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Clackamas River Bull Trout Reintroduction Project

FY 2015 Annual Report

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U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office

Oregon Department of Fish and Wildlife
Native Fish Investigations Program

On the cover: *The confluence of Pinhead Creek with the Clackamas River (Photo by C. Allen, USFWS).*

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CLACKAMAS RIVER BULL TROUT REINTRODUCTION PROJECT 2015 ANNUAL REPORT

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CLACKAMAS BULL TROUT REINTRODUCTION PROJECT
2015 ANNUAL REPORT

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Bull trout were last documented in the Clackamas River in 1963. A 2007 feasibility study indicated the Clackamas River could biologically support bull trout and would be a good candidate for a reintroduction effort. Implementation of the bull trout reintroduction program began in 2011, with the goal of establishing a naturally reproducing population of between 300 – 500 spawning adults by the year 2030. In 2015, we continued efforts to reintroduce bull trout into the Clackamas basin by collecting and transferring 300 juveniles, 74 subadults, and 7 adults from the Metolius Basin. Monitoring and evaluation were conducted to 1) ensure that the proposed action does not threaten the donor stock population, 2) assess the effectiveness of the reintroduction strategy for re-establishing a self-sustaining bull trout population, and 3) evaluate the effects of the reintroduction on Endangered Species Act-listed salmonids that currently occupy the Upper Clackamas River Basin. To meet these objectives, we obtained redd count data for the donor population and monitored the behavior of tagged fish in the Clackamas using fixed passive integrated transponder tag interrogation. Through the first five years of the project, 1) the donor population has remained healthy (>800 spawning adults); 2) transferred bull trout have dispersed throughout the upper Clackamas; and 3) some bull trout have exhibited spawning behavior. Implementation and monitoring of the reintroduction project will continue to be evaluated on an annual basis and the reintroduction strategy will be adaptively managed.

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1) Introduction

Bull trout (*Salvelinus confluentus*) are native to the Pacific Northwest, and currently occupy habitat in Oregon, Washington, Idaho, Montana, Nevada, and Canada. Bull trout prefer cold, clean water in complex stream habitats, and populations have been negatively affected by several factors including habitat degradation (e.g., Fraley and Shepard), barriers to migration (e.g., Rieman and McIntyre 1995), and the introduction of non-native trout species (e.g., Leary et al. 1993). As a result, the abundance of bull trout has declined in many populations across their native range (Rieman et al. 1997) leading to their listing under the Endangered Species Act in 1999 (64 FR 58910).

The restoration of bull trout to historic habitat is consistent with the recovery goals in the U.S. Fish and Wildlife Service's (USFWS) finalized Bull Trout Recovery Plan (USFWS 2015a), and is particularly relevant to habitats in the western portion of the species' range due to the extensive loss of distribution and the documented extirpation of multiple bull trout populations. The Willamette River, a tributary of the lower Columbia River, has experienced extirpations of bull trout from four major basins, including the Clackamas River (Figure 1). Although the overall recovery strategy is to reduce and minimize threats affecting bull trout and their habitat in the Willamette River Basin, the establishment of self-sustaining populations will likely require reintroduction into some areas given the size of the basin and low probability of natural recolonization following widespread extirpations. Reintroduction of bull trout in the Clackamas River will help to achieve distribution in the Clackamas River core habitat (defined as habitat that contains, or if restored would contain, all of the essential physical elements to provide for the security of and allow for the full expression of life history forms of one or more local populations of bull trout) and will increase abundance of adult bull trout in the Willamette River, which is consistent with the final Coast Recovery Unit Implementation Plan for Bull Trout (USFWS 2015b).

This report documents the progress in the fifth year (2015) of the joint effort between the State of Oregon, USFWS, U.S. Forest Service (USFS), and other collaborators (i.e., the Confederated Tribes of Warm Springs Reservation (CTWSR), National Marine Fisheries Service (NMFS), Portland General Electric (PGE), and the U.S. Geological Survey (USGS)) to reintroduce bull trout into the Clackamas River. The implementation phase of the project began following publication of a final rule establishing a nonessential experimental population of bull trout in the Clackamas River under section 10(j) of the ESA (76 FR 35979 on June 21, 2011). Following publication of the 10(j) rule, the first transfers of bull trout to the Clackamas Basin occurred during the spring and summer of 2011 (ODFW 2011). This report format will be structured, where appropriate, to answer the questions listed in sections 3.2 and 3.3 of the Implementation, Monitoring, and Evaluation Plan developed by the USFWS Oregon Fish and Wildlife Office and Columbia River Fisheries Program Office (2011). Additional project background on the reintroduction and project management strategy can be found in that plan (www.fws.gov/oregonfwo/Species/Data/BullTrout/Documents/ClackamasBT_IME_Plan.pdf).

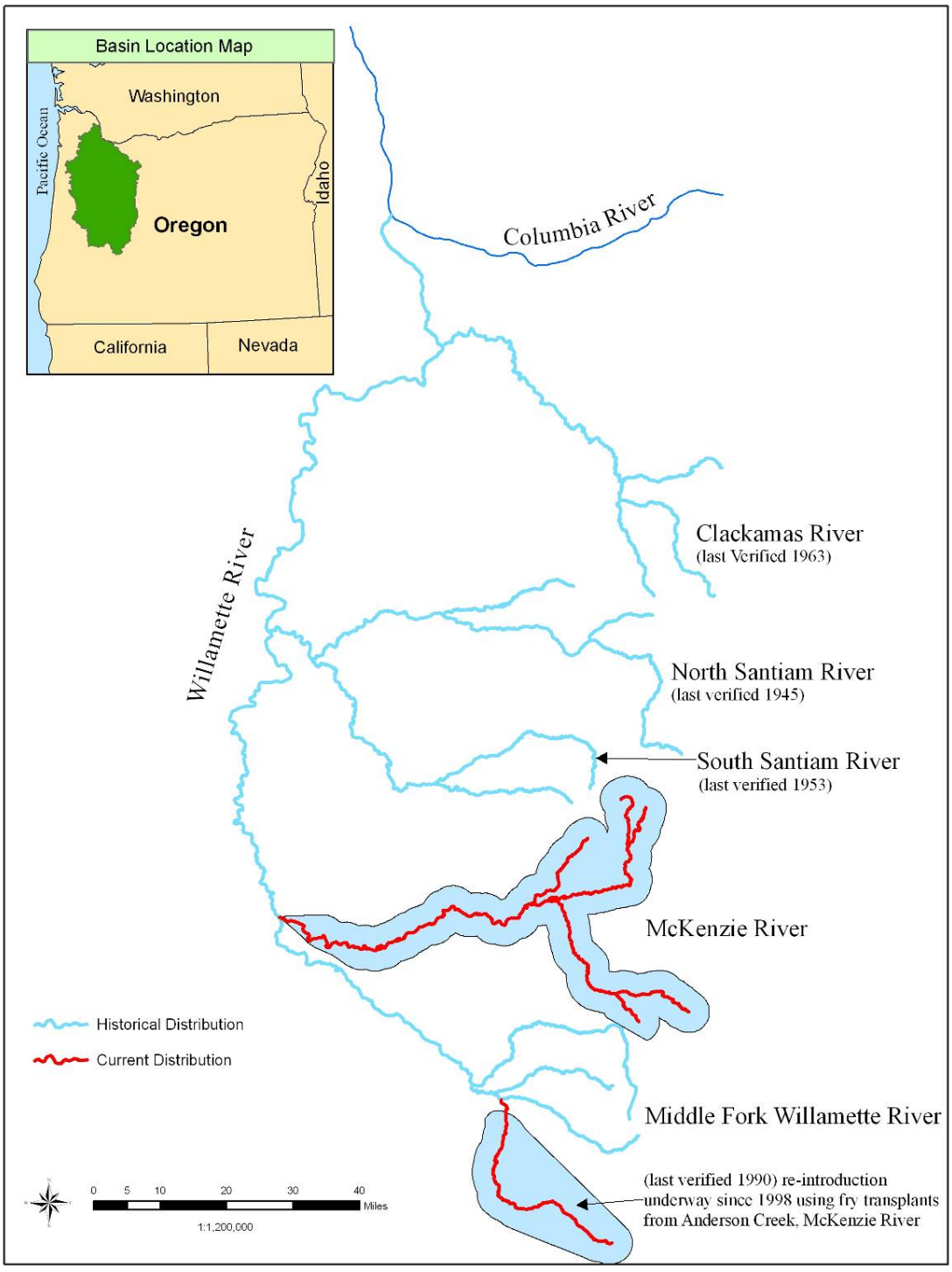

Figure 1. Historical and current bull trout distribution in the Willamette Basin.

The goal of the project is to re-establish a self-sustaining bull trout population of 300 – 500 spawning adults in the Clackamas River by 2030. If successful, this project will contribute to the conservation and recovery of bull trout in the Willamette Basin and to the overall recovery of bull trout outlined in the final Bull Trout Recovery Plan (USFWS 2015a, 2015b). We define a self-sustaining population as one that maintains a minimum adult annual spawning abundance of 100 individuals, contains a level of genetic diversity representative of the donor stock, and requires little or no additional transfers. The numerical goal of 300-500 spawning adults is consistent with recovery planning targets for the abundance necessary to achieve these characteristics. Although the amount of suitable habitat in the Clackamas River suggests there is sufficient capacity to support a population of this size, bull trout distribution across the species' range, even within areas of suitable habitat, is patchy; thus, the true capacity of the Clackamas River Basin for bull trout is unknown.

The actions described in the remainder of this report are intended to address the following three objectives:

(1) Ensure that the proposed action does not threaten the donor stock population;

(2) Monitor and evaluate the effectiveness of the bull trout reintroduction strategy for re-establishing a self-sustaining bull trout metapopulation in the Clackamas River; and

(3) Evaluate the effects of bull trout reintroduction on ESA-listed salmonids that currently occupy the Upper Clackamas River Basin.

2) Methods

2.1) Study Area

The study area for the purposes of this report includes the Clackamas River Basin upstream of River Mill Dam (Figure 2).

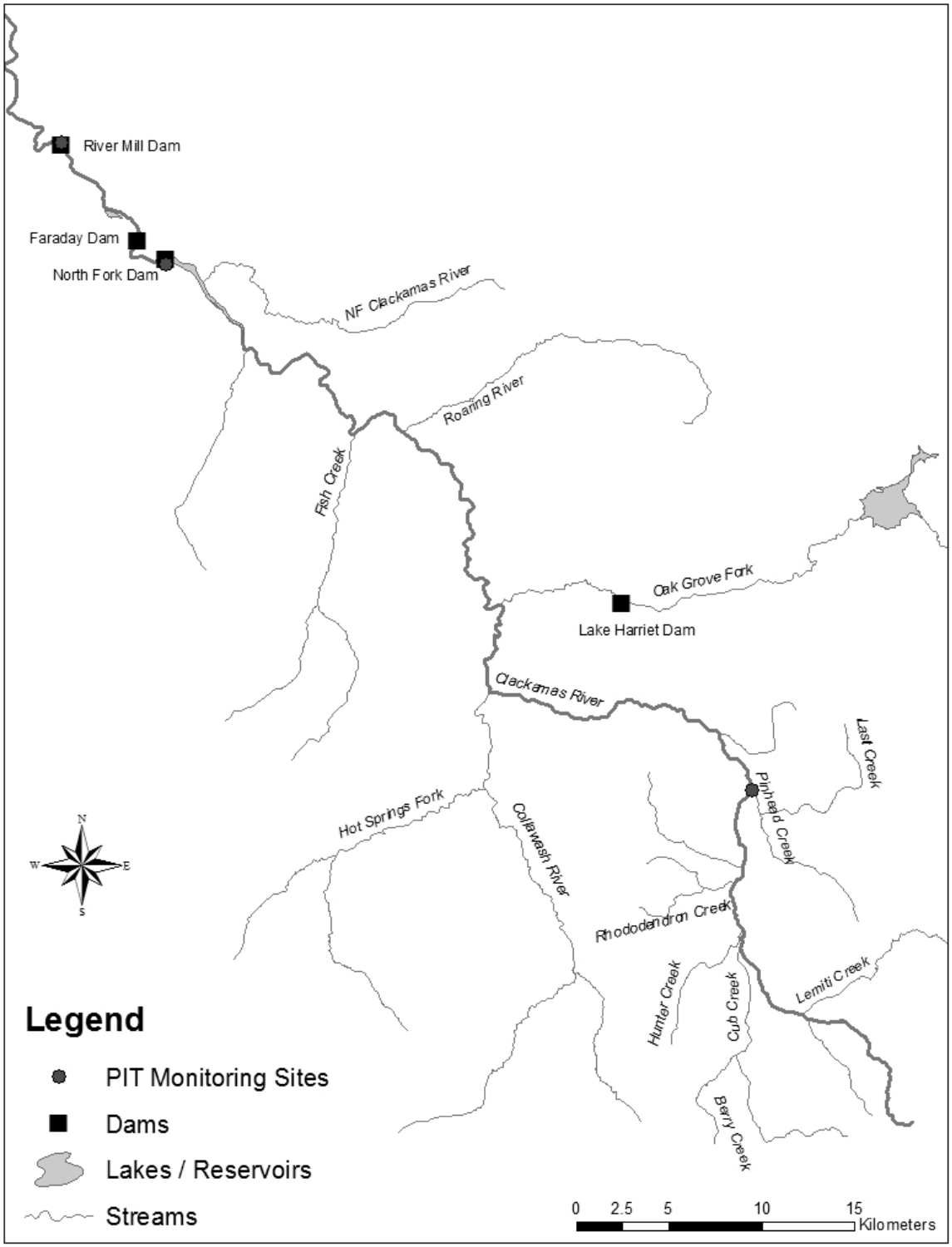

Figure 2. Study area, illustrating the locations of PIT sites that were active in 2015.

