U.S. Fish and Wildlife Service

Assessment of Bull Trout Passage and Delay during operation of the Imnaha River Weir for the Imnaha River spring/summer Chinook Salmon Program

2017 Annual Progress Report

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On the cover: *Fluvial bull trout from the North Fork Imnaha River. Photograph by Justin R. Cook*

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Abstract – Bull Trout are listed across their entire range in the U.S. (coterminously) under the Endangered Species Act as a threatened species. A potential threat to Bull Trout that has recently received considerable attention is the operation of weirs and the resulting influence on Bull Trout migrations. Some Bull Trout in the Imnaha River Core Area migrate from the Snake or lower Imnaha rivers, past a weir operating to collect Chinook Salmon, to spawning areas in the upper Imnaha River. We investigated whether the operation of the Imnaha River weir impacted (based on previously derived benchmarks) Bull Trout during their spawning migration. Marking of bull trout with individual unique Passive Integrated Transponder (PIT) tags and monitoring their detections at PIT tag arrays were used to monitor the migratory behavior of Bull Trout when the weir was in operation. The percentage of Bull Trout that passed the weir was estimated to be 83.2-97.9%, which met the yearly benchmark (76.5%) but may have been below the 4-year running average benchmark (92.9%). Overall, the median time it took Bull Trout to move from just below to just above the weir was 8 days. The benchmarks for delay in August (median 2 days, maximum 8 days) were met whereas the benchmarks for delay in July (median 4 days, maximum 8 days) were not met. Thus, in 2017, the operation of the weir may have slowed the rate of Bull Trout moving past the weir during their spawning migration. However, this conclusion is specific to 2017 which may not represent a typical year or average impact of the weir. In addition, a considerable number of Bull Trout were detected entering the ladder or trap associated with the weir, without actually being trapped. If these fish had been trapped, handled and passed above the weir during initial ladder detection or trap entrance, most benchmarks would have been met and impacts to Bull Trout during their spawning migration would have appeared minimal. This finding suggests it may be valuable to improve the ability to capture Bull Trout on their initial entry into the ladder or trap.

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Preface

This report is intended to document annual work and activities associated with Bull Trout passing the weir, in the Imnaha River (Oregon), which is operated for the Chinook Salmon program of the Lower Snake River Compensation Program. This report is for the calendar year 2017. This report is generally technical in nature and, for context, references and discusses operations and benchmarks that were previously established by co-managers. This report is not a policy document and, while its contents may inform the process, is not for the direct purpose of establishing final policy.

Introduction

Bull Trout (*Salvelinus confluentus*) are listed under the Endangered Species Act as a threatened species. Bull Trout were listed across their entire range in the U.S. (coterminously) on November 1, 1999 (see USFWS 2015a). Factors contributing to the listing of Bull Trout included range wide declines in distribution, abundance and habitat quality. Land and water uses that alter or disrupt habitat requirements of Bull Trout can be a threat to the persistence of bull trout. Commonly considered examples of such threats include dams, timber harvest, and nonnative fish (USFWS 2015a). A potential threat that has recently received considerable attention (for example, see Kelly Ringel 2014) is the operation of weirs and the resulting influence on Bull Trout migrations. The operation of weirs is prevalent throughout the part of the Columbia River basin that is accessible to anadromous fish.

The Mid-Columbia Recovery Unit (MCRU) is one component of the coterminous Distinct Population Segment (DPS). The MCRU has numerous core areas, one of which is the Imnaha Core Area (Figure 1). The Imnaha Core Area consists of at least five putative local populations (Barrows et al. 2016). Spawning and early rearing for the Upper Imnaha Population is focused in the North Fork Imnaha River, South Fork Imnaha River, and the portion of the mainstem just below the confluence of these two forks (Buchanan et al. 1997). While the absolute number of Bull Trout that spawn likely varies between years, the majority of Bull Trout spawning in the Imnaha River occurs upstream of river kilometer (rkm) 80 (Sausen 2017), generally in headwater areas (ODFW 2005). Some bull trout from the Upper Imnaha Population express a fluvial life history, migrating between the spawning areas and lower Imnaha River or mainstem of the Snake River.

This investigation focused specifically on previously handled Bull Trout tagged with a passive integrated transponder (PIT) tag migrating from the Snake or lower Imnaha rivers to the spawning areas. The majority of this migration occurs between May and August. Bull Trout that move from the lower Imnaha River to their spawning area pass through the entire area where Chinook Salmon (*Oncorhynchus tshawytscha*) spawn. Chinook Salmon spawning in the Imnaha River includes hatchery- and natural origin spawners. A weir to implement the Chinook Salmon hatchery program exists (see Hoffnagle 2005), below the headwater areas where Bull Trout are generally believed to spawn (Buchanan et al. 1997, ODFW 2005). The weir is permitted to operate from May 1 to October 1 per the Section 10 permit 18030, with the understanding that flow conditions actually control when installation and operation occurs. However, the weir generally operates from June or July into mid-September each year.

