoring — Are detection capabilities at the mainstem FCRPS projects sufficient for proper monitoring and evaluations (PIT detection capability, direct observation, video)? Structured bull trout video monitoring should be implemented at all the projects when direct counts are not being conducted.

4. Avian Predation — What is the nature and extent of avian predation on bull trout. When and where is it occurring?

5. Climate Change — Are the potential effects of climate change as it affects mainstem habitat manipulated by FCRPS operations considered in plans to accommodate bull trout?

In coordination with the Service and NMFS, the Corps should begin to develop performance standards appropriate for bull trout. The standards should consider direction contained in the recovery plan for these species. Stands should be implemented as soon as possible. As further research develops new information the performance standards should be adjusted accordingly, in coordination between the Service, NMFS, and the Corps.

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Appendix B: Action Agency Comments on the Draft Version (April 2015) of this Report with FWS Responses

The April 2015 draft version of this report was provided to the U.S. Army Corps of Engineers (COE), the U.S. Bureau of Reclamation, and the Bonneville Power Administration for their review and comment. Comments were submitted by all three agencies via email. In addition, the COE provided comments that were embedded in the report itself. The comments were extracted from the emails and the report and formatted as lists with FWS responses to each comment, including whether or not changes were made to the report. The four lists of comments/responses follow in this Appendix.

FWS Responses to Corps of Engineers Email Comments on FWS Draft Report: "Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout"

This document provides FWS responses to comments submitted by the COE in their 06-09-15 email regarding the draft report document: *Mainstem bull trout synthesis Draft Report_4_1_2015.pdf*

Comments were extracted from the email, numbered sequentially, and followed by responses in bullet format and italics.

A. The specific limitations of this report, as it pertains to supporting consultation on the operation and maintenance of the FCRPS include the following:

1) Most of the recommendations pertain to broad species recovery objectives, planning, and information needs of USFWS.

- *Most recommendations occur in the subbasin sections and are focused on bull trout populations, life history details, and migratory characteristics. These recommendations could provide useful and necessary information for both recovery and management objectives.*
- *Many of the recommendations could also provide information that would describe spatial and temporal aspects of bull trout life history and migration patterns that would establish context relevant to interactions with the mainstem and the hydroprojects.*
- *In Chapter 2, "Potential Impacts of Mainstem Dams, Their Operation, and Associated Impoundments on Bull Trout", relevant factors are presented as "data gaps and research needs", but could also be interpreted as recommendations. We think these factors are directly relevant to potential effects of the FCRPS and may be useful to support consultation "on the operation and maintenance of the FCRPS".*

2) The potential effects of the FCRPS on bull trout described in the report are extremely speculative and not supported by the limited data set that does exist.

- *There are many "potential effects" described in the report. Without information on the* ***specific*** *effects that are "extremely speculative and not supported by the limited data", we are unable to respond directly to this comment. We encourage you to review our responses to your similar comments that were embedded in the report for more detail.*
- *We describe effects as* ***potential*** *in the report because in most cases, we recognize that the data are limited. We disagree with your characterization of "speculative". The data may be limited in many cases, but with our collective experience and knowledge regarding bull trout life history, we at least have a qualitative basis for descriptions of potential effects.*

3) The synthesis does not consider the decades of research and improvements of the FCRPS directed towards juvenile and adult salmonids in the Columbia Basin.

- *The vast amount of research and improvements that have been made throughout the FCRPS are a significant accomplishment, and the COE should be commended for its work. Unfortunately, the COEs accomplishments are not the subject of this report. Most of the research that has been conducted, and improvements that have been made, were directed at anadromous salmonids. Bull trout are not anadromous, and their life history and migratory patterns and behavior are much different than anadromous salmonids.*
- *The synthesis acknowledges the fish passage structures that are in place (i.e. improvements) and attempts to describe their function relative to bull trout life history.*

4) There is almost no discussion on the most significant limitation in evaluating the impacts of FCRPS O&M on bull trout, which is the extremely limited numbers of fish available to evaluate.

- *We describe the impacts of the FCRPS and O&M on bull trout as "****potential*** *effects".*
- *This synthesis is a compendium on bull trout in the Columbia Basin; what we know, what we don't know and potential issues relevant to the recovery of the species. One of the primary purposes of this synthesis is to identify data gaps and research needs to help reduce what we don't know about bull trout so we can focus on the relevant factors to make progress towards recovery. A future step in this process will address the details of how we move forward. Potential challenges associated with filling data gaps and conducting research on bull trout that use the mainstem Columbia and Snake rivers do not change the need for the information.*

5) The summary discusses "significant" bull trout populations in the mainstem lower Snake and Columbia Rivers. While "significant" is not defined in the report, it should be noted that bull trout occur at an extremely low abundance in the mainstem lower Snake and Columbia Rivers.

- *The term "significant" was used in the 2000 Biop, and it was not defined where it was used. It is used in the 2000 Biop along with "substantial" to refer to bull trout in the mainstem. Neither term was used in a numerical or statistical sense.*

- *This synthesis is a compendium on bull trout in the Columbia Basin; what we know, what we don't know (including mainstem abundance) and potential issues relevant to the recovery of the species. We have identified these items as data gaps or research needs. The purpose of this synthesis did not include consideration of the details (e.g. bull trout abundance) associated with the studies required to fill these gaps or address these needs.*

B. Comments embedded in the remaining text of the email.

6) While this report explicitly states that the information and findings contained within it are valuable for future Section 7 consultation on FCRPS O&M,….

- *This statement occurred in the Executive Summary, and we will change the usage of "are valuable" to "may be useful".*

7) ….it is important to note that many of the recommendations and identified data gaps are not applicable to minimizing the effects of the proposed FCRPS O&M action.

- *We partially agree that "many of the recommendations and identified data gaps are not"* ***directly*** *"applicable to minimizing the effects of the proposed FCRPS O&M action." We argue that data gaps regarding bull trout interactions with mainstem dams and passage facilities* ***are*** *applicable to minimizing effects.*
- *In addition, many of the recommendations and data gaps were identified to improve our understanding of bull trout migratory behavior, particularly in the mainstem. A better understanding of migratory behavior could certainly help to understand effects of the FCRPS if any, thus making it easier to minimize those effects.*

8) Most of the recommendations pertain to broad species recovery objectives and information needs of the U.S. Fish and Wildlife Service (see "1" above).

- *See response to comment #1 above.*

9) The potential negative impacts of the FCRPS on bull trout that are presented in the report are extremely speculative and not supported by the limited data that does exist.

- *See response to comment #2 above.*

10) Furthermore, there is no speculation on the potential positive impacts FCRPS O&M may have on bull trout, including increased foraging opportunity, increased overwinter habitat and increased thermal refugia, all of which may increase productivity and survival of bull trout that use the mainstem Snake and Columbia Rivers.

- *We are not sure what these increases are relative to? If the baseline is a free-flowing Columbia/Snake River system, without the FCRPS, we would be interested in how you determined these things were increased relative to that condition.*
- *We have discussed some of the potential positive effects you mention in response to your comments that were embedded in the report.*

11) In the summary of the synthesis report there is a discussion of "significant" bull trout populations in the mainstem, which does not seem supported by the data.

- *See response to comment #5 above.*

12) Furthermore, there are discussions of establishing performance standards; however, there is no discussion on how impractical, if not impossible, it will be to collect enough bull trout to make meaningful evaluations and management decisions. There should be discussion on how this significant challenge will be overcome or at the very least some acknowledgement that this is a significant limitation to getting more information on the effects of FCRPS on bull trout.

- *The discussions you mention, start with a citation from the 2000 Biological Opinion as follows: "From the Service's 2000 BiOp, Reasonable and Prudent Measure (RPM) 10.A.2.2 (lower Columbia River) state that if the information from studies conducted after December 2000 determines, in consultation with the Service, that there is a significant bull trout population in these reaches that is affected by the FCRPS "... then performance standards and appropriate measures shall be developed to ensure that upstream and downstream passage for bull trout is not impeded at FCRPS dams."*
- *When the 2000 Biop was written, almost nothing was known about bull trout use of the mainstem. As we continue to build our knowledge, and develop a new Biological Opinion to follow your Biological Assessment, we plan to re-visit the issue of performance standards and determine how they might be developed or characterized.*
- *The current synthesis is a compendium on bull trout in the Columbia Basin; what we know, what we don't know (including mainstem abundance) and potential issues relevant to the recovery of the species. We have identified these items as data gaps or research needs. The purpose of this synthesis did not include consideration of the details (e.g. bull trout abundance) associated with the studies required to fill these gaps, address these research needs, or develop performance standards.*

13) The report synthesizes the very limited data on bull trout within the FCRPS. However it fails to incorporate more than 6 decades of intensive study on FCRPS O&M effects to other salmonids in the Columbia River basin. It would seem logical to use numerous studies of other salmonids for evaluating potential effects of FCRPS O&M on bull trout. Specifically, radio, PIT, and acoustic telemetry have been used to evaluate passage and survival for juvenile and adult salmon passing upstream and downstream at all lower Snake and Columbia River FCRPS projects. While there may be key differences in life history strategy and migration timing that would render some results less applicable, there are numerous studies which are probably very directly applicable.