2.2) Implementation

2.2.1) Donor stock availability

Oregon Department of Fish & Wildlife conducted an annual redd count survey in fall 2013 on the Metolius River and its tributaries (Jack Creek, Heising Springs, Canyon Creek/Roaring Creek, Candle Creek, Jefferson Creek, and the Metolius River; see Harrington and Wise 2012). The threshold for determining whether the donor population is sufficiently healthy to allow transfers to the Clackamas (as determined through redd counts) is currently 800 spawning individuals (USFWS 2011).

2.2.2) Pathogen screening

Per agreement in the Clackamas Bull Trout Reintroduction Implementation, Monitoring and Evaluation Plan (IM&E Plan) protocols (USFWS and ODFW 2011), bull trout fry (n = 150) were collected by PGE at the Monty screw trap and via electrofishing in Jack and Canyon Creeks between February and March, 2015. During 2015, we collected 60 bull trout juveniles (70 – 250 mm) from the Monty Screw trap (courtesy of PGE). Screening for pathogens was conducted by ODFW (fry) and USFWS (juveniles). Additionally, USFWS Fish Health staff obtained samples from bull trout captured in Lake Billy Chinook during spring 2015. Fish health staff screened for IHNV, IPNV, VHSV, OMV, ISAV, and *M. cerebralis*, as well as other treatable pathogens and parasites (Barry et al. 2014).

2.2.3) Donor stock collection

Juveniles – Our target for juvenile collection was 1000 individuals (USFWS and ODFW 2011). Juvenile (70 – 250 mm TL) bull trout were collected between April 6 and May 21, 2015. The principal method of collection was with 1.5 m rotary screw traps in Jack (10T 0606929 4927980 – NAD 83), Canyon (10T 0606994 4928695 – NAD 83), and Candle (10T 0608209 4935732 – NAD 83) creeks. The rotary screw traps were checked Monday through Thursday by a crew from the ODFW and catch was enumerated daily, sorted by year class (e.g., 1, 2, and 3 year old), and placed into perforated cages (one cage per year class) that were placed in-stream in proximity to the screw trap. Bull trout fry and all by-catch were enumerated and immediately released. Juvenile bull trout were also incidentally captured in the trap nets during subadult and adult collection efforts (see below).

Subadults and Adults – In 2015, our goal was to collect up to 100 subadults (251 – 450 mm TL) and 30 adults (451 – 650 mm TL). Subadult and adult bull trout were captured using a variety of methods to maximize the likelihood of capturing enough individuals and putative different life history forms. The principal method of collection was Oneida trap nets that were set and checked Monday through Thursday each week from May 11 - June 5 in the Metolius arm of Lake Billy Chinook (downstream of the Eyerly property). Fish were also collected via angling by ODFW from the Metolius arm of Lake Billy Chinook. Following capture, bull trout were transported in oxygen-supplemented tanks to the Round Butte Fish Isolation Facility where they

were held in circular tanks (2,500 L) supplied with flow through water from Lake Billy Chinook (10 – 11 °C). Each fish was checked for injury before being placed in the tanks and fish of the appropriate size (251 – 650 mm TL) were held for a minimum 48 h depuration period as a precaution against transfer of New Zealand mud snails that have been recently documented in Lake Billy Chinook. Bull trout that exhibited injury or other prior trauma after visual inspection by USFWS Fish Health staff on site at Round Butte Isolation Facility were returned later the same day to their original capture location and released, or sacrificed and necropsied by USFWS Fish Health.

2.2.3.a Tagging

Each Wednesday or Thursday during the collection period, collected bull trout were tagged with a PIT tag. All bull trout were tagged using half-duplex (HDX) PIT tags (ORFID, Portland, USA and Biomark, Boise, USA). Fish were anesthetized using Aqui-S 20E (20 – 25 ppm). Individuals $\geq$300 mm (total length) received a dorsal sinus implant of a 23 mm tag, bull trout 151 – 299 mm received an abdominally implanted 23 mm tag, and bull trout 70 – 150 mm received an abdominally injected 12 mm tag. All tags were sanitized in ethanol and betadine, then rinsed with distilled water prior to insertion. Bull trout were also administered a prophylaxis of 20 mg/kg azithromycin and all subadults and adults were administered an additional prophylaxis of 20 mg/kg oxytetracycline via intraperitoneal injection.

Following tag insertion, the fish were allowed to recover for a minimum of 18 h before being transported to the Clackamas River.

2.2.3.b Transport

We transferred bull trout to release sites in the upper Clackamas River using a 700 – 1,100 L water tank with supplemental oxygen and 4.5 – 4.9 ppm of Aqui-S 20E. During June, juveniles were transported concurrently with subadults and adults but held in 15 L buckets with small holes drilled in the sides and top to allow water exchange. The buckets were suspended in the transport tanks to prevent injury to any fish. The fish were netted from their holding tanks in the morning and transported for 2~5 h by highway to the release sites. Water temperature was monitored in transit. Frozen blocks of Lake Billy Chinook water were added to the transport tank periodically during transport to help control temperature increases and to slowly acclimate fish to the temperature at the release location. The Clackamas River was always within 1.5°C of holding temperatures at the Round Butte Fish Isolation Facility.

2.2.4) Release locations and timing

All juvenile bull trout were released in habitat identified in the Feasibility Assessment (Shively et al. 2007) as suitable for spawning and early juvenile rearing (Patch 4 in Figure 3). Subadult and adult bull trout were released in the Big Bottom area (Figure 4). Juveniles were released into Berry Creek (Figures 3 and 4).

Subadults and adults were transferred individually from the transport tank to the river using a rubber bagged dip net. Every effort was made to release fish in slow moving water in close proximity to cover (large woody debris) and fish were given as much time as needed to recover from the mild anesthesia (4.5 – 4.9 ppm Aqui-S 20E) used in transport before being released from the net. Fish were never out of the water for more than several seconds.

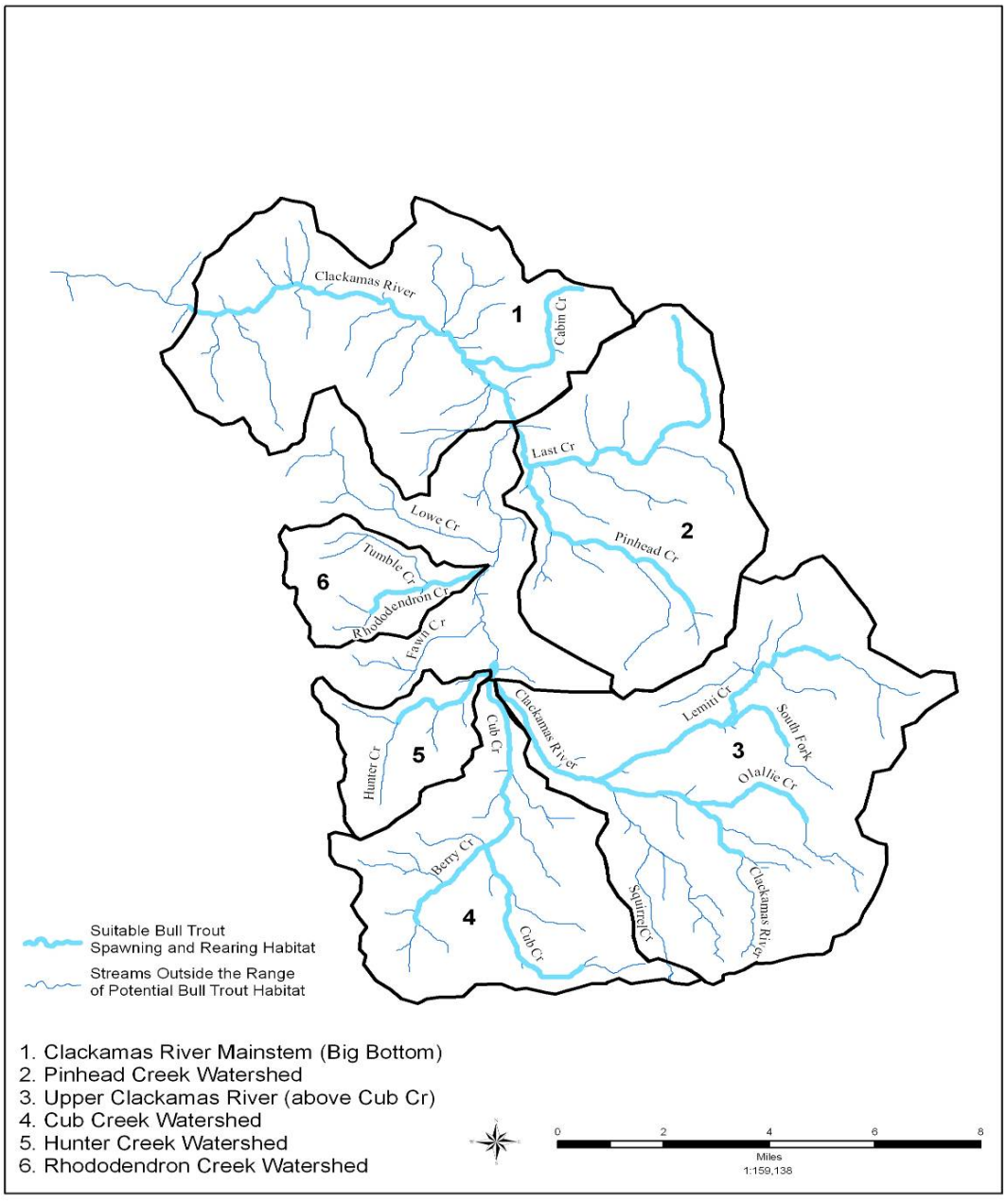

Figure 3. Suitable habitat patches for spawning and juvenile rearing based on Shively et al. 2007.

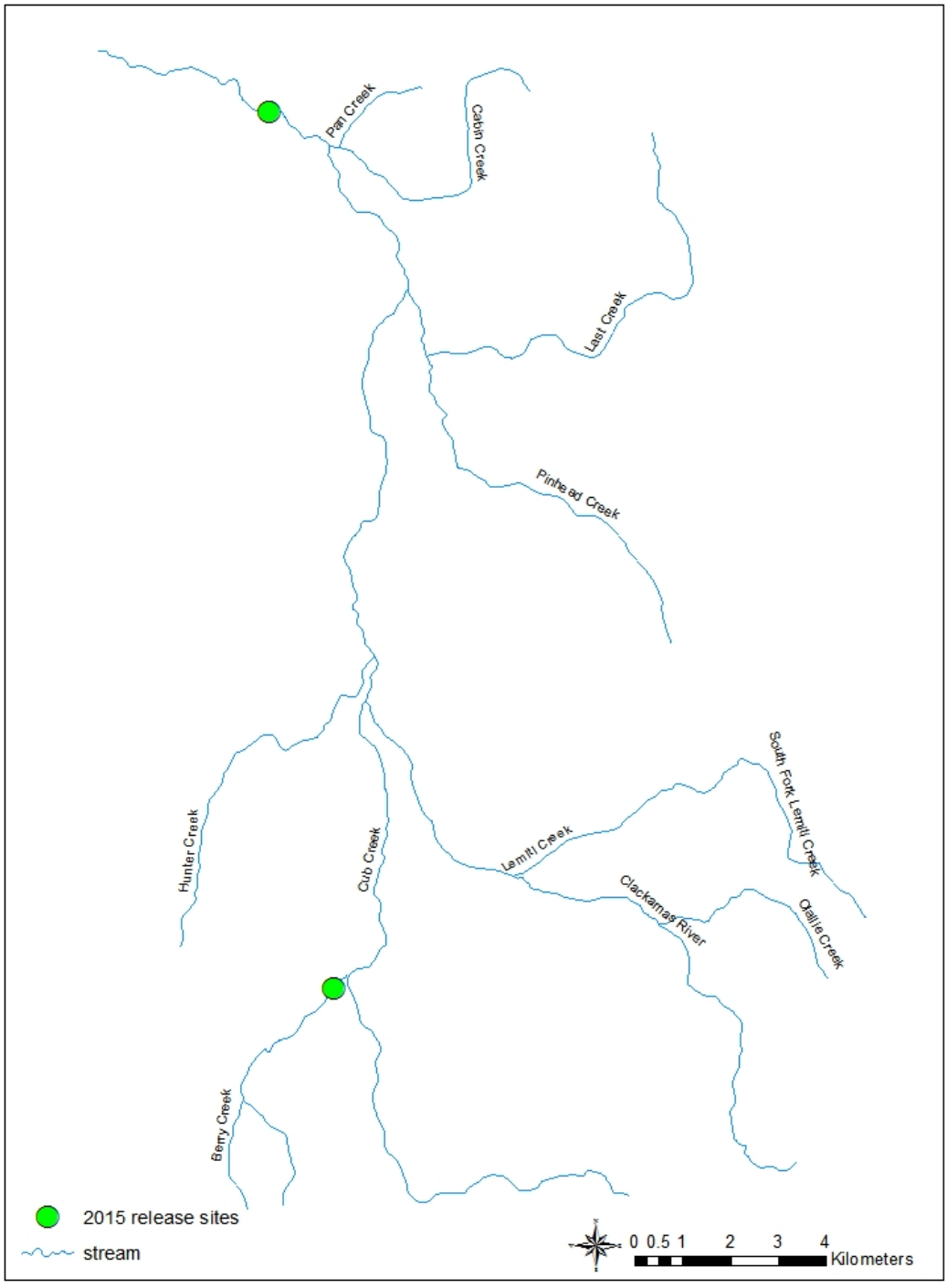

Figure 4. Release locations for bull trout in the upper Clackamas River in 2015. Most juveniles were released into Berry Creek at the Berry Creek bridge (the lower-most site on the figure; Table 4). Adult/subadults were released approximately 100 m downstream of the FR 4650 bridge in the Big Bottom area of the mainstem upper Clackamas River (upper-most site on the figure).