Project Goal

To provide information that can be used to minimize the incidental take of ESA-listed Bull Trout in the Imnaha River during operation and management of the Imnaha River weir and acclimation site for brood collection of spring/summer Chinook Salmon.

Project Objectives

1. During 2017-2020, assess the passage rate (conversion) of Bull Trout that is associated with the operation of the Imnaha River weir for collection and enumeration of adult spring/summer Chinook Salmon. Target passage benchmarks are an average across the four study years of at least 92.9% of PIT-tagged adults passing with no less than 76.5% in any given year (point estimates).

2. During 2017-2020, assess the migration delay (delay) of Bull Trout that is associated with the operation of the Imnaha River weir for collection and enumeration of adult spring/summer Chinook Salmon. Target delay benchmarks are median passage (between lower [IR4] and upper [IR5] antenna arrays) of no longer than 8 days for May, 6 days for June, 4 days for July and 2 days for August and September, with no individual taking longer than 8 days in any month.

3. Minimize and standardize impacts to Bull Trout during operation of the Imnaha River Weir through adaptive management during planned monitoring activities of passage and delay. This will be done through ongoing and continued discussions and coordination between the U.S. Fish & Wildlife Service (USFWS), National Oceanic & Atmospheric Administration (NOAA)-Fisheries, co-managers, and cooperators and may involve revising benchmarks, implementing operational changes or modification of structures.

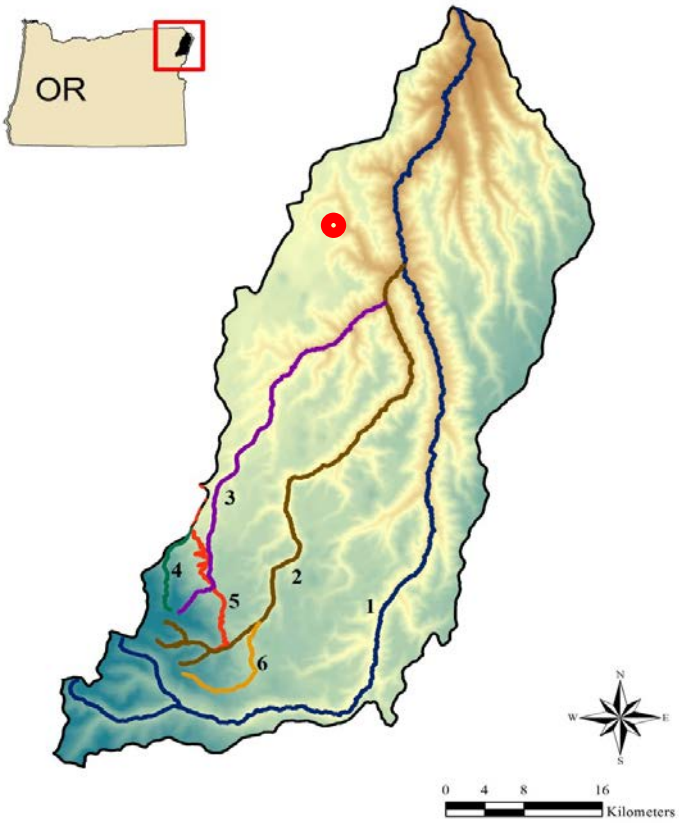

Figure 1. Local populations of Bull Trout in the Imnaha River subbasin can be found in the Imnaha River (1), Big Sheep Creek (2), McCully Creek (4) (currently a tributary to the Grande Ronde River subbasin), and Lick Creek (6); Bull Trout can also be found rearing in Little Sheep Creek (3), and the Wallowa Valley Improvement Canal (5). The Imnaha Fish Weir and acclimation site is identified (red dot).

Endangered Species Act

Operation of the Imnaha River weir must result in acceptable and, ideally, minimal impacts to listed Bull Trout (USFWS 2016). Results from this investigation will be used to gauge weir impacts and inform weir operations in the Imnaha River and may also be used to help gauge impacts and inform operations in similar situations where weirs are operated. Specifically, this investigation addresses Terms and Conditions 2.1 and 3.1 within the USFWS Biological Opinion (USFWS 2016, also see USFWS 2015b) on the Imnaha River Satellite Facility Weir modification:

> *(2.1) Within 6 months of the issuance of this opinion, a small group of subject matter experts will be convened, including representatives from the Service, ODFW, IPC, and the NPT, to develop and recommend a feasible sampling strategy for identifying the potential impacts from operation of the new weir and quantitatively evaluating bull trout movement past the Imnaha Satellite Facility when the weir is blocking the channel. It is expected that this strategy will capitalize on the large number of PIT- tagged bull trout in the river. The agreed-upon approach must be intensive enough to assess the duration of potential migration delays in the immediate vicinity of the weir.*
>
> *Within one year of the date of the sampling strategy being finalized, the agreed-to sampling strategy will be implemented for a four year period. Data collected from this sampling effort will be shared with the La Grande Field Office and adaptive management procedures will be used to adjust weir operations, as needed, if serious migration problems are observed.*
>
> *(3.1) Establish a monitoring program, in coordination with the La Grande Field Office and based on the sampling strategy described in Term and Condition 2.1, to evaluate bull trout passage and help assess incidental take from operation of the new weir. The monitoring program shall be intensive enough to identify any subadult or adult passage problems, should they be occurring. Adaptive management procedures will be used to adjust weir operations, as needed, if serious fish passage problems are identified through this monitoring program.*