- *The vast majority of six decades of study was focused on anadromous salmonids. As you acknowledge, there are key differences in life history strategy, migration timing and behavior, and habitat use that make direct extension of much of this research to bull trout problematic.*
- *We certainly agree with your point that when there are mainstem studies and research that were conducted to benefit anadromous fish, and that are directly applicable to bull*

trout, they should be used to help evaluate potential effects of the FCRPS on bull trout passage, connectivity, and survival.

- *Since the COE has been involved in most of this research over the last six decades, and are much more familiar with the details, we think it would be more efficient for the COE to identify the relevant studies in a future Biological Assessment.*

FWS Responses to Bureau of Reclamation Email Comments on FWS Draft Report: "Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout"

This document provides FWS responses to comments submitted by the BOR in their 06-09-15 email regarding the draft report document: *Mainstem bull trout synthesis Draft Report_4_1_2015.pdf*

Comments were extracted from the email, numbered sequentially, and followed by responses in bullet format and italics.

General Comments

1a) The paper is a useful compilation of available information regarding bull trout use of the mainstem Columbia and Snake Rivers and current, ongoing research.

- *We agree that this paper is a useful compilation of available information regarding bull trout use of the mainstem Columbia and Snake rivers. In addition, we believe that information within this paper will prove beneficial to managers that are working to address the many bull trout issues within the various subbasins.*

1b) However, the paper is narrowly focused on evaluation of FCRPS effects. Statements such as "This report is in response to the impending re-initiation of consultation on effects of the FCRPS on bull trout" (P. 24), and similar statements throughout the document (including the entire Section 2: "Potential impacts of mainstem dams, their operation and impoundments on bull trout") creates confusion about the purpose of the document.

- *We disagree that the paper is narrowly focused on evaluation of FCRPS effects. For example, much of Chapter 1 discusses subbasin bull trout local populations. A large portion of Chapter 2 now includes summaries for the non-FCRPS dams in the mid-Columbia River. In addition, this is a technical report, not an effects analysis.*
- *We assembled and synthesized the available information around the three fundamental questions identified in the introduction.*
- *Describing interactions with mainstem dams and their impoundments is an essential component of describing mainstem use.*
- *We simply state that the impending re-initiation of consultation on the effects of the FCRPS is our rationale for undergoing this effort. We re-worded the abovementioned statement to more clearly describe the focus/purpose of the document.*

1c) Analysis of effects to bull trout from FCRPS project actions is a step usually undertaken by Action Agencies with in-depth understating of the action and the best available science in a biological assessment.

- *This is a technical report, not an effects analysis or biological assessment. We believe the information compiled in this report may be useful to the Action Agencies for producing a biological assessment. We agree that the Action Agencies have a much better understanding of the action, and a much better understanding of the work that has been conducted to improve passage conditions for anadromous fish. We assume the Action Agencies will take the opportunity to discuss these factors in a biological assessment. Much of this detailed knowledge that resides with the Action Agencies will be useful to the FWS for development of a biological opinion. In addition, we feel that this synthesis of available information may also be useful to managers and other entities by identifying information gaps and research needs.*

1d) This paper would be most useful if it were limited to the synthesis of available information that would inform those analyses.

- *That was our intent, and we hope we were successful.*

2) The paper is also too general in scope to be an effective analysis document by including both FCRPS and non-FCRPS projects. A proper effects analysis document would clearly define a discreet action area, environmental baseline, and proposed action. Effects of the action and cumulative effects would then be considered in context of the environmental baseline. This paper does not follow such a format and it is confusing and misleading to represent it as an effects analysis.

- *We do not represent this report as an effects analysis. This comment contradicts a previous comment (see 1b above) claiming the paper is "narrowly focused". We think the non-FCRPS projects you mention were cited in Chapter 1 in the relevant subbasin reviews, and also in Chapter 3, the synthesis. We had eliminated the mid-Columbia hydroproject write-ups from Chapter 2 because they were not FCRPS projects. We have decided to re-insert the mid-Columbia hydroproject summaries for the following reasons: 1) for a more complete synthesis of the available information on bull trout use of the mainstem; 2) because there is a large body of potentially useful information on use of the mainstem by bull trout; and 3) because data on bull trout migration patterns and behavior around the mid-Columbia projects might be useful to help understand what to expect around other mainstem projects that are data-poor.*

3) The paper also seems to draw very broad conclusions across the entire Columbia basin while generalizing based upon data from smaller areas of the basin. Summarizing the importance of the "mainstem Columbia" by cumulatively considering all core areas and populations of the entire basin is misleading because the geographical location affects the use by bull trout. For example, the mainstem may be important FMO habitat that is used year-round by bull trout populations in the Snake and upper portions of the Columbia basin, whereas it would be

misleading to use data from those populations to characterize the use and importance of mainstem habitat for bull trout far downstream where the habitat looks very different.

- *We used the available information from data-rich subbasins and portions of the Columbia River to identify* ***research needs and potential effects*** *in areas where very little work has been done to determine the extent of mainstem use. We do not think this is misleading. The recent designation of the mainstem Columbia as critical FMO habitat acknowledges the importance of the mainstem Columbia as habitat for foraging, migration (e.g., connectivity between subbasins), and overwintering. We do not agree that the data is presented in a way that is misleading. Without more detailed information on specific parts of the report where you think we have been misleading, we are unable to respond more directly to this comment.*

4a) Though characterized as "potential effects", the paper's tone throughout suggests that the FCRPS has a large, negative effect on bull trout and yet the actual data does not necessarily support these conclusions.

- *Based on the available information, we suggest the need to conduct further investigations into bull trout use of the mainstem Columbia and Snake rivers, and indicate the importance of evaluating how FCRPS mainstem dams and their reservoirs may potentially affect bull trout and mainstem critical habitat (P. 159). We drew our conclusions and identified research needs based either on existing information, or the lack of sufficient information that indicates a research need. At no point did we definitively conclude that the FCRPS has a large negative, positive, or neutral effect on bull trout, nor was that the purpose of this report.*
- *We have changed "potential impacts" to "potential effects" in many places in the report to help address the perceived "negative tone". Identifying "potential effects" from available information is substantially different than concluding "large, negative effects".*

4b) It appears that there are few bull trout, more in some populations while less in others, using the mainstem and where more bull trout use the mainstem they do seem to be able to survive, pass the dams, and grow in the mainstem.

- *Studies to specifically investigate bull trout use of the mainstem have not been conducted for many of the subbasins and even fewer investigate bull trout while in the mainstem (migration, connectivity and survival). Thus, your observation that "there are few bull trout, more in some populations while less in others, using the mainstem" is due largely to the absence of data rather than the actual situation. We acknowledge in the report that at least a portion of the bull trout that use the mainstem are able to survive, pass the dams, and grow in the mainstem. However, information is not sufficient to quantitatively define survival rates or overall upstream and downstream passage efficiency. We also acknowledge that the reservoirs (p. 18) potentially provide beneficial seasonal environments where bull trout forage, migrate, and overwinter.*

4c) All "potential effects" are speculated as occurring unless it has been proven otherwise, and no consideration is given to positive effects from improvements for salmon in the system that also benefit bull trout. An appropriate effects analysis, including beneficial effects of FCRPS projects, should be done before drawing conclusions.

- *"Potential" effects are described in the report as "potentially occurring". We do not speculate that they **are** occurring unless there are data to support that conclusion. In most cases, we are relegated to "potential" because of a lack of data to develop definitive conclusions.*
- *This is not an effects analysis.*
- *Improvements for salmon in the system were acknowledged, but any positive effects on bull trout are assumed and we state that information to assess this is lacking (p. 16, p. 17). The "improvements for salmon in the system" were designed for anadromous salmonids, not fluvial salmonids (e.g., bull trout). Thus it is not clear whether these improvements are as suitable for bull trout as they are for salmon.*
- *We acknowledge that the reservoirs (p. 18) potentially provide beneficial seasonal environments where bull trout forage, migrate and overwinter.*

Page-Specific Comments

5) P. 14: End of paragraph on bull trout movement within the mainstem – States "Providing opportunities to disperse by eliminating impediments to migration and improving migratory corridor habitat conditions is critical for maintaining genetic diversity and the persistence of bull trout local populations and metapopulations." This statement is accepted, generally-speaking, but the relatively small numbers of bull trout using the mainstem Columbia River do not support that migration opportunities are limiting bull trout persistence.