2.3) Monitoring and Evaluation

2.3.1) Bull trout reintroduction effectiveness

We used an instream PIT detection array in Pinhead Creek and the PIT tag monitoring sites at PGE facilities to document the behavior and seasonal distribution of juvenile, subadult and adult fish and add to the information we have previously collected to address the following questions (IM&E Plan, USFWS and ODFW 2011):

1) Do translocated subadult and adult bull trout remain in the upper Clackamas Basin (above River Mill Dam)?

    1a) If yes, what is their seasonal distribution?
    1b) If yes, is there evidence of spawning activity?
    1c) If no, do they return?

2) Is there successful production of progeny?

    2a) If yes, which life stage(s) produced them?

During 2015, a half-duplex PIT tag detection array was operated at the mouth of Pinhead Creek to detect movement of PIT tagged bull trout from March 25, 2015 to November 19, 2015. The site consisted of an Oregon RFID Multi-Antenna Half Duplex Reader running four swim-though type antennas. The reader was powered by two 12 volt battery banks which were charged by solar panels. Solar power was routed through a Xantrex (XW-MPPT60-150) solar charge controller. To reduce electromagnetic noise during charging, each battery bank was isolated from the reader by a West Fork Environmental battery switcher (WFE-1c-AV) set to switch battery banks every 2 hours. After installation, the site was visited approximately once per week to download data and insure proper function until the end of the monitoring season.

Pinhead Creek flows into the Clackamas River through two channels; a mainstem and a side channel directly to the south. The site consisted of four antennas total with two antennas monitoring the mainstem and two antennas monitoring the side channel directly above the confluence with the Clackamas River. All four antennas were installed in a pass through orientation and covered the wetted width of each channel.

The Pinhead PIT array was down for two separate periods during the 2015 monitoring season. On March 31, the reader malfunctioned and no data was collected for eight days. On September 9, the site was vandalized and three of the four antennas were damaged. A site visit on September 10 discovered the vandalism and fixed two of the damaged antennas. The site was not monitoring the side channel for approximately 20 hours due to the vandalism.

Prior to May 2015, there were six established PIT detection arrays operated by PGE at various facilities associated with the Clackamas Hydro Project. During May and October 2015, five additional PIT detection arrays were added for a total of 11 arrays (Figure 5). Eight of the arrays

were operated with KarlTek (KLK5000) PIT tag readers and three with Oregon RFID readers. Table 1 is a summary of the PIT detection arrays at the Clackamas Hydro Project.

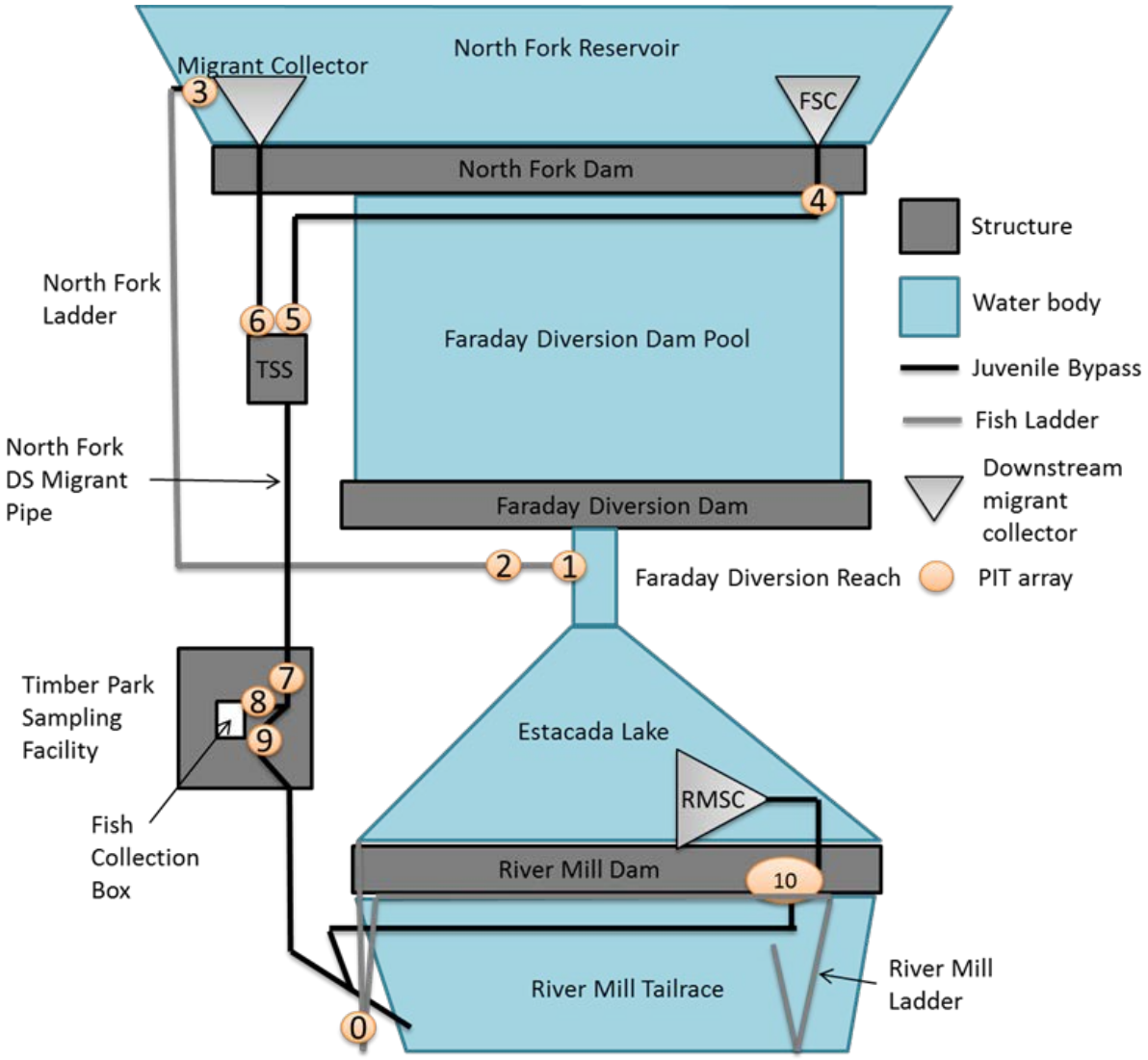

Figure 5. Schematic of PIT antenna array at the Clackamas Hydro Project. FSC = Floating surface collector; TSS = Tertiary screen structure; RMSC = River Mill surface collector (figure provided by Portland General Electric).

Table 1. PIT detection arrays at the Clackamas Hydro Project (Information provided by Portland General Electric).

Array Number	Datalogger	Operated Since	Antennas	Site Purpose
0	KarlTek KLK5000	Apr 2013	2	Detect fish passing through the River Mill ladder.
1	Oregon RFID	May 2015	1	Detect fish at the entrance of the North Fork fish ladder.
2	OregonRFID	May 2013	4	Detect fish near (upstream and downstream) the old adult sorting facility on the North Fork ladder.
3	OregonRFID	May 2015	3	Detect fish exiting the North Fork ladder.
4	KarlTek KLK5000	Oct 2015	1	Detect fish from the FSC just downstream of the flow control structure.
5	KarlTek KLK5000	Oct 2015	1	Detect fish from the FSC just upstream of the tertiary screen structure.
6	KarlTek KLK5000	Oct 2015	1	Detect fish from the North Fork migrant collector just prior to entering the tertiary screen structure.
7	KarlTek KLK5000	Dec 2011	1	Detect fish in flume entering Timber Park.
8	KarlTek KLK5000	Dec 2011	1	Detect fish diverted into the sampling box at Timber Park.
9	KarlTek KLK5000	Dec 2011	1	Detect fish bypassed back to the pipeline at Timber Park.
10	KarlTek KLK5000	Jan 2013	1	Detect fish in the River Mill Surface Collector.

2.3.1a Adult life stage retention

Our ability to monitor whether subadult and adult fish remained in the study area upstream from River Mill Dam has diminished due to the cessation of the radio-telemetry program. However, retention can be inferred from fish re-entering the study area after previously passing downstream of the Clackamas Hydro Project. Bull trout PIT detections and observations at the Clackamas Hydro Project PIT arrays were used to determine whether PIT tagged subadult and adult fish have left and subsequently re-entered the study area.

2.3.1b Subadult/adult seasonal distribution

Radio tracking was ended in 2014. However, detections of PIT-tagged bull trout at the mouth of Pinhead Creek and at PGE facilities downstream were used to describe subadult and adult seasonal distribution.

2.3.2) Juvenile life stage retention and seasonal distribution

A PIT tag detection array was not installed to specifically monitor the outmigration of juvenile bull trout that were released into Berry Creek during 2015, although migrants from the Berry

Creek releases that subsequently moved into Pinhead Creek during the monitoring season could be detected.

2.3.3) Reproduction

Foot surveys were conducted in the upper Clackamas River and several major tributaries (i.e., patches). In early August, prior to the putative spawning season, a zero count pass was conducted to mark anything that might be suspected of being a new bull trout redd on subsequent surveys. During the suspected peak (based on observations of Clackamas spawning bull trout in 2011, 2012, 2013, and 2014) of spawning and after the suspected conclusion of spawning, the upper Clackamas River and its tributaries were surveyed for the presence of bull trout redds by census spawning surveys August 31 – September 15, and September 24 – October 14 (details about locations surveyed and methods used to identify bull trout redds can be found in Appendix A).

2.3.4) Genetics

Caudal fin tissue (approximately 1 cm^2) was collected from each bull trout transferred to the Clackamas. These samples have been archived at the USFWS Abernathy Fish Technology Center (Longview, Washington). This sample archive will provide the opportunity for a parentage analysis in subsequent years of the reintroduction project.

2.3.5) Impacts to listed salmon and steelhead

Due to the discontinuation of the radio-telemetry program, we no longer have the ability to determine whether translocated subadult and adult bull trout have entered HVZ areas. Similarly, we lack the ability to determine the total time each fish spent in HVZ areas. However, detections of bull trout at Clackamas Hydro Project PIT arrays and observations at the adult sorting facility were used to help infer when bull trout may have entered North Fork Reservoir and other areas within PGE's hydro project facilities.

3) Results

3.1) Implementation

3.1.1) Donor stock availability

In 2015 a total of 550 bull trout redds were documented in the Metolius Basin (Erik Moberly ODFW pers. comm.). Assuming an average of 2.3 adult bull trout/redd (a ratio which falls within the range of those found by Dunham et al. 2001), the estimated adult abundance of spawning adults was approximately 1,265 in 2015 (Figure 6), again satisfying the criteria (>800 spawning adults) to continue transfers to the Clackamas in 2016.