Study Area and Weir Operation

The Imnaha River Satellite Facility is located on the Imnaha River approximately 48 km south of the town of Imnaha, Oregon, near river kilometer (rkm) 73. The facility is located on U.S. Forest Service (USFS) property. The Imnaha River Satellite Facility serves as the adult collection and juvenile acclimation and release facility for the Imnaha River spring/summer Chinook Salmon hatchery program within the USFWS-Lower Snake River Compensation Plan Program. The existing facility was constructed in 1988 and is operated by the Oregon Department of Fish and Wildlife (ODFW) with assistance from the Nez Perce Tribe (NPT) through co-operative agreements with the LSRCP Office. Spawning, incubation and early rearing for this program occurs at Lookingglass Fish Hatchery, operated by ODFW. Lead management entities identified in the current 2008 – 2017 U.S. v. Oregon Management Agreement include the Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and ODFW, and the target release goal identified is 490,000 smolts annually.

Since 1982, a picket weir has been installed for brood stock collection at the site with a target installation period in early to mid-May. The picket barriers required manual installation accomplished by workers wading into water that was often high and fast flowing, which led to

precarious situations. Installation of the picket weir occurred anytime from late-May to late-July when river flows subsided following the spring runoff. This often resulted in a significant portion of the spring/summer Chinook Salmon run passing the weir site before installation occurred and compromised management objectives and introduced concerns identified by NOAA-Fisheries for this ESA-listed population and corresponding hatchery program.

A new bridge-style weir and structure was completed in fall 2015 (Figure 2). Picket panels can be installed manually onto the structure from the bridge. The new weir can be operated under a wider range of river flows, and the need for workers to enter the river during potentially unsafe flows should be eliminated. This modification assists in meeting management objectives and addresses NOAA-Fisheries permitting and incidental take concerns regarding the Imnaha River spring/summer Chinook Salmon program.

Figure 2. Pictures of the new bridge-style weir installed at the Imnaha River Acclimation Facility and Brood collection ponds during October 2015. Weir panels are in the "down" position and pivot from the lower portion of the bridge to operate. Photos by USFWS – Lower Snake River Compensation Plan Office.

Methods

Per the USFWS Biological Opinion, Bull Trout PIT-tagged as part of ongoing investigations by co-managers and cooperating agencies were used to address the objectives. During or prior to 2017, Idaho Power Company (IPC) biologists PIT-tagged Bull Trout captured in the Snake River, ODFW personnel PIT-tagged Bull Trout captured moving upstream at the weir during Chinook Salmon operations, and the Nez Perce Tribe (NPT) biologists PIT-tagged Bull Trout captured in a screw trap operated downstream of the town of Imnaha. Overall, each effort put tagged Bull Trout that may be observed for multiple years into the Imnaha River subbasin. We used detections of PIT-tagged Bull Trout that moved through the Imnaha River in 2017, specifically between the lower (IR4) and upper (IR5) PIT arrays (Figure 3) to achieve the objectives of the study. The histories of these detections were evaluated to determine whether they exhibited a pattern reflective of the behavior of interest, Bull Trout migrating upstream when the weir was operating (for example, detected during weir operation, not pre- or post-operation, detected moving upstream rather than only downstream, and tagged prior to capture at the weir in 2017).