- *The main point of the topic sentence for this paragraph is the elimination of impediments.*
- *The sentence you are referring to is clear, concise and consistent with what the bull trout recovery plan states. In addition, data are not sufficient to support your statement that "relatively small numbers of bull trout using the mainstem Columbia River". Migration opportunities would apply to any bull trout using the mainstem, whether it is only a few or many. We also state in that same paragraph that "Long-range migrants have been observed to be a relatively small component of bull trout populations (Warnock et al. 2011; Schaller et al. 2014), but represent the only opportunity for genetic connectivity among subbasins and possible recolonization of areas where bull trout have been extirpated. Thus, if data were sufficient to conclude that "relatively small numbers of bull trout" are using the mainstem, this conclusion would be consistent with the statement above.*

6) P. 15, Range of Mainstem Movements, 2nd bullet: Use of the river stated as a percentage of linear distance could be misleading. It's not clear how this conclusion was reached.

- *We do not think this is misleading. It is based on empirical data (detection and genetic information). See p. 143 -144 for the description of how this information was determined.*

7) P. 16, 1st bullet: "When a greater number of mainstem dams are present within the migration corridor between subbasins, observations of connectivity between bull trout populations are less frequent." This is a far-reaching conclusion drawn from a relatively small data set of observations over many different studies. If there is an analysis of data leading to this conclusion it should be cited.

- *This statement is based on the observations and the available information. It is not a far-reaching conclusion (p. 150). We agree that definitive conclusions cannot be drawn from this simple comparison of information because there are also biological limitations and other factors that influence connectivity between basins. This is stated on p. 150.*
- *We agree that further clarification is needed in this bullet, especially for the audience that only reads the executive summary and not the entire document.*

8) P. 18, Impacts Associated with Reservoirs, 1st bullet: The last sentence states "high reservoir water temperatures during the summer months may adversely affect bull trout migration patterns, growth, and survival." Generally speaking, bull trout would only use the mainstem Columbia River habitats in the winter months where the reservoir temperatures limit their use in summer.

- *That is our point. Potential adverse effects on migration, growth and survival.*

9) P. 18, Impacts Associated with Reservoirs, 2nd bullet: It is not clear if data supports the statement about the majority of Walla Walla bull trout not surviving.

- *It is very clear that available information suggests the majority of Walla Walla subbasin bull trout that enter the mainstem may not survive to return to the subbasin. See p. 60. We will add further clarification to this paragraph (p. 60) in the body of the report.*

10) P. 23, bottom of page, 3 fundamental questions: As part of the first question, the even more fundamental question that needs answered is the importance of the Columbia River mainstem to bull trout recovery at each population scale. Efforts should then be focused on the areas where the mainstem indeed serves as important FMO habitat to a significant portion of the population. In many populations, other limiting factors would likely be a higher priority.

- *This paper is organized around the three stated questions. We acknowledge there are many other questions at various population scales that have yet to be addressed. Similarly, we agree that there are other limiting factors within the various subbasins that need to be addressed (some of these limiting factors are discussed in Chapter 1), but are beyond the scope of this paper. The recent designation of the mainstem as critical FMO habitat highlights the importance of mainstem habitat for bull trout.*
- *The importance of mainstem habitat to each of the local (subbasin) populations and/or core areas does not necessarily correlate with the number of bull trout or the number of local populations using it. For example, the opportunity for small numbers of bull trout from various local populations or core areas to connect with other local populations (genetic exchange) has been shown to affect the genetic integrity of the entire population (listed entity – Coterminous United States Population of Bull Trout) and contribute to its*

persistence and recovery (see Revised Draft Recovery Plan 2014). This is one example of how FMO habitat in the mainstem is important to the population as a whole.

11) P. 40, Recommendations, 2nd para, last sentence: "There is little doubt that the Columbia River is an important part of the life cycle for Hood River bull trout as a source of rearing, foraging, and overwintering habitat." This is a very strong conclusion drawn from a handful of bull trout observations. An analysis showing the proportion of the population using the mainstem would be helpful to support this conclusion.

- *We have clarified the statement to better reflect the data used to represent the importance of the Columbia River to Hood River Bull trout.*
- *Your suggestion for an analysis that would estimate the proportion of the population using the mainstem could be identified as a research need by BOR in a biological assessment. However, remember that the importance of mainstem habitat does not necessarily correlate with the proportion of the specific population using it (see response to previous comment).*

12) P. 66, Recommendations: Yakama bull trout are not found to use the mainstem Columbia River, so it is not clear why additional effort should be directed towards monitoring, genetic sampling, etc. in the mainstem. Efforts should be focused in basins where data indicates the mainstem may be important for their life cycle.

- *Our statement on page 66 is "Efforts should continue to be directed toward PIT and radio- tagging, and collecting genetic samples from bull trout captured at **all available monitoring sites**" not just in the mainstem as your comment indicates.*
- *Walla Walla bull trout were also previously not found to use the mainstem Columbia River until the appropriate level of sampling and monitoring methods were implemented. Mainstem use may be presently unknown in many subbasins because of an insufficient or non-existent sampling and monitoring program.*
- *In addition, the paragraph you refer to includes a discussion of in-basin factors that may be affecting use of the mainstem by Yakima bull trout. This is a case where continued or additional monitoring may be essential to determine if in-basin conditions are limiting use of the mainstem, or if the mainstem is being used, but that use has not been detected.*

13) P. 86, bullets 1 and 2: Is there enough data to support these two statements in this population?

- *We agree that limited information exists for bull trout in this subbasin, but there is data to support these statements. Please see Table 1.7, 1.8, 1.9 and the many reports cited.*

14) P. 110, first paragraph: It is important to note that the mainstem Columbia and Snake Rivers were designated as critical habitat with the migratory conditions at the time, including the dams and fish passage structures. All effects of the structures are part of the environmental baseline. This entire section should be predicated that "potential effects" are just the first thought process to catalog where effects could be evaluated based upon what we know about each specific

project and bull trout biology. It should not be assumed that the effects actually exist and are limiting bull trout populations.

- *We believe the definition of "potential" is sufficient without further predication. "Potential" effects are described in the report as "potentially occurring". We do not assume that they **are** occurring and limiting bull trout populations unless there are data to support that conclusion.*

15) P. 114, Last sentence of the "Connectivity" section: States "If bull trout from the Hood River and Deschutes River subbasins exhibit similar movement patterns to bull trout from other subbasins…" Generally speaking bull trout do exhibit these movements, but it should not be the basis for an effects analysis without supporting data.

- *This is not an effects analysis, it is a technical report.*
- *Where data is sufficient, movement patterns of fluvial bull trout to and from the Columbia and Snake rivers have been very similar across the relevant subbasins. We think it is reasonable to assume that fluvial bull trout from the Hood River and Deschutes River subbasins where data are relatively sparse, also follow similar patterns. Please see the Hood River and Deschutes River subbasin summaries for supporting data.*

16) P. 139, Migration to the Mainstem: The relatively small number of bull trout using the mainstem from each of the subbasins should be mentioned, with a discussion that some subbasins have a relatively higher use of the mainstem habitats than others.

- *We will clarify this paragraph by indicating that bull trout use of the mainstem appears to be higher in some subbasins than in others based on the information available.*
- *This section concentrates on **whether or not** bull trout from a given subbasin have been observed migrating to the mainstem, not how many or what proportion of the population uses the mainstem. The Abundance section discusses estimating the number of bull trout from a given subbasin that use the mainstem and what is currently known (p. 141).*

17) P. 140, Migration Timing: The sentence "Further, subbasins with fewer anthropogenic impacts and alterations to the migratory corridors may allow for less impeded migration" is somewhat speculative with no corresponding data cited.

- *This is a summary statement based on available information and professional judgment. We believe it is reasonable to suggest that the presence of anthropogenic impacts such as dewatering, channelization, grade control structures, and diversion dams may impede migration. This notion is obvious and does not need specific supportive citations. For further information, please see the bull trout recovery plan.*

18) P. 154, Connectivity: This paragraph is an example of the tone referenced in the general comments. It reads as if the assumption is that dams lack adequate passage routes and impede migration, whereas data indicates that some dams are passable by bull trout and the migration delay is unknown but not indicated to be an effect.