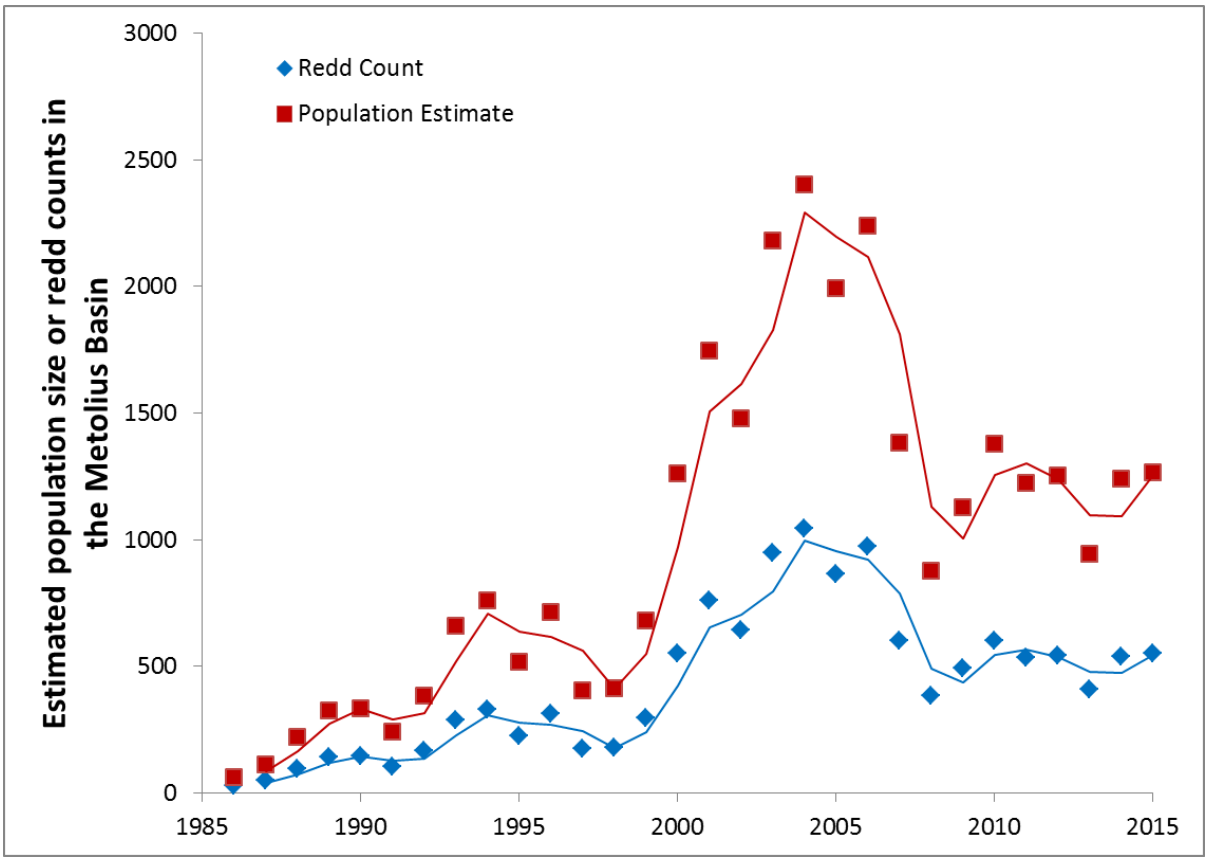

Figure 6. Raw redd counts and population estimates through 2015 for the Metolius bull trout population. Population estimates were calculated by multiplying redd counts by 2.3 (Dunham et al. 2001).

3.1.2) Pathogen screening

All samples screened in 2015 tested negative for IHN, IPN, VHS, paramyxo, and aquareo virus. However, all 60 juveniles tested positive for *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD). All transplanted fish were treated with a prophylaxis of azithromycin to mitigate for the effects of BKD.

3.1.3) Donor stock collection

A total of 86 subadult and adult bull trout (251 – 650 mm TL) were captured for translocation (10 via angling and 76 via trap) (Table 2). Of these, 5 were not used because they had been previously PIT tagged by another research project (4 fish) or died prior to tagging (1 fish). We translocated 74 subadult and 7 adult bull trout to the Clackamas River (Table 3).

We translocated 300 PIT tagged juveniles (70 – 250 mm TL) to the Clackamas River (Berry Creek). In addition, 11 juveniles died during collection efforts (all prior to transport) and two hybrid bull trout captured in Canyon Creek were sacrificed and given to Fish Health. These fish were not included in the total (Table 3). To date, 2,140 bull trout have been translocated from the Metolius to the Clackamas River (Table 3).

Table 2. Origin of subadult and adult bull trout collected in the Metolius River system for transport to the Clackamas River. Fish were either collected by angling for fish in the upper Metolius arm of Lake Billy Chinook, or from Oneida trap nets set in the upper Metolius arm of Lake Billy Chinook.

Capture dates (2015)	Angling	Trap Nets
May 11-14	1	4
May 18-21	2	17
May 26-28	0	23
June1-3	7	27

Table 3. Count by year and life stage of bull trout captured in the Metolius River Basin and translocated to the Clackamas River Basin.

	Count Translocated					
Life stage	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
Juvenile	58	509	615	305	300	1787
Subadult	24	43	91	46	74	278
Adult	36	17	8	7	7	75

3.1.4) Release locations and timing

There were nine releases of juveniles and four releases of subadult and adult bull trout in 2015 (Tables 4 and 5; Figures 3 and 4).

Table 4. Release date, number released, capture source in the Metolius drainage, and release location of juvenile bull trout in the Clackamas drainage in 2015. Juveniles were captured in 1.5 m rotary traps deployed near the mouth of Jack, Canyon, and Candle creeks (Metolius River tributaries), electrofishing Jack, Canyon and Candle Creeks or in Oneida trap nets set in the Metolius arm of Lake Billy Chinook. From May 22-June 5, 13 large juveniles were released 100m downstream of the 4650 bridge due to holding and transport constraints.

Release Date	Juvenile count by collection location (Jack Cr/Canyon Cr/Candle Cr/Lake Billy Chinook)	Count transferred	Release location
April 10	7/12/2/0	53	Berry Creek Bridge
April 17	10/36/7/0	83	Berry Creek Bridge
April 24	7/11/6/0	8	Berry Creek Bridge
May 1	6/13/7/0	82	Berry Creek Bridge
May 8	10/4/20/0	24	Berry Creek Bridge
May 15	3/2/7/3	30	Berry Creek Bridge
May 22	6/6/4/42	4	Berry Creek Bridge and100m downstream of 4560 bridge
May 29	0/0/0/28	7	Berry Creek Bridge and100m downstream of 4560 bridge
June 5	0/0/0/41	7	Berry Creek Bridge and100m downstream of 4560 bridge
Source Totals:	Jack Creek	49	
	Canyon Creek	84	
	Candle Creek	53	
	Lake Billy Chinook	114	
	Total translocated to Clackamas:	**300**	

Table 5. Date of release, quantity by capture method, total released, and release location of subadult and adult bull trout in 2015. All fish were collected in the Metolius arm of Lake Billy Chinook in Oneida trap nets or by angling in the Metolius arm. With the exception of one subadult that was released at the Berry Creek Bridge on 5/29, all fish were released in the Clackamas River in slow moving water 100 m downstream of the 4650 bridge (Figure 4).

Release Date	Subadult/adult count and collection method	Count transferred	Release Location
May 15	4 subadults trap net; 1 subadult angling	5	100 m downstream of 4650 bridge
May 22	14/3 subadults/adults trap net; 2 subadults angling	19	100 m downstream of 4650 bridge
May 29	2/21 subadults/adults trap net	23	100 m downstream of 4650 bridge
June 5	1/27 subadults/adults trap net; 6/1 subadults/adults angling	34	100 m downstream of 4650 bridge

3.2) Monitoring and Evaluation

3.2.1) Bull trout reintroduction effectiveness

3.2.1a Adult life stage retention:

During 2015, nine translocated fish were detected at various PIT arrays within PGE's hydro project facilities and one untagged bull trout was observed at the adult sorting facility (Table 6). The nine PIT tagged fish were originally released as juveniles (2), subadults (6), and adults (1) between May 24, 2012 and June 5, 2014. Currently, growth rates for migratory bull trout in the Clackamas Basin are largely unknown, but an examination of the comprehensive detection histories and observations of each fish since translocation (Appendix B) indicated that most were either adult or near adult-sized fish at the time they were detected at PGE's hydro project facilities in 2015.

Table 6. PIT-tagged bull trout detected at PGE facilities during 2015 as of 10/26/2015.

PIT ID	Length at Release (TL)	Release Date	Release Site
0000_0000000177419262	320 mm	6/20/2013	4650 Bridge (Clackamas R.)
0000_0000000177419577	633 mm	6/28/2012	4670 Side Chan. (Clackamas R.)
0000_0000000177419566	368 mm	7/12/2012	4670 Side Chan. (Clackamas R.)
0000_0000000177419485	157 mm	5/9/2013	Pinhead/Last Cr.
0000_0000000177419340	350 mm	6/13/2013	DS of Austin H.S. (Clackamas R.)
0113_0379091166899210	108 mm	5/24/2012	Pinhead Cr.
0000_0000000177419238	330 mm	6/26/2013	4650 Bridge (Clackamas R.)
982_000361679189	331 mm	6/5/2014	4650 Bridge (Clackamas R.)
0000_0000000177419331	364 mm	6/13/2013	DS of Austin H.S. (Clackamas R.)

Of the nine translocated bull trout detected at the Clackamas Hydro Project facilities during 2015, four were adult or near adult-sized fish that returned upstream past North Fork Dam during May and early June. Additionally, one fish returned in September for a total of 5 bull trout passed upstream in 2015 (this fish was not detected on any of the arrays in the Project facilities, however). Three of these fish were also observed in the observation tank at the North Fork adult sorting facility where total length was determined (Table 7, Figure 7). One individual (PIT ID 0000_0000000177419577) that was outplanted on June 28, 2012 as a 633 mm TL adult, had migrated downstream to the vicinity of North Fork Dam from January 31, 2012 to March 3, 2012 and was subsequently relocated within the Faraday Dam Forebay during 2013 until it passed upstream of North Fork Dam on May 11, 2015 (Appendix B). This fish had grown approximately 17 mm since translocation (650 mm TL) and was not subsequently detected during 2015. A second individual (PIT ID 0000_0000000177419262) that was outplanted on June 20, 2013 as a 320 mm TL subadult appears to have migrated downstream toward North Fork Reservoir during fall 2013 and again was detected near North Fork Reservoir in November and December of 2014 before attempting to move upstream through the North Fork fish ladder on January 6, 2015. This fish appears to have resided downstream from North Fork Dam from January 6, 2015 to May 12, 2015 when it successfully passed upstream of the dam (Appendix B). This fish had grown approximately 238 mm since translocation (558 mm TL) and was subsequently detected entering Pinhead Creek (indicating a possible spawning migration) on August 29, 2015. A third individual (PIT ID 0113_0379091166899210) that was outplanted on May 24, 2012 as a 108 mm TL juvenile in Pinhead Creek had not been detected following translocation until it was detected at the North Fork fish ladder entrance on May 28, 2015 and it passed upstream of the dam on June 8, 2015. This fish had grown approximately 242 mm since it was outplanted (350 mm TL) and has not subsequently been detected during 2015. A fourth PIT tagged bull trout (PIT ID 0000_0000000177419485) was detected moving upstream past North Fork Dam on May 26, 2015 but was not visually observed in the adult sorting facility.

This fish was outplanted as a 157 mm TL juvenile in Pinhead Creek on May 9, 2013 and was last detected in Pinhead Creek (indicating a possible spawning migration) on August 25, 2015. An additional bull trout (approximately 350 mm) was observed moving quickly through the North Fork adult sorting facility on September 24, 2015. The fish was not detected at PIT antennas indicating that it had either shed its tag or it was a naturally produced fish.

Table 7. Bull trout observed in the observation tank at the North Fork adult sorting facility during 2015.

PIT ID	Release Date	Release Length (TL)	Recapture Date	Recapture Length (TL)*	Growth Since Release**
0000_0000000177419577	6/28/2012	633 mm	5/11/2015	650 mm	17 mm
0000_0000000177419262	6/20/2013	320 mm	5/12/2015	558 mm	238 mm
0113_0379091166899210	5/24/2012	108 mm	6/8/2015	350 mm	242 mm

* Determined while in observation tank and may not be exact measurement.
** Growth determined using inexact measurements acquired from observation tank.

Figure 7. Bull trout observed in the North Fork adult sorting facility observation tank.

Five of the nine PIT tagged bull trout detected at PGE's hydro project facilities during 2015 have not been detected returning to the study area upstream of North Fork Dam as of December 31, 2015. As previously noted, growth rates in the Clackamas Basin are unknown, but most of the bull trout detected are likely adult or near adult-sized fish. An examination of the comprehensive detection histories of each fish since translocation revealed that one individual (PIT ID 0000_0000000177419566) that was outplanted as a 368 mm TL subadult on July 12, 2012 moved downstream of River Mill Dam during July 2014, attempted to pass upstream to North Fork Reservoir in early May 2015, but had moved back downstream of River Mill Dam via the River Mill Surface Collector on May 17, 2015 (Appendix B). This fish was last detected in the River Mill fish ladder on September 11, 2015. A second individual (PIT ID 0000_0000000177419340) that was outplanted as a 350 mm subadult on June 13, 2013 was

detected moving downstream of North Fork Dam via PGE's North Fork Downstream Migrant Pipe to below River Mill Dam on May 25, 2015. This fish then ascended the River Mill fish ladder on May 28, 2015 and subsequently moved downstream of River Mill Dam via the River Mill Surface Collector on September 6, 2015. The other three individuals (PIT IDs 0000_0000000177419238, 982_000361679189, 0000_0000000177419331) were outplanted as subadults on June 27, 2013, June 5, 2014, and June 6, 2013 at 300 mm TL, 331 mm TL, and 364 mm TL, respectively. Two of these fish (PIT IDs 0000_0000000177419238 and 982_000361679189) left the study area via the North Fork Downstream Migrant Pipe on August 12, 2015 and September 12, 2015, respectively (Appendix B). One of these fish (PIT ID 0000_0000000177419331) exited Pinhead Creek on September 19, 2015 (presumably following spawning) and quickly left the study area via the North Fork Downstream Migrant Pipe on October 4, 2015.