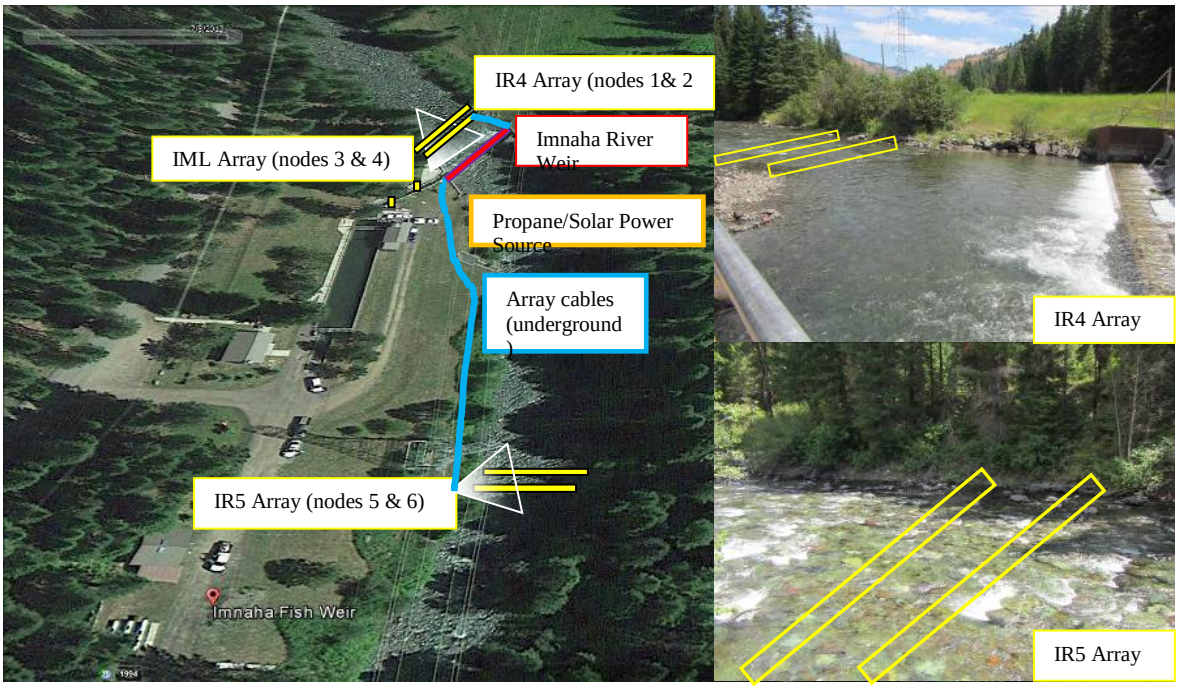

Figure 3. Location of the six Passive Integrated Transponder (PIT) tag detection arrays near the Imnaha River weir site. The IR4 Array (nodes 1 & 2), IR5 Array (nodes 5 & 6) are within the bankfull area of the Imnaha River. The IML Array (nodes 3 & 4) is located in the adult ladder leading to the adult collection trap. Photos on the right show where the IR4 Array(top right) and IR5 Array (bottom right) are positioned and correspond to shaded triangles showing a perspective from the bank. The orange block is the location of the transceiver and power. All locations are approximations.

Objective 1. During 2017, assess the passage rate (conversion) of Bull Trout that is associated with the operation of the Imnaha River weir for collection and enumeration of adult spring/summer Chinook Salmon.

To address Objective 1, both during and after the Chinook Salmon spawning season, data on Bull Trout conversion was summarized and analyzed and disseminated to the subject panel experts from coordinating agencies for discussion during coordination calls. Relative to Objective 1, the *observed percent* of Bull Trout that passed the weir was calculated as:

$$\text{a)} \quad ((D_{56} + A_{56}) / D_{12}) \times 100$$

Where D_{12} = the number of uniquely PIT-tagged Bull Trout determined through detection histories to have reached IR4 (the PIT tag antenna array downstream of the weir); D_{56} = a) the number of PIT-tagged Bull Trout trapped and released downstream from IR5 (the PIT tag antenna array upstream of the weir) plus b) the number of PIT-tagged Bull Trout that were not trapped, presumably got above the weir by swimming through or under weir panels, and were determined through detection histories to have passed upstream of IR5; and A_{56} = the number of PIT-tagged Bull Trout that were captured in the trap and transported and released above IR5. The method outlined calculated the *observed percent* (no expansions or adjustments) of tags passing the weir (conversion). Although detection efficiency was thought to be relatively high at both IR4 and IR5, we also calculated the *expanded percent* of Bull Trout passing the weir. This was done by expanding detections at IR5 using an estimated detection efficiency. Finally, some Bull Trout were also detected moving between IR4 and the ladder or trap, but not detected at IR5 (for example, a fish may have entered the trap only to exit it later and get detected again at IR4). It is possible that managers may be able to adjust operations so that these fish are trapped when they initially enter the ladder or trap (cannot or do not swim back out). If these fish were then released above the weir and migrated upstream past IR5, this would impact the estimated percent of Bull Trout passing the weir. Thus, we also calculated *observed percent - possible* of Bull Trout passing the weir by including the additional detections that would be anticipated at IR5 after releasing these fish.

Objective 2. Assess migration delay of Bull Trout during the 2017 operation of the Imnaha River Weir during the spring/summer Chinook Salmon return.

To address Objective 2, we also used PIT-tagged Bull Trout that moved through the Imnaha River. As in Objective 1, we specifically used tagged fish detected at or between the lower and upper PIT arrays (IR4 and IR5) during the trapping season. Development of the target delay benchmarks was also outlined in the monitoring proposal. Relative to Objective 2, the time (in days) for an individual Bull Trout to pass the weir site was calculated as:

$$\text{b)} \quad date_{56} - date_{12} \quad \text{(or)}$$
$$\text{c)} \quad date_{trans} - date_{12}$$

Where $date_{12}$ = the Julian day a PIT-tagged Bull Trout was first detected at IR4; $date_{56}$ = the Julian day a PIT-tagged Bull Trout was first detected at IR5; $date_{trans}$ = the Julian day a PIT-

tagged Bull Trout that had been captured at the weir facility was transported and released into the Imnaha River above IR5. Median passage times (in days) for each month were calculated from individual passage times from equations b and c.