- *We have clarified this paragraph so it is more objective without the negative connotations.*

19) P. 183, Appendix A: The relationship between the main report and Appendix A is unclear. Why was this included as an Appendix? Is much of the information duplicative?

- *Appendix A represents an initial effort to assemble all of the available information on bull trout and use of the mainstem Columbia and Snake rivers. Most of the material in Appendix A is simply organized data, much of it from COE sources. It also includes some of the content and excerpts from the 2000 Biop. This information may be useful and appropriate for multiple activities that could include development of research and work plans to fill data gaps and research needs, a future consultation on the FCRPS, and/or recovery planning efforts by the FWS In addition, some sections of the report refer to Appendix A for various types of information. We agree that some of the information is duplicative.*

FWS Responses to Bonneville Power Administration Email Comments on FWS Draft Report: "Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout"

This document provides FWS responses to comments submitted by BPA in their 06-12-15 email regarding the draft report document: *Mainstem bull trout synthesis Draft Report_4_1_2015.pdf*

Comments were extracted from the email, numbered sequentially, and followed by responses in bullet format and italics.

1) In addition to noting that we have reviewed and agree with comments provided to you earlier this week by the Bureau of Reclamation and U.S. Army Corps of Engineers, we also wanted to provide you with some high level summary comments.

- *We addressed each Bureau of Reclamation and U.S. Army Corps of Engineers comment individually within the document when necessary/appropriate and provided responses to each comment in separate documents. If BPA would like to read the abovementioned response documents, please contact the COE and Bureau of Reclamation directly.*

2) In short, we appreciate the paper's efforts to compile the best available data regarding bull trout usage of the mainstem Columbia and Snake Rivers.

- *This was our intention, and we thank you for the acknowledgement.*

3) However, while the draft report may provide some useful information for future bull trout consultations, we also find many recommendations largely focused on additional research, monitoring, and evaluation that are not applicable to the FCRPS consultation and minimizing the effects of associated operations.

- *Most "recommendations" occur in the subbasin sections and are focused on bull trout local populations, life history details, and migratory characteristics. These recommendations could provide useful and necessary information for both recovery and management objectives.*
- *Many of these recommendations could also provide information that would describe spatial and temporal aspects of bull trout life history and migration patterns that would establish context relevant to interactions with the mainstem and the hydroprojects.*
- *In Chapter 2, "Potential Impacts of Mainstem Dams, Their Operation, and Associated Impoundments on Bull Trout", relevant factors are presented as "data gaps and research needs", but could also be interpreted as recommendations. We think these factors are directly relevant to potential effects of the FCRPS and may be useful to support consultation on the operation and maintenance of the FCRPS.*
- *Recommendations, data gaps, and research needs identified in the report include biological and physical factors, some of which may not be directly related to FCRPS effects. But others are directly related, and will likely be applicable to the FCRPS consultation. The document is intended to be useful to inform multiple management issues and research, not only for FCRPS consultation.*

4) We believe that the draft paper conflates issues of lack of observations of bull trout and uncertainty associated with lack of information with potential effects.

- *We do not agree. Both limited bull trout observations and limited data to infer FCRPS effects lead directly to the recommendations in Chapter 1, the data gaps and research needs discussed in Chapter 2, and the synthesis of these data in Chapter 3. We present the available data in the first two chapters, which in many cases is limited, and discuss* ***potential*** *effects of the FCRPS. These effects are discussed as* ***potential*** *throughout the report because of limited bull trout observations and limited data on interactions with FCRPS projects.*

5) Throughout the draft paper there are suggestions of negative effects of dams on bull trout with very little, if any, consideration to the FCRPS improvements for juvenile and adult salmonids that also benefit bull trout.

- *Most FCRPS improvements were made for* ***anadromous*** *fish, and they were acknowledged and discussed throughout the report. Whether these improvements benefit* ***fluvial*** *bull trout, which are not anadromous, is a different question. You imply that these improvements benefit bull trout, and in the report we discuss the overall lack of data to determine benefits or not. We also discuss the fundamental differences (life history, physical characteristics, habitat use, migration timing and behavior) between bull trout and anadromous fish which lead to the uncertainty regarding suitability of the improvements.*
- *We have also edited much of the report to remove the negative connotations where they are not justified.*

6) The draft report could be improved by incorporating the substantial improvements to the FCRPS for both juvenile and adult salmonids, as these improvements provide benefit to bull trout as well.

- *Improvements for anadromous fish in the system were acknowledged in the report, but the information available suggests for the most part, that positive effects on bull trout are assumed and assessment data specifically for bull trout is lacking (p. 16, p. 17).*
- *Bull trout life history, physical characteristics, habitat use, and migration timing and behavior differ tremendously from juvenile and adult anadromous salmonids. To conclude that these improvements definitively provide benefits to bull trout as well, without the appropriate data or evaluations, is not valid.*

7) Given the limited data, low abundance of bull trout in the mainstem, and availability of salmon/steelhead passage routes, and that there have been no observations of bull trout use of the mainstem Columbia and/or Snake River for many of the subbasin populations and little is known about habitat use in the mainstem (e.g. Deschutes River, John Day River, Clearwater River, Umatilla River, Grande Ronde River, Salmon River, and Yakima River), the recommendation in the Summary, Appendix A that concludes, "in coordination with the Service and NMFS, the Corps should begin to develop performance standards appropriate for bull trout" does not seem appropriate at this time.

- *The recommendation you mention comes from a citation from the 2000 Biological Opinion as follows: "From the Service's 2000 BiOp, Reasonable and Prudent Measure (RPM) 10.A.2.2 (lower Columbia River) states that if the information from studies conducted after December 2000 determines, in consultation with the Service, that there is a significant bull trout population in these reaches that is affected by the FCRPS "... then performance standards and appropriate measures shall be developed to ensure that upstream and downstream passage for bull trout is not impeded at FCRPS dams." Your actual quote is a re-statement of this towards the end of the Summary. We obviously cannot change recommendations from the existing Biological Opinion.*
- *When the 2000 Biop was written, almost nothing was known about bull trout use of the mainstem. As we continue to build our knowledge, and develop a new Biological Opinion to follow your Biological Assessment, we plan to re-visit the issue of performance standards and determine how they might be developed or characterized. Performance standards for bull trout may not resemble performance standards currently in place for listed anadromous fish.*

8) Similar to the above observation, we believe much of the summary contained in Appendix A would be more appropriate for USFWS's recovery planning efforts than for attribution to the FCRPS.

- *Appendix A represents an initial effort to assemble all of the available information on bull trout and use of the mainstem Columbia and Snake rivers. Most of the material in Appendix A is simply organized data, much of it from COE sources. It also includes some of the content and excerpts from the 2000 Biop. This information may be useful and appropriate for multiple activities that could include development of research and* *work plans to fill data gaps and research needs, a future consultation on the FCRPS, and/or recovery planning efforts by the FWS.*

FWS Responses to Corps of Engineers Embedded Comments on FWS Draft Report: "Use of the Mainstem Columbia and Lower Snake Rivers by Migratory Bull Trout"

This document provides FWS responses to comments submitted by the COE that were embedded in the draft report: *Mainstem bull trout synthesis Draft Report-6_2_2015-COE NWDReview.pdf*

Comments were extracted from the document, followed by the page number (highlighted) on which they occurred, and numbered sequentially from 1 through 50. Responses are in italics, and follow each comment.

g4pmadh9
D:20150410094050-07'00'4/10/2015 8:40:50 AM
P15
1) Need to check sample sizes. Is this based on just 2 or 3 bull trout observations?

The statement is based on three individual bull trout. We have edited this bullet and inserted sample size.

g4pmadh9
D:20150410094450-07'00'4/10/2015 8:44:50 AM
P16
2) This first sentence is very contradictory to the statements below. To conclude that connectivity is decreased when there are more mainstem dams, except where you have lots of data and monitoring, suggests the fist sentence is simply not supported.

We have re-worded this bullet to clarify. We have added sample size and identified other factors that may affect connectivity.

g4pmadh9
D:20150410094701-07'00'4/10/2015 8:47:01 AM
P16
3) They are poorly understood, yet this report speculates heavily on all the potential negative impacts to bull trout which are not really supported by any data.

We have changed "impact" to "affect" in many places (including the paragraph where this comment was made) when there is not sufficient data to conclude a negative impact.

g4pmadh9
D:20150410095312-07'00'4/10/2015 8:53:12 AM
P17
4) FCRPS projects have undergone extensive improvements to aid in fish passage. Because there is no evidence to suggest bull trout lack sufficient passage at FCRPS projects it seems this bullet is not supported.