3.2.1b Seasonal Distribution

There were 90 individual bull trout detected at the Pinhead Creek PIT array during the 2015 monitoring season (Figure 8). There were seven PIT tagged bull trout adults detected at the PIT array from July through October with movement peaking in August. There were 36 individual bull trout released as subadults detected from June through October with movement peaking during August and September. There were 47 individual bull trout released as juveniles detected during all months of operation except for November. The array was not operated from December through February and experienced periods of down time during the monitoring season, therefore some detections may have been missed.

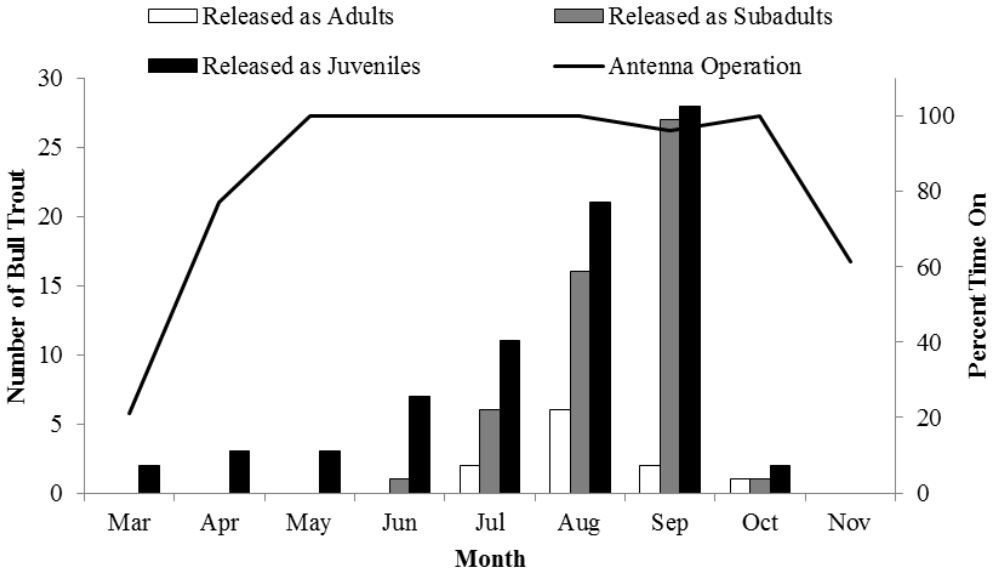

Figure 8. Unique monthly detections of PIT tagged bull trout at the Pinhead Creek PIT array. Array operational status is displayed in percentage of hours per month the array was on and functioning.

Bull trout from all release years were detected on the Pinhead Creek PIT array (Figure 9). No adult bull trout from release years 2011 (n=36) and 2013 (n=8) were detected at the array during 2015. Additionally, no subadult (at time of release) bull trout from release years 2011 (n=24) and 2015 (n=74) were detected during 2015. Detections of juveniles and subadults from release year 2013 were the highest at the Pinhead Creek PIT array during the monitoring season.

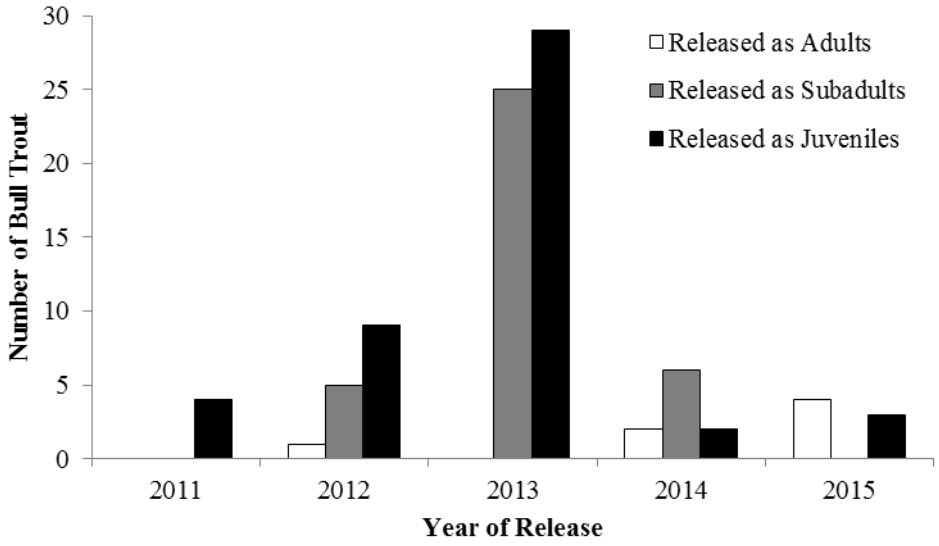

Figure 9. Bull trout from all release years were detected on the Pinhead Creek PIT array.

The relative high numbers of detections of bull trout released as juveniles and subadults in 2013 coincide with peak numbers of fish translocated for both life stages for that year (Table 8). Juveniles released in 2011 were detected at a higher percentage than fish released in 2013. However, the relatively low number of detections could have effected the results. Over half of the adult bull trout translocated in 2015 were detected at the Pinhead Creek PIT array which represented a higher percentage when compared to previous years translocated adult detections.

Table 8. Number of bull trout transferred to the Clackamas River Basin each year by life stage and subsequent PIT tag detections at the Pinhead Creek PIT array during 2015.

Year of Release	Juvenile Release Number	Number Detected	%	Subadult Release Number	Number Detected	%	Adult Release Number	Number Detected	%
2011	58	4	6.89	24	0	0.00	36	0	0.00
2012	509	9	1.76	43	5	11.62	17	1	5.88
2013	615	29	4.71	91	25	27.47	8	0	0.00
2014	305*	2	0.65	46	6	13.04	7	2	28.57
2015	300*	3	1.00	74	0	0.00	7	4	57.14

*Released in Berry Creek.

Comprehensive detection histories for the translocated fish are summarized in Appendix B. Five bull trout (four PIT tagged and one untagged) moved upstream past North Fork Dam, re-entering the Upper Clackamas Basin. The four PIT tagged fish passed upstream of the dam from May 11, 2015 to June 8, 2015 (Table 9). The untagged bull trout was observed by PGE staff as it moved quickly through the window at the adult sorting facility with Chinook and coho salmon. The fish was estimated to be approximately 350 mm and passed upstream through the facility on September 24, 2015. At least two of the five bull trout that moved upstream of North Fork Dam were subsequently detected in late August as they entered Pinhead Creek, presumably to spawn (Appendix B).

Table 9. Bull trout detected or observed at the North Fork adult sorting facility during 2015.

PIT ID	Detection/Observation Date (N.F. Adult Sorting Facility)	Length (TL) at Detection/Observation
0000_0000000177419577	5/11/2015	650 mm
0000_0000000177419262	5/12/2015	558 mm
0000_0000000177419485	5/26/2015	NA
0113_0379091166899210	6/8/2015	350 mm
NA	9/24/2015	350 mm

3.2.2) Juvenile life stage retention and seasonal distribution

Based on detection histories, a small number of bull trout released as juveniles in Pinhead Creek may have outmigrated into the mainstem Clackamas River during 2015. The actual number of outmigrants is unknown as the site did not operate year round and bull trout could have moved outside of the monitoring season. Additionally, the life stage of these bull trout is unknown as these fish would have been from releases prior to 2014. Five bull trout released as juveniles in Berry Creek were detected entering Pinhead Creek. Two juveniles were released during 2014 and the remaining three were from the 2015 release group.

3.2.3) Reproduction

No bull trout spawning behavior or redd construction was visually observed during any of the spawning surveys performed in the upper Clackamas River and associated tributaries (i.e., we didn't actually observe any bull trout on redds, as in previous years). A total of 59 presumed bull trout redds were identified in 2015 (Appendix A). This is the highest count since the reintroduction began in 2011.

3.2.4) Genetics

Tissues were collected from 390 bull trout in 2015. All samples were archived at the USFWS operated Abernathy Fish Technology Center (Abernathy, Washington).

3.2.5) Impacts to listed salmon and steelhead

Occupancy of the HVZ by bull trout during 2015 is largely unknown. However, the comprehensive detection histories of nine PIT tagged bull trout detected at various PIT antennas throughout PGE's hydro project facilities during 2015 indicate that both subadult and adult bull trout appear to occupy habitat extending from downstream of River Mill Dam to North Fork Reservoir for much of the year (Appendix B). It is also reasonable to speculate that bull trout opportunistically forage on salmon, steelhead and other species while in the vicinity of PGE's hydro project facilities. In many cases, it is unclear how long a particular bull trout has occupied a given area prior to its detection moving upstream through one of the fish ladders. This is due in part to the limited detection capability for fish migrating downstream past the dams. In other instances, occupancy timing can be inferred through an examination of detection histories. For example, one individual (PIT ID 0000_0000000177419577) that was outplanted on June 28, 2012 as a 633 mm TL adult, appeared to have resided downstream of North Fork Dam and upstream of River Mill Dam for over 657 days before passing upstream of North Fork Dam via the North Fork fish ladder on May 11, 2015. Similarly, another individual (PIT ID 0000_0000000177419566) that was outplanted on July 12, 2012 as a 368 mm TL subadult appeared to have resided upstream of River Mill Dam but downstream of Faraday Division Dam for over 421 days and was last detected re-ascending the River Mill fish ladder on September 11, 2015.

In addition, three likely adult-sized bull trout were detected at the Timber Park Sampling Facility during August, September and October 2015, having entered the downstream migrant surface collector at North Fork Dam (Appendix B). These fish were deposited downstream of River Mill Dam and have not been subsequently detected. It may be reasonable to expect these fish to re-enter the study area next spring, after overwintering downstream of the hydro project. These downstream detections may represent only a portion of the bull trout that entered PGE's hydro project downstream of North Fork Dam this fall and winter because all bull trout that pass downstream of the dam may not enter the surface collector, and not all bull trout may have PIT tags (i.e., translocated fish that have shed tags or naturally produced fish).

PGE provided a partial analysis (i.e., using fish detected moving upstream through one of the two ladders) of bull trout residence time within the PGE Project area (G. Wyatt, pers. comm. Feb. 15, 2016). The average occupancy time between 2013 and 2015 was 4.4 months (n = 12 fish), indicating that some bull trout spent considerable time in the Project area during the spring and fall migration periods. Further assessment to determine a more complete picture of life stages entering and exiting the Project area over given periods of time is warranted to help evaluate the impacts of bull trout to listed salmon and steelhead within the Clackamas Hydro Project area.

4) Conclusions

The Pinhead Creek PIT array experienced two periods of downtime during the 2015 monitoring season. The periods of downtime generally coincide with juvenile outmigration and adult spawning timing, thus it is likely that some detections were lost. However, since juveniles have not been released since 2013 in the Pinhead Creek Subbasin, relatively few tagged individuals should be left to outmigrate. The short downtime in September was during peak spawning migration movements. However, the main channel was monitored by at least one antenna and only the side channel lost detection capabilities. Most bull trout use the mainstem channel for migration based on PIT detections. It is also possible that detections were lost outside of the monitoring season. Winter conditions, e.g., not enough sunlight for solar power, snow levels, probable low detections, make operation of the array unwarranted at this time.

Some PIT tag detections of bull trout released as juveniles and subadults are likely adults returning to spawn as many detections were from fish released during prior years and have probably reached maturity. Detection histories support this conclusion based on timing of detections that are analogous to spawning migrations in other bull trout populations.

While juveniles from every release year were detected at the Pinhead Creek PIT array, not all years for adult and subadults releases were represented. The fates of the 44 adults and 98 subadults are unknown at this time. There are several possible scenarios that could explain why bull trout from these release groups were not detected including; these fish did not survive, subadults were not mature and therefore did not make spawning movements into Pinhead Creek, or that spawning took place elsewhere in the Clackamas River Basin. Surveys on the mainstem Clackamas River during 2015 enumerated 11 bull trout redds, some of which, could have been made from fish released during these years (Appendix A).

We have evidence that demonstrates individuals representing each translocated life stage that previously migrated downstream of North Fork Dam had successfully returned upstream past the dam as adult or near adult-sized fish. Of particular note, two of these individuals were subsequently detected in Pinhead Creek, presumably to spawn. Multiple individuals were also detected emigrating from the study area or remained in the vicinity of PGE's hydro project facilities, but given that multiple migrants recently returned to the study area, these fish should not necessarily be considered lost to the population.

Evidence confirming successful natural production has not been documented in the Clackamas River. It is conceivable that the untagged bull trout observed moving upstream through the North Fork adult sorting facility during September was naturally produced, or it could be possible that it was a translocated fish that had shed its PIT tag.

Occupancy of the HVZ by bull trout during 2015 is poorly understood. However, the number of PIT tagged bull trout detections at PGE's hydro project facilities during 2015 has notably increased over previous years as the translocated population increases, matures, and migratory ranges are established throughout the basin.

Overall, the reintroduction effort is showing signs of potential success in reaching the project's goal. Bull trout are generally staying within the Clackamas Basin and exhibiting spawning behavior in increasing numbers; the number of presumed bull trout redds observed each year continued its upward trend with the greatest number of redds identified (59 redds in 2015) to date. Data gaps include evidence of successful natural reproduction, survival from egg to juvenile life stages, and any potential impacts to listed salmon and steelhead both inside and outside of High Vulnerability Zones.

