Oregon Department of Fish and Wildlife and
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Clackamas River Bull Trout Reintroduction Project

FY 2013 Annual Report

Patrick M. Barry, J. Michael Hudson, Jack D. Williamson, Marci L. Koski, and Shaun P. Clements

Oregon Department of Fish and Wildlife
Native Fish Investigations Program

U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office

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

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Mount Hood National Forest

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 2013 ANNUAL REPORT

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Disclaimers

CLACKAMAS BULL TROUT REINTRODUCTION PROJECT
2013 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 a reintroduction began in 2011, with the goal of establishing a naturally reproducing population of between 300 – 500 spawning adults by the year 2030. In 2013, we continued efforts to reintroduce bull trout into the Clackamas basin by collecting and transferring 615 juveniles, 91 subadults, and 8 adults from the Metolius Basin. In addition, we conducted monitoring and evaluation of the reintroduction 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 Subbasin. To meet these objectives, we obtained redd count data for the donor population and monitored the behavior and survival of tagged fish in the Clackamas using fixed and mobile radio telemetry and fixed passive integrated transponder tag interrogation. Through the first three years of the project, 1) the donor population has remained healthy (>900 spawning adults); 2) transferred bull trout have dispersed throughout the Clackamas, all but one subadult and one adult have remained in the Clackamas and its tributaries, and some bull trout have exhibited spawning behavior in the first three years of the reintroduction; and 3) bull trout have generally not occupied areas of the Portland General Electric Clackamas River hydroelectric facility in which anadromous smolts may be vulnerable to predation. Implementation and monitoring of the reintroduction project will 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 1989), 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 one of the primary recovery goals in the U.S. Fish and Wildlife Service's (USFWS) Draft Recovery Plan (USFWS 2002a), 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 subbasins, 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) (draft recovery criterion 1 and recovery objective 1) and will increase abundance of adult bull trout in the Willamette River Recovery Unit (draft recovery criterion 2 and recovery objective 2; USFWS 2002b).

This report documents the progress in the third year (2013) 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).

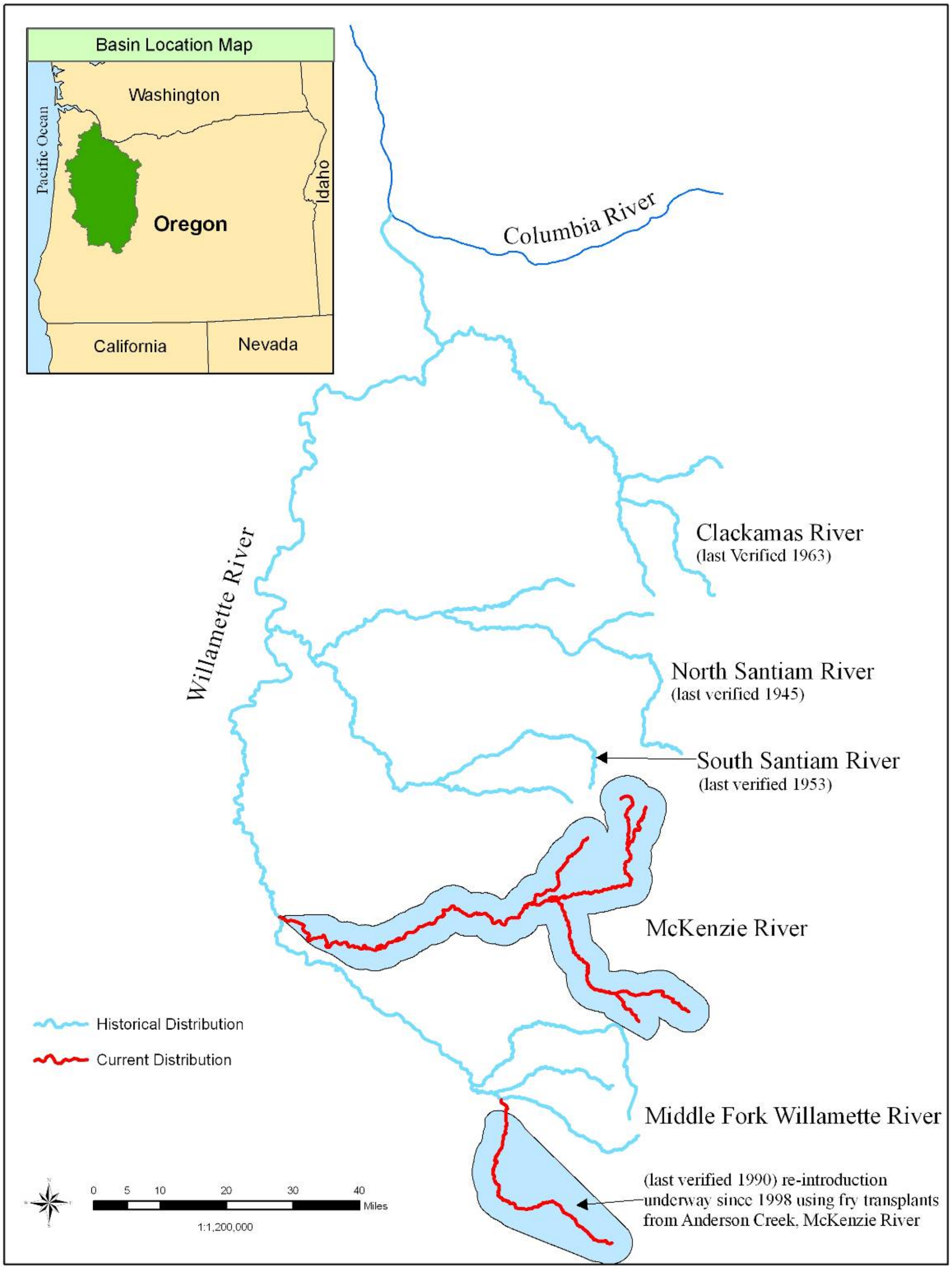

Figure 1. Historical and current bull trout distribution in the Willamette Basin.

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 criteria outlined in the Draft Bull Trout Recovery Plan (USFWS 2002b). 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 draft 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 Subbasin 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 Subbasin.

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).

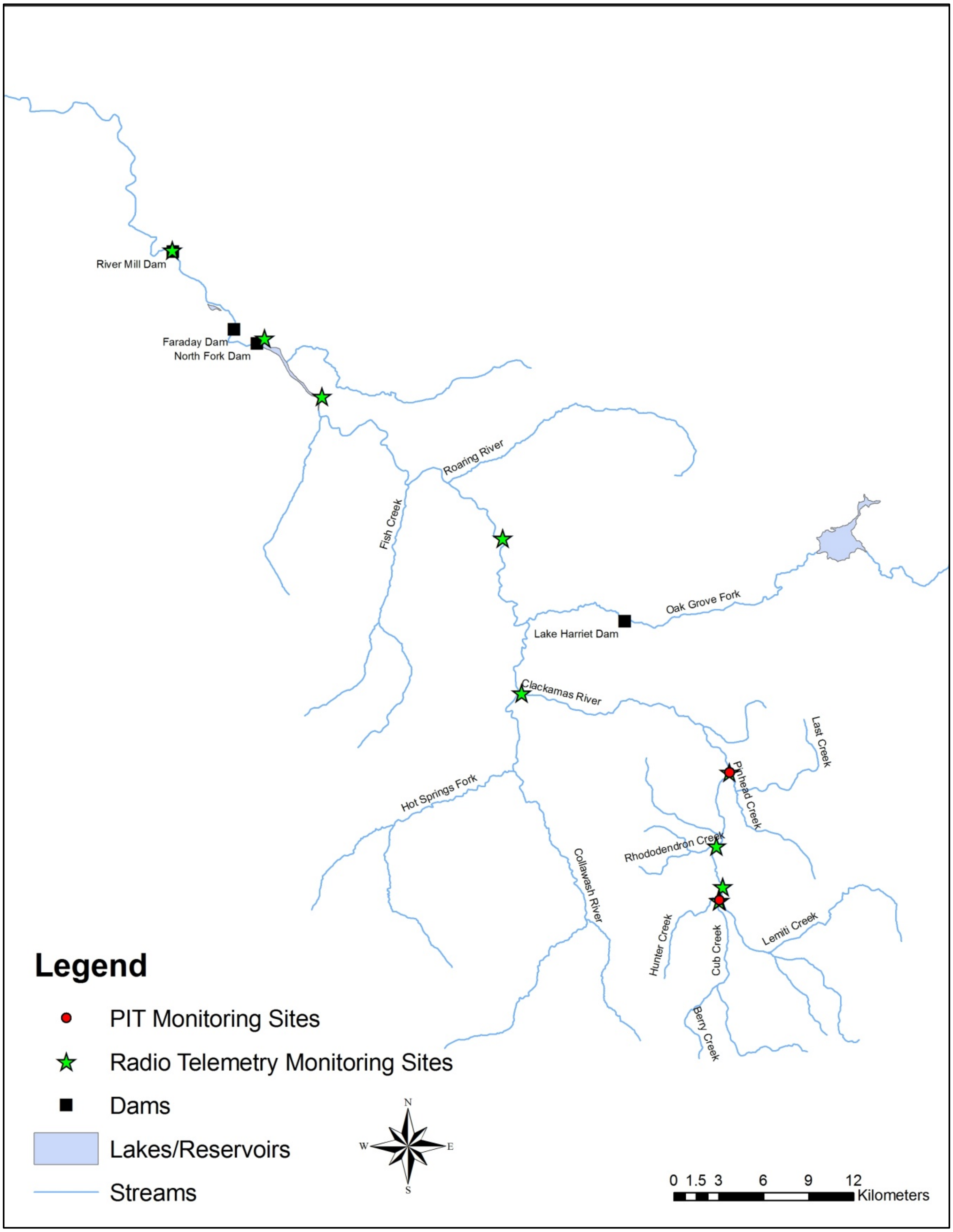

Figure 2. Study area, illustrating the location of fixed monitoring sites that were active in 2013. See Table 1 for site descriptions and operational dates of each station.

2.2) Implementation

2.2.1) Donor stock availability

Oregon Department of Fish & Wildlife conducted an annual redd count survey in October/November 2012 and 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 2002c, 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 2012), bull trout fry (n = 150) were collected by PGE at the Monty screw trap between March and April, 2013. In 2013, 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). Fish health staff screened for IHNV, IPNV, VHSV, OMV, ISAV, and *M. cerebralis*, as well as other treatable pathogens and parasites (Appendix 1).

2.2.3) Donor stock collection

<u>Juveniles</u> - Juvenile (70 – 250 mm TL) bull trout were collected between April 4 and June 26, 2013. The principal method of collection was with 1.5 m rotary screw traps in Jack (10T 0607241 4927765 – 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).