The "extensive improvements to aid in fish passage" were mostly designed for anadromous salmonids, not fluvial salmonids. Thus it is not clear whether these improvements are suitable for bull trout as well as salmon and steelhead. We agree that there is not much evidence to suggest passage is sufficient or not for fluvial bull trout. That is why this bullet is listed under "potential impacts". We have re-worded this bullet.

g4pmadh9
D:20150410095618-07'00'4/10/2015 8:56:18 AM
P17
5) Virtually all of the changes have been targeted towards improving salmonid passage and survival. Bull Trout, being salmonids, it seems reasonable to believe that these improvements have either improved or at worst not harmed bull trout passage and survival.

*Your comment would be more accurate if it said "targeted towards improving **anadromous** salmonid passage and survival." You are correct; bull trout are salmonids, but their life history, physical characteristics, and migratory behavior are quite different than most species of anadromous salmonids. We have re-worded this bullet.*

g4pmadh9
D:20150410095715-07'00'4/10/2015 8:57:15 AM
P17
6) Do you have any evidence of even a single bull trout attempting to pass an FCRPS project and failing?

There have been a number of PIT-tagged bull trout that were detected in ladders at several different mainstem dams, then never detected or observed again. So it is difficult to conclude that they either did, or did not pass successfully. No changes.

g4pmadh9
D:20150410100147-07'00'4/10/2015 9:01:47 AM
P17
7) We have conducted spillway and turbine survival studies on steelhead, many of which were A-run fish which were included to serve as a surrogate for bull trout. Spillway survival was 98% and turbine survival was 91%.

Juvenile salmonid survival has been studied extensively at all FCRPS projects and routinely exceeds 96% survival. It is unlikely juvenile or subadult bull trout would deviate substantially in their survival from the extensive studies which have been conducted on salmonids.

We are familiar with the array of survival studies that have been conducted for anadromous fish at various projects throughout the FCRPS, although not in great detail. You hypothesize that these studies mighty be directly applicable to bull trout. That hypothesis is reasonable, but it is only a hypothesis. Studies should be conducted specifically for bull trout to determine whether your hypothesis is correct or not.

In your second comment, we think you mean "juvenile ***anadromous*** *salmonid survival". Again, we are familiar with the studies you describe, although not in great detail. As we pointed out previously, bull trout life history and migratory behavior are quite different than both adult and juvenile anadromous salmonid life history and migratory behavior, possibly including the most likely route of passage for downstream migrants. Thus, we are not convinced that the survival estimates you cited are appropriate or applicable to downstream migrant adult and subadult bull trout. No changes.*

g4pmadh9
D:20150410102008-07'00'4/10/2015 9:20:08 AM
P17
8) Additionally, 79 tagged bull trout used in a study in the Mid-C found no evidence of even a single mortality related to hydropower project passage. Unless there is a proposed mechanism of why FCRPS dams might be more harmful to bull tout than Mid-C projects, it seems pretty safe to say that bull trout survival is probably very high. Particularly if one also accounts for the voluminous research on salmonid passage and survival at FCRPS projects.

We are familiar with bull trout research in the mid-Columbia, but not at a level of detail that would allow us to determine if the sampling design, analytical approach, detailed results, and interpretation would apply to other projects such as those that comprise the FCRPS. You also mention "voluminous research on salmonid passage and survival at FCRPS projects". As we have pointed out previously, bull trout life history and migratory behavior are quite different than both adult and juvenile anadromous salmonid life history and migratory behavior, so it is unclear how much of this research you mention might apply to bull trout. No changes.

g4pmadh9
D:20150410100336-07'00'4/10/2015 9:03:36 AM
P17
9) Perhaps, but the context that turbine passage survival of salmonids frequently exceeds 90% is important to include.

This is simply a descriptive statement which is true. Since the focus of this synthesis is bull trout, we do not think it is useful to cite a survival estimate based on anadromous salmonids. No changes.

g4pmadh9
D:20150410102116-07'00'4/10/2015 9:21:16 AM
P17
10) Again, is there a proposed mechanism for why Mid-C projects would provide better passage and survival conditions for bull trout? It seems very logical that we would expect the

same level of survival (100%) as those projects.

This comment is similar to comment #8. Following, is part of our response to that comment. We are familiar with bull trout research in the mid-Columbia, but not at a level of detail that would allow us to determine if the sampling design, analytical approach, detailed results, and interpretation would apply to other projects such as those that comprise the FCRPS. No changes.

g4pmadh9
D:20150410102712-07'00'4/10/2015 9:27:12 AM
P18
11) Additionally, reservoirs may enhance growth and survival and foraging opportunity for bull trout. Some of the largest and most robust populations in the pacific northwest occur in reservoir systems.

We discuss the potentially beneficial seasonal reservoir conditions in this bullet, as well as the potentially detrimental seasonal conditions. Your general comment regarding robust adfluvial populations in the Northwest is not directly relevant to bull trout populations that use FCRPS reservoirs without additional detail that describes the similarity of the adfluvial populations you mention and habitat they use, to FCRPS subbasin populations, their life history, and their habitat use. We have made minor edits to this bullet for clarity.

g4pmadh9
D:20150410103141-07'00'4/10/2015 9:31:41 AM
P18
12) This is extremely speculative. A very limited number of tributaries are monitored and so it is impossible to determine the disposition of bull trout that migrate to the mainstem. A more accurate statement would be that not all outmigrants return to the Walla Walla river, which may suggest great connectivity between populations.

This comment is based on PIT-tagged bull trout. After a PIT-tagged Walla Walla bull trout enters the mainstem, it would be difficult for it migrate elsewhere without being detected. All of the nearest tributaries are wired with PIT arrays (Umatilla, Yakima, Tucannon) and all of the relevant mainstem dams are also wired (McNary, Ice Harbor, Priest Rapids). Our statement "may not survive" relates to this situation where no future detections were made for these bull trout. There is a small possibility that some of these bull trout "connected" with a different subbasin without being detected, but our statement, "may not survive" is a reasonable conclusion. We have only made minor edits to this bullet since it is in the Executive Summary. We have clarified this paragraph where it occurs in the body of the report on page 60 (your comment #23).

g4pmadh9
D:20150410105528-07'00'4/10/2015 9:55:28 AM
P19
13) A significant limitation that needs to be addressed by the USFWS is how these supposed gaps and research "needs" will be achieved given the low abundance of bull trout in the lower

Snake and Columbia River. Years of effort by USFWS staff have resulted in very low numbers of captured bull trout. This is an important consideration in determining a) the criticality of the information and b) whether pursuing this research will provide any real management value given sample sizes will likely be extremely small.

This synthesis is a compendium on bull trout in the Columbia Basin; what we know, what we don't know and potential issues relevant to the recovery of the species. One of the primary purposes of this synthesis is to identify data gaps and research needs to help reduce what we don't know about bull trout so we can focus on the relevant factors to make progress towards recovery. A future step in this process will address the details of ***how*** *we move forward. Potential challenges associated with filling data gaps and conducting research on bull trout that use the mainstem Columbia and Snake rivers do not change the need for the information. No changes.*

G0ODDMJL
D:20150602132657-07'00'6/2/2015 12:26:57 PM
P19
14) This report presents evidence that these conditions are suitable (Mid C work, FCRPS count data and PIT detections). 'Suitable conditions' are more closely related to fish locomotion abilities and therefore are reasonably transferable from one site to an other for the same species/size of fish. If an Ice Harbor sytle fishway passes bull trout successfully at a PUD dam, it is reasonalble to assume that it will also work at an FCRPS dam.

There is evidence that ***some*** *bull trout enter and move within* ***some*** *of the FCRPS fish ladders, but several important questions and data gaps remain. Such as fish passage efficiency; the proportion of bull trout that approach a fish ladder that eventually successfully pass. "Suitable conditions" are not only related to fish locomotion abilities but also to fish behavior. No two fish ladders are exactly alike so it is not a given that because bull trout appear to successfully pass one fish ladder that all other fish ladders with a similar design will pass bull trout equally successfully. We have made minor edits to this bullet for clarity.*

G0ODDMJL
D:20150602132739-07'00'6/2/2015 12:27:39 PM
P19
15) what is meant by conveyance channels? Also, see comment on first bullet.

Our use of the term conveyance channels (conveyance of fish to the fish ladder proper) refers collectively to powerhouse collection systems/channels, transportation channels under spillways (e.g. LWG), and junction pools; anything that conveys upstream migrants to a fish ladder proper. No changes.

G0ODDMJL
D:20150602133035-07'00'6/2/2015 12:30:35 PM
P19
16) what would constitute 'passage delay' for a fish that is not obliged to migrate, and has no directed migration (could be up or downstream much of the year)? Other than in the late

summer / fall, this metric makes little sense.