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Appendix A

Clackamas River Bull Trout Reintroduction Project: Spawning Surveys, 2015

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November 2015

Abstract. We assessed the feasibility of integrating a census bull trout redd survey of the upper Clackamas River basin with habitat surveys currently conducted by ODFW's Aquatic Inventories Project. We counted 59 presumed bull trout redds in this basin in 2015. This was a 59% increase relative to the count in 2014 and more than a three-fold increase since 2013. The majority of redds were observed in Pinhead Creek (N=47). Bull trout redds were observed in lower Oak Grove Fork (N=1), the Clackamas River section known as "Big Bottom" (N=6), and in the upper reaches of Clackamas River (N=4). During surveys, no bull trout were seen spawning or holding on redds. Coho salmon were not observed in the basin during the surveys, however, many Chinook salmon were seen spawning in Big Bottom, which added a potentially confounding factor to bull trout spawning surveys in these reaches. Stream temperatures taken during surveys suggest that most of the upper Clackamas River surveyed provided thermally suitable habitat during the typical bull trout spawning period. To reduce sampling error, spawning surveys should be conducted at most three weeks apart and cover the entire potential spawning period (August 15-November 1), especially in the Pinhead Creek watershed and suitable reaches of the Clackamas River. Temperature loggers should be used next year to further evaluate potential bull trout spawning habitat and inform future monitoring activities in the upper Clackamas River basin.

Introduction

Bull trout were extirpated from the Clackamas River basin by the 1960s. Following completion of a reintroduction feasibility assessment in 2007, annual transfers of bull trout from the Metolius River basin began in 2011 and have continued through 2015. The goal of the reintroduction is to establish a self-sustaining population of 300-500 adult spawners. The reintroduction was divided into three phases of approximately 6-7 years each (see USFWS 2011). Phase one involved active transfers of fish into the basin and intensive monitoring using radio telemetry, PIT tags, e-fishing, and redd surveys. Phase two is scheduled to begin in 2017 and will involve continued monitoring of progress towards the reintroduction goal. During this phase, we anticipate that spawner abundance will be tracked using annual redd surveys. The surveys to date have been conducted by an *ad hoc* group of volunteers and have not consistently covered the entire sample frame of potential spawning habitat. Additionally, redd surveys have several potential sources of bias (see Dunham et al. 2001) that have not been addressed by the current approach (e.g., timing, observer bias). Our objective was to 1) evaluate the feasibility of incorporating a census redd survey of all potential bull trout spawning habitat into existing habitat monitoring conducted by ODFW, 2) refine the sample frame to focus surveys in areas where bull trout may spawn (temperature, substrate, barriers), and 3) identify the optimal revisit interval during the spawning season.

Methods

A 5-person crew conducted spawning surveys in the upper Clackamas River and several major tributary basins (Figure 1). We conducted a zero-count in early August, prior to the start of bull trout spawning. The zero-count was used to train field crews in bull trout redd identification by analyzing characteristics of old redds (i.e., redds constructed prior to August) and flagging areas that could be mistaken for new redds; and to assess the time and logistics required to complete the census. Further field training in identifying new bull trout redds (i.e., August-October) was conducted during the first census survey in Pinhead Creek. We identified a new bull trout redd by its pocket-mound structure, smaller gravel size relative to substrate in Chinook salmon redds, and light coloration of redd gravel relative to darker surrounding substrate matrix. A census spawning survey was completed in each of the following time periods: 1) August 31 to September 15, and 2) September 24 to October 14. Additional surveys were conducted on October 22 by Chinook salmon spawning surveyors (ODFW) in Reach 2 and 3 of the Clackamas River and on November 4 by Chris Allen (USFWS) and Jack Williamson (USFS) in Last Creek.

The field crew georeferenced and recorded observations of three main features in field data books: new redds, bull trout, and potential upstream passage barriers. Additionally, in stream reaches deemed by a field crew to contain little spawning habitat, patches of potential spawning

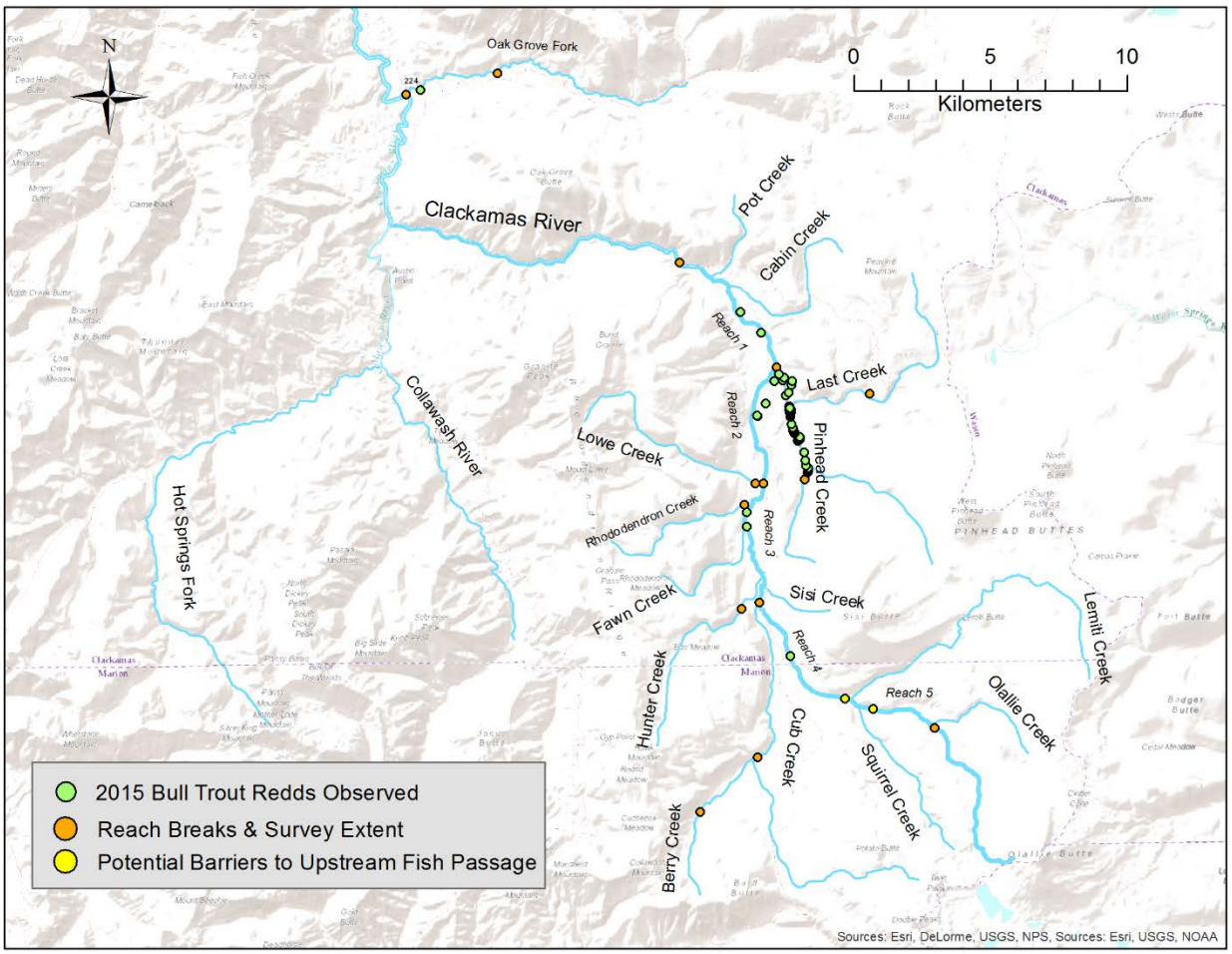

Figure 1. Map of survey extent, potential barriers, and bull trout redds observed in the upper Clackamas River Basin, 2015.

gravel were measured, georeferenced, and recorded. When a new bull trout redd was observed, the crew recorded the maximum length and width and flagged the site – the flag included the redd number, survey code, date, surveyor name, and redd location if the flag was some distance from the redd. Observations of Chinook salmon spawning were recorded as a feature or reach note. At the start and end of each survey reach, stream temperature and time was recorded, and upstream and downstream photos were taken.

An Access database was created for storing data from the census surveys of 2015 and for previous surveys for which field data records were found. Each year spawning surveyors recorded observations of some bull trout redds described as “potential”, “possible”, “likely”, “test dig?” or some other variant registering uncertainty in their observations. All bull trout redd observations recorded by spawning surveyors were entered in this database and descriptions of uncertainty were included as a feature note. (See Appendix I for dataset from 2015.)

Results and Discussion

We counted 59 bull trout redds in the upper Clackamas River Basin in 2015 (Table 1, Appendix I). This was a 59% increase relative to the count in 2014 and more than a three-fold increase

since 2013. Most the bull trout redds were observed in the Pinhead Creek watershed (N=48). Partial carcasses of two adult bull trout (a 65 cm male and a female) were found during the upper Pinhead Creek survey on August 31; they likely were preyed upon by otters. Their heads were collected and stored in a freezer for potential genetic and otolith analysis. Lower Pinhead Creek (Reach 1) has several sections with high habitat complexity, including three or more channels. We surveyed with 4-5 experienced observers to cover these complex sections. Even still, there was evidence that the redd detection of this large field crew was substantially less than 100%. An experienced observer, following behind the crew and taking photos of redds and habitat, surveyed a shorter section of lower Pinhead Creek and found three new redds that had not been flagged. It is not clear if the crew missed these new redds or saw these areas and judged them not to be new redds; nevertheless, the potential for experienced surveyors to miss new redds in complex areas like lower Pinhead Creek suggests that the census survey likely represents a minimum redd count.

Table 1. Number of bull trout redds counted in the upper Clackamas River basin since surveys began in 2011. In certain years, some streams and reaches were not surveyed (*NS*) or the field data were not available (*NA*). These counts included redds described by surveyors in their field data records as "potential", "possible", or "likely."

		Redd Count					
Stream	Reach	2015	2014	2013	2012	2011	Reach Description
Pinhead Creek	1	13	21	10	9	*NA*	To Last Cr.
Pinhead Creek	2	34	14	2	5	*NA*	Last Cr.-FS140 Road
Last Creek	1	1	2	3	2	*NA*	To Camp Cr.
Clackamas River	1	1	*NS*	*NS*	*NS*	*NS*	FS4650-Pinhead Cr.
Clackamas River	2	5	*NS*	*NS*	*NS*	*NS*	Pinhead Cr.-Lowe Cr.
Clackamas River	3	2	*NS*	*NS*	*NS*	*NS*	Lowe Cr.-Cub Cr.
Clackamas River	4	2	*NS*	1	*NS*	*NS*	Cub Cr.-Lemiti Cr.
Clackamas River	5	0	*NS*	*NS*	*NS*	*NS*	Lemiti Cr.-Ollalie Cr.
Oak Grove Fork	1	1	*NS*	2	*NS*	*NS*	First 2.5 km
Lowe Creek	1	0	*NS*	*NS*	*NS*	*NS*	First 1 km
Rhododendron Cr.	1	0	*NS*	*NS*	*NS*	*NS*	First 1 km
Hunter Creek	1	0	*NS*	*NS*	*NS*	*NS*	First 1.5 km
Cub Creek	1	0	*NS*	*NS*	*NS*	*NS*	To Berry Cr.
Cub Creek	2	0	*NS*	*NS*	*NS*	*NS*	First 2.5 km
Berry Creek	1	0	*NS*	*NS*	*NS*	*NS*	First 3 km
TOTAL		59	37	18	16	5	

Bull trout redds were also observed in the Clackamas River (N=10) and Oak Grove Fork (N=1) (Figure 1, Table 1), where no bull trout were observed spawning. Many Chinook salmon were observed actively spawning throughout this part of the survey area. These redds were identified as those of bull trout mainly because the spawning gravel was substantially smaller than the substrate in the Chinook salmon redds observed during the survey and because these redds were located adjacent to instream cover (e.g., undercut bank, instream large wood, boulders) and relatively lower velocity flow, which is more typical of bull trout spawning behavior. One bull trout redd identified during the first survey was not visible during the second survey because of the superimposition of a large Chinook salmon redd. A Chinook salmon spawning surveying crew noted on October 22 that four of the five flagged bull trout redds in Reach 2 of the Clackamas River were more typical of Chinook salmon redds (Sara Akin, ODFW, personal communication). The Chinook crew did not measure the redds so we could not compare redd dimensions to determine if these observations may have resulted from redd superimposition or enlargement by Chinook salmon, and we did not attempt to evaluate observer error of either crew. Bull trout redd identification in the first three reaches of the Clackamas River could be confounded by the spatial and temporal overlap of Chinook salmon spawning and the potential for redd superimposition and Chinook test digs to increase observer error. This increased chance of observer error contributes to greater uncertainty in bull trout redd observations in this part of the sample frame.