Similar to calculating the proportion of PIT tags passing the weir, calculating passage time or travel time for individuals depended upon the detection probability of each observation site. Detection efficiency was estimated to be relatively high; thus, we calculated delay using raw (unexpanded) detections. A number of Bull Trout were observed entering the ladder or trap associated with the weir, then returning downstream. Using the same data and tagged fish as well as a similar approach to that described above, we also calculated the $delay_{initial}$ that would have occurred if Bull Trout were captured the initial time they were observed entering the ladder or trap.

Results

Bull Trout

In 2017, the weir began operating on July 3 and ceased operating on September 10. The PIT tag arrays were in operation throughout this entire period. PIT tag detections between July 1 and September 8 were considered for this evaluation. During this period, 191 uniquely PIT-tagged Bull Trout were detected. One hundred and forty-three of these PIT-tagged Bull Trout were used in subsequent evaluations (see Appendix A).

Objective 1. Conversion

Based on detection histories, 143 unique Bull Trout were detected between IR4 and the trap and useful for calculating conversion. Of these 143 fish, 119 Bull Trout were released above or detected at IR5. Based on the *observed percent* (119/143), the conversion rate from below the weir to above the weir was 83.2%. The detection efficiency of IR5 was estimated to be 85% (R. Kinzer, Nez Perce Tribe, personal communication). Based on the *expanded percent* ((119/0.85)/143), the conversion rate from below the weir to above the weir was 97.9%. Fifteen of the 143 PIT-tagged Bull trout were detected moving between IR4 and the ladder or trap, but were not detected at IR5. If these fish were trapped, released above the weir, and swam past IR5, we would have expected to detect 13 of them (15 x 0.85) at IR5. Based on the *observed percent - possible* ((119+13)/143), the conversion rate from below the weir to above the weir would have been 92.3%.

Objective 2. Delay

Based on detection histories, 97 unique Bull Trout were detected at both IR4 and IR5 (or, in the case of transported fish, placed above IR5) and were thus, useful for calculating delay. Overall delay ranged from 0-65 days with a median of 8 days (Figure 4). Delay in July (based on 92 Bull Trout) ranged from 0-65 days with a median of 9 days. Delay in August (based on five Bull Trout) ranged from 0-5 days with a median of 0 days. As noted earlier, some Bull Trout were

detected entering the ladder or trap but were never actually trapped or detected moving upstream past IR5. If these fish had ultimately been trapped, released above the weir and migrated upstream past IR5, 108 total Bull Trout would have been used in calculations of delay ($delay_{initial}$). Overall $delay_{initial}$ would have ranged from 0-42 days with a median of 2 days. In addition, $delay_{initial}$ in July (based on 102 Bull Trout) would have ranged from 0-42 days with a median of 2 days and $delay_{initial}$ in August (based on six Bull Trout) would have ranged from 0-5 days with a median of 0 days.

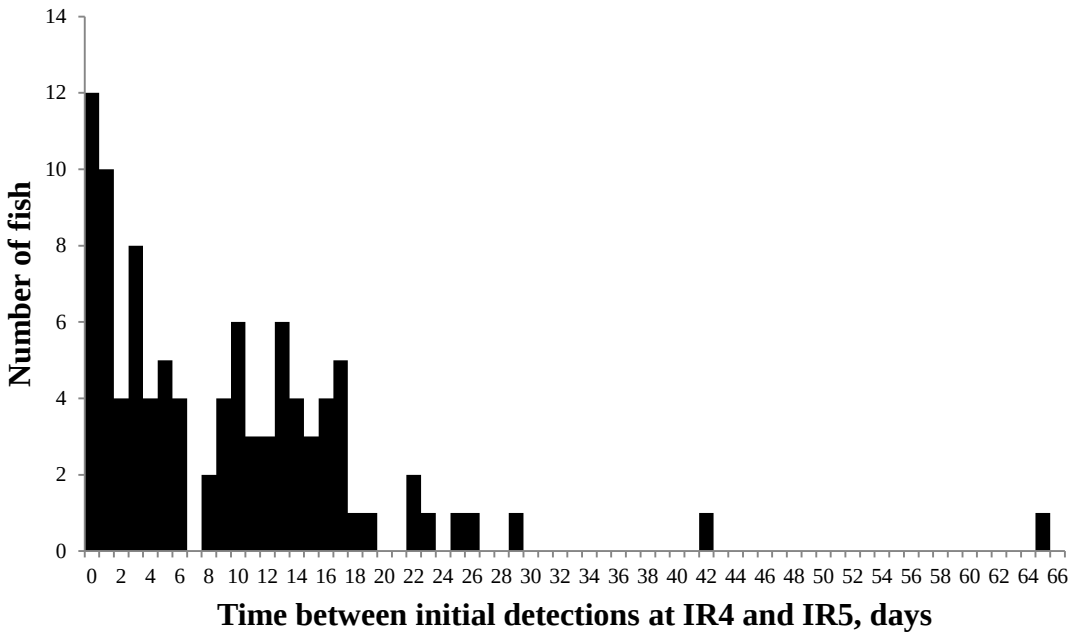

Figure 4. The number of days it took Bull Trout to move from IR4 to IR5. The number of days represents the time between the initial detection at IR4 and initial detection at IR5.