We did not propose "passage delay" as a metric. However, you point out one of several fundamental differences between bull trout migration and anadromous fish migration; a difference we identified in several of our previous responses to your comments. Migration characteristics for bull trout require context since their life history is variable along with their migration patterns. For example, from April-July, migratory adults are typically making their way back to headwater spawning areas. This is relatively directed migration. From October-January subadult and adult bull trout commonly disperse from headwater areas to forage and overwinter. This also is relatively directed migration. An evaluation of passage delay for bull trout would need to reflect their life history and be conducted during a relevant time period when directed migration is occurring. No changes.

G0ODDMJL
D:20150602133314-07'00'6/2/2015 12:33:14 PM
P20
17) Most of these will be extremely difficult to get because adequate #s of test fish are not available.

We have identified these items as data gaps or research needs. The purpose of this synthesis did not include consideration of the details associated with the experiments required to fill these gaps or address these needs. No changes.

G0ODDMJL
D:20150602133219-07'00'6/2/2015 12:32:19 PM
P20
18) Is there evidence of this? Not presented or cited in this report.

Citations have been added in the body of the report (e.g. page 133).

G0ODDMJL
D:20150602133855-07'00'6/2/2015 12:38:55 PM
P24
19) This may provide a useful contrast with populations upstream of Bonneville: do their mainstem migratory characteristics differ?

The only documented core area for bull trout downstream from Bonneville is in the Lewis River drainage. These bull trout are considered either resident or adfluvial (Swift, Yale Reservoirs). It is possible for bull trout from these reservoirs to access the Columbia River (downstream via spill, turbines), but unlikely or at best, very infrequent given the obstacles. In addition, the only upstream passage at these dams is trap and haul at Merwin Dam. No changes.

g4pmadh9
D:20150410132351-07'00'4/10/2015 12:23:51 PM
P34
20) These examples certainly highlight the extraordinary growth potential in the reservoir. This

is particularly noteworthy with respect to size/fecundity relationships in salmonids.

We agree. From our extensive work in the Walla Walla Basin we had the opportunity to observe growth for resident bull trout that remained in the headwaters, as well as for migratory individuals that used only the lower Walla Walla during their migrations and individuals that also used the Columbia. Growth was extraordinary for both non-resident groups. We did not have the opportunity to compare other factors such as available forage base, water temperature, etc. for these two migratory groups. No changes.

G0ODDMJL
D:20150602134802-07'00'6/2/2015 12:48:02 PM
P36
21) If we are including all mainstem effects, it seems like incidental catch by anglers should be included as well. Unlike passage through fish ladders, angling mortality is fairly well understood and documented. Incidental catch of bull trout by rec anglers is probably not well reported.

We have included incidental catch by anglers in this synthesis where observations were available. Most or all of the existing information on angler catch is reported in the section where this comment occurs (Bonneville Pool, likely Hood River fish). Unfortunately, the data are so sparse (so few fish) it is difficult to infer an effect. No changes.

g4pmadh9
D:20150410135657-07'00'4/10/2015 12:56:57 PM
P48
22) Further evidence supporting high bull trout survival for fish passing hydropower projects.

This bull trout passed downstream through The Dalles, and we presume it was still alive when harvested. We are not sure how you were able to infer "high bull trout survival for fish passing hydropower projects" based on one fish. No changes.

g4pmadh9
D:20150410141127-07'00'4/10/2015 1:11:27 PM
P60
23) I don't believe you have the data to support this statement. It should be more appropriately phrased that 46% of bull trout emigrating from WW River do not return. You have little to no information on disposition. It could well be that this is a source population and good connectivity is allowing these WW bull trout to spawn in other sub basins.

See response to comment #12. No changes.

g4pmadh9
D:20150410141645-07'00'4/10/2015 1:16:45 PM
P63
24) It should be discussed here the extraordinary difficulty in capturing bull trout to implant tags. Very few bull trout were available, making it pretty clear no discernable management

information would be provided from the study regarding FCRPS impacts to bull trout. It seems like invasive tagging/collecting/marking with no real ability to get usable management information is not a benefit to bull trout recovery.

"Capturing bull trout to implant tags" was not "extraordinarily difficult", and there were many bull trout available. The specific problem was not knowing which individuals were more likely to migrate to the mainstem. Funding for the first year of this study was provided too late to conduct sampling and tagging of fish. Equipment acquisition, testing, configuration, and deployment were the primary activities. The second year of this study was the first opportunity to actually tag bull trout with the goal of observing mainstem use. The primary issue described above was determining which bull trout to tag, not knowing whether they would remain within the Walla Walla Basin, or migrate to the mainstem. Of the fish we tagged, only seven actually moved into the mainstem. The third and final year of funding allowed us to modify our approach to sampling and tagging with the goal of having a larger sample size of bull trout that migrated to the mainstem. Numbers of tagged mainstem migrants were similar (six), and the sample size was still too small. At this point, we would describe our approach more as a feasibility assessment; i.e., can we build a large enough sample size to collect useful information? With the additional three years of the six year study, we hoped to determine if this Walla Walla Basin project was feasible, and whether we had the ability to collect useful information on mainstem use. With a "yes" answer, work would be continued in the Walla Walla Basin. With a "no" answer, our proposal for this project reflected a shift into the Snake River with a focus on the Tucannon subbasin. Since the funding was terminated, we were never able to determine the best location and approach for learning more about use of the mainstem by bull trout. No changes.

g4pmadh9
D:20150410143033-07'00'4/10/2015 1:30:33 PM
P82
25) Why? We analyzed a dozen or so fish collected over multiple years and 95+% were shown to originate from the Tucannon River. As described, the Tucannon is the most likely source of bull trout to encounter LSR projects. What will addtional genetic analyses tell us?

We assume you are referring to work that is described in DeHaan and Bretz (2012). Analysis of samples from 12 bull trout collected either on the separator or in condition samples at the Little Goose juvenile facility indicated 11 were from the Tucannon Basin (92%) and one was from the N.F. Imnaha. We have recommended collecting genetic samples (non-invasive fin clips) when there is the opportunity in all mainstem areas, not just at Little Goose in the Snake River. The objective is to continue to increase our understanding of the extent of mainstem use, and to further describe the spatial aspects of migratory patterns for the various subbasin populations. We have made minor edits to this bullet for clarity.

g4pmadh9
D:20150410144127-07'00'4/10/2015 1:41:27 PM
P104
26) This is so vague that it does not provide any real use in terms of what specifically might be done to reduce potential impacts.

It is difficult to think about "what specifically might be done to reduce potential impacts" before the potential impacts, if any, have been identified. We have edited this paragraph to make it clearer and less "vague". We would also remind you that this synthesis attempts to identify data gaps and research needs, and not "what specifically might be done to reduce potential impacts".

g4pmadh9
D:20150410145112-07'00'4/10/2015 1:51:12 PM
P110
27) Most of this and the following potential impacts are extremely speculative and not in any way supported by available data. In fact, most available data on passage and survival of bull trout provide strong evidence that passage and survival (and thus connectivity) are not an issue at FCRPS projects.

We assume you are referring to this introductory paragraph. We have replaced "impacts" with "affect" or "effects" in most cases when a specific "impact" has not been determined. Most of the statements in this paragraph are general, and describe "potential effects". We think concrete walls across the mainstem certainly have the "potential" to affect or impede passage for an array of species, even with passage measures in place. And it is certainly true that the reservoirs have replaced the former free-flowing mainstem corridor, and that the changes in habitat associated with this "conversion" may affect survival or migration timing. Many of these conditions have the potential to affect, and need to be examined at each of the projects relative to bull trout biology, life history, and migratory behavior to determine if, in fact, there is an effect. We are not familiar with "data on passage and survival of bull trout" that provides "strong evidence that passage and survival (and thus connectivity) are not an issue at FCRPS projects". If you could provide us with these data we would certainly appreciate it. No changes.

g4pmadh9
D:20150410145244-07'00'4/10/2015 1:52:44 PM
P112
28) What evidence suggests this is a migration barrier? Everything listed below suggests just the opposite...bull trout pass the project with little impact.