<u>Subadults and Adults</u> - Subadult (251 – 450 mm TL) and adult (451 – 650 mm TL) bull trout were captured using a variety of methods to maximize the likelihood of capturing both sufficient individuals and putative different life history forms. The principal method of collection was Oneida trap nets that were set and checked Monday, Tuesday, and Wednesday each week from June 3 – June 27 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 and at Monty Campground. Subadult bull trout were also collected from the selective water withdrawal tower (SWW) at Round Butte Dam (operated by PGE). 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 (9 – 10 °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 Tuesday or Wednesday during the collection period, the subadult and adult fish were tagged with a radio transmitter and PIT tag. Sixty subadult/adult fish were tagged with one of two sizes of radio tags (4.3 or 11 g (in air): Models NTC-6-2 or MCFT2-3FM, Lotek Wireless). Fish were anesthetized using Aqui-S 20E (20 – 25 ppm). Appropriately sized tags were inserted in the body cavity through a small incision just large enough to accommodate the tag. The wound was sutured shut with dissolvable sutures (4-0 Ethilon nylon suture- black monofilament) sufficient to close the incision (3 – 4 stitches). The 4.3 g tags were inserted into 320 – 419 mm individuals and 11 g tags were inserted into 332 – 642 mm bull trout.

All bull trout were PIT-tagged using a half-duplex (HDX) tag (ORFID, Portland, USA and Biomark, Boise, USA). Each fish was anesthetized as above (subadults and adults were PIT tagged at the time of radio tagging) and individuals ≥300 mm (fork 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 HDX PIT tag. All tags were sanitized in ethanol and betadine, then rinsed with distilled water prior to insertion. The 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 18 – 48 h before being transported to the Clackamas River.

2.2.3.b Transport

We transferred the fish 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. 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 approximately two to five h by highway to the release sites. Water temperature was monitored in transit with an Oakton Temp 5 thermistor thermometer. Frozen blocks of Lake Billy Chinook water were added to the transport tank periodically during transport to ensure that the temperature did not increase and to slowly acclimate fish to the temperature at the release location. The Clackamas 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 2 in Figure 3). Subadult and adult bull trout were released in the Big Bottom area (Figure 4). When releasing juveniles into habitat patches (i.e., Pinhead and Last creeks, Figure 3), fish were distributed widely (as opposed to releasing them in 1 – 2 locations). This was an attempt to minimize intra-specific predation and/or competition. In general, we backpacked juveniles into habitat patches, using approximately 10 L of oxygen supplemented water per backpack, with no more than 25 similarly-sized bull trout per pack (i.e., year class). After reaching a release site, the location of the site was recorded using a hand held global position system device and fish were acclimated to the ambient stream temperature by placing a bag in the stream until the temperature was within $\pm$1°C of ambient (generally <35 min). To maintain dissolved oxygen levels, the bag remained closed until fish were released.

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 (usually 2 – 10 s) 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.

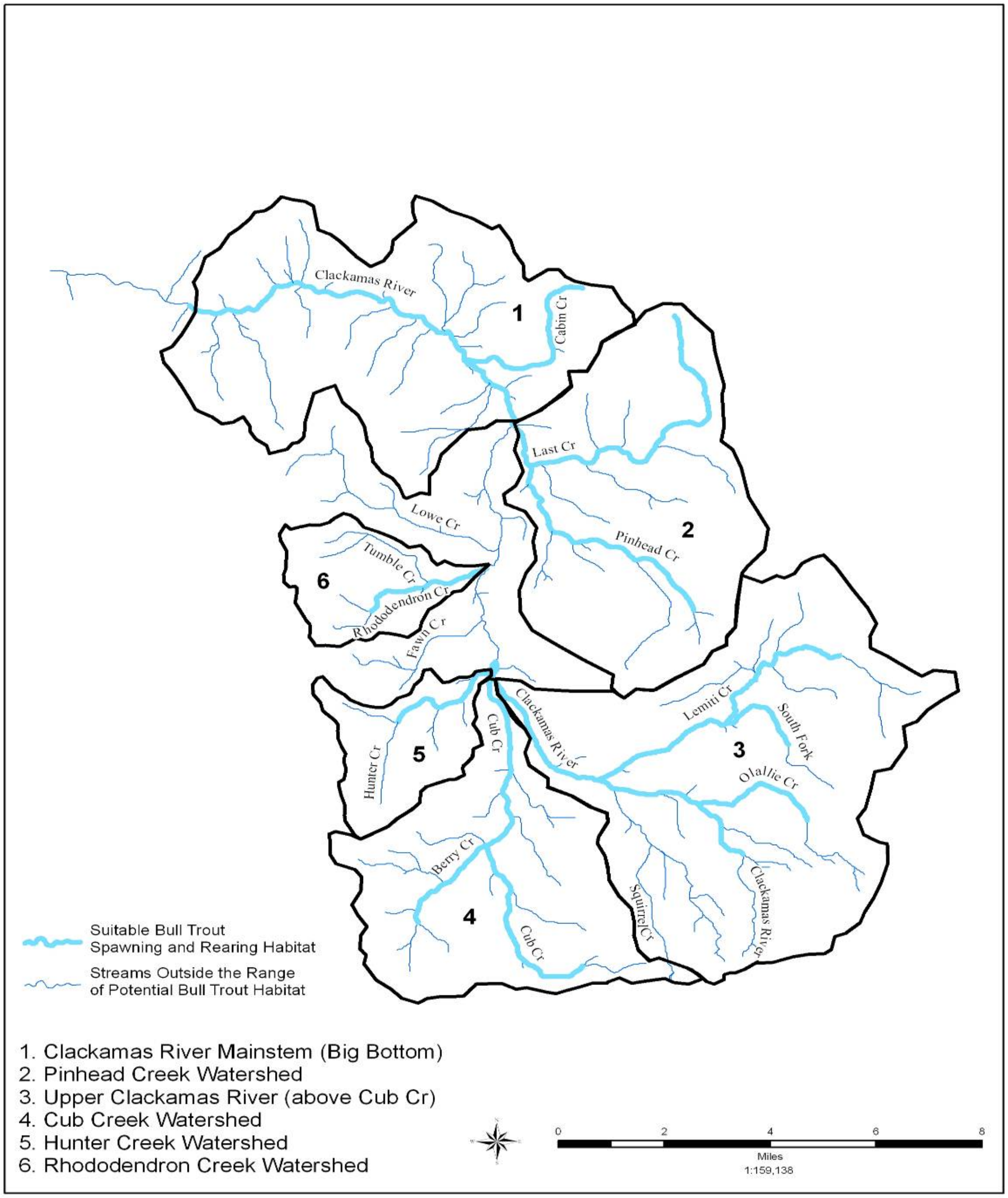

Figure 3. Suitable habitat patches for spawning and juvenile rearing based on Shively et al. 2007.

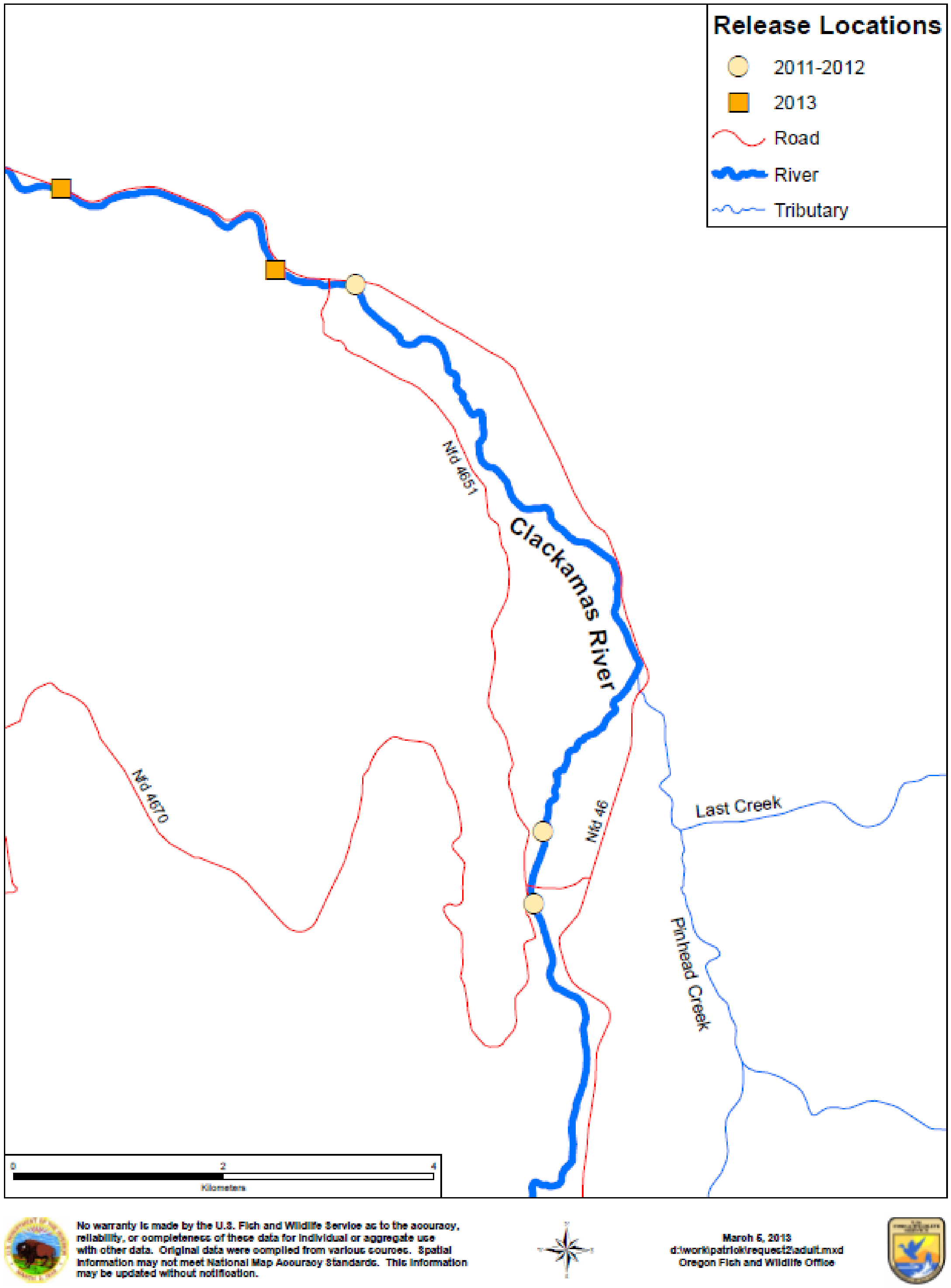

Figure 4. Release locations of subadult and adult bull trout in the upper Clackamas River within the Big Bottom reach. Circles and squares represent release locations used on one or more occasions of subadult and adult bull trout collected from the Metolius Basin (see Table 7).