Findings

In 2017, the operation of the weir allowed bull trout to meet the benchmark for converting from below the weir to above the weir. This was evidenced by the 83.2-97.9% conversion rate. The benchmark that has been established for an acceptable conversion is no less than 76.5% in a given year. The conversion in 2017 may have been in the lower half of the benchmark range (76.5-100%) for a given year, and between 9.7% below and 5.0% above the benchmark established for a 4-year running average (92.9%). Thus, while the 2017 value met the yearly benchmark, it appears that the conversion during the next three migration years will need to average 91.2-96.1% for conversion to meet the 4-year running average benchmark.

In 2017, the operation of the weir appeared to delay the rate at which some Bull Trout migrated upstream past the weir. This was evidenced by the time it took Bull Trout to move from IR4 to IR5. Median travel times were 9 (maximum of 65) and 0 (maximum of 5) days during, July and

August, respectively. The benchmarks for delay are median travel times of 4 and 2 days (both with a maximum of 8 days) during July and August, respectively. Thus, benchmarks were achieved in August but not in July, when 95% of the PIT-tagged Bull Trout used in the analysis migrated through the study area (during the time the weir was operated).

In 2017, Bull trout passed the weir through various routes. Evidence suggests these routes included a) through designed openings in the weir panels that are near the streambed, b) through the trap and c) through openings when panels were pulled. Overall, various passage routes resulted in some Bull Trout that were i) handled/passed, ii) not handled/passed and iii) not handled/did not pass. In general, each of these handled/not handled and passed/did not pass categories contained Bull Trout from a wide range of sizes (Figure 5).