We describe the dam as a ***potential*** *impediment because of the sparse data that does not allow a thorough evaluation. This section of the report describes "very limited passage data" in the context of migration timing. It also describes a single PIT-tagged bull trout using the fish ladder at Bonneville. This is very limited data and it certainly does not lead us to the conclusion that "bull trout pass the project with little impact". The Hood River Subbasin section in Chapter 1 of this report shows historical bull trout observations at and around Bonneville in Table 1.2. Observations at Bonneville were made from 1941 through 2005, plus the PIT-tagged bull trout detected in 2012. From these data, there were six ladder observations, one PIT detection in the ladder, three inferred downstream passages (likely Hood River bull trout that were observed below Bonneville), and one downstream passage observation in the bypass. There was enough data for the PIT-tagged bull trout detected in 2012 to conclude successful* *passage downstream, and subsequently upstream through the ladder where it was detected. The single bull trout observed in the bypass in 2005 was released downstream, indicating successful passage. From the other historical observations of bull trout, one can infer successful downstream passage for three fish observed below Bonneville if you assume they are Hood River bull trout. The other historical observations in the Bonneville ladders do not include enough information to conclude successful passage or impact. The only reasonable conclusion one can draw from these sparse data is that it is not possible to evaluate whether there is a delay, or a problem with passage or not. We have re-worded this section for clarity and we have replaced migration barrier with migration impediment.*

G0ODDMJL
D:20150602140308-07'00'6/2/2015 1:03:08 PM
P113
29) If these fish are spending time in the mainstem to rear, what would indicate a migration delay?

You posed a similar question in comment #16 on page 19. We have provided our response to that comment below.

You point out one of several fundamental differences between bull trout migration and anadromous fish migration; a difference we identified in several of our previous responses to your comments. Migration characteristics for bull trout require context since their life history is variable along with their migration patterns. For example, from April-July, migratory adults are typically making their way back to headwater spawning areas. This is relatively directed migration. From October-January subadult and adult bull trout commonly disperse from headwater areas to forage and overwinter. This also is relatively directed migration. An evaluation of migration delay for bull trout would need to reflect their life history and be conducted during a relevant time period when directed migration is occurring. No changes.

G0ODDMJL
D:20150602140051-07'00'6/2/2015 1:00:51 PM
P119
30) Note that ish detected by ladder PIT systems have already 'found' the fish ladder.

We agree. Following is a clarification of the point we are trying to make. Based on years of monitoring returning bull trout at the mouth of the Walla Walla River, we rarely see returning fish later than early June. Based on these data, our assumption is that if the bull trout detected in the ladder at McNary in late June are returning to the Walla Walla River, they should have already passed the dam, and should have already entered the Walla Walla River. Our comments in the report for why that had not occurred, suggested that these fish could have been delayed (i.e. late June) because of difficulty finding the ladder and/or difficulties navigating the ladder. We have edited this paragraph for clarity.

g4pmadh9
D:20150410145722-07'00'4/10/2015 1:57:22 PM
P119
31) No, but a direct survival study in 2013 demonstrated 90+% survival for A-run steelhead (similar size/shape to bull trout) for turbine and spillway passage.

The statement in the report where this comment was made is a broad statement regarding both upstream and downstream passage and survival for bull trout at McNary Dam. Your comment refers to only two downstream passage routes. This comment is similar to your previous comment #7. Our response to that comment is repeated below. No changes.

We are familiar with the array of survival studies that have been conducted for anadromous fish at various projects throughout the FCRPS, although not in great detail. You hypothesize that these studies mighty be directly applicable to bull trout. That hypothesis is reasonable, but it is only a hypothesis. Studies should be conducted specifically for bull trout to determine whether your hypothesis is correct or not.

*In your second comment, we think you mean "juvenile **anadromous** salmonid survival". Again, we are familiar with the studies you describe, although not in great detail. As we pointed out previously, bull trout life history and migratory behavior are quite different than both adult and juvenile anadromous salmonid life history and migratory behavior, possibly including the most likely route of passage for downstream migrants. Thus, we are not convinced that the survival estimates you cited are appropriate or applicable to downstream migrant adult and subadult bull trout. No changes.*

G0ODDMJL
D:20150602140718-07'00'6/2/2015 1:07:18 PM
P122
32) Ice Harbor style ladders are used throughout the system and hdraulic criteria are similar across all Columbia Basin dams that have salmon passage. If bull trout can pass one mainstem Columbia or Snake River ladder, it is likely they can pass all of them

You have made several comments earlier in the report regarding the ability of bull trout to successfully pass mainstem fish ladders. We have provided our responses to those previous comments below.

There have been a number of PIT-tagged bull trout that were detected in ladders at several different mainstem dams, then never detected or observed again. So it is difficult to conclude that they either did, or did not pass successfully.

*There is evidence that **some** bull trout enter and move within **some** of the FCRPS fish ladders, but several important questions and data gaps remain. Such as fish passage efficiency; the proportion of bull trout that approach a fish ladder that eventually successfully pass. "Suitable conditions" are not only related to fish locomotion abilities but also to fish behavior. No two fish ladders are exactly alike so it is not a given that because bull trout appear to successfully pass one fish ladder that all other fish ladders with a similar design will pass bull trout equally* *successfully. No changes.*

G0ODDMJL
D:20150602141118-07'00'6/2/2015 1:11:18 PM
P134
33) It would have been helpful to have read this prior to Section 2 - consider switching the order.

Our intent with Chapter 3 was to synthesize and summarize the detailed subbasin data in Chapter 1 and mainstem dam data in Chapter 2. And to conclude with the resulting research needs and data gaps. We do not disagree with your comment, but at this point, we don't plan on re-arranging the chapters along with the extensive editing that would be required. We hope the final editing, including addressing your comments and others, will help report continuity as intended.

G0ODDMJL
D:20150602141726-07'00'6/2/2015 1:17:26 PM
P148
34) Migration through a free-flowing Columbia or Snake river was not without energetic costs - fish still need to climb the same height to get to historic spawning grounds. Per an ISAB comment on FCRPS adult salmon studies, we spent over 8 years studying the issue of energetic costs of dam passage for salmon and found no effect on survival. One main difference here is that bull trout are replenishing their energy reserves while rearing/overwintering in the mainstem, salmon are not.

We do not disagree with your initial comment regarding migration, although we think there is a major difference between navigating the relatively flat, continuous gradient in a free flowing river and navigating that same gradient when it has been confined to several locations (mainstem dams) resulting in a much steeper climb over a much shorter distance. Your attempt to transfer the results of salmon studies to bull trout has been addressed previously in our responses to multiple comments. Salmon life history including multiple years in the ocean accumulating marine-derived nutrients for their freshwater migration is completely different than migratory bull trout life history that relies totally on the freshwater ecosystem. No changes.

G0ODDMJL
D:20150602143428-07'00'6/2/2015 1:34:28 PM
P148
35) Or it may increase survival because reservoir provide a richer forage base for rearing/overwintering bull trout, and slower velocities for leisurely upstream migration (just counter-speculating here).

In this sentence we describe a subset of the potential factors that could affect bull trout survival including energetic costs, biotic interactions, and altered environmental conditions in the reservoirs. You mention a "richer forage base". If you mean compared to the original, free flowing river, we would be interested to see the data or citation to support this. You are correct *that reservoir velocities are likely much slower than free flowing river velocities would be. Our statement in the report is meant to relate bull trout survival to the entire array of factors associated with the FCRPS, and your comment over-simplifies this complex situation. No changes.*

G0ODDMJL
D:20150602143957-07'00'6/2/2015 1:39:57 PM
P154
36) 7 of the 8 dams have juvenile fish bypass systems. Some bull trout have been detected in these systems.

We have edited this paragraph to include juvenile fish bypass systems. We discuss the detection of PIT-tagged bull trout in the bypass systems in the individual mainstem dam sections in Chapter 2.

G0ODDMJL
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P155
37) Any bull trout larger than a large steelhead smolt could not pass through the separator bars at transport projects, and would be diverted back to the river (downstream of the dam).

We are not sure how large a "large steelhead smolt" is, and whether a subadult bull trout is larger or smaller. There is likely a size range for both steelhead smolts and subadult bull trout that are present and migrating in the mainstem. We discuss observations of bull trout in the condition samples in the individual mainstem dam sections in Chapter 2. These fish obviously passed through the separator bars and may have been transported. Similar size bull trout also pass through the bars when condition sampling is not being conducted, and they also are transported. No changes.

G0ODDMJL
D:20150602150510-07'00'6/2/2015 2:05:10 PM
P156
38) If the purpose of this section is to highlight FCRPS effects, we disagree with the inclusion of predation by birds and fish (except where dams create a predation advantage, such as in the immediate tailrace). We agree that predation is a mainstem effect. It is also an effect in the estuary and ocean.