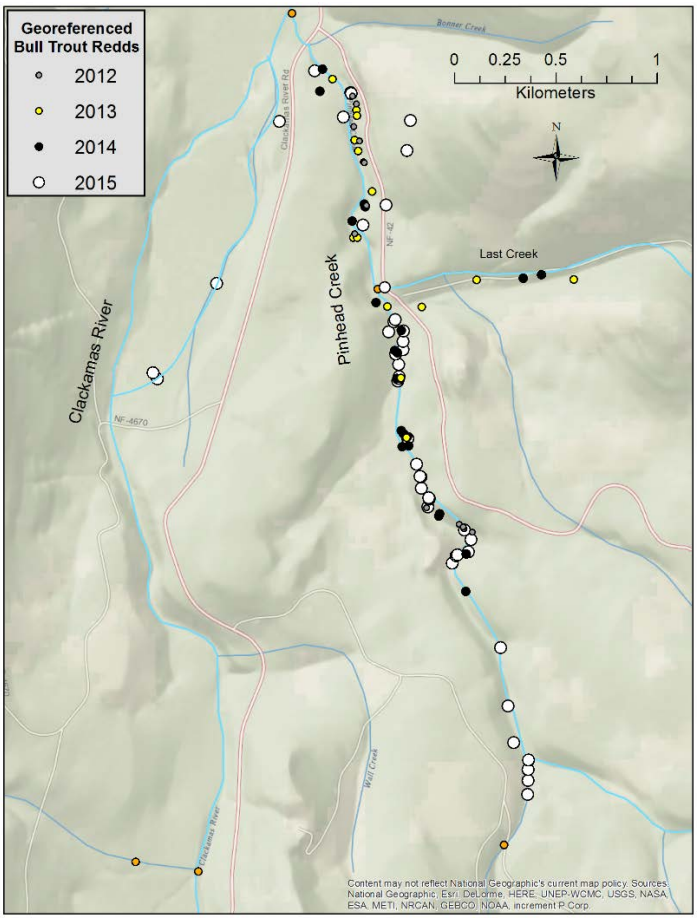

Figure 2. Bull trout redd distribution in Pinhead Creek, Last Creek, and Reach 2 of the Clackamas River for 2012-2015. Some redds in each year were not georeferenced, only redds that were georeferenced are shown. Redds coordinates have not been snapped to the stream.

The sampling schedule in 2015 contributed to increasing the chance of observer error and bias toward undercounting redds in three ways. First, we noted that some of the new redds observed during the survey on August 31 looked like old redds by the final survey on October 14. If redds

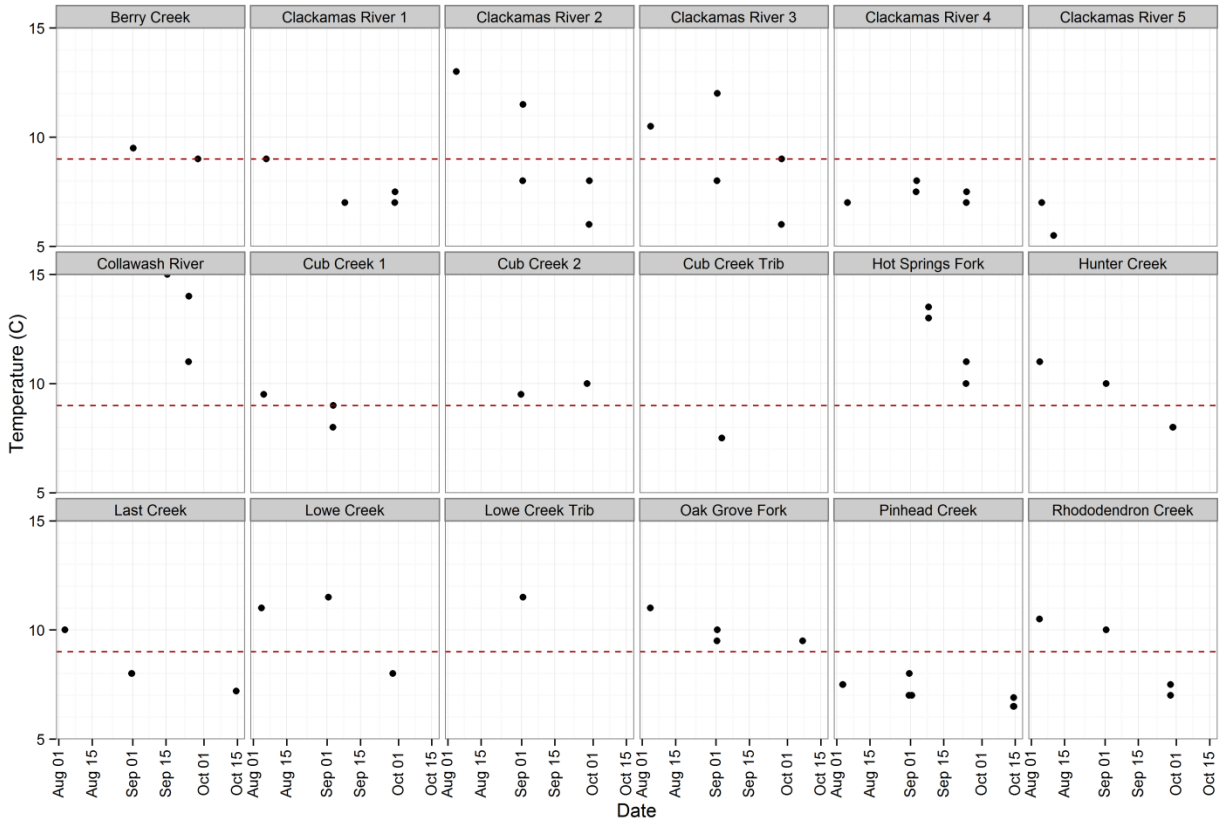

Figure 3. Stream temperatures (C) recorded during bull trout spawning surveys in the upper Clackamas River Basin, 2015. Red dotted line represents the 9 C threshold considered to be the temperature below which bull trout will begin spawning. Temperature measurements were not taken in every survey.

were missed during the first survey, the 44 days between surveys would preclude observers from correcting some of the errors of omission committed in the first survey and thus negatively bias the redd count. Second, there were several redds noted by the crew that were judged to be old redds even though they displayed some characteristics of a new redd (e.g., pocket-mound structure and brighter coloration of the substrate). There is at least some chance that these were new redds that were either missed during the first survey or constructed in early September and then aged enough by the second survey to be more ambiguous and difficult for observers to identify as new. If some of these ambiguous redds were indeed new bull trout redds, then this would contribute to a bias to undercount in 2015. Third, without knowledge of bull trout spawning timing in this sample frame, the last surveys were scheduled to be completed by October 14 even though bull trout are capable of spawning into early November in other parts of their geographical distribution. Indeed, spawning surveyors for the Clackamas River Chinook salmon project observed two new bull trout redds in the Clackamas River on October 22 and observers on a November 4 survey of Last Creek also counted a new bull trout redd. Three changes to the survey protocol would ameliorate at least some of the observer error and bias toward undercounting redds: 1) conduct a zero count that thoroughly attempts to identify these

areas of ambiguity, 2) census surveys should be no more than three weeks apart, 3) the survey schedule should span the entire potential spawning period (August 15 – November 1) until actual spawning timing in the upper Clackamas River basin is better understood. These changes would remove some of the ambiguity in identifying new redds and likely give the crew another chance at identifying new redds that were missed during the previous survey.

The sample frame for spawning surveys was expanded in 2015 to include the upper Clackamas River and more of its tributaries. We gained information about the adequacy and accessibility of spawning habitat for bull trout using stream temperatures recorded during surveys and georeferencing the location of potential passage barriers, respectively.

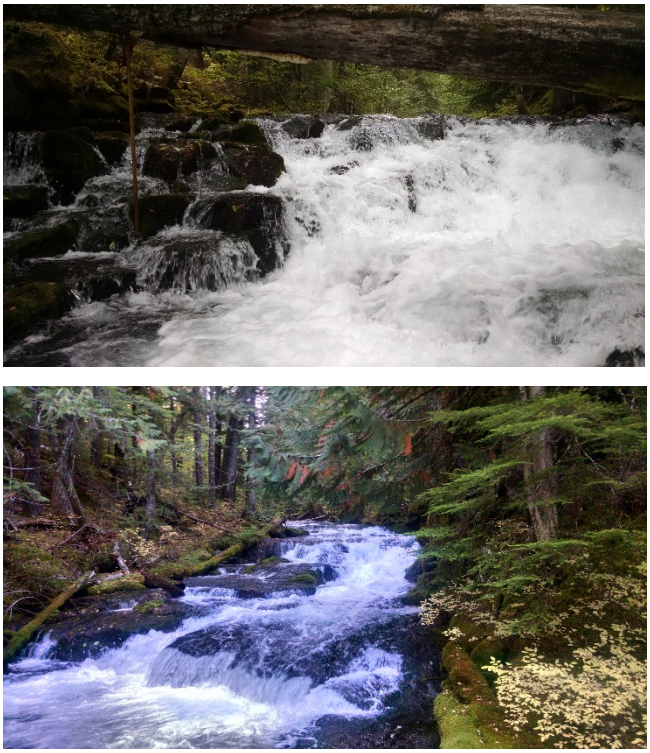

Figure 4. Potential barriers to upstream fish passage in the upper Clackamas River (Reach 5).

Bull trout are thought to begin spawning as stream temperature drop below 9 C (see Pratt 1992). We can use this temperature threshold to assess when there would be potential for bull trout spawning in individual reaches of the sample frame (Figure 3). Reaches that were below 9 C throughout the bull trout spawning season (i.e. August 15 – November 1) were Pinhead Creek, Last Creek, Reaches 1, 4, and 5 of the Clackamas River, and a small unnamed tributary of Cub Creek. Reaches that were below 9 C by October 1 were Reaches 2 and 3 of the Clackamas River, lower Cub Creek, Hunter Creek, Lowe Creek, and Rhododendron Creek. Sections that bordered this temperature threshold were Berry Creek, Oak Grove Fork, and upper Cub Creek. The Collawash River and Hot Springs Fork may not provide thermally suitable habitat during the typical bull trout spawning season. These temperature data represent only a snapshot of the thermal conditions in this sample frame and suggest that a better thermal picture may be useful for making monitoring decisions such as where and when to conduct bull trout spawning surveys. This could be done by deploying temperature loggers from June through October in several locations in the upper Clackamas River and its major tributaries.

Two potential barriers to upstream fish passage have been identified, both in the upper Clackamas River (Figures 1 and 4). These potential barriers are comprised of a 2-2.5 m bedrock step with no jump pools and no distinct thalweg. High velocity, turbulent flow hits the angled surfaces of several basalt columns within the step and deflects flow at various angles. When seen in person, it is difficult to understand how adult fish would get upstream of these steps. Water samples have been taken upstream of these site and will be analyzed for bull trout eDNA. Two surveys upstream of these sites, Reach 5 of the Clackamas River, were conducted and no redds

were observed. Further evaluation of these steps as fish passage barriers is warranted because substantial high-quality bull trout habitat exists upstream of these steps.

Acknowledgements

We thank Tony Cardello, Matt Colvin, John Cox, and Dirk Patterson (ODFW) for conducting surveys; Alex Neerman, Sharon Tippery, Eric Brown, and Ryan Jacobsen (ODFW) for assistance with coordinating field crews and accommodating survey schedules; Brian Cannon and Sara Akins (ODFW) for spawning data from their October 22 survey of the Clackamas River; Jack Williamson (USFS) for providing past field data and assistance in the field; Chris Allen (USFWS) for editorial and field assistance; and Patrick Barry (USFS) for advice on survey protocol, sample frame, and past work in the upper Clackamas River basin.

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Appendix I. All bull trout redds observed in the upper Clackamas River basin in 2015.