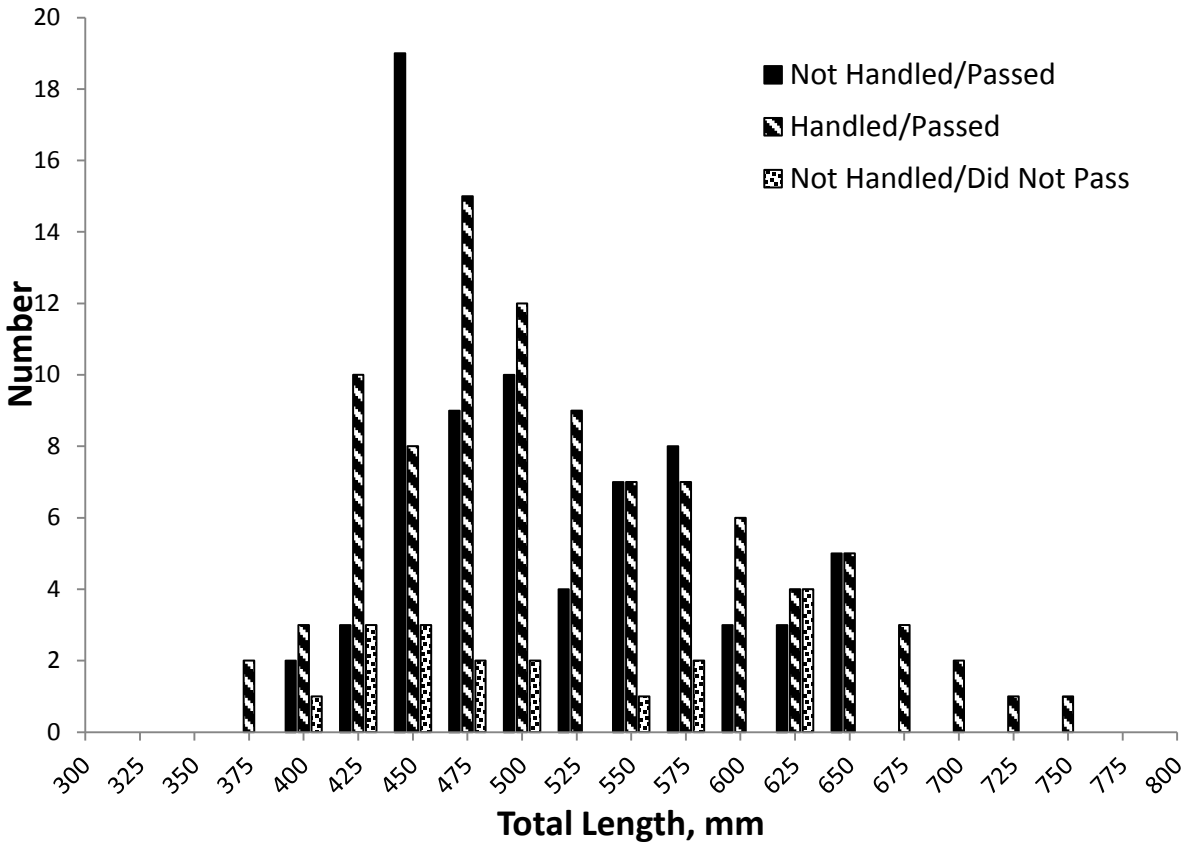

Figure 5. The size distribution of Bull Trout exhibiting various migratory behaviors (Passed *or* Did Not Pass *the weir*) and passage routes (*not trapped and therefore* Not Handled *or captured in the trap and therefore* Handled) at the Imnaha River weir (courtesy of R. Wilkinson, Idaho Power Company, personal communication).

The ability to meet the conversion and delay benchmarks for Bull Trout may be improved by increasing the ability to trap (and therefore pass) Bull Trout the first time they enter the ladder or trap associated with the weir. Based on the previous analysis by the co-managers to establish the

benchmark standards, it is reasonable to expect that Bull Trout captured and released above the weir during their upstream movement would likely have moved past IR5 within one day after being trapped. In 2017, if all bull trout detected in the ladder or trap were actually trapped on the date of their initial entry (or detection), handled then released above the weir, both conversion and delay would have been improved over what was observed. In this case, the conversion of PIT-tagged Bull Trout passing the Imnaha River weir (92.3%) would have met the yearly benchmark for conversion (≥76.5%) and nearly met the 4-year running average benchmark for conversion (92.9%). In this case, Bull Trout passing the Imnaha River weir would also have met all the benchmarks for delay, with the exception of a maximum delay of 8 days in July. In July, 19.6% of the Bull Trout would have taken longer than 8 days to move from IR4 to IR5. Overall, it seems prudent to consider modifying the physical conditions at, as well as the design and operation of, the ladder and trap so that Bull Trout which enter either of these are actually trapped on their initial entry. In part, as a result of this analysis, discussions with co-managers, NOAA-Fisheries and the USFWS occurred after the 2017 weir operations on potential operational improvements to implement during 2018 operations. Improved ladder attractant flows, in ladder physical improvements and trap capture improvements are planned for 2018 operational year.

This report represents one year of a multi-year investigation. The ability of Bull Trout to negotiate the Imnaha River weir in 2017 may reflect a number of variables that are not entirely clear at this point. For example, the behavior we observed by Bull Trout may be specific to the flow, temperature and Chinook Salmon conditions in the river in 2017. Furthermore, 2017 is the only year of data to this point, and it is not yet possible to consider annual variation in these metrics.

Acknowledgements

We thank the Columbia River Fish & Wildlife Conservation Office for technical support of this work; the Lower Snake River Compensation Plan Office for funding this work and providing valuable coordination. We are grateful to R. Wilkinson for data on Bull Trout size and passage routes as well as R. Kinzer for estimates of detection efficiency at IR5. We thank all those who improved this report through their review of earlier drafts. In particular, R. Engle, B, Johnson, R. Kinzer and J. Vogel helped to develop the final report. We are also grateful to the numerous co-managers (Oregon Department of Fish and Wildlife, the U.S. Forest Service, the Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, the National Marine Fisheries Service, and the Idaho Power Company) for their support of and participation in this work.

Literature Cited

Barrows, M.G., D.R. Anglin, P.M. Sankovich, J.M. Hudson, R.C. Koch, J.J. Skalicky, D.A. Wills, and B.P. Silver. 2016. Use of the mainstem Columbia and lower Snake rivers by migratory bull trout: data synthesis and analyses. U.S. Fish and Wildlife Service, Columbia River Program Office, Vancouver, Washington.

Buchanan, D.V., M.L. Hanson and R.M. Hooton. 1997. Status of Oregon's Bull Trout. Oregon Department of Fish & Wildlife, Portland, Oregon.

Hoffnagle, T., K.A. Frenyea, R.W. Carmichael and P. J. Keniry. 2005. A Comparison of Run Timing, Spawn Timing and Spawning Distribution of Natural and Hatchery spring Chinook Salmon *Oncorhynchus tshawytscha* in the Imnaha River, Oregon. ODFW Information Report 2005-03. Oregon Department of Fish & Wildlife, Salem, Oregon.

Kelly Ringel, B. M., J. Neibauer, K. Fulmer, and M. C. Nelson. 2014. Migration patterns of adult bull trout in the Wenatchee River, Washington 2000-2004. U.S. Fish and Wildlife Service, Leavenworth, Washington. 81pp with separate appendices.

ODFW. 2005. 2005 Oregon Native Fish Status Report Volume II Assessment Methods & Population Results. Oregon Department of Fish & Wildlife, Salem, Oregon.

Sausen, G. 2017. 2016 Bull Trout redd monitoring in the Wallowa Mountains. Annual Report. U.S. Fish & Wildlife Service, La Grande, Oregon. 56 p.