We have included this section on avian predation for precisely the reason you stated in your comment; "except where dams create a predation advantage". The dams created the reservoirs, and the reservoirs have created a predation advantage from two perspectives. First, the reservoir habitat conditions are more suitable for warm/cool water predators such as smallmouth bass, walleye, and pikeminnow compared to free-flowing river conditions. As a result, predator populations have increased. Second, the reservoirs have increased predation efficiency compared to free-flowing river conditions when flows and velocities were much higher and the turbulence and turbidity associated with the higher flows made predation more difficult. In addition, hydrosystem operations have been correlated with predation effects in the *literature. No changes.*

G0ODDMJL
D:20150602150024-07'00'6/2/2015 2:00:24 PM
P159
39) Is there a citation for this? There are many other factors driving the distribution and size of piscivorous bird colonies. Ive not heard this particular explanation before.

We were not able to locate citations for these statements. This paragraph has been deleted.

g4pmadh9
D:20150413154439-07'00'4/13/2015 2:44:39 PM
P159
40) Given the difficulty in obtaining adequate sample sizes of bull trout in numerous field seasons of effort, which is driven at least in part by the relatively low abundance of bull trout in the mainstem, there should be discussion on how this significant challenge will be overcome or at the very least some acknowledgement that this is a significant limitation to getting more information on the effects of FCRPS on bull trout.

You raised this issue in several of your previous comments (#13, #17). Our responses to those comments are listed below:

#13. This synthesis is a compendium on bull trout in the Columbia Basin; what we know, what we don't know and potential issues relevant to the recovery of the species. One of the primary purposes of this synthesis is to identify data gaps and research needs to help reduce what we don't know about bull trout so we can focus on the relevant factors to make progress towards recovery. A future step in this process will address the details of ***how*** *we move forward. Potential challenges associated with filling data gaps and conducting research on bull trout that use the mainstem Columbia and Snake rivers do not change the need for the information. No changes.*

#17. We have identified these items as data gaps or research needs. The purpose of this synthesis did not include consideration of the details associated with the experiments required to fill these gaps or address these needs. No changes.

g4pmadh9
D:20150413154828-07'00'4/13/2015 2:48:28 PM
P159
41) How so? Specifically, what indicates the importance of further investigation?

Throughout this synthesis, we have presented and discussed the body of information regarding bull trout relative abundance, spatial and temporal migratory patterns in the subbasins as well as the mainstem, upstream and downstream passage details at the various FCRPS projects, and the limited data on habitat use in the mainstem. Along with this discussion, we have identified factors that remain unclear, and/or questions that remain unanswered. This final section of the report attempts to summarize all of this. We would say that the factors that "indicates the *importance of further investigation?" are already described throughout the synthesis, and we will not attempt to repeat them here. No changes.*

g4pmadh9
D:20150413154939-07'00'4/13/2015 2:49:39 PM
P160
42) A very likely and equally important issue to consider with respect to effects of FCRPS O&M.

No response required.

G0ODDMJL
D:20150602152445-07'00'6/2/2015 2:24:45 PM
P160
43) This could be determined, in part, by swimming performance assessments (e.g. Mesa et al. 2008; Mesa et al. 2004). Also, evidence presented in this paper suggests that the conditions are suitable, though there is no size info. Suggest further digging into the PIT data to assess the size range of fish passing (detected) FCRPS and PUD ladders.

Studies to determine the suitability of physical and hydraulic conditions for bull trout in FCRPS fish ladders would likely consist of several different components. Work done by Mesa et al. (2004, 2008) is certainly part of this. Tagging or mark/recapture studies may be another part. You are correct about evidence presented in this synthesis that suggests conditions in various ladders were suitable for at least some bull trout, primarily because we have empirical data that shows some individuals passed successfully (e.g. PIT detection in natal subbasin following PIT detections in a FCRPS ladder). There is much more data presented in this synthesis where it is not possible to determine if ladder passage was successful and if physical and hydraulic conditions were suitable. Your idea for "digging into the PIT data to assess the size range of fish passing (detected) at FCRPS and PUD ladders" is a good one. We were not able to do that for this synthesis. Most of the size data for bull trout is size at tagging. To estimate size when the fish is observed, elapsed time since tagging and growth rates are required. This is an example of one of the components mentioned in the first sentence of this paragraph to help understand the suitability of conditions in the FCRPS fish ladders.

G0ODDMJL
D:20150602151229-07'00'6/2/2015 2:12:29 PM
P160
44) I think these ladders are very similar to FCRPS ladders, so the previous statement that the "suitability of physical andn hydraulic conditions... is largely unknown" seems contradictory. These ladders use the same or very similar hydraulic design criteria.

Although we are familiar with these mid-Columbia River studies, we are not fluent on the study design, analytical methods, results, and conclusions. So we are not sure how relevant the studies are to FCRPS ladder passage evaluations. We are also not convinced that results from one ladder are transferrable to other ladders given different entrance characteristics, conveyance channel configurations, ladder length, etc. No changes.

G0ODDMJL
D:20150602151254-07'00'6/2/2015 2:12:54 PM
P160
45) through bypass systems,

The next sentence after your comment identifies the juvenile bypass systems. No changes.

g4pmadh9
D:20150413091320-07'00'4/13/2015 8:13:20 AM
P161
46) A direct survival study was conducted in 2014 by Normandeau at McNary Dam comparing spillway and turbine passage survival of A-run steelhead. These results are very applicable to bull trout and should be included in this synthesis.

We are familiar with this study, but not at a level of detail that would allow us to determine if the sampling design, analytical approach, results, and interpretation would apply to bull trout. There are many reports on studies that have been done in the FCRPS that may be useful for thinking about potential effects to bull trout. It was not part of our goal to review all of these reports and include the relevant ones in this synthesis. This kind of report review is a good example of a standard component for bull trout studies going forward. This concept was discussed in our response to your comment #43. No changes.

g4pmadh9
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P202
47) How is a "significant" bull trout population being defined? It seems the abundance of bull trout in the mainstem is so low that it is logistically almost impossible to conduct any sort of performance study evaluation.

"Significant" was not defined in the 2000 Biop where it was used. It is used in the 2000 Biop along with "substantial" to refer to bull trout in the mainstem. Neither term was used in a numerical or statistical sense. In addition, "bull trout population" used in reference to the mainstem was not totally accurate either. When the Biop was written in 2000, our knowledge of bull trout population structure and dynamics was limited. We now know based on genetic analysis that the relevant bull trout population unit is the "local population" which is anchored in subbasin headwater areas (i.e. spawning, early rearing). Individuals from multiple "bull trout populations" use the mainstem both to complete their life cycle (i.e. fluvial), and for longer term dispersal and connectivity between local populations which is required to maintain genetic diversity and persistence over the long term. The second part of your comment attempts to conclude that bull trout abundance is not sufficient to conduct a "performance study evaluation". The 2000 Biop identified "performance standards and appropriate measures" to "ensure upstream and downstream passage for bull trout is not impeded". We have addressed this comment in previous responses. See response to comment #40. No changes.

g4pmadh9
D:20150414135344-07'00'4/14/2015 12:53:44 PM
P204
48) See Normandeau 2014 direct survival and injury study at McNary Dam...very applicable to this issue and should have been included in this synthesis.

See our response to your comment #46.

g4pmadh9
D:20150414133640-07'00'4/14/2015 12:36:40 PM
P204
49) While this information might be interesting, how will it reduce the impacts of the FCRPS on bull trout? What specific information is lacking from the way counts are conducted now that warrant this additional effort?

The primary purpose of this synthesis is to compile the existing body of information on bull trout and mainstem use to identify not only what we know, but also what we don't know. What we don't know translates into data gaps and research needs. In many cases, information is lacking to determine whether or not there is a FCRPS-related impact. Monitoring would provide data to establish when and where bull trout are present around FCRPS projects, and what routes of upstream and downstream passage they may be using. This kind of information will help determine whether there is an impact or not, and if so, what might be done about it.

The way counts are currently conducted has been structured around anadromous fish (e.g. no winter monitoring). Bull trout life history and behavior may require counts to be conducted over different time periods, locations, and/or with different methods to acquire the necessary information. No changes.

g4pmadh9
D:20150414133342-07'00'4/14/2015 12:33:42 PM
P204
50) How will we ever be in a position to make any meaningful evaluation of performance standards given the extreme study limitations we have identified in previous RME efforts in the mainstem FCRPS?

Many of the data gaps and research needs we have identified would help us make progress on our understanding of bull trout behavior in the mainstem and how they interact with the various FCRPS projects. We need to increase our understanding, fill many of the data gaps, and address some of the needed research before we can contemplate what performance standards might look like for bull trout. Your comments on performance standards seem to reflect the salmon experience and what has been established for anadromous fish. We may end up with a different approach for bull trout, but for now, we need to concentrate on the data gaps and research needs. No changes.

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