2.3) Monitoring and Evaluation

2.3.1) Bull trout reintroduction effectiveness

We used a combination of fixed monitoring sites and mobile tracking to document the survival, behavior, and retention of juvenile, subadult, and adult fish 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? If no, does changing the release timing/location provide a different result?

2) Do juveniles remain in the habitat patches in which they are outplanted in the short-term or do they move relatively quickly out or into other habitat patches?

    2a) If they stay, how are juveniles distributed within tributaries?

Fixed radio telemetry and PIT tag monitoring sites were operated throughout the Clackamas River from the most downstream site, River Mill Dam, upriver to the Cub Creek confluence (Figure 2). Sites were chosen to adequately cover the expected distribution of subadult and adult bull trout in the Clackamas River (Table 1), and to determine whether there was spatial overlap between anadromous salmonids and radio-tagged bull trout in proximity to the hydro-system. Each fixed monitoring site was powered by AC power (Rivermill, North Fork, and Promontory Park sites), or DC power when AC power was unavailable. All sites were housed in waterproof environmental enclosures and logged data continuously. The DC powered sites consisted of two 12-V 104 Amp hour (Ah) batteries that had enough stored power to run for approximately 21 days in the absence of power generation. Battery banks were charged via hydroelectric generators and/or photo voltaic charging systems. Each site was visually checked at least once per week to minimize data loss or monitoring interruption. Each battery charge was also checked at that time using a hand-held voltmeter to ensure there was an adequate charge to run until the next weekly service check. During the expected peak outmigration of anadromous salmonids (e.g., October 15 – December 15 and April 15 – June 15) the fixed telemetry sites in the High Vulnerability Zones (HVZs) were checked and downloaded once weekly to determine whether bull trout were overlapping in space with smolts migrating from the upper Clackamas River, as required by the Stepwise Impact Reduction Plan (SIRP, NMFS 2011; USFWS and ODFW 2011).

Table 1. Site names, brief rational of site inclusion, operational dates, and distribution of fixed telemetry sites in the Clackamas River watershed.

Site name	**Site purpose**	**Operational dates**	**Clackamas River kilometer**
River Mill Dam	River emigration/anadromous predation prevention	June 30, 2011 – Present	37
North Fork Dam	Anadromous predation prevention	June 30, 2011 – Present	48
Promontory Park	Reservoir occupancy	June 30, 2011 – Present	51
Oak Grove Powerhouse	Downstream/upstream occupancy	June 30, 2011 – Present	77
Collawash/Clackamas river confluence	Downstream/upstream occupancy	June 30, 2011 – Present	92
Pinhead Creek	Downstream/upstream occupancy, spawning indication	June 30, 2011 – Present	109
Cub/Berry creek confluence	Downstream/upstream occupancy, spawning indication	August 25, 2011 – October 19, 2011	125[1]
Rhododendron Creek	Downstream/upstream occupancy, spawning indication	August 15, 2013 – November 16, 2013	115
Hunter Creek	Downstream/upstream occupancy, spawning indication	August 8, 2013 – November 14, 2013	118
Cub Creek	Downstream/upstream occupancy, spawning indication	August 4, 2013 – November 19, 2013	119
Upper Clackamas River	Downstream/upstream occupancy, spawning indication	August 4, 2013 – November 19, 2013	119

[1]This is a calculated linear measurement for descriptive purposes from the confluence of the Clackamas and Willamette rivers (see Figure 2).

Half-duplex PIT tag monitoring sites were operated at three locations in 2013: the mouth of Pinhead Creek, Pinhead Bridge, and the confluence of Cub Creek with the upper Clackamas River (Figure 2). The sites consisted of two 12-V 100 Amp hour (Ah) batteries that had enough stored power to run for approximately 4 – 5 days in the absence of power generation. Battery banks were charged via photo voltaic charging systems. Each site was visually checked at least once per month to prevent data loss or monitoring interruption. During most of these visual checks, antenna detection efficiency was optimized for 12 mm and 23 mm PIT tags. Test tags of each size were passed through the antennas at multiple sites and the antennas were re-tuned to maximize the detection ability of each antenna. Each battery charge was also checked at that time using a hand-held voltmeter to ensure there was an adequate charge to run until the next service check.

The Pinhead PIT tag monitoring site was moved due to electromagnetic noise issues upstream from the previous location on the main channel and side channel that independently flow into the Clackamas River (Figure 2). The new site was located just above the FR 46 bridge over Pinhead Creek and consisted of two antennas in series that could be used to determine directionality of detected tags. This site was operational beginning April 8, 2013, prior to any juveniles being released in Pinhead Creek that year (Table 2). The site configuration also enabled efficiency estimation, assuming fish released above and detected at the antennas were moving downstream, and as long as both antennas remained functional. While there were periods of time that only one antenna was operational (Table 3), the array was functioning and continuously collecting data through July 3, 2013. During the Independence Day weekend, the site was lost due to vandalism. The Pinhead PIT tag monitoring site was moved back downstream to its previous location with two antennas on the mainstem of Pinhead Creek and two antennas on the side channel of Pinhead Creek (Figure 2). When this site was moved back downstream, this site was operated by a single MUX to reduce the electromagnetic noise issues previously encountered at this site when the antennas were operated with two MUXs. Only one antenna on each of the channels was operational for most of August (Table 2). At the end of August, all four antennas were operating through November 26 (Table 2) at unknown efficiencies. In addition, there were four occasions when the array was not functioning due to insufficient power (Table 3).

Table 2. 2013 Pinhead PIT tag monitoring site configurations and associated dates. Pinhead arrays both bridge and mouth sites had two antennae per channel designated either D/S for downstream or U/S for upstream, while Cub and Upper Clackamas sites had one antenna per channel.

Antenna Site	Dates of operation	Antenna	Location
Pinhead Bridge	April 8 – July 3	A1	D/S antenna above FR 46 bridge
		A2	U/S antenna above FR 46 bridge
Pinhead Mouth	August 5 – 26	A1	Single antenna on Pinhead mainstem at mouth
		A2	Single antenna on Pinhead side channel at mouth
	August 26 – November 26	A1	D/S antenna on Pinhead mainstem at mouth
		A2	U/S antenna on Pinhead mainstem at mouth
		A3	D/S antenna on Pinhead side channel at mouth
		A4	U/S antenna on Pinhead side channel at mouth
Cub Creek/Upper Clackamas River Confluence	August 7 – November 26	A1	Single antenna on upper Clackamas River at the confluence with Cub Creek
		A2	Single antenna on Cub Creek at the confluence with the upper Clackamas River

Table 3. 2013 Pinhead PIT tag monitoring site array functional status (reason for failure). Pinhead sites had one or two antennae per channel throughout the year; see Table 2. Cub Creek/Upper Clackamas River Confluence had one antenna per channel; see Table 2.

Site	**Dates**	**Status**
Pinhead Bridge	April 8 – 9	Completely functional
	April 9 – 23	**A2 not functional** (disconnected antenna)
	April 23 – May 26	Completely functional
	May 26 – 30	**A1 not functional** (disconnected antenna)
	May 30 – June 19	Completely functional
	June 19 – July 3	**A1 not functional** (disconnected antenna)
	July 3 – present	**Array not functional** (vandalism incident)
Pinhead Mouth	August 5 – 26	Single antenna functional on each channel
	August 26 – October 21	Completely functional
	October 21 – 23	**Array not functional** (insufficient power)
	October 23 – 29	Completely functional
	October 29 –30	**Array not functional** (insufficient power)
	October 30 – November 11	Completely functional
	November 11 – 12	**Array not functional** (insufficient power)
	November 12 – 26	Completely functional
Cub Creek/Upper Clackamas River Confluence	August 7 – November 26	Array functional with unknown antenna efficiencies. A2 was lost during storm event first weekend of October and not reconnected until first week of November.

An additional PIT tag monitoring site was installed in 2013 at the confluence of Cub Creek to the upper Clackamas River on August 7. This array included one antenna spanning Cub Creek and one antenna spanning the upper Clackamas River (Table 2). The efficiency of these antennas was not determined because there was only one antenna per channel, but dates of operation for the array were documented (Table 3).

PIT antenna efficiency was estimated for the Pinhead bridge site using detections of free-swimming fish during times when both antennas were operating simultaneously. Efficiency was estimated using a modified approach of Zydlewski et al. (2006), which was a function of tags detected at one antenna v. the other antenna v. both antennas:

$$E_{\text{in situ Antenna 1}} = (d_{\text{common to Antenna 1 + 2}}) \times (d_{\text{unique to Antenna 2}} + d_{\text{common to Antenna 1 + 2}})^{-1}$$

$$E_{\text{in situ Antenna 2}} = (d_{\text{common to Antenna 1 + 2}}) \times (d_{\text{unique to Antenna 1}} + d_{\text{common to Antenna 1 + 2}})^{-1}$$

$$E_{\text{Combined}} = 1 - [(1 - E_{\text{in situ Antenna 1}}) \times (1 - E_{\text{in situ Antenna 2}})],$$

where "d" is the number of tags detected. These calculations have two critical assumptions: 1) The probability of a tagged fish being detected by the first antenna is independent of the probability of it being detected by the second antenna; and 2) The tagged fish moving through the first array continues to move in the direction of the next array. For times when both antennas were operational, we do not violate these assumptions. Although the antennas are connected to a single MUX, the probability of detection for each antenna is independent of the other. For times when only one antenna was functioning, the efficiency was estimated for that specific antenna from when both antennae were operational. In both cases, only fish detected one time at the site were used in the calculation and were assumed to be moving downstream. Confidence intervals (95% CI) were determined for the estimate (Crow 1956, Rohlf and Sokal 1969).

Detection efficiency was estimated for each tag size (i.e., 12 and 23 mm) based on the pattern of detection of juveniles released above the antennas in spring 2013. The relatively small number of fish, unknown fish movement behavior (i.e., assumption of directed movement upstream/downstream v. "hanging out" around an antenna), and lack of antennae in series at times (e.g., only one antenna in each channel at Cub Creek / Upper Clackamas River site for the year, and in most of August for the Pinhead Mouth site) prevented estimates of antenna efficiency for sites and times other than when the Pinhead Bridge site was operational.

2.3.1a Adult life stage retention

Determination of whether subadult and adult fish remained in the study area was based on the detection of radio tagged individuals below River Mill Dam either at fixed sites (Rkm 37; Table 1) or by mobile detection of fish below River Mill Dam. Fish that passed below River Mill Dam but were later detected re-entering the study area were classified as having remained in the study area for the purposes of the reintroduction.

We estimated the survival of each radio tagged release cohort of subadults and adults combined to the beginning of the putative spawning season. Survival was estimated by dividing the number of presumed alive radio tagged individuals by the number of released radio tagged individuals detected within a temporal interval (Pollock et al. 1989). A number of factors that may affect survival have changed among years, including handling procedures, surgical techniques, and radio tag type. Thus, we are unable to attribute differences in mortality among years to a specific factor. In fact, attempts have been made each year to improve survival among cohorts by reducing individual fish handling, sedating fish in transport, and releasing cohorts away from areas where natural predation has been observed in previous years. These data are included in this report because the authors feel that it is pertinent for the purposes of modifying our methods in subsequent years of the project in an attempt to reduce undesirable fates and to provide some estimation of the number of subadults and adults likely still alive in the system.

For these reasons, survival should be considered minimum survival estimation. Apparent sources of mortality were categorized by most probable cause. Categories include 1) predation, as inferred by recovery of a tag that had been chewed or found in close proximity to several other tags in similar condition, 2) angling, including tags that have been reported found by anglers and tags that have disappeared from areas with observed fishing pressure, 3) handling related, which include mortalities observed within three weeks of release, surmised by the date of mortality, geographic location of the mortality/disappearance, and the circumstances surrounding recovery of the tag for each individual 4) post spawn, which include mortalities observed within one month after the putative spawning period, 5) hydroelectric spill, which include individuals spilled over North Fork Dam, 6) volitional emigration, which include individuals that have left the study area by swimming through the PGE bypass pipe that provides downstream passage below the hydroelectric project (although not a direct source of mortality, exposes the individual to a popular anadromous fishery that substantially increases angling capture likelihood and removal and/or mortality), and 7) unknown, which includes mortalities that do not clearly fit into any other category, i.e., over-winter/spring mortality.

Subadult and adult bull trout within the study area were classified as live or dead based on detections of radio tagged fish and interrogations by fixed PIT arrays. An individual was classified as dead when: 1) we recovered a tag 2) we collected repeated observations of a tag in one location (typically over the course of several weeks), or 3) a tag was not detected for more than a month and the entire study area had been surveyed (typically via aerial telemetry in fixed wing aircraft). The classification was changed if a subsequent PIT interrogation suggested that an individual had successfully shed the radio tag and survived to cross a PIT array. The time of mortality for the first two scenarios was estimated based on the first time the individual ceased moving. In the latter scenario, the fish was assumed to have been removed by an angler and was considered dead at the date of the last detection.

2.3.1b Subadult/adult seasonal distribution

We monitored the seasonal distribution of radio-tagged fish using the fixed sites (Table 1; see above) and by mobile tracking from a truck, plane, and on foot. A location census of radio-tagged individuals was conducted at least once weekly during the putative spawning season (late August – October). This census was typically made by driving from the downstream most point in the study area (North Fork Reservoir), to the upstream most point in the study area (upper Cub Creek and upper Clackamas River) in an attempt to locate each radio-tagged individual. If an individual/s was not located during this census survey, the remainder of the week's effort was focused on locating the missing individual/s. Each tributary believed capable of accommodating bull trout at any life stage (70 – 650 mm bull trout) was searched because if an area was not searched, we could not confirm fish presence or absence for that region. These tributaries include, but were not limited to: Oak Grove Fork of the Clackamas River, Collawash River, Roaring River, Fish, Cabin, Pinhead, Last, Lemiti, Olallie, Squirrel, Cub, Berry, Hunter, Fawn, Rhododendron, Lowe, and Kansas creeks. Due to concerns of anadromous predation and interest in reintroduction success (Monitoring Objectives 2 & 3; USFWS and ODFW 2011), missing fish were located as soon as possible when staff were available, particularly during the period of anadromous smolt congregation/emigration (i.e., April 15 – June 15 and October 15 – December 15) and suspected bull trout spawning migration (August – October).

Tracking of individual bull trout was prioritized based on the project goals. The highest priority was to detect fish in the HVZ. The next priority was to obtain relatively precise (accurate enough to observe paired bull trout) locations of fish in tributaries during the spawning season. Throughout the putative spawning season (August – October), priority was given to precisely locating individuals that were utilizing tributaries and Clackamas headwater reaches. These individual locations were given a higher priority than precisely locating individuals in downstream reaches, or individuals that were suspected mortalities downstream of Big Bottom (Figure 3). Other criteria that designated individuals' higher priority than others included (based on observations obtained during weekly location censuses): directional movement toward or occupancy of HVZs, long upstream migrations, close proximity to suspected spawning tributaries, and suspected staging behavior (occupancy of the same location for several censuses).

Additional information on subadult/adult seasonal distribution was collected using the PIT arrays at Pinhead Creek (mouth and bridge sites) and the Cub Creek/Upper Clackamas River monitoring sites. These arrays provided information on subadult/adult activity in these tributaries through the year (Table 3), but especially during the late summer/early fall when these fish were exhibiting spawning behavior. In addition, information was gained on recruitment of juveniles into the adult population. The value of these data will increase over time as the project moves away from radio telemetry, additional fish are translocated, juveniles are recruited into the adult population, and bull trout that are naturally produced in the Clackamas River basin are PIT tagged. Detections are reported to include translocation year, size of fish when translocated, and dates of activity in the respective tributaries.

2.3.2) Juvenile life stage retention and seasonal distribution

The number of juvenile bull trout that emigrated past the Pinhead bridge monitoring site after translocation in spring 2013 was estimated using the formula: sum(number of fish detected moving downstream at the Pinhead bridge array × the estimated efficiency of the array)$_p$, where p is a discrete time period between April and the beginning of July. Because efficiency estimates for the Pinhead Mouth monitoring site were not calculated after July 3, the total estimated number of emigrants from Pinhead Creek for the year was adjusted by adding only those fish actually detected at the Pinhead PIT monitoring site after July 4 to those estimated to have migrated prior to July 4.

We monitored patch-level occupancy of juvenile bull trout in the Pinhead Creek patch using the approach identified in the bull trout reintroduction IM&E plan (USFWS and ODFW 2011). This approach used the protocol that has been developed (USFWS 2008) and implemented (USFS 2009) for monitoring the recovery of bull trout. In the case of the Clackamas reintroduction this protocol was useful, in part, due to limited resources for monitoring distribution and occupancy and because sample effort can reflect acceptable levels of confidence. Alternative, relatively labor intensive approaches (including the American Fisheries Society, Western Division's bull trout sampling protocol) may be necessary to achieve maximum statistical rigor. Briefly, in 2013 the sample design consisted of surveying randomly selected, spatially-balanced 50 m reaches. Reaches were sampled from bottom to top by electrofishing using a Smith-Root LR-24. Voltage, frequency, and duty cycle were dependent on water temperature and conductivity. Field sampling in the Pinhead/Last creeks patch occurred August 12 – 21, 2013. Sampling occurred in 20 reaches (Figure 7). Fifteen of these reaches were sampled in previous years. Since several reaches that were sampled in the past were dry during the sampling period, five additional reaches were added to increase the total number of reaches being sampled in watered habitat because several reaches that were sampled in the past were eliminated because they were dry during the sampling period.

2.3.3) Reproduction

Foot surveys were conducted in tributaries in which bull trout were suspected of spawning based on observations of radio-tagged fish. Prior to the putative spawning season, a zero count pass was conducted on Pinhead Creek to mark anything that was suspected of being a bull trout redd on subsequent surveys. During the suspected peak (based on observations of Clackamas spawning bull trout in 2011 and 2012) of spawning and after the suspected conclusion of spawning, the upper Clackamas River upstream of the Cub Creek confluence, and Pinhead Creek and its' tributaries were surveyed for the presence of redds by single pass counts on September 18 and October 7, respectively by crews of two to four individuals per reach or stream looking for redds, live bull trout spawning, or bull trout carcasses. Oak Grove Fork was also surveyed by a single pass count on October 24. Bull trout redds were identified by: 1) observed presence of bull trout via radio telemetry and/or visual observation or 2) by size. Surveys were conducted after bull trout had likely concluded spawning for the year but while coho and Chinook salmon were still spawning. Due to the temporal and spatial overlap among bull trout and salmon redds, we used redd size to help differentiate bull trout and salmon redds. Redds that ranged in size from 0.3 – 0.7 m in length measured from the upstream margin of the excavated pit to the downstream end of the depositional mound were considered bull trout redds whereas redds 1 – 2 m in length or larger were considered coho or Chinook salmon redds.

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

The total time each subadult and adult bull trout spent in HVZ areas was monitored using fixed and mobile telemetry, as described above.

3) Results

3.1) Implementation

3.1.1) Donor stock availability

A total of 544 redds were documented in redd surveys conducted in the Metolius subbasin in 2012 (Harrington and Wise 2012). 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 1,251 in 2012 (Figure 5). Annual redd surveys in the Metolius sub basin in 2013 documented the presence of 410 redds (B. Hodgson, ODFW pers. Comm.), yielding a population estimate of 943 spawning adults, again satisfying the criteria (>800 spawning adults) to continue transfers to the Clackamas in 2014.

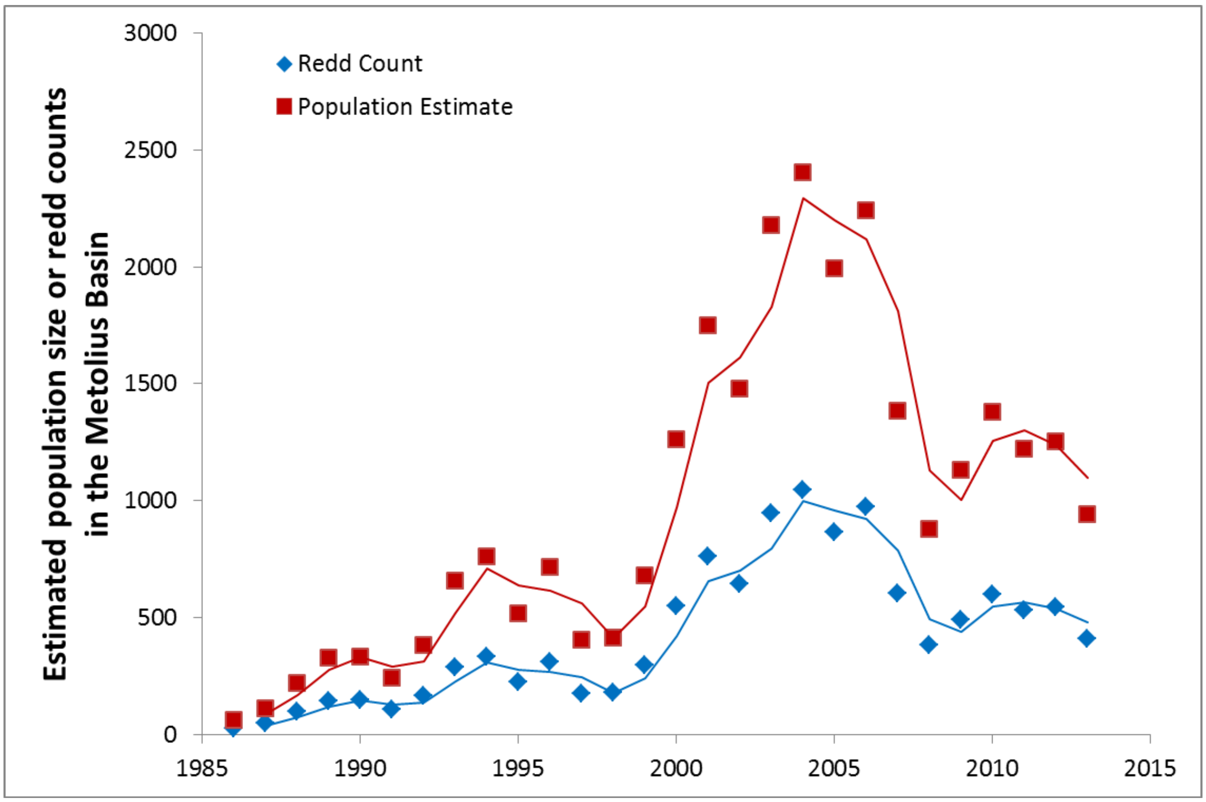

Figure 5. Raw redd counts and population estimates through 2013 for the Metolius bull trout population. Population estimates were calculated by multiplying redd counts by 2.3 (Dunham et al. 2001).

3.1.2) Pathogen screening

All samples screened in 2013 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 113 subadult and adult bull trout (251 – 650 mm TL) were captured for translocation (3 via angling, 1 in the selective water withdrawal tower, 109 via trap net) (Table 4). Of these, 14 were not used for various reasons (e.g., previously PIT tagged by another research project, scars from apparent raptor interaction, hook injury, deformed jaw, missing fins, blind in both eyes, opercle deformity, scale loss, >650 mm, etc.). We translocated 91 subadult and 8 adult bull trout to the Clackamas River (Table 5) and radio tagged all adults and 52 subadults.

We translocated 615 PIT tagged juveniles (70 – 250 mm TL) to the Clackamas. In addition, 10 juveniles died during collection efforts on April 24, May 22, and May 29 (all prior to transport) that were not included in the total (Table 6). One suspected hybrid bull × brook trout was captured during juvenile trapping efforts and euthanized. To date, more than 1,400 bull trout have been translocated from the Metolius to the Clackamas River (Table 5).

Table 4. Origin of subadult and adult bull trout collected in the Metolius River system for transport to the Clackamas River. Fish were either collected from the Portland General Electric operated surface water withdrawal tower (SWW) at Round Butte Dam, by angling for fish (The Confederated Tribes of Warm Springs Reservation) in the lower Metolius River, or from Oneida trap nets set in the upper Metolius arm of Lake Billy Chinook.

Capture dates (2013)	SWW	Angling	Trap Nets
June 3 – 7	0	0	43
June 10 – 14	0	0	42
June 17 – 19	1	0	13
June 24 – 26	0	3	11

Table 5. Count by year and life stage of bull trout captured in the Metolius River Basin and translocated to the Clackamas River Basin.

Life stage	Count Translocated			
	2011	2012	2013	Total
Juvenile	58	509	615	1,182
Subadult	24	43	91	158
Adult	36	17	8	61

Table 6. Dates, quantity released, capture source in the Metolius drainage, and release location of juvenile bull trout in the Clackamas drainage in 2013. Juveniles were captured in 1.5 m rotary traps deployed near the mouth of Jack, Canyon, and Candle creeks (Metolius River tributaries) or in Oneida trap nets in the Metolius arm of Lake Billy Chinook.

Release Date	**Juvenile count by collection location (Jack Cr/Canyon Cr/Candle Cr)**	**Count transferred**	**Release location**
April 11	12/6/12	30	Last Cr
April 25	44/29/13	86	Last Cr
May 2	45/12/26	83	Pinhead Cr
May 9	31/7/16	54	Pinhead Cr
May 16	30/9/35	74	Pinhead Cr
May 23	88/5/42	135	Last Cr
May 30	52/3/13	68	Pinhead Cr
June 6	6 Lake Billy Chinook	6	Last Cr
June 13	32 Lake Billy Chinook	32	Last Cr
June 20	44 Lake Billy Chinook	44	Last Cr
June 27	3 Lake Billy Chinook	3	Last Cr
Source Totals:	Jack Creek	302	
	Canyon Creek	71	
	Candle Creek	157	
	Lake Billy Chinook	85	
	Total translocated to Clackamas:	**615**	

3.1.4) Release locations and timing

There were eleven releases of juvenile and three releases of subadult and adult bull trout in 2013 (Tables 6 and 7; Figures 3 and 4). Juveniles were outplanted to more than 47 different reaches spread over 12 weeks. Subadults and adults were released at two different locations spread over three weeks (Figure 4).

Table 7. Date of release, quantity by capture method, total released, and release location of subadult and adult bull trout in 2013. All fish were collected in the Metolius arm of Lake Billy Chinook in Oneida trap nets, or by angling in the Metolius arm, or by angling at the US Forest Service Monty Campground. All fish were released in the Clackamas River in slow moving water 400 m downstream of the 4650 bridge, or approximately 1.6 km downstream of Austin Hot Springs in a low gradient reach along a US Forest Service constructed large woody debris structure (Figure 4).

Release Date	Subadult/adult count and collection method	Count transferred	Release Location
June 13	54 subadults trap net; 4 adult trap net	58[1]	400 m downstream of 4650 bridge; 1.6 km downstream of Austin Hot Springs
June 20	24 subadults trap net; 2 adult trap net	26	400 m downstream of 4650 bridge
June 27	10 subadults trap net; 2 adults trap net; 3 subadults angling	15	400 m downstream of 4650 bridge

[1] This was the cumulative catch of two weeks' trapping effort. Fish were not hauled the week previous due to transport tank malfunction.

3.2) Monitoring and Evaluation

3.2.1) Bull trout reintroduction effectiveness

3.2.1a Adult life stage retention:

Zero individuals from the 2011, 2012, or 2013 cohorts were detected leaving the study area in 2013. For the 2013 cohort, the estimated minimum survival of the radio tagged subadult/adult fish to the time of spawning in 2013 (August 5) was 98%. For the 2011 cohort, the estimated minimum survival of radio tagged subadult/adult fish to the time of spawning in 2013 (from the time of release in 2011) was 28% (Table 8).

Sources of probable mortality of radio tagged subadults and adults include (2011, 2012, & 2013 cohorts combined though December 15, 2013; n = 180); predation (16%), angling (6%), handling related (5%), post spawn (3%), hydroelectric spill (3%), volitional emigration (1%), and unknown (6%) (Table 8).

Table 8. Counts of radio tagged individuals released (n = 180), probable cause of mortalities by cohort, and number of individuals presumed alive at the beginning of each spawning period. Spawning period was assumed to begin August 5 each year based on detections of fish crossing PIT arrays in Pinhead Creek in 2011, 2012, and 2013. Fates were determined based on best judgment of PIT tag interrogation, ground and aerial mobile telemetry, and observations from fixed telemetry sites.

		Release cohort					
		2011		**2012**		**2013**	
		subadult	**adult**	**subadult**	**adult**	**subadult**	**adult**
Radio tagged individuals released		24	36	43	17	52	8
Most probable cause of mortality	Predation	2	10	14	2	1	0
	Angling	3	2	2	2	0	1
	Handling related	5	3	0	0	1	0
	Post spawn	1	4	0	0	0	1
	Hydroelectric spill	1	2	0	1	0	0
	Volitional emigration	1[3]	1[2]	0	0	0	0
	Unknown	5	5	1	0	0	0
Number presumed[1] alive at beginning of spawning period	2011	16[4]	24	-	-	-	-
	2012	10[5]	9	41[4]	16	-	-
	2013	8[5]	9	26	13	51[4]	8

[1]Individuals presumed alive by confirmation of upstream movement, varied telemetry signal intensity observed from a fixed location, or interrogation at PIT array and remain within the study area

[2]Volitional emigration led to presumed capture by angler and subsequent mortality

[3]Individual was censored from survival analyses until it either returns or is confirmed mortality

[4]All of these fish likely were not mature during the first year but may mature in subsequent years

[5]Transmitter battery expired for some of these individuals

3.2.1b Seasonal Distribution

Visual observation of distribution data suggests there was no difference in the distribution of the 2011, 2012, or 2013 radio tagged cohorts, so the data were pooled in subsequent analyses. In general, the surviving members of the 2011 and 2012 cohorts over-wintered (Jan – Feb 2013) in large pools between the upper reaches of Big Bottom downstream to North Fork Reservoir. Beginning in February 2013, bull trout that were residing downriver (below rkm 92, or downstream of the confluence of the Collawash and Clackamas rivers) began to move upriver toward Big Bottom, where the majority of radio tagged individuals (approximately 80%) remained throughout the summer. After the 2013 cohort was released in June, the majority (99%) of radio tagged individuals remained within 800 m of the release site for two weeks before dispersing from the release sites to habitat throughout Big Bottom and upstream beyond the FS 4670 bridge. In July 2013, six radio tagged bull trout (from 2011, 2012, and 2013 cohorts) began to stage 100 m downstream of Pinhead Creek's confluence with the Clackamas River, and one large bull trout was observed in Pinhead Creek on August 6. Through October 10, 2013, eight individual radio tagged subadult and adult bull trout occupied Pinhead. Individual radio tagged bull trout spent between 1 – 45 d of the putative spawning period in Pinhead Creek (median occupancy = 12.5 d). Occupancy during the spawning season was also observed in Cub (2 individuals, median = 2.5 d), Hunter (1 individual, 3 d), and Rhododendron creeks (4 individuals, median = 1.5 d), upper Clackamas River (5 individuals, median = 20 d), Oak Grove Fork (4 individuals, median = 1 d), and the Collawash River (2 individuals, median = 25.5 d) during the putative spawning period in 2013. Occupancy was suspected (based on mobile telemetry observation of individuals near the confluence with the Clackamas) in several other tributaries including Lowe, Kansas, and Fawn creeks. Bull trout that did not enter suspected spawning areas during the putative spawning season (August – October) remained largely dispersed throughout the Big Bottom reach. Spawning could occur in the Clackamas mainstem, but we have not evaluated that to date. This distribution persisted until late October. During November, bull trout were distributed in pools from the lower end of Big Bottom and down river to the confluence of the Collawash and Clackamas rivers. Throughout December there was little movement of any bull trout. One subadult bull trout occupied the North Fork Dam fore bay intermittently from December 2 through December 14, 2013. This individual was located near the floating log boom for more than three days, and several attempts were made to relocate that individual to habitat outside of the High Vulnerability Zone. Ultimately, surface ice on the reservoir prevented relocation during the month of December. No bull trout moved through the hydroelectric project in a downstream direction in 2013, leaving the study area. To date only two bull trout have left the study area through volitional emigration (in 2011).

PIT monitoring sites at Pinhead Creek and Cub Creek/Upper Clackamas River provided additional resolution on subadult/adult movements into these tributaries in 2013. Bull trout from all three translocation years were detected moving into at least one of these tributaries (Table 9). Of particular interest, we detected two fish that were released as juveniles in 2011 (170 – 212 mm TL at release). We assume these fish have reached sexual maturity. A total of 16 PIT tagged bull trout were detected in Pinhead Creek between July 2 and November 5. Six PIT tagged bull trout were detected in the upper Clackamas River above Cub Creek between August

10 and September 30. One of these latter fish was detected both in Pinhead Creek and the upper Clackamas River above the confluence with Cub Creek.

Table 9. Subadult/adult bull trout, including total length upon release (TL), interrogated at PIT monitoring sites in 2013.

Release year	**TL at release (mm)**	**Range of dates interrogated at site**	
		Pinhead	**Cub/Upper Clackamas**
2011	170	August 10 – September 6	
	212	July 2 – September 4	
	305	August 10 – October 17	
	370		August 10
	450		August 28 – September 30
	460	August 9 – September 1	
	470	August 29 – September 1	
	470		September 2
	550	September 1 – October 7	
2012	335	September 6 – September 17	
	345	August 21 – September 24	
	350	September 8-15	
	350	August 10 – September 24	
	376	November 5	
	381	September 7 – 18	
	555	August 29 – October 13	
	611	August 28 – September 20	
	645		August 28
2013	530		August 12
	600	August 16 – September 1	September 4
	610	August 28 – September 23	

3.2.2) Juvenile life stage retention and seasonal distribution

We detected 169 juveniles (27%) moving downstream past the Pinhead Bridge PIT monitoring site following translocation and prior to July 4. Adjusting this for the efficiency of the bridge array (Table 10), we estimate that 206 bull trout (33%; 95% CI = 176-236) may have left Pinhead Creek prior to July 4. In general, the fish detected leaving during this period appear to be larger than those not detected leaving, though it is unclear whether this is a function of tag size or body size (Figure 6). The time between release and detection at the PIT array prior to July 4 ranged from <1 d to 55 d (median = 5 d).

Table 10. Estimated detection efficiency of the up (A1) and downstream (A2) antennas at the Pinhead Bridge PIT array for fish tagged with 12 and 23 mm HDX PITs in spring 2013.

Tag Size	**A1**	**A2**	**Combined**
12 mm	50%	31%	67%
23 mm	69%	100%	100%

Another five juveniles were detected at the antennae prior to July 4, but were detected multiple times, suggesting behavior not indicative of directed emigration. An additional 15 individuals from the 2013 juvenile cohort were detected at this monitoring site after July 4. Therefore, an estimated 221 juvenile bull trout (36%) left Pinhead Creek after translocation in 2013.

Thirteen bull trout from the 2012 juvenile cohort were also detected at these monitoring sites in 2013. Nine of these were detected prior to loss of monitoring equipment on July 3 (144 – 197 mm TL at release). The remaining four were detected after August 5 (91 – 158 mm TL at release). These 13 fish have not previously been detected at these monitoring sites and were exhibiting a behavior indicative of directed emigration. No juveniles released in Pinhead Creek in any year were detected at the Cub Creek/Upper Clackamas River monitoring site.

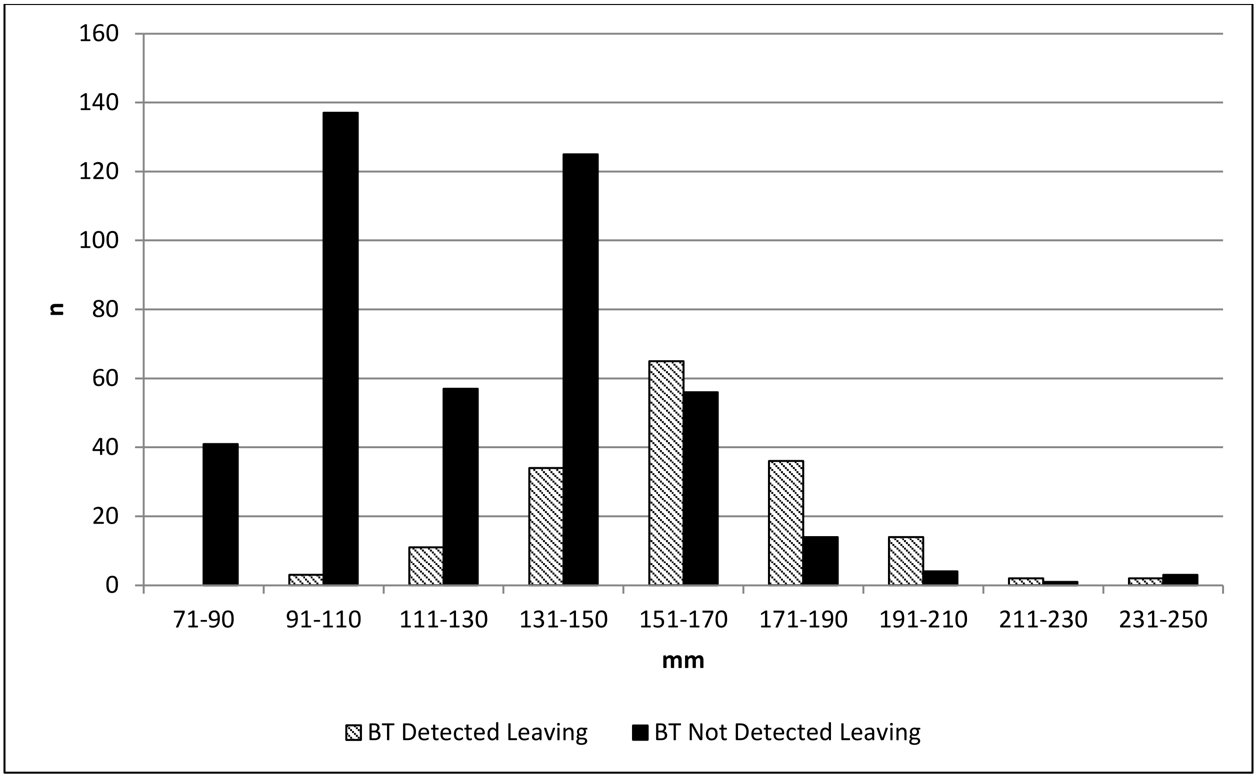

Figure 6. Total length-frequency distribution of juvenile bull trout detected leaving Pinhead Creek via PIT tag monitoring and bull trout not detected leaving.

In the summer of 2013, the Pinhead Creek patch was occupied by translocated bull trout. For the first time since the project was implemented, juvenile sampling via electrofishing resulted in the capture of two juvenile bull trout in 2013. These fish were captured in Pinhead Creek above the confluence of Last Creek in two different reaches (Reach 22 and Reach 71; Figure 7). One fish was translocated from Canyon Creek on May 24, 2012 and had grown from 104 mm to 145 mm TL. The other fish was translocated from Jack Creek on May 2, 2013 and had grown from 134 mm to 146 mm TL. The estimated naïve site-specific detection probability for Pinhead Creek was 10% based upon the capture of bull trout in 2 of the 20 reaches sampled.

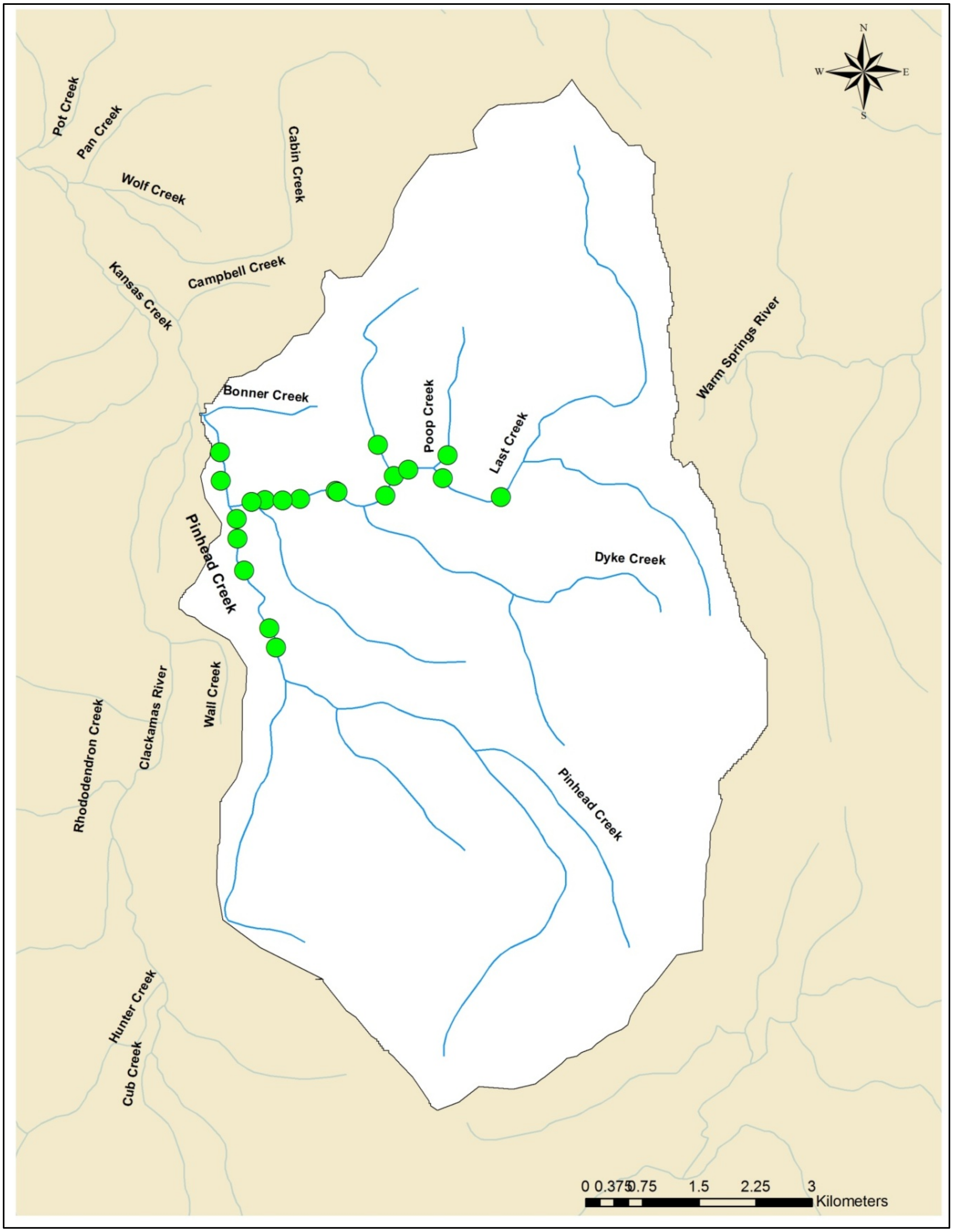

Figure 7. Sites surveyed via backpack electrofishing for the presence of outplanted juvenile bull trout.

3.2.3) Reproduction

No bull trout spawning behavior or redd construction was observed on the zero count survey on August 6, 2013, however one adult bull trout was seen and identified by a surveyor in Pinhead Creek. We observed 12 presumed bull trout redds in 2013, 9 during subsequent spawning surveys and 3 while surveying for radio tagged fish. Consistent with past years, adults were observed actively spawning in Pinhead and Last creeks in September and October. Occupancy of Pinhead by radio tagged individuals in 2013 (n =8, 3 – 45 d), was about half of that observed 2011 (n = 21) and 2012 (n = 18), but PIT interrogation revealed that six other individuals were present with either expired radio tag batteries (n = 4) or individuals that had shed their radio tags (n = 2). Additionally, adults were directly observed spawning in the upper Clackamas River upstream of the Cub Creek confluence for the first time. Adult bull trout also occupied the Oak Grove Fork (n = 4, 1 – 47 d) during the putative spawning season. A survey of this reach yielded two presumed bull trout redds. Radio tagged bull trout were also detected in Cub (n = 2, 2 – 3 d), Hunter (n = 1, 3 d), and Rhododendron (n = 4, 1 – 2 d) creeks and the Collawash River (n = 2, 9 – 42 d) during the putative spawning season, but we did not survey these areas for redds.

3.2.4) Genetics

Tissues were collected from 723 bull trout in 2013. All samples were archived at the USFWS operated Abernathy Fish Technology Center (Abernathy, Washington).

3.2.5) Impacts to listed salmon and steelhead

Three bull trout entered the HVZs in spring 2013 (April 15 – June 15) and were intermittently present for up to two days in total but without continuous occupancy. During the fall, three different individuals entered the HVZ (October 15 – December 15), with one individual exceeding the three day threshold necessitating relocation out of the HVZ. This individual was not relocated because surface ice on the reservoir prevented safe relocation of the individual. The remaining individuals were not present for more than 4 h per visit.

4) Conclusions

Monitoring and evaluation of project effectiveness relative to bull trout has revealed that recently reintroduced subadult and adult bull trout have largely remained in the Clackamas River within the study area. Of particular note, some of the subadult and adult outplants from 2011 and 2012 remained in the subbasin and migrated into Pinhead Creek more than one year after being translocated from the Metolius River, presumably to spawn. Some of these individuals were outplanted as juveniles and subadults that were not sexually mature upon release and may have reached sexual maturity in the Clackamas River Subbasin. Overall, only two subadult and adult bull trout of the 219 transferred to date have been observed emigrating from the system.

In general, estimated antenna efficiency was higher for 23 mm tag detection than for 12 mm tag detection (Table 10). While our on-site antenna detection efficiency evaluations with test tags were not done in a quantitative manner, we believe these estimated antenna efficiencies are reflective of our observations during visual checks. A more robust approach in the future combining the use of test tags and bull trout detections at the antennas may be warranted.

An estimated 33% of juvenile bull trout were detected moving downstream at the Pinhead Creek monitoring sites subsequent to translocation in 2013. This percentage is conservative as some juveniles may have suffered mortality subsequent to translocation, but prior to emigration. There could also be some unknown rate of tag loss. The size distribution of fish detected leaving versus those not detected leaving could be real or reflective of these same pre-emigration affects (e.g., post-translocation mortality, tag loss). It is unknown what the fate of these individuals was after leaving Pinhead Creek. No juveniles that were translocated in 2013 were detected at the PIT antenna array monitoring movement into Cub Creek and the upper Clackamas River upstream of the confluence with Cub Creek and none were detected at the downstream end of the study area at PIT arrays within the hydroelectric project. Two juveniles released in Pinhead Creek in 2011 were detected re-entering Pinhead creek during the spawning season in the fall of 2013, providing the first evidence of juvenile transplants being recruited into the spawning population. Furthermore, this may indicate that if there is successful bull trout natural production in the Clackamas River, the potential for recruitment of natural progeny into the spawning population exists.

The fate of most translocated juveniles is unknown. However, for the first time since the reintroduction was implemented, juvenile bull trout were captured during an electrofishing survey in Pinhead Creek, including one individual that was transferred the prior year, suggesting that at least some are remaining in this tributary to rear. A better understanding of bull trout survival in Pinhead Creek will provide insight to whether or not a resident component to the population is being established

The project’s overall likelihood of success has likely increased each year because of improvement in the survival of adults/subadults between the date of release to the start of the spawning season (67% – 98%). We have taken a number of steps to improve post-release survival including: using smaller radio tags, treatment with antibiotics, altering the release location away from areas of presumed high natural predation, and transporting fish in a low concentration of anesthetic. It is unclear which, if any of these factors contributed to the increase in post release survival; regardless, fish are surviving in higher numbers to the time of spawning.

We documented evidence suggestive of spawning in each year since implementation of the reintroduction. While the majority of spawning activity has been observed in Pinhead Creek, we documented the first evidence of spawning activity in the upper Clackamas and the Oak Grove Fork in 2013. Furthermore, we have evidence of repeat spawning (between years) and movement between the upper Clackamas and Pinhead Creek within the same spawning season. Mobile and fixed telemetry data suggest that spawning may be occurring in other areas as well. Post spawning mortality (estimated by confirmation of mortality of adults within one month after they were observed spawning) is low (2%). Not unexpectedly, no wild progeny have been captured to date. If successful spawning did occur in 2011 and/or 2012, it is possible that we have two generations of F1 wild bull trout in the Clackamas River but they would likely be in low abundance.

The effects to salmon and steelhead predation to this point can only be inferred from bull trout distribution data. There has been little bull trout residence of areas in which anadromous smolts are deemed vulnerable to predation by bull trout. Further, annual counts of outmigrating smolts and juvenile anadromous salmonids (have indicated no correlated reductions in population abundance since implementation of the reintroduction project in 2011.

The results of the annual pathogen screening suggest that there was low risk for transferring pathogens of concern to the Clackamas basin. In 2013, we repeated the 2012 pathogen screening protocols (150 fry lethally sampled, and 60 juveniles lethally sampled) because of concern for the potential negative effect of handling spawning adults. Lethal testing of the juvenile bull trout life stage was continued in lieu of non-lethal seminal and ovarian fluids collected from gravid adults. Given the healthy status of the Metolius bull trout population and the relatively high abundance of the juvenile life stage, the annual sacrifice of 60 juveniles, in addition to the 150 fry, is expected to have no measurable impact on the overall Metolius population.

The Metolius spawning population currently includes > 900 spawning individuals. However, bull trout prey base population abundance in the Metolius system (kokanee) is currently in decline. Thus, donor stock population abundance will be closely monitored as the reintroduction and donor stock collection continues.

Overall, the reintroduction effort is showing signs of potential success in reaching the project's goal. Bull trout are staying in-basin, surviving at a high rate, and spawning has now been detected in three distinct areas of the Clackamas River.

5) Acknowledgements

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Appendix 1: Fish Health Sampling for the Clackamas River Bull Trout Reintroduction Project

2013

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Introduction

The U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW) and additional partners have recently completed the second year of a reintroduction of bull trout to the Clackamas River (hereafter "Project"). A critical component of the Project is screening of bull trout to minimize risk of pathogen transmission from Metolius River donor stock to native fish populations in the Clackamas River. Pathogen screening protocols for the Project, which have been implemented since 2009, were initially developed by ODFW's Fish Health Services Division and are outlined in the USFWS's Implementation, Monitoring and Evaluation Plan (IMEP) (USFWS 2011). Prior to the 2012 field season, both agencies evaluated the pathogen screening protocol and determined that revisions to portions of the protocol were warranted. The 2012 revisions, summarized below, were developed by the USFWS and ODFW staff listed above.

The revised protocol was implemented effectively during the 2012 field season. Following the field season, technical staff from ODFW and USFWS, in addition to fish health personnel from each agency, met to discuss whether changes to the protocol for the 2013 field season were warranted. Recommendations from that meeting have been incorporated into this document and represent the protocol that will be implemented by ODFW and the USFWS in 2013. We anticipate that as long as the Project continues to translocate bull trout annually from the Deschutes Basin to the Clackamas Basin, that this protocol will be updated on an annual basis.

Background and Summary of 2012 Revisions

The original screening protocol included lethal testing of 150 fry and non-lethal testing of 60 ripe bull trout adults for ovarian fluid/milt for virus detection the fall prior to the year of transfer. While collecting the fry was a relatively easy endeavor, obtaining the 60 adult samples for testing in 2009 and 2010 proved logistically challenging and imposed risk to the Metolius bull trout population. In 2010, over 700 adults were handled as they entered spawning tributaries in order to obtain 60 fish that had gonads mature enough to express ovarian fluid or milt. Based in part on potential impacts to the population from excessive handling, overall cost of collections, and the relatively low risk from virus dissemination based on previous analysis by ODFW, a decision was made by ODFW in 2011, in consultation with the USFWS Oregon Fish and Wildlife Office, to discontinue the adult pathogen screening component of the protocols in the near-term.

In response to this decision, the Lower Columbia River Fish Health Center (LCRFHC), USFWS, developed an alternative to the adult pathogen screening component that met the intent of Fish Health Policies for ODFW and the USFWS, eliminated pre-spawning handling risks to the adult bull trout population, and reduced financial costs of the pathogen screening program (costs are being paid for by the USFWS). The pathogen screening revisions developed by LCRFHC were reviewed and supported by ODFW Fish Health Services and subsequently incorporated into the 2012 protocol.

The primary revision incorporated into the 2012 protocol involved the replacement of the adult pathogen screening component with lethal testing of the juvenile bull trout life stage. While adults are generally the preferred life stage for comprehensive pathogen testing, the juvenile life stage also represent a viable age for screening pathogens in the population and numerically is the largest life stage to be transferred to the Clackamas River during Phase One of the Project. Given the healthy status of the Metolius bull trout population and the relative abundance of the juvenile life stage, the sacrifice of 60 juveniles (70 – 250 mm) in addition to the 150 fry, on an annual basis is expected to have no measurable impact on the overall population. Staff from the LCRFHC (K. Lujan) will lead the testing and reporting on the juvenile life stage. All juvenile sampling (and the fry sampling outlined below) must be completed and negative for virus before bull trout are released in the Clackamas River. As explained in more detail below, we also developed a management decision process in the 2012 protocol to guide project actions in the case of positive test results.

In 2012, LCRFHC staff recommended quarantine of the entire bull trout cohort on clean water for two weeks until health assays were completed to account for environmental factors and because pathogen interactions may differ between tributaries and throughout the capture of juveniles. We were not able to implement this recommendation in 2012 due to space limitations and other logistics in a hatchery or other captive setting and due to potential impacts to survival probability of the cohort to be transferred. To inform project partners regarding disease concerns and potential means of minimizing risk, fish health staff will put together a one page document outlining 1) the pathogens of concern (specific to this project), 2) the current status of these pathogens in the Deschutes and Clackamas Basins, and 3) the measurable benefits of juvenile quarantine (i.e., how will quarantine increase ability to detect disease or reduce the risk (and by how much) of transferring disease inadvertently beyond what is currently implemented). Based on this document project cooperators will meet in mid/late 2013 to determine whether to attempt quarantining in 2014

Pathogen Screening of the Fry Life Stage

The 2012 revisions did not modify the screening protocol for the fry life stage. Collections of 150 bull trout fry sample will continue as stated in the original IMEP protocols (USFWS 2011): each year of transfer will continue to require the lethal testing of 150 fry in the spring, preferably with samples being obtained from more than one spawning tributary (collections from the lower mainstem Metolius will accomplish this objective). The bull trout fry life stage is the most susceptible life stage to infectious hematopoietic necrosis virus (IHNV) making it a logical choice for virus detection. The small size of fry limits testing to viruses unless DNA techniques (polymerase chain reactions, PCR) are employed to test for other pathogens. As in previous years, Rick Stocking, ODFW Fish Health Service's fish health specialist working at the Pelton-Round Butte Project, will test and report on the fry samples. All fry sampling (and juvenile sampling outlined above) must be completed and negative for virus before bull trout are released in the Clackamas River.

Proposed Numbers and Life Stages to be Transferred in 2013

During the first two years of the Project, we annually targeted for transfer 1,000 juveniles (70 – 250mm), 30 subadults (250 – 450mm), and 30 adults (450 – 650mm). In 2012, capture efficiency of adults was poor and thus we substituted thirteen subadults for adults while still targeting a total of 60 subadults and adults in combination. The following are the numbers of fish and life stages transferred during the first two years of the Project, and targeted numbers for 2013:

	2011	**2012**	**2013 (targeted)**
Juvenile	58	509	1000
Subadult	24	43	70
Adult	36	17	30

While juvenile bull trout are proposed for annual releases into the Clackamas River through the first phase of the project (seven years), continuation of the transfer of adults and subadults beyond year two of the project, and each subsequent year in Phase 1, will be assessed by the Clackamas Bull Trout Project Implementation Committee. The decision to move forward with transfers of adults and subadults in 2013 is based on 1) the older life stages of bull trout are generally remaining in the Clackamas Basin following transfer; 2) the adult life stages are showing signs of reproduction; and, 3) monitoring bull trout distribution via PIT tag and radio telemetry suggests bull trout do not occupy areas of the Clackamas Hydroelectric Project that are deemed of high vulnerability to migrating salmon and steelhead in the Clackamas River (ODFW

2012; ODFW 2013 (under development)). At the November 2012 annual meeting of the Clackamas Project Implementation Committee, we discussed monitoring results from the first two years of the project and determined there was no reason, based on the criteria above, to eliminate the transfer of older life stages to the Clackamas River in 2013.

Deschutes River Anadromous Fish Reintroductions & Associated Increase in Risk of Pathogen Transfer to the Clackamas River

Increasing risk of pathogen transmission due to the recent initiation of anadromous fish reintroductions over the Pelton-Round Butte Project in the Deschutes Basin has been a recent point of discussion among Clackamas Project technical staff and Fish Health staff from ODFW and USFWS. In light of the increasing risk, Fish Health personnel (Gutenberger & Amandi) have recommended phasing out over the next few years the use of older life stages of donor stock to minimize risk of pathogen transfer. Older life stages have been exposed to and carry more pathogens and can show clinical BKD infections. To support these fish health recommendations and to inform possible future modifications to the Project Implementation strategy, Clackamas Project technical staff, working in collaboration with Fish Health personnel, will investigate the feasibility of conducting a formal risk assessment in 2013 that would provide a comprehensive quantification of risk. In the interim, the Project implementation plan will continue to include the transfer of older life stages, including a slight increase in total numbers of older life stages in the short-term in acknowledgement that 1) fish health concerns and increasing risk over time may cause an elimination of the use of older life stages as donor stock prematurely, prior to completion of Phase One of the Project (i.e. increase transfer numbers while risk is lower); and 2) monitoring over the first two years of the project suggests preliminary success with the utilization of the older life stages and limited impacts to anadromous salmonids.

Pathogen Testing 2013

In the Spring of 2013 we will implement the existing protocol largely unchanged from the 2012 version including the lethal testing by ODFW of 150 bull trout fry from the Metolius River mainstem and lethal testing by LCRFHC of 60 juveniles collected from multiple spawning tributaries of the Metolius River. Fish health testing will include the salmonid pathogens listed in Table 2.1, (from the Handbook of Aquatic Animal Health: Protocols and Procedures, USFWS, Chapter 2.2 Sampling, 2003). Detection of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD), will be by direct fluorescent antibody test (DFAT) or enzyme-link immunosorbent assay (ELISA) with confirmation by PCR. In addition, some additional parasites of interest, such as *Ichthyophonus* and *Nucleospora salmonis* will be included in the testing. The tissues collected for pathogen testing would be: skin and gills (for external parasites), gills, spleen and kidney (for viruses and bacteria), the intestine, heart and head (for parasites).

Although quarantine of bull trout during pathogen testing was recommended again by Fish Health personnel for the 2013 field season, technical project staff determined that space limitations and other logistics associated with keeping bull trout in captivity preclude the ability to quarantine bull trout.

The USFWS also proposes to take advantage of the 2013 fishing season on Lake Billy Chinook and collect tissue samples from adult bull trout that are legally harvested in the recreational fishery that peaks in March/April/May. Staff from agencies assisting in this effort will need to ensure that mortalities/tissues are immediately put on ice (do not freeze!) bagged, dated and delivered to Fish Health personnel within 24 hours of collection [Lower Columbia River FHC, 201 Oklahoma Rd., Willard (Bingen) WA 98605]. Contact Susan Gutenberger or Ken Lujan at 509.538.2400 for Fed Ex account information. Mortalities collected at the Fish Transfer Facility at Round Butte Dam will also provide opportunities for pathogen testing. Rick Stocking, at the ODFW Pelton/Round Butte Fish Health laboratory, will examine these fish. The sample tissues and pathogens will be tested as mentioned above.

Additional Fish Health Recommendations for 2013

It is recommended that all bull trout be treated with an intraperitoneal injection of 20 mg/Kg azithromycin and 20 mg/Kg oxytetracycline during PIT tagging to help control BKD and Gram negative bacterial septicemias. Fish were not treated with oxytetracycline in 2012 due to the late start and the potential stress from two separate antibiotic injections. However the fish recovered easily and the drug is again recommended for 2013. The Metolius bull trout have a notable incidence of *R. salmoninarum,* and the azithromycin will help reduce pre-spawning mortality and vertical transmission of the bacterium to the progeny. The oxytetracycline will help control pathogens such as *Aeromonas salmonicida* and *Flavobacterium psychrophilum* that may become patent during the handling events. Prior to transfer, a one hour bath of formalin (1:6000) with supplemental aeration is recommended if more than six individual bull trout display signs of external fungus, and debilitating parasites on the skin and gills. If formalin treatment is warranted, attention will be paid to the dilution factor of the effluent to meet NPDES guidelines (and treatment will only occur if fish are held at Wizard Falls Hatchery or Round Butte Fish Isolation Facility). In addition, a disinfected PIT needle that is sharp enough to easily penetrate the skin is to be used for each fish tagged. If needles are re-used, they should be disinfected in concentrated iodophor for at least 1 minute and thoroughly rinsed with potable water.

Agency Roles and Responsibilities Associated with the Pathogen Screening Protocol

If untreatable/uncontrollable pathogens (IHNV, IPNV, VHSV, OMV, ISAV, or *M. cerebralis)* are detected in any life stage, the LCRFHC and/or ODFW Fish Health Services will present a written health report and risk assessment to the Clackamas Manager's Committee for review and deliberation. During the interim period between a “stop transfer” recommendation from pathology and the Clackamas Manager’s Committee review, no fish will be transferred to the Clackamas River until a decision has been made as to how to proceed.

Through 2011, ODFW’s Fish Health Services led the effort to implement the pathogen screening protocols for the Project. As agreed to by ODFW in February 2012, the USFWS (Lower Columbia River Fish Health Center) was responsible for the lab testing and reporting for bull trout juveniles and adults, the supply of antibiotics and training in their use, and some of the collection of samples in the field in 2012. ODFW will continue in 2013 to test the fry and report their findings to the LCRFHC and members of the Project’s Implementation Committee and LCRFHC will continue to provide a similar level of support as in 2012.

D. Sample Number

Unless otherwise dictated by the receiving jurisdiction, the number of fish to be collected from each lot must be in accordance with a plan that provides 95% confidence that at least one infected fish will be collected if the minimum assumed pathogen prevalence level (APPL) of infection equals or exceeds 5%. Examples of the number of fish to sample for various population sizes are listed in Table 2.3. Table 2.3 also includes examples of the number of fish to sample if a 2% or 10% APPL is required by the requesting authority. If the population size is estimated to be between two grouping levels, the sample is taken from the next higher population class (Amos 1985; OIE 2000; Ossiander and Wedemeyer 1973; Thoesen 1994).

Table 2.3. Sample number based on an assumed pathogen prevalence level (APPL) in the population of 10%, 5 %, or 2%.

Lot Size	Number of Fish Required for Sample		
(number of fish)	10% APPL	5% APPL	2% APPL
50	20	35	50
100	23	45	75
250	25	50	110
500	26	55	130
2000	27	60	145
>100,000	30	60	150

Revision 2, 9/2003

From the Handbook of Aquatic Animal Health: Protocols and Procedures, USFWS, Chapter 2.2 Sampling. 2003

Oregon Department of Fish and Wildlife
U.S. Fish and Wildlife Service

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