USFWS (U.S. Fish and Wildlife Service). 2015a. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2015b. Imnaha River Satellite Facility Weir Modification - Formal Section 7 Consultation (FWS reference 01EOFW00-2013-F-0174). March 11, 2015. La Grande Field Office, La Grande, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2016. NOAA's Issuance of Section 10(a)(1)(A) Permits for the Continued Operation and Maintenance of the Northeast Oregon and Southeast Washington spring/summer Chinook, Steelhead, and Rainbow Trout Hatchery Programs funded under the Lower Snake River Compensation Plan and the Northwest Power Act. Formal Section 7 Consultation (FWS reference 01EOFW00-2015-F-0154). August 22, 2016. Washington Fish and Wildlife Office, Eastern Washington Field Office,Spokane, Washington and La Grande Field Office, La Grande, Oregon

Appendix A

Codes associated with PIT-tagged bull trout used in this analysis.

3D9.1C2D908AA3	3D9.1C2DE242FB	3DD.0077720919	3DD.007774EBDA
3D9.1C2D90BDB9	3D9.1C2DE24ABB	3DD.0077720A5E	3DD.007774F394
3D9.1C2D90E5B3	3D9.1C2DE24D25	3DD.0077720B67	3DD.0077750322
3D9.1C2D911B3B	3D9.1C2DE24DF8	3DD.00777219D6	3DD.00777506A0
3D9.1C2D91220E	3D9.1C2DE25266	3DD.00777223FD	3DD.0077751EC7
3D9.1C2D913AF4	3D9.1C2DE2675D	3DD.0077722786	3DD.0077753A4B
3D9.1C2D913E71	3D9.1C2DE27640	3DD.0077723173	3DD.007775434F
3D9.1C2D9140CF	3D9.1C2DE27C79	3DD.0077723976	3DD.0077755631
3D9.1C2D91412D	3D9.1C2DE285AF	3DD.00777243C5	3DD.00777575FC
3D9.1C2D914EC2	3D9.1C2DE28B38	3DD.0077724771	3DD.007775810F
3D9.1C2D915573	3D9.1C2DE29769	3DD.0077724C44	3DD.0077758D1B
3D9.1C2D915596	3D9.1C2DE2A03F	3DD.0077724E9A	3DD.0077759B89
3D9.1C2D915900	3D9.1C2DE2A4A5	3DD.0077726303	3DD.0077759D79
3D9.1C2D915A1B	3D9.1C2DE2AABE	3DD.00777267B5	3DD.007775ACF7
3D9.1C2D91674C	3D9.1C2DE2AE43	3DD.00777267C3	3DD.007775B34C
3D9.1C2D917582	3D9.1C2DE2B723	3DD.0077726831	3DD.007775B372
3D9.1C2D917D41	3D9.1C2DE2E5AE	3DD.007772729D	3DD.007775B9FA
3D9.1C2D919670	3D9.1C2DE2F089	3DD.0077728DEE	3DD.007775C922
3D9.1C2D91A2E5	3D9.1C2DE2FF1A	3DD.0077729012	3DD.007775D3EC
3D9.1C2D91CE7C	3D9.1C2DE2FF7F	3DD.00777290B1	3DD.007775D480
3D9.1C2DE10245	3D9.1C2DE30BBB	3DD.00777290B8	3DD.007775DFB5
3D9.1C2DE10CEE	3D9.1C2DE34079	3DD.00777290E9	3DD.007775E02E
3D9.1C2DE10F33	3D9.1C2DE345F5	3DD.0077729230	3DD.007775E1DB
3D9.1C2DE119C7	3D9.1C2DE35031	3DD.00777296DA	
3D9.1C2DE134ED	3DD.007770D814	3DD.00777297ED	
3D9.1C2DE1355E	3DD.007771A6E9	3DD.0077729F04	
3D9.1C2DE138D6	3DD.007771AEA2	3DD.007772BBC9	
3D9.1C2DE14642	3DD.007771AFB2	3DD.007772CC21	
3D9.1C2DE161F0	3DD.007771B9CD	3DD.007772CFE4	
3D9.1C2DE16C44	3DD.007771BB04	3DD.007772D000	
3D9.1C2DE18911	3DD.007771C579	3DD.007772D48B	
3D9.1C2DE1998D	3DD.007771C738	3DD.007772D4C2	
3D9.1C2DE1AC24	3DD.007771C7C3	3DD.007772D92B	
3D9.1C2DE1E28C	3DD.007771E167	3DD.00777353ED	
3D9.1C2DE216F2	3DD.007771E48E	3DD.0077736100	
3D9.1C2DE22296	3DD.007771E499	3DD.0077737976	
3D9.1C2DE228FC	3DD.007771E4D9	3DD.007773CF7D	
3D9.1C2DE2318E	3DD.007771E583	3DD.007774B1E8	
3D9.1C2DE23650	3DD.007771EC3C	3DD.007774C9C0	
3D9.1C2DE23699	3DD.007771FE7F	3DD.007774E6CA	

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