Stream	Reach	Date	Feature_ID	Utm_east	Utm_north	Feature_note	Temp.C
Clackamas River	2	9/29/2015	1B	587396	4979952	not far downstream (~12 m from potential redd "A2", marked by DP, very likely a BT redd	6
Clackamas River	2	9/1/2015	A2	587374	4979981	bt redd, or chk test dig	8
Clackamas River	2	9/1/2015	A1	587690	4980423	Potential bull trout redd, test dig 1.5 m us, both look like bt redds, in areas where bt would spawn; however, possible confounding with chk test digs	8
Clackamas River	2	9/29/2015	2B	588000	4981225	pretty small substrate, very likely bull trout redd	6
Clackamas River	2	9/29/2015	B1	587515	4982998	bull trout redd	7
Clackamas River	3	10/22/2015	C1	586982	4975922	small gravels, smaller than a CHK redd, not a CHK location (lower flow velocity)	NA
Clackamas River	3	10/22/2015	C2	587000	4976448	small gravels, smaller than a CHK redd, not a CHK location (lower flow velocity)	NA
Clackamas River	4	9/24/2015	B1	588585	4971188	Bull trout redd	7
Clackamas River	4	9/24/2015	B2	588585	4971188	Possible 2nd redd, maybe test dig, small	7
Clackamas River	1b	9/8/2015	A1	586759	4983759	bull trout redd in side channel	7
Last Creek	1	11/4/2015	C1	588571	4980301	Small, well-defined redd	NA
Oak Grove Fork	1	10/7/2015	B1	575057	4991858	left, adj to boulder margin, not obvious redd, gravel suitable for BT, not ChK	9.5
Pinhead Creek	1	10/14/2015	B2jc	588541	4980184		6.9
Pinhead Creek	1	10/14/2015	B3ca	588413	4980712		6.9
Pinhead Creek	1	10/14/2015	B1jc	588527	4980811		6.9
Pinhead Creek	1	10/14/2015	B2ca	588631	4981079		6.9
Pinhead Creek	1	10/14/2015	B1ca	588648	4981228		6.9
Stream	Reach	Date	Feature_ID	Utm_east	Utm_north	Feature_note	Temp.C

Pinhead Creek	1	10/14/2015	B2dp	588317	4981246		6.9
Pinhead Creek	1	10/14/2015	B1ss	588264	4981427	b1ss, b2ss on same gravel bar pool tailout, I m apart	6.9
Pinhead Creek	1	10/14/2015	B2ss	588624	4981427	b1ss, b2ss on same gravel bar pool tailout, I m apart	6.9
Pinhead Creek	1	10/14/2015	B1dp	588174	4981475	between mouth and 46 bridge	6.9
Pinhead Creek	1	10/14/2015	B1tc	NA	NA	150 m ds of "chk"sized redd, it was small, lost databook	6.9
Pinhead Creek	1	10/14/2015	B2tc	NA	NA	15 m us of "chk" sized redd	6.9
Pinhead Creek	1	10/14/2015	B3tc	NA	NA	50-100 m us "chk"	6.9
Pinhead Creek	1	10/14/2015	B4tc	NA	NA	100m us of pinch point	6.9
Pinhead Creek	2a	8/31/2015	A10	588854	4979040		8
Pinhead Creek	2a	8/31/2015	A9	588875	4979076		8
Pinhead Creek	2a	8/31/2015	A8	588881	4979080		8
Pinhead Creek	2a	8/31/2015	A7	588934	4979096	possible duplicate (unique coordinates)	8
Pinhead Creek	2a	10/14/2015	B18	588948	4979156		6.5
Pinhead Creek	2a	10/14/2015	B17	588915	4979203		6.5
Pinhead Creek	2a	10/14/2015	B16	588735	4979318		6.5
Pinhead Creek	2a	10/14/2015	B15	588740	4979356		6.5
Pinhead Creek	2a	10/14/2015	B14	588740	4979360		6.5
Pinhead Creek	2a	10/14/2015	B13	588739	4979362	small redd, test?	6.5
Pinhead Creek	2a	10/14/2015	B12	588703	4979411		6.5
Pinhead Creek	2a	10/14/2015	B11	588700	4979466		6.5
Pinhead Creek	2a	8/31/2015	P2A2	588695	4979468		8
Pinhead Creek	2a	8/31/2015	A5	588679	4979528	2 potential test digs nearby	8
Pinhead Creek	2a	10/14/2015	B10	588635	4979656		6.5
Pinhead Creek	2a	10/14/2015	B8	588585	4979940	redds are consecutive us/ds right at trib mouth	6.5
Pinhead Creek	2a	10/14/2015	B9	588585	4979940	redds are consecutive us/ds right at trib mouth	6.5
Pinhead Creek	2a	10/14/2015	B7	588589	4979953	same spot as potential redd flag 4a from 2014	6.5
Pinhead Creek	2a	10/14/2015	B6	588593	4979961		6.5
Pinhead Creek	2a	10/14/2015	B4	588590	4980023		6.5
Pinhead Creek	2a	10/14/2015	B5	588590	4980023		6.5
Pinhead Creek	2a	8/31/2015	A4	588576	4980074		8
Stream	Reach	Date	Feature_ID	Utm_east	Utm_north	Feature_note	Temp.C
Pinhead Creek	2a	10/14/2015	B3	588611	4980096		6.5

Pinhead Creek	2a	10/14/2015	B2	588612	4980136	potential? Small, likely test dig	6.5
Pinhead Creek	2a	10/14/2015	B1	588614	4980188	not positive, likely	6.5
Pinhead Creek	2a	8/31/2015	A3	588567	4980234		8
Pinhead Creek	2a	8/31/2015	A2	588572	4980243		8
Pinhead Creek	2b	9/1/2015	A11	589227	4977895	margin, under log	7
Pinhead Creek	2b	9/1/2015	A12	589229	4977965		7
Pinhead Creek	2b	9/1/2015	A13	589229	4978018	mid-channel	7
Pinhead Creek	2b	9/1/2015	A14	589232	4978065	under yew branches	7
Pinhead Creek	2b	9/1/2015	A15	589159	4978152	beautiful long redd	7
Pinhead Creek	2b	9/1/2015	A16	589131	4978333	nice redd, slightly old, needs gps location, flagged	7
Pinhead Creek	2b	10/14/2015	B1PIN2	589094	4978622	bright gravel, but mound a little flattened	6.5

Appendix B

Comprehensive Detection Histories for Bull Trout Detected at PGE Facilities During 2015

Telemetry Code	PIT Tag Code	Size at Tagging or Recapture (TL)	Date Released (*), Detected or Recaptured	Location Released (*), Detected, or Recaptured
26	**0000_0000000177419262**	**320 mm**	**6/20/2013***	**Clackamas R. (Lower 4650 Bridge)***
			7/15/2013 to 10/7/2013	Mobile Telem. Near 1 mi US of Collawash
			10/14/2013	Mobile Telem. Riverside Camp Ground
			10/29/2013	Mobiel Telem. Job Corp
			11/8/2013 to 11/9/2013	Fixed Telem. Oak Grove Powerhouse
			11/12/2013	Fixed Telem. Promontory Park
			12/15/2014	Fixed Telem. Promontory Park
			1/6/2015	PIT Detection – North Fork Old Sort Facility
			1/9/2015**	Fixed Telem. Promontory Park**
			1/15/2015**	Fixed Telem. Promontory Park**
			5/7/2015 to 5/10/2015	PIT Detection – North Fork Ladder Entrance
			5/11/2015	PIT Detection – North Fork Old Sort Facility
		~558 mm	5/12/2015	North Fork Adult Sorting Facility
			8/29/2015 to 8/31/2015	PIT Detection – Pinhead Cr. Array (mouth)
103	**0000_0000000177419577**	**633 mm**	**6/28/2012***	**Clackamas R. (4670 Side Channel)***
			6/30/2012	Fixed Telem. Near Pinhead Mouth
			7/16/2012	Mobile Telem. 1 mi DS of 4650 Bridge
			7/25/2012	Mobile Telem. 0.5 mi DS of Pinhead
			7/26/2012	Fixed Telem. Near Pinhead Mouth
			8/21/2012	Mobile Telem. 3 mi US of 4650 Bridge
			8/23/2012 to 9/10/2012	Fixed Telem. Near Pinhead Mouth
			8/23/2012 to 9/10/2012	PIT Detection – Pinhead Cr. Array (mouth)
			9/10/2012	Mobile Telem. 0.1 mi US in Pinhead
			9/11/2012	Mobile Telem. “Constructing Redd” 0.8 mi US in Pinhead Cr.
			9/15/2012	PIT Detection – Pinhead Cr. Array (mouth)
			9/13/2012 to 9/28/2012	Mobile Telem. in lower Pinhead Cr.
			9/25/2012 to 9/26/2012	PIT Detection – Pinhead Cr. Array (mouth)
			9/27/2012	Fixed Telem. Near Mouth of Pinhead Cr.
			10/1/2012	PIT Detection – Pinhead Cr. Array (mouth)
			10/1/2012	Mobile Telem. 0.3 mi DS of Pinhead
			10/8/2012	Mobile Telem. 0.1 mi US of 4650 Br.
			10/09/2012	Fixed Telem. Collawash Confluence
			10/10/2012	Fixed Telem. Promontory Park
			10/10/2012	Fixed Telem. Oak Grove Powerhouse
			10/11/2012	Fixed Telem. North Fork Dam
			10/11/2012	Fixed Telem. Promontory Park
			10/15/2012 to 11/2012	Mobile Telem. Near Lazy Bend Camp Gr.
			12/27/2012	Mobile Telem. Carter Br. Camp Gr.
			1/31/2013 to 3/3/2013	Fixed Telem. North Fork Dam
			7/23/2013 to 10/7/2013	Mobile Telem. Near Faraday Forebay
			10/14/2013 to 11/12/2013	Mobile Telem. Faraday Channel near bridge
			5/7/2015	PIT Detection – North Fork Old Sort Facility
		~650 mm	5/11/2015	North Fork Adult Sorting Facility
166	**0000_0000000177419566**	**368 mm**	**7/12/2012***	**Clackamas R. (4670 Side Channel)***
			7/14/2012	PIT Detection – Pinhead Cr. Array (mouth)
			8/2/2012 to 11/6/2012	Mobile Telem. 1-2 mi US of 4670
			11/13/2012	Mobile Telem. 1 mi US of 4680 rd.
			11/20/2012	Mobile Telem. US of Pinhead in Clack.
			2/8/2013	Mobile Telem. 2 mi US from Collawash
			3/7/2013	Mobile Telem. 1.2 mi DS Austin HS Gate
			5/14/2013	Mobile Telem. 1.5 mi US of Collawash

Telemetry Code	PIT Tag Code	Size at Tagging or Recapture (TL)	Date Released (*), Detected or Recaptured	Location Released (*), Detected, or Recaptured
			5/24/2013	Fixed Telem. Near Pinhead Mouth
			6/19/2013 to 6/21/2013	Fixed Telem. Near Pinhead Mouth
			7/15/2013 to 7/30/2013	Mobile Telem. Near 4670 Bridge
			8/11/2013	Fixed Telem. Collawash Confluence
			8/12/2013	Fixed Telem. Oak Grove Powerhouse
			8/12/2013	Mobile Telem. 1.5 mi DS of Oak Grove
			8/28/2012 to 8/29/2012	Fixed Telem. North Fork Dam
			9/9/2013	Mobile Telem. Lazy Bend Campground
			9/16/2013 to 11/12/2013	Mobile Telem. Big Eddy area
			7/12/2014	Timber Park D/S Sampling Facility
			7/17/2014	PIT Detection – River Mill Ladder
			7/27/2014	PIT Detection – River Mill Surface Collector
			8/1/2014	PIT Detection – River Mill Ladder
			5/9/2015	PIT Detection – North Fork Ladder Entrance
			5/13/2015 to 5/14/2015	PIT Detection – North Fork Old Sort Facility
			5/17/2015	PIT Detection – River Mill Surface Collector
			5/28/2015	PIT Detection – River Mill Ladder
			9/6/2015	PIT Detection – River Mill Surface Collector
			9/11/2015	PIT Detection – River Mill Ladder
NA	**0000_0000000177419485**	**157 mm**	**5/9/2013***	**Pinhead/Last Creek***
			5/13/2013	PIT Detection – Pinhead Cr. Array (mouth)
			5/23/2015	PIT Detection – North Fork Ladder Entrance
			5/25/2015	PIT Detection – North Fork Old Sort Facility
			5/26/2015	PIT Detection – North Fork Ladder Exit
			8/24/2015 to 8/25/2015	PIT Detection – Pinhead Cr. Array (mouth)
NA	**0000_0000000177419340**	**350 mm**	**6/13/2013***	**Clackamas R. (1 mile D/S of Austin H.S)***
			5/25/2015	Timber Park D/S Sampling Facility
			5/27/2015	PIT Detection – River Mill Ladder
			5/30/2015	PIT Detection – River Mill Surface Collector
			6/9/2015	PIT Detection – River Mill Surface Collector
NA	**0113_0379091166899210**	**108 mm**	**5/24/2012***	**Pinhead Creek***
			5/28/2015 to 5/31/2015	PIT Detection – North Fork Old Sort Facility
			6/2/2015	PIT Detection – North Fork Old Sort Facility
			6/7/2015	PIT Detection – North Fork Old Sort Facility
		~350 mm	6/8/2015	North Fork Adult Sorting Facility
			6/8/2015	PIT Detection – North Fork Ladder Exit
NA	**0000_0000000177419238**	**300 mm**	**6/27/2013***	**Clackamas R. (Lower 4650 Bridge)***
			9/22/2014 to 9/30/2014	PIT Detection – Pinhead Cr. Array (mouth)
			8/12/2015	Timber Park D/S Sampling Facility
NA	**982_000361679189**	**331 mm**	**6/5/2014***	**Clackamas R. (D/S of Lower 4650 Bridge)***
			9/12/2015	Timber Park D/S Sampling Facility
61	**0000_0000000177419331**	**364 mm**	**6/13/2013***	**Clackamas R. (1 mile D/S of Austin H.S)***
			6/20/2013 to 11/11/2013	Fixed Telem. Collawash Confluence
			11/12/2014	Mobile Telem. 0.5 d/s of Riverside C.G.
			7/14/2014 to 10/30/14	Fixed Telem. Collawash Confluence
			11/18/2014	Fixed Telem. Promontory Park**
			7/16/2015	PIT Detection – Pinhead Cr. Array (mouth)
			7/29/2015	PIT Detection – Pinhead Cr. Array (mouth)
			9/8/2015 to 9/19/2015	PIT Detection – Pinhead Cr. Array (mouth)
			10/4/2015	Timber Park D/S Sampling Facility

** Possibly erroneous detection (telemetry data not proofed